

# PROCEEDINGS

## 13<sup>th</sup> WORLD CONGRESS OF THE RSAI

Virtual Conference  
MAY 25-28  
**2021**

**SMART REGIONS  
- Opportunities for  
sustainable development  
in the digital era**

**ISBN 978-989-54216-1-9**



**RSAI**  
REGIONAL SCIENCE ASSOCIATION INTERNATIONAL





# *Welcome to the 13<sup>th</sup> RSAI Congress 25-28 May 2021*

**RSAI wish you a pleasant and inspiring participation!**

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## Welcome to the 13th World Congress of the RSAI

Dear Friends and Colleagues,

It is our pleasure to welcome you to the 2021 RSAI World Conference! On behalf of the Regional Science Association International, the Local Organizing Committee, and the Scientific Committee, we would like to thank you for joining us at this historical meeting, and for sharing your experience, research and views with all the participants.

Organized by the Moroccan Section of the RSAI, the 2021 RSAI World Conference is intended to be a major international forum for researchers and policy-makers in the field of Regional Science across the world, focusing on today's most challenging issues. The World Conference brings together more than 500 participants from 53 different countries. The papers cover all major areas of the field, with applications for a wide range of regions in the globe.

Since we have decided that the congress would run 100% online, many colleagues from the Association have joined us in an extraordinary effort to organize a high standard, inclusive, online event. Recognizing the key role played by former RSAI President, Mark Partridge, we would like to extend our sincere gratitude and appreciation for the hard work and dedication provided by all of them.

Going online has shown to bring us some opportunities. We have contacted every single national section and invited them to propose special sessions dedicated to their countries/regions. We have received positive responses from almost all sections. This is really invigorating and motivating, further developing the sense of community belongingness that may motivate a larger number of young regional scientists to engage more broadly in the Association. We now have the opportunity to have a truly global conference, with the participation of many of RSAI sections!

This World Conference is a unique opportunity to showcase some of the exceptional work regional scientists are doing all over the world. There are 35 slots dedicated to 25 national sections, in addition to an even larger number of parallel sessions, and five outstanding keynote speakers.

Going online also made possible a wider participation across the world, allowing us to minimize the number of competing sessions, to allocate time slots with time zones in mind, and to reduce drastically registration fees.

We are pleased you were able to join us, and we wish you an excellent and memorable conference! Your participation and commitment to RSAI are very important and truly appreciated. In the next days, you will all have the opportunity to grab a big picture of our Association, being exposed to different topics and approaches people are using across the world.

Please receive our warmest welcome!



**Eduardo Haddad**  
*President,  
Regional Science Association  
International*



**Abdellatif Khattabi**  
*Chair, Local Organising Committee  
President, Moroccan Regional  
Science Association*



**Andrea Caragliu**  
*Executive Director,  
Regional Science Association  
International*

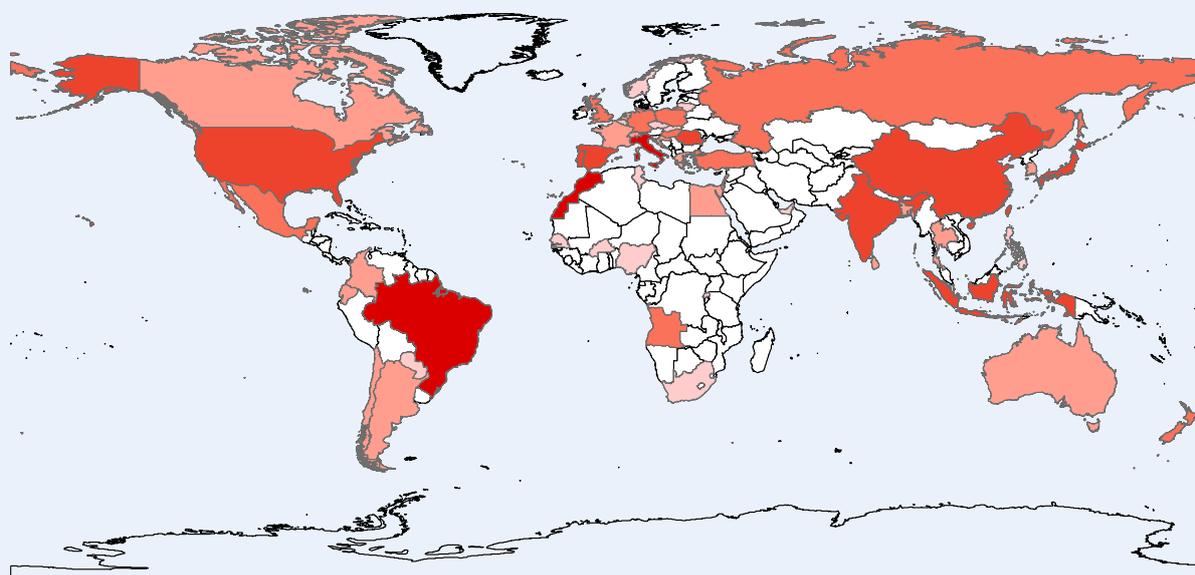
## A truly World Congress

On behalf of the Moroccan Regional Science Association (AMSR) and the Regional Science Association International (RSAI), it is our pleasure to welcome you all to the 13th World Congress of the RSAI.

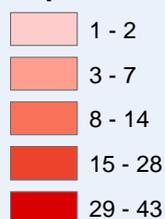
This last year has brought well known troubles to the whole world. At the time we are writing these words, the worst pandemic in over a century is still exerting a major toll on our every lives, among which the need to resort to online scientific events such as the one we are joining between May 25 and 28, 2021.

Yet, the RSAI took this as an opportunity to further broaden the geographical and disciplinary scope of our main global gathering. The map below shows the broad coverage of participants in this RSAI World Congress, as evidenced by the 53 Countries included in the program (proxied by Country of the institution of affiliation of the first author).

While older supranational sections (NARSC and ERSA) are as usual largely represented, we are very happy to report an important presence of PRSCO and LARSA national sections, too. Moreover, and this is among the main goals of this edition of the World Congress, we witnessed a positive feedback from many regional scientists located in African Countries where no national section of the RSAI is to date present. We hope this congress will sow seeds for the creation of new national sections, with the fundamental help of AMSR, presently the only national section active on the Continent. In the medium run, hopefully a new supranational section will emerge, including all such new sections, while also coordinating their activities.



**Papers accepted to the 2021 RSAI World Congress**



The RSAI World Congress is also a place of strong networking. In the next map, the intensity of co-participation for authors presenting papers accepted to regular sessions of the congress is represented with blue lines, with increasing thickness showing more frequent interactions of presenters sharing the same sessions. Blue lines cross all oceans and suggest a high propensity of exchange of ideas among regional scientists all over the world.

The last map shows with green lines that an analogous message comes from interaction of authors presenting papers accepted in special sessions during the World Conference. The geography of interactions appears relatively different, with thicker lines connecting North America and Europe, and between China and South Asia.



Beyond the pre-existing networks, we wish this Congress to be an opportunity for all of you (us!) to open new nodes, and further diffuse our discipline.

Have a safe, interesting, and productive Congress!

The RSAI World Congress Organizing Committee

## Programme Overview

Tuesday, May 25, 2021	Wednesday, May 26, 2021	Thursday, May 27, 2021	Friday, May 28, 2021
			Session New Zealand 1 [05:30-07:00]
<b>OPENING CEREMONY</b> [08:30-09:00]			<b>INTERVAL</b> [07:00-09:00]
PLENARY SESSION I Keynote speech: <b>Tawfik Mouline</b> [09:00-09:30]			Session New Zealand 2 [9:00-10:30]
Parallel sessions 1 [09:30-10:45]	Parallel sessions 6 [09:30-10:45]	Parallel sessions 11 [09:30-10:45]	Parallel sessions 16 [09:30-10:45]
<b>INTERVAL</b> [10:45-11:00]	<b>INTERVAL</b> [10:45-11:00]	<b>INTERVAL</b> [10:45-11:00]	<b>INTERVAL</b> [10:45-11:00]
Parallel sessions 2 [11:00-12:15]	Parallel sessions 7 [11:00-12:15]	Parallel sessions 12 [11:00-12:15]	Parallel sessions 17 [11:00-12:15]
<b>LUNCH BREAK</b> [12:15-13:15]	<b>LUNCH BREAK</b> [12:15-13:15]	<b>LUNCH BREAK</b> [12:15-13:15]	<b>LUNCH BREAK</b> [12:15-13:15]
Parallel sessions 3 [13:15-14:30]	Parallel sessions 8 [13:15-14:30]	Parallel sessions 13 [13:15-14:30]	Parallel sessions 18 [13:15-14:30]
<b>INTERVAL</b> [14:30-14:45]	<b>INTERVAL</b> [14:30-14:45]	<b>INTERVAL</b> [14:30-14:45]	<b>INTERVAL</b> [14:30-14:45]
PLENARY SESSION II Keynote speech: <b>Edward Glaeser</b> [14:45-15:45]	PLENARY SESSION III Keynote speech: <b>Siqi Zheng</b> [14:45-15:45]	PLENARY SESSION IV Keynote speech: <b>Isabelle Thomas</b> [14:45-15:45]	PLENARY SESSION V Keynote speech: <b>Alessandra Faggian</b> [14:45-15:45]
<b>INTERVAL</b> [15:45-16:00]	<b>INTERVAL</b> [15:45-16:00]	<b>INTERVAL</b> [15:45-16:00]	<b>CLOSING CEREMONY</b> [15:45-17:15]
Parallel sessions 4 [16:00-17:15]	Parallel sessions 9 [16:00-17:15]	Parallel sessions 14 [16:00-17:15]	
<b>INTERVAL</b> [17:15-17:30]	<b>INTERVAL</b> [17:15-17:30]	<b>INTERVAL</b> [17:15-17:30]	
Parallel sessions 5 [17:30-18:45]	Parallel sessions 10 [17:30-18:45]	Parallel sessions 15 [17:30-18:45]	

**NOTE: all hours in time zone (GMT+1). Please adjust your time schedule by comparing your current time with the one reported at the following link: <https://time.is/GMT+1>.**

## Overview Parallel Sessions

Tuesday, May 25, 2021							
ROOM	FIPE	NEREUS	Casablanca	Marrakech	Agadir	Fes	Essaouira
09:30-10:45 Parallel sessions 1	SS08	SS51.1	RS01.1	RS02.1	RS03.1	RS12.1	SS18.1
11:00-12:15 Parallel sessions 2	SS16.1	SS48B.1	RS07.1	RS08.1	RS21.1	RS10.1	SS18.2
13:15-14.30 Parallel sessions 3	SS43	RS14.4	R16.1	RS18.1	RS10.2	RS02.7	SS12.1
16:00-17:15 Parallel sessions 4	SS55.1	SS56.1	RS15.1	RS14.1	RS06.1	RS09.1	SS12.2
17:30-18:45 Parallel sessions 5	SS56.2	SS45.1	RS02.2	RS04	RS05	RS10.3	SS10

Wednesday, May 26, 2021								
ROOM	FIPE	NEREUS	Casablanca	Marrakech	Agadir	Fes	Essaouira	Lagouira
09:30-10:45 Parallel sessions 6	SS57	SS51.2	RS02.3	RS11.1	RS19.1	RS09.2	SS18.3	SS27
11:00-12:15 Parallel sessions 7	SS16.2	SS48B.2	RS03.2	RS15.2	RS14.2	RS10.4	SS18.4	SS28
13:15-14.30 Parallel sessions 8	SS44	SS64	RS07.2	RS18.2	RS12.3	RS17.2	SS19.1	SS33
16:00-17:15 Parallel sessions 9	SS55.2	SS58.1	RS06.2	RS21.2	RS09.3	RS10.5	SS19.2	SS23
17:30-18:45 Parallel sessions 10	SS46	SS45.2	RS02.4	R16.2	RS18.4	RS10.6	SS01	SS38.1

Thursday, May 27, 2021							
ROOM	FIPE	NEREUS	Casablanca	Marrakech	Agadir	Fes	Essaouira
09:30-10:45 Parallel sessions 11	SS52	SS51.3	RS02.6	RS20	RS18.3	RS10.7	SS18.5
11:00-12:15 Parallel sessions 12	SS22	SS53	RS02.5	RS15.3	RS06.3	RS09.4	SS18.6
13:15-14.30 Parallel sessions 13	SS60	SS38.2	RS03.3	SS17.1	RS21.3	RS11.2	SS40.1
16:00-17:15 Parallel sessions 14	SS54	SS58.2	RS22	RS19.2	RS08.2	RS12.5	SS40.2
17:30-18:45 Parallel sessions 15	SS63	SS61	RS01.2	RS07.3	RS17.1	RS11.3	SS24

Friday, May 28, 2021								
ROOM	FIPE	NEREUS	Casablanca	Marrakech	Agadir	Fes	Essaouira	Lagouira
								SS42.1 (05:30-07:00)
09:30-10:45 Parallel sessions 16	SS31	SS51.4	RS14.3	PCNS	RS09.5	RS10.9	SS36	SS42.2 (09:00-10:30)
11:00-12:15 Parallel sessions 17	SS59	SS62	RS10.8	RS03.4	SS49	RS12.4	SS29	SS48A
13:15-14.30 Parallel sessions 18	SS41	SS65	RS03.5	RS13	RS01.3	SS17.2	SS09	RS15.4

## Instructions to Chairs, Presenters, and Discussants

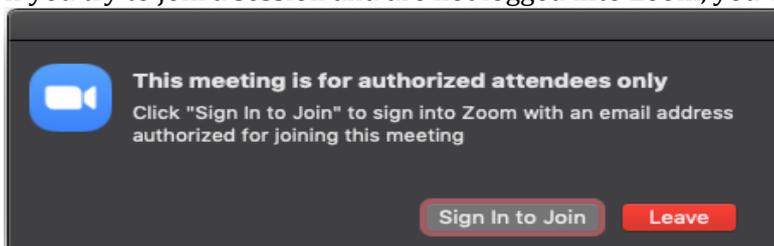
1. Sessions are will last 1 hour and 15 minutes. Please stick to the times shown in the program. Each presentation is assigned a specific time, all expressed in the GMT+1 zone (please be sure and check how this translates into your own time zone). If you have a no-show, use the time for a discussion of the proceeding paper(s) or for a recess. Please do not shift papers to fill voids, as individuals may want to attend a particular paper.
2. The majority of sessions have 3 papers. In 3 paper sessions, each presenter is allowed 18 minutes for presentation, followed by a 5 minutes discussion. In 4 papers session, each presenter is allocated 15 minutes, followed by 3 minutes discussion. In the few 5 paper sessions, each paper should be allocated 12 minutes, with about 10 minutes at the end of the session for generic questions.
3. Hold each individual to the time available. If a speaker continues after time has expired, please let her/him know that time has expired. The audience and the other speakers will respect and support your decision.
4. Because of the limited time available, the conference assumes no formal discussion to follow presentations. However, Chairs of each session are free to organize their sessions as refereed ones, i.e. sessions where papers are assigned a discussant. In this case, Session chairs are asked to please get in touch as soon as possible with the Authors of the papers of their sessions to verify their availability to have a discussant assigned to their papers.
5. The discussant, if any, should provide a 3-minute discussion of the paper's main merits and limitations, possibly suggesting ways to address them for future reference.
6. In case the session is refereed, please adjust presentation times accordingly so as to leave room for all presenters and related discussants.

## Zoom Requirements

For the meeting this year, the 2021 RSAI World Congress will restrict meeting participants to logged-in users only. This means that you must be logged in to Zoom to attend any of the sessions.

If you do not have a Zoom account, you will not be able to join the meeting.

If you try to join a session and are not logged into Zoom, you will receive the following messages:



Click on the **Sign In to Join** button. If you already have an account, log in to Zoom. If you do not have an account, you may sign up at this time.

Having a Zoom account allows you to create your own Instant Meetings or Schedule Meetings. An account also allows you to access your personal settings, where you can update your profile or upgrade your plan at any time.

### How do I sign up for Zoom?

You can sign up for a free Zoom account at [zoom.us/signup](https://zoom.us/signup).

### How much does Zoom cost?

A basic Zoom license is free.

## Issues with logging in?

For any issue when logging in, you may write to the following email addresses, where specialized staff will assist you in the procedure:

Virtual room name	Email address
<b>FIPE</b>	<a href="mailto:RSAI.FIPE@gmail.com">RSAI.FIPE@gmail.com</a>
<b>NEREUS</b>	<a href="mailto:RSAI.NEREUS@gmail.com">RSAI.NEREUS@gmail.com</a>
<b>Lagouira</b>	<a href="mailto:RSAI.Lagouira@gmail.com">RSAI.Lagouira@gmail.com</a>
<b>Essaouira</b>	<a href="mailto:RSAI.Essaouira@gmail.com">RSAI.Essaouira@gmail.com</a>
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## Themes

### Umbrella Theme

#### *Smart Regions – Opportunities for sustainable development in the digital era*

The themes which will zoom in particular on the pressing challenges of meeting the 2030 Agenda of Sustainable Development Goals, in both developed and developing economies. As a new challenge to regional science research is caused by the emerging digital technologies and their implications for analysis, monitoring, evaluation and forecasting of spatial dynamics at all levels, the theme chosen for the congress is ‘Smart Regions- Opportunities for Sustainable Development in the Digital Era’. Therefore, the potential of spatial and temporal big data, machine learning, artificial intelligence, social media information, and of the new spatial maps emerging from digitization and robotization will be addressed by the congress as well, as these forces will have far-reaching impacts on human behaviour and interaction in space.

### General Themes

RS01 - Entrepreneurship  
 RS02 - Infrastructure, transportation and accessibility  
 RS03 - Knowledge and innovation  
 RS04 - Local finance  
 RS05 - Location theory and applications  
 RS06 - Methods in Regional Science and Urban Economics  
 RS07 - Migration and regional labor markets  
 RS08 - Real estate and housing  
 RS09 - Regional and urban policy  
 RS10 - Regional development  
 RS11 - Rural development  
 RS12 - Spatial implications of climate and environmental change

RS13 - Spatial planning  
 RS14 - The spatial dimension of sustainable development  
 RS15 - Theoretical and empirical urban economics  
 RS16 - Tourism  
 RS17 - Globalization and territorial intelligence  
 RS18 - Resilience and Risk Management  
 RS19 - Green economy and complexity of socio-ecosystems  
 RS20 - Biodiversity, ecosystems and ecosystem services  
 RS21 - Agriculture, fisheries and food security  
 RS22 - Nexus: water, agriculture and energy

### Special Sessions’ Themes

SS01 - Alternatives for integrating development with infrastructure provision in the global South  
 Manisha Jain and Jörg Knieling  
 SS08 - Subjective well-being and spatial inequalities  
 Camilla Lenzi and Giovanni Perucca  
 SS09 - Regional, national and supranational identities: determinants and policy implications  
 Enrique López Bazo and Giovanni Perucca  
 SS10 - Regions and cities at the edge of the new technological era  
 Roberta Capello and Camilla Lenzi  
 SS12 - SMEs/Family Businesses and Regional Development  
 Lech Suwala, Rodrigo Basco and Stefano Amato  
 SS16 - Smart, sustainable, resilient regions: Responses to pandemic challenges - Contributions of the Romanian Scholars  
 Daniela L. Constantin and Cristina Serbanica  
 SS17 - Data science, machine learning and big data for regional Sciences  
 Jean-Claude Thill, Hicham Mharzi Alaoui, Said Lahssini and Hicham Hajji  
 SS18 - Urban Future in the Global South  
 Abdul Shaban and Tomaz Ponce Dentinho

SS19 - The spatial dimension of energy transition policies, practices and technologies  
 Andrea Caragliu and Marcello Graziano  
 SS22 - Regional Disparities in the EU and Hungary in the Age of Digitalization and the Pandemic  
 Zoltán Gál  
 SS23 - Understanding the role of Renewable Energy in the Water, Agriculture, Energy Nexus in West and North Africa  
 Mariama Camara and Mary Thompson-Hall  
 SS24 - Education inequality and Economic development: a regional perspective  
 Amaghous Jabrane and Ibourk Aomar  
 SS27 - Discontent, Hate & Intolerant Attitudes  
 Alessandra Michelangeli, Alessandra Faggian and Daria Denti  
 SS28 - Smart Actors for Smart Regions  
 Chiara Tagliaro and Gianandrea Ciaramella.  
 SS29 - Strengthening the resilience of socio-ecological systems  
 Sumana Bandyopadhyay, Lakshmi Sivamakrishnan, Tomas Ponce Dentinho and Said Lahssini  
 SS31 - Regional Economic Development in Asia  
 Yuri Mansury and Budy Resosudarmo

SS33 - Plastic pollution and its environmental impact

Abdellatif Khattabi and Diane Pruneau

SS36 - Glocalization and Regional Development

Hideki Fukui and Shinya Ishizaka

SS38 - Resilience and peripheral areas: development patterns and policies in the borderlines

Karima Kourtit, Gabriela Carmen Pascariu, Ramona Tiganasu and Loredana Maria Simionov

SS40 - The productivity gap and the re-launch of productivity in Europe

Roberta Capello and Silvia Cerisola

SS41 - Regional perspective of the different global crisis for small countries in 21 century – case study of Croatia

Vinko Mustra

SS42 - Regional and urban resilience in a turbulent world: perspectives from Aotearoa New Zealand

Philip Morrison and Jacques Poot

SS43 - Advances in Regional Science: Contributions of Italian Scholars

Roberta Capello

SS44 - Mapping Co-Working Spaces: Spatial Patterns and Location Factors

Tüzin Baycan, Grzegorz Micek and Anastasia Sinitsyna

SS45 - Selected regional science topics in Mexico

Serena Eréndira Serrano Oswald

SS46 - Poverty and Local Economy Development in Ecuador

Fabian Vilema

SS47 - Regional Development in Sub-Saharan Africa

Tomaz Ponce Dentinho

SS48A - Arctic regions: economic, climate and epidemiologic challenges

Alexander Pilyasov

SS48B - Regional Science in Russia

Alexander Pilyasov

SS49 - Sharing Economy and Urban Sustainability in Thailand

Sutee Anantsuksomsri and Nij Tontisirin

SS51 - Sustainable Regional Development in China

Ling Xue and Jian Wang

SS52 - Regional Science in Lebanon

Nadim Farajalla and Lina Maddah Souheil

SS53 - Regional Science in Egypt

Michael L. Lahr

SS54 - Regional Science in Paraguay

Eduardo A. Haddad

SS55 - Regional Science in Angola

Tomaz Ponce Dentinho

SS56 - The Colombian Economy and its Regional Structural Challenges

Jaime Bonet

SS57 - Regional Science in Bangladesh

Md. Musleh Uddin Hasan

SS58 - Argentinean social and economic challenges

Pedro Luis Elosegui

SS59 - Labour mobility and regional development

Annekatrien Niebuhr

SS60 - Greek Regional Science

Yannis Psycharis

SS61 - Brazil Regional Science

Terciane Sabadini

SS62 - Moroccan Regional Science

Abdellatif Khattabi

SS63 - Chilean Regional Science

Yasna Cortés Garriga

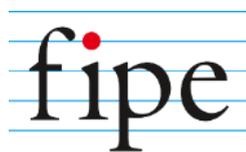
SS64 - Portuguese Regional Science

Francisco Carballo-Cruz

SS65 - Urban Neighborhoods: Accessibility, Segregation, and Neighborhood Change

Neil Reid

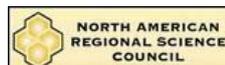
## Conference Collaborators



Fundação Instituto de Pesquisas Econômicas



MOHAMMED VI  
POLYTECHNIC  
UNIVERSITY



## Organizing Committee

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**President, RSAI:** Eduardo Haddad

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Said Hajib, Centre National de Recherche Forestière, Rabat

Said Lahssini, Ecole Nationale Forestière d'Ingénieurs, Salé

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Elisabete Martins

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 Kieran Donaghy, Cornell University  
 Kingsley Haynes, George Mason University  
 Lahssini Said, Ecole Nationale Forestière d'Ingénieurs  
 Laurie Schintler, George Mason University  
 Leila Kebir, University of Lausanne  
 Lily Kiminami, Niigata University  
 Loubna El Mansouri, Institut Agronomique et Vétérinaire Hassan II  
 Manfred Fischer, Vienna University of Economics  
 Mark Partridge, Ohio State University  
 Marlon Boarnet, University of Southern California  
 Mohamed Sinane, Ecole Nationale Hassania des Travaux Publics  
 Mohamed Wakrim, AMSR  
 Mostafa Lamrani Alaoui, Ecole Nationale Forestière d'Ingénieurs  
 Neil Reid, University of Toledo  
 Nouzha Chekrouni, University of Meknes  
 Oumahani Eddelani, Université Sidi Med Ben Abdallah, Fes  
 Patricio Aroca, University Adolfo Ibáñez  
 Paul Snow, Peking University  
 Peter Batey, University of Liverpool  
 Peter Nijkamp, Open University, Heerlen  
 Philip Mc Cann, Sheffield University  
 Rachida El Morabet, Faculté des Lettres et des Sciences Humaines de Mohammedia  
 Roberta Capello, Politecnico di Milano  
 Rudiger Ahrend, OECD  
 Said Hajib, Centre National de Recherche Forestière  
 Serena Eréndira Serrano Oswald, National Autonomous University of Mexico  
 Siqi Zheng, MIT  
 Sumona Banerjee, University of Calcutta  
 Terry Clower, George Mason University  
 Tomaz Dentinho, University of the Azores  
 Uwe Blien, Otto-Friedrich-University Bamberg  
 Vincente Royuela, University of Barcelona  
 Yacoubi Khebiza Mohamed, Université Cadi Ayyad Marrakech  
 Yoshiro Higano, University of Tsukuba

# Day by day programme

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**Presenting authors are underlined**

**All hours in time zone (GMT+1)**

**Please adjust your time schedule by comparing your current time with the one reported at the following link: <https://time.is/GMT+1>**

# Monday, 24 May 2021

## ADVANCED BRAINSTORM CARREFOUR (ABC)

09:25 - 17:40 GMT+1, Monday, 24th May, 2021

### Urban Empires - Cities as Global Rulers in the *New Urban World*

Room: Marrakech

<https://us02web.zoom.us/j/83917560314>

Organizers book editors: Edward Glaeser, Peter Nijkamp and Karima Kourtit (eds.)

*The Regional Science Academy*



#### Aims and Scope of ABC

We live in the 'urban century'. Cities all over the world – in both developing and developed countries – display complex evolutionary patterns. A recently published study, *Urban Empires*, charts the backgrounds, mechanisms, drivers, and consequences of these radical changes in our contemporary systems from a global perspective and analyses the dominant position of modern cities in the 'New Urban World'.

In this session, various contributors of the above mentioned publication will present and discuss the drastic change cities have undergone internationally from a broad perspective, and consider their emerging roles in our global network society. Contributions from renowned scholars provide advanced analytical contributions, the spatial scaling applied and theoretical perspectives on the competitive profile of urban agglomerations in a globalizing world. The works that will be presented trace and investigate the economic and political drivers of network cities in a global context, and explores the unprecedented challenges over governance that are presented by mega-cities. These also identify and map out the new geography of the emergent 'urban century'.

With contributions from well-known and influential scholars from around the world, *Urban Empires* session serves as a touchstone for students and researchers keen to explore the scientific and policy needs of cities, as they become our age's global power centers.

**09:25 – 09:30 | Welcome**

**Peter Batey**

President, *The Regional Science Academy* (TRSA)

**09:30 - 11:00**

**Chair: Peter BATEY**

- 1) **Do Urban Empires Rule the World? An Introduction**  
Edward GLAESER, Karima KOURTIT and Peter NIJKAMP
- 2) **Measuring the unmeasurable: The empirics of non-geographical proximity**  
Andrea CARAGLIU
- 3) **A Scientific Program on Urban Performance and Dynamics**  
Roberto CAMAGNI, Roberta CAPELLO and Andrea CARAGLIU

**11:00 - 11:30 | Break**

**11:30 - 13:00**

**Chair: Andrea CARAGLIU**

- 4) **Defining City Size and Growth**  
Michael BATTY
- 5) **In Pursuit of High-Performance Global Cities - An Extended Dea Model: For Assessing Urban Socio- Economic and Environmental Indicators**  
Soushi SUZUKI, Karima KOURTIT and Peter NIJKAMP
- 6) **Metropolitan Cities: Which Development Strategies? Which New Perspectives For Improving Productivity? Which Governance Tools?**  
Luigi FUSCO GIRARD

**13:00 - 13:30 | Break**

**13:30 - 15:00**

**Chair: Abdellatif KHATTABI**

- 7) **Seoul as an Urban Empire: Evidence from Spatial Interaction Models**  
John CARRUTHERS and Su-Jung LEE
- 8) **The Changing Industrial Organization of American Megaregions**  
Harrison S. CAMPBELL, Isabelle NILSSON and Neil REID
- 9) **The Analysis of Big Data on Cites and Regions - Some Computational and Statistical Challenges**  
Laurie SCHINTLER and Manfred FISCHER

**15:00 - 15:30 | Break**

**15:30 - 17:30**

**Chair: Laurie SCHINTLER**

- 10) **The Public Expenditure Impact on Urban Population Growth**  
Steven CRAIG and Janet KOHLHASE
- 11) **Resilience to a Cyber-Attack on the Detroit Automobile Industry: A Computable General Equilibrium Approach**  
Adam ROSE and Zhenhua CHEN
- 12) **Material Flows in the Global City**  
Genevieve GIULIANO, Sanggyun KANG, Nathan HUTSON and Quan YUAN
- 13) **The "New Urban World": Challenges for Large Urban Agglomerations**  
Eduardo HADDAD and Ana BARUFI

**17:30 - 17:40 | Conclusion**

**Karima KOURTIT**

**Tuesday, 25 May 2021**

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## OPENING CEREMONY

08:30 - 09:00 Tuesday, 25th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/87868893044>

### Welcome Speeches



**Eduardo Haddad**  
President, Regional Science  
Association International



**Abdellatif Khattabi**  
Chair, Local Organising Committee  
President, Moroccan Regional  
Science Association



**Andrea Caragliu**  
Executive Director, Regional  
Science Association International



**Neil Reid**  
NARSC Executive Director



**André Torre**  
ERSA President



**Rachel S. Franklin**  
PRSCO President



**Serena S. Oswald**  
LARSA President

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## PLENARY SESSION I

09:00 - 09:30 Tuesday, 25th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/87868893044>

### Keynote Speech



*Towards a new post-COVID-19 world*

**Mr . M. Tawfik Mouline**

General Director Royal Institute for Strategic Studies, Morocco

**Chair André Torre**, University Paris Saclay, INRAE, France

**Discussant Karima Kourtit**, Open University, Heerlen, Netherlands

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# PARALLEL SESSIONS (1)

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## **Special Session: SS08 - Subjective well-being and spatial inequalities**

**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/87320775891>**

**Chair Camilla Lenzi**

## SUBJECTIVE WELL-BEING, INEQUALITIES AND THE GEOGRAPHY OF DISCONTENT IN EUROPEAN REGIONS

Giovanni Perucca, Camilla Lenzi

Politecnico di Milano, Italy

### ABSTRACT

The rise of a geography of discontent in the European Union (EU) documented in recent studies highlights a strong spatial association between discontent, regional economic decline and poor occupational opportunities, suggesting that economic disparities within the EU are at the origin of some of the most recent and shocking political events as Brexit. This paper re-examines this statement by disentangling the effect on discontent of different socioeconomic disadvantage conditions at the interregional, intraregional and individual levels. Making use of a large dataset on the discontent perceived by more than 760,000 EU citizens between 2013 and 2018, our analysis confirms that a geography of discontent exists across EU regions. Nevertheless, our findings also highlight that intraregional disparities matter more for discontent and individual socioeconomic disadvantage conditions amplify further this negative effect.

## EVALUATING THE POPULATION' SPATIAL ACCESSIBILITY TO PRIMARY HEALTH CARE UNITS

**[Diana F. Lopes](#)<sup>1</sup>, [João L. Marques](#)<sup>1</sup>, [Ana L. Ramos](#)<sup>2</sup>, [Eduardo A. Castro](#)<sup>1</sup>**

<sup>1</sup>GOVCOPP, DCSPT, University of Aveiro, Portugal. <sup>2</sup>GOVCOPP, DEGEIT, University of Aveiro, Portugal

### ABSTRACT

Primary Health Care (PHC) is a key component of the Portuguese health system, representing the population's first contact level with the National Health Service. Understanding geographical imbalances in the spatial planning of the PHC is essential to reach a proper distribution that will culminate in a most effective prevention of disease progression on a large scale.

Within this context, it is critical to have a correct identification of the spatial accessibility to the primary health care units and having tools to assist analysing how to mitigate spatial inequalities. Previous studies have greatly improved our understanding of the role played by geographic distribution of health services in population health maintenance, with extensive research being devoted to the place-based accessibility theory, with special focus on the gravity-based methods (including the two-step floating catchment area (2SFCA) method).

Although they represent a good starting point to analyse disparities across different regions, the results are not intelligible for policy-making purposes. Given the weaknesses of these methods and the multidimensional nature of the topic, this study intends to: (i) highlight the main concepts and measurements of access; and (ii) exploit and propose a framework based on multiple criteria decision analysis methods and Geographic Information Systems to evaluate the population' spatial accessibility to healthcare facilities.

Regarding the latter, within the scope of the DRIVIT-UP project – DRIVIng forces of urban Transformation: assessing pUblic Policies – this study proposes a sociotechnical approach based on the UTASTAR model to build an index to evaluate the population' spatial accessibility to the Portuguese PHC units.

The starting point was to link scientific with policy-based evidence to properly define and structure the multidimensional spatial accessibility index, which unfolds in the dimensions of proximity and availability. The proximity assessment considers the travel time of individuals to the PHC units, and the mobility of populations when accessing healthcare. The availability dimension involves the coverage of PHC network in terms of human resources in health (general practitioners and nurses).

Respecting that multidimensional structure, the technical component of the proposed approach encompasses the adoption of a variant of the UTASTAR-based method, which will be able to model preferences provided by policy-makers and experts, grounded in different socioeconomic scenarios. The process of gathering the viewpoints and preferences of policy-makers and experts about spatial accessibility to PHC units constitutes the social component.

Given the current pandemic context and the limited availability of policy-makers and experts involved in this study, i.e. health administrators and health professionals, that are the frontline soldiers against COVID-19, the proposed socio-technical approach was thoroughly conceived, through the design of an interface that allows individuals to interact and emit their preferences, in a user-friendly fashion way. Also, a reduced number of judgments is required from the policy-makers and experts to avoid the risk of triggering rejection by them, without compromising the model accuracy and quality. The proposed methodology will be later applied to build an index to evaluate the population' spatial accessibility to the Portuguese PHC units.

## KING LEOPOLD'S SKELETON: THE AFTEREFFECTS OF COLONIALISM ON URBAN FORM AND SPATIAL INEQUALITY IN KINSHASA, DRC

[Nathan Hutson](#), [Wise Lubanda](#)

University of North Texas, USA

### ABSTRACT

Research Idea and Approach- Kinshasa (former Leopoldville) was originally established by the Belgians for the purpose of efficiently transporting ivory and rubber back to the mother country. The urban form of the city created a spatially-determined social stratification with a small riverfront core of Gombe surrounded by a vast unplanned network of alleys and self-constructed homes housing the vast majority of the native population. Kinshasa emerged as the DRC's primate city and sole administrative center, despite its location at the far periphery of the country. The city thereby replicates spatial inequality at both the national and local level. This dichotomy is apparent in modern day Kinshasa as the historic area of Gombe is well kept with a street grid similar to that one might find in a European city featuring palatial buildings and a large golf course. Ordinary Congolese are physically and culturally separated from Gombe yet continue to view it as the symbol of success. Many of the DRC's new elite now occupy homes and spaces vacated by Belgians. This paper aims to document the ways in which Kinshasa's colonial urban form has influenced post-colonial social development in order to determine the extent to which urban form perpetuates social stratification. Methodology- The paper relies on interviews conducted with current Gombe residents, Kinshasa residents outside of Gombe, and expats in first world cities. Specific questions include whether Kinshasa residents regard Gombe as the "downtown" or the most important part of the city despite its peripheral location. Socially ascendant Kinshasa residents are asked how much importance they would assign to living in or near the colonial core for reasons of social mobility. Interviews with older Kinshasa residents chart the shifting symbolism of Gombe through the colonial period, "Africanization" phase typified by the 1972 Rumble in the Jungle match which brought Congo (Zaire) to the world stage, and the Congolese civil war in the 90s which resulted in thousands of well-off Congolese fleeing the capital. Expected Findings- While research is ongoing, the effects of colonial urban form are still felt in Kinshasa with its premise of promoting inequality between the Europeans and Africans still functioning as a class based rather than race-based separation which compounds unequal access to education, jobs, and municipal services. We predict that recent emigres will recognize Gombe's controversial role in Kinshasa's development, however we also predict that second generation emigrants will be favorably disposed to Gombe due to its "ordered", Western appearance.

**COMING OUT OF THE WOODS. DO LOCAL SUPPORT SERVICES  
INFLUENCE THE PROPENSITY TO REPORT SEXUAL VIOLENCE?**

**Daria Denti<sup>1,2</sup>, Simona Iammarino<sup>1</sup>**

<sup>1</sup>London School of Economics, United Kingdom. <sup>2</sup>Gran Sasso Science Institute, Italy

**ABSTRACT**

Sexual crimes against women are severely underreported to the police, allowing for impunity of perpetrators. Observers suggest that a stimulus towards reporting the crime comes from nearby support services for victims of sexual offences - like refuges and advisors. Still, the evidence about the effects of nearby support on the reporting of sexual crimes remains scattered and mainly qualitative. This paper provides quantitative evidence on this effect, by exploiting the uneven geography of local support services which resulted in the UK after the introduction of the austerity program. Findings highlight a positive net effect of the provision of local support services on the victims' propensity to report. The positive effect holds also in the aftermath of a space-neutral high- impact media campaign empowering women to report sexual violence. This evidence relates to relevant policy implication, given that in some countries the austerity-driven cuts to public budgets have reduced and dispersed the local availability of support services, making digital support and/or helpline the only available options in many places.

## **National Session: SS51.1 - Sustainable Regional Development in China**



**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84686769452>**

**Chair Jian Wang**

**MEASURING THE POPULATION SIZE OF CITIES IN CHINA**

**Yi Niu, Jinyu Wang**

Capital University of Economics and Business, China

**ABSTRACT**

City size is a key indicator across many disciplines that study cities including planning, economics and geography, but its measures are full of difficulties and controversies, particularly in China. This paper provides another measure of city size in China, and describes its main characteristics and evolution, by using the population data at the township level, the land cover data at 30-meter resolution, as well as the satellite images of night lights. In each prefecture city's urban proper, county-level city or county, we recognize a township as urban if it has (1) at least 1 km<sup>2</sup> or 10% urban land, (2) night lights brighter than approximately 10, and we also require a city size no less than 50,000. Our preliminary results, quite different from the official data, suggest following results during 2000-2010. First, the number of cities increased from 1,115 to 1,612, and the average city size from 370 thousand to 440 thousand. Second, almost no cities shrank, while the rural areas around some cities were losing population. Third, some county-level cities and counties have large "cities" (larger than 500 thousand or even one million), while in some prefecture's city proper cities were small (smaller than 500 thousand). We will conduct similar analyses by individual regions including East-Central-West, Northeastern China, Beijing-Tianjin-Hebei Urban Agglomeration, Yangtze River Delta, Pearl River Delta, etc. We believe this paper provides more accurate description of the size and evolution of cities during China's fast urbanization.

## URBAN NETWORK EXTERNALITIES AND ECONOMIC GROWTH OF URBAN AGGLOMERATION REGIONS IN CHINA

Hongming Zhang<sup>1</sup>, Tieshan Sun<sup>2\*</sup>, Yuanxi Li<sup>3</sup>

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### ABSTRACT

Urban agglomeration regions are the center of future urbanization and the engine of future economic growth in China, which are advanced spatial organizations of interconnected cities. Previous studies have analyzed the spatial form of the urban agglomeration region, but shed little light on the economic benefit from the compact urban network in the urban agglomeration region. This study first proposes a theoretical framework for urban network externality and its mechanism. The complex network method is employed to evaluate the development of urban agglomeration regions in China. Further, based on panel data from 2003-2018 of 12 urban agglomeration regions, this study has tested the hypotheses proposed. The basic result demonstrates that there is significant positive urban network externality among urban agglomeration regions. Moreover, the relationship of network centrality and economic growth takes the form of inverted U. At last, industrial structure similarity and proportion of secondary industry of central cities have a positive effect on urban network externality. These results suggest that the urban agglomeration region is indeed an efficient form to boost economic growth by urban network externalities. At the same time, appropriate network centrality can help to make the best of urban network externalities. Raising the industrial structure similarity and the proportion of secondary industry of central cities is a way to produce more urban network externalities.

### KEYWORDS

Agglomeration, Economic growth, Externality, Urban agglomeration region, Urban network

### 1. INTRODUCTION

With the rapid improvement of transport infrastructure and information technology, the interaction between firms from different cities becomes increasingly close and frequent. Urban networks implying firm networks have been the main form of spatial organization. To put it more exactly, of a mainly horizontal and non-hierarchical nature, urban networks are systems of relationships and flows (Camagni et al. 1993), where previously independent cities with complementary functions cooperate and achieve scope economies (Batten 1995). The notion of synergy, often formulated as  $1+1>2$ , is another way to explain this phenomenon, which means the performance of an urban network is better than the sum of cities alone (Meijers 2005). More formally, this economic advantage of urban networks could be expressed as urban network externalities emerging from the complementary relationships and synergies in cooperative activities (Capello 2000).

Urban agglomeration regions, characterized by compact spatial organization and close economic links (Fang 2015), are the spatial carriers of urban networks. Just as the worldwide rise of mega-region discovered by Florida et al. (2008), urban agglomeration regions will also play a leading role in the future urbanization in China. The linkage intensity between cities in urban agglomeration regions is a key standard for evaluating the development of urban agglomeration regions (Fang et al. 2020), making urban agglomeration regions become urban networks by nature. Urban agglomeration regions are also the major engines for future economic growth because reciprocity caused by intense network connection between cities could bring positive urban network externalities. As proposed by Camagni et al. (2016), the key to economic growth is not the development of large mega-cities, but factors such as external linkages and cooperation network.

There have been some empirical studies on urban network externalities. The pioneering work made by Boix et al. (2007) proposed the concept of urban network externality based on agglomeration economy and established an urban growth model. They set the spatial weight matrix based on a high-tech urban knowledge network and used the panel SLX model to analyze and compare the impact of agglomeration economy and urban network externalities on employment growth. Gong et al. (2020) established a theoretical model of housing price based on urban network externalities and used the SLX model with a binary spatial weight matrix, confirming the existence of positive network spillovers in housing prices in eastern Chinese cities. Urban network externalities, though analyzed directly, should have been paid more attention to the relationship between network characteristics and regional growth.

Several attempts have been made to focus on the effects of urban networks on economic growth. Shi et al. (2020) combined an urban network approach and a spatial econometric framework to investigate the impact of indigenous factors, cross-territorial flows, and positions in the regional capital network on urban growth and estimated their spatial spillovers. Huang et al. (2020) made use of train frequency data to construct urban networks, analyzed the structure of

urban networks using complex network methods, finally examined the impact of urban network externalities on urban economic growth. Previous work has been carried out more on the city-level economic growth. However, there has been a lack of research on the urban network externalities of economic growth at the regional level, especially on urban agglomeration regions in China.

A wide body of empirical studies has been published on the spatial structure of urban agglomeration regions in China (Gao et al. 2017, Lan et al. 2019), but few endeavors have been made to the economic growth. Applying a DID estimation on panel data of Chinese cities, Li et al. (2017) showed that there's no significant labor productivity benefit in urban agglomeration regions. No wonder that they find such a result because the network connection between cities matters for economic growth rather than being part of the planning region proposed by the government. Further, Ma et al. (2019) focused on the influencing factors and mechanisms of the economic efficiency of urban agglomeration regions and checked the effects of externalities. They just compared urban agglomeration regions to cities, but the contributing role of the urban network is still neglected.

In general, the research on the urban network externalities of regional economic growth is still limited, so is the research on industrial mechanisms of such externalities. Therefore, the purpose of this study is to explore the relationship between economic growth and urban network at the regional level. Taking urban agglomeration regions in China as the study area, this study builds urban networks in each urban agglomeration region based on the industrial investment between cities, adopts complex network methods to characterize the network. Furthermore, a panel data model is estimated to test the hypotheses put forward at first.

The remaining part of the paper proceeds as follows. In Section 2, a theoretical framework is established for urban network externalities, and the hypotheses are proposed. Section 3 describes the urban agglomeration regions used for this study. The complex network methods and an empirical framework are introduced in Section 4. Section 5 analyzes the empirical results to examine the hypotheses. Finally, Section 6 provides the conclusion and policy implications.

## 2. THEORETICAL FRAMEWORK

### 2.1. From agglomeration externality to urban network externality

Compared with agglomeration externality in traditional urban and regional economics, urban network externality no longer regards cities as isolated units, but as nodes in the urban network. The interaction between urban network nodes produces urban network externality, which does not depend on geographic proximity (Camagni et al. 1993). Externality refers to the impact on the output of the firm due to the interaction between firms that occurs externally to the firm per se. Traditionally, the agglomeration externality is limited within the boundary of the city. According to the scope of agglomeration externality, it can be divided into two categories: MAR externality (localization economy) occurs in the same industry, while Jacobs externality (urbanization economy) occurs in different industries (Glaeser et al. 1992, Henderson et al. 1995). The externality that arises between firms in different cities is urban network externality, so this externality can be seen as an extension of the agglomeration externality in a larger geographical space. The main difference between these two concepts is that agglomeration externality, whose spatial scope is limited, will decay with distance, while urban network externality has no spatial scope limitations and depends on the strength of functional connections between different cities rather than geographic proximity (Burger et al. 2016).

Three mechanisms of MAR externality are labor pooling, input sharing, and knowledge spillover. Similarly, Duranton et al. (2004) summarized three mechanisms of agglomeration economy as sharing, matching, and learning. These three mechanisms occur between firms, but there is no reason to confine them to firms in the same city. In other words, these three mechanisms are also mechanisms for urban network externality generated by firms in different cities. The close connection between cities allows various factors to communicate and interact on a larger spatial scale. Therefore, the city as a network node can obtain the urban network externality from the labor pool, input sharing, and knowledge spillover in the entire urban network. The benefit of sharing, matching, and learning produced by agglomeration economy can extend to all cities in the network.

A major reason why agglomeration externality can transcend urban boundaries is the decline of transportation costs. The micro-foundation in traditional urban and regional economics is the spatial choice of economic entities. The existence of trade costs makes the spatial proximity of firms and labor an important source of the agglomeration economy. Due to market access effect and cost-of-living effect, both firms and labor will be in a self-reinforcing process of gathering to the big market (Baldwin et al. 2011). Similarly, the close connection between firms and labor is also the source of urban network externality. With the advancement of regional integration, the decline of transportation costs has made it easier for factors and commodities to flow across cities. The development of information technology has also enabled innovation activities to be carried out in different cities at the same time. The sharing of knowledge and technology has become increasingly less dependent on face-to-face communication. In addition, the emergence of urban networks is also the result of the agglomeration diseconomy. The congestion effect caused by excessive agglomeration within a single city will promote the relocation of firms. Just as firms in a city are connected due to agglomeration, firms scattered in different cities belonging to the same city network can also establish a cross-city connection through lower transaction costs. In this way, the agglomeration externality will break through the spatial scope of the traditional agglomeration economy and realize the agglomeration of firms from different cities in the urban network through network linkages.

Based on the same micro-foundation, urban network externality is the expansion of agglomeration externality in the spatial scope. That is, the unified market composed of different cities forms a larger-scale agglomeration. Urban network externality, however, has its unique mechanism at a more macro level. In traditional urban and regional economics,

increasing returns to scale is an important mechanism for large cities to produce agglomeration economies. Similarly, Alonso (1973) proposed the concept of borrowed size. It is believed that small cities can borrow the agglomeration economy of neighboring large cities, and at the same time enjoy the benefits of the small scale to avoid the agglomeration diseconomy. In this way, small cities around large cities can maintain high economic growth rates and efficiency. Burger et al. (2015) further improves the concept and measurement method of borrowing size and introduces this concept into the study of urban network externality. They believe that it is important for firms to obtain the benefits of agglomeration rather than being close to the agglomeration area. Therefore, the borrowed size can be interpreted as the network connection between different cities, which can replace geographical proximity to some extent. Therefore, intense network linkages between cities are the source of positive urban network externality. The above discussion can be summarized as the following hypothesis.

Hypothesis 1: The network linkages between cities have positive effects on regional economic growth, reflecting the positive urban network externality.

## 2.2. Network centrality and urban network externality

Despite the positive urban network externality proposed above, the structure of urban networks is also a critical factor that influences economic growth. The centrality of urban networks stems from the geographic agglomeration of economic activity among cities, thus the inequality between cities. Therefore, the effect that network centrality has on urban network externality, or economic growth, can be understood with the help of long-standing debate on the relationship between agglomeration (or inequality) and economic growth.

For a region in the early stages of development, it is often the case that all the cities in the region are equally at the low-income level. The emergence of one or some cities with favorable conditions is the prerequisite for the future prosperity of a region. With regional integration deepens, core cities become wealthy at the expense of peripheral cities, forming a core-periphery pattern (Krugman 1991). Even though agglomeration seems to cause a huge income gap in the static models, the growth spurred by agglomeration is strong enough to benefit both the core and periphery in a dynamic setting (Fujita et al. 2003). Despite the agglomeration demonstrated in NEG models, the growth-promoting agglomeration externalities have long been noticed (Jacobs 1985). Urban network externality is the expansion of agglomeration externality in one city to intercity interaction. The high level of network centrality means the intense interaction between the agglomeration center and its surrounding cities. The agglomeration center, on the one hand, will obtain a larger market size, which provides both the purchasing power and the labor force. On the other hand, production factors, such as capital and technology, will spill over from the agglomeration center to surrounding cities, improving the economic status of surrounding cities significantly. In this way, urban network externalities, concentrated on one core but radiating out to its periphery, will boost the economic growth of the entire region.

However, as agglomeration isn't beneficial all the way, network centrality could also be harmful to the economic growth of the region overall. As mentioned above, agglomeration enhances growth only at the very beginning of the development. In the later stages, growth will be hindered due to agglomeration diseconomies (Williamson 1965). From the perspective of the network, extreme network centrality won't bring congestion diseconomies but engender the drawback of increasing inequality between cities. Both agglomeration and inequality, as the source of network centrality, can be regarded as the accumulation of production factors necessary for growth at least in the early stages of development (Castells-Quintana et al. 2014), but limit the urban network externality beyond some critical level. As the extreme income inequality can exert negative effects on growth through some transmission channels (Castells-Quintana et al. 2017), network centrality will hamper the efficiency of interaction between agglomeration center and its surrounding cities. First, the impaired purchasing power of surrounding cities will decrease consumer demand. Second, the labor force will be largely drawn to the agglomeration center, which causes an obvious mismatch in the labor market that is unemployment in the core and vacancy in the periphery. At last, the surrounding cities cannot utilize the capital and technology from the network center, which restricts the gain from urban network externality. Therefore, in the later stages of development, further concentration in the network can also lead to the deterioration of economic growth. Based on the positive and negative effects of network centrality, we derive the following hypothesis.

Hypothesis 2: Network centrality will lead to higher economic growth in the early stages of development but lower economic growth in the later stages, implying the relationship between network centrality and economic growth has the shape of inverted U.

## 2.3. Industrial linkage and urban network externality

The urban network externalities originate from the economic linkage between firms from different cities, which can be represented as industrial linkage at a more macro level. Therefore, the perspective of industrial linkage is indispensable to study the mechanism of urban network externality. For the source of agglomeration externalities within a city, whether specialization or diversification promotes agglomeration has become the focus of debate (Glaeser et al. 1992, Henderson et al. 1995). MAR externality refers to the externality generated by specialized agglomeration, where knowledge spillover mainly occurs between firms within the same industry due to similar technology. Contrary to MAR externalities, Jacobs externality refers to externality brought about by diversified agglomeration, where firms from different industries generate knowledge spillover in the absence of fierce competition, which is also conducive to the collision of different ideas for innovation. However, it is not the case, because industries with too large technological gaps may have a completely different technological foundation and knowledge base, making knowledge spillover difficult.

The concept of technological relatedness, put forward by Frankel (1955), will help to illustrate the relation between industrial linkage and urban network externality. Based on technological relatedness, Frenken et al. (2007) first proposed the concept of related variety, clarifying that the diversity of products and services can promote regional economic growth because of the more inter-industry knowledge spillover. What's more, they emphasized that knowledge spillover within a region mainly occurs between related industries with similar knowledge, while only a very limited portion occurs between unrelated industries. Therefore, they divide variety into related variety and unrelated variety. The cognitive distance between related industries is not large, so that firms can more effectively share knowledge, lowering the cost of cross-industry knowledge spillover. The knowledge bases between unrelated industries are completely different, which make the process of interaction more uncertain and costly, then hinder knowledge spillover between industries.

With the concept of related variety, the impact of industrial structure similarity on urban network externality can be examined. The more similar the industrial structures between cities are, the more likely there will be related variety because only cities with similar industrial structures can have closer technological relatedness. For cities with large differences in industrial structure may have a vertical relationship of labor division similar to that in the central place theory, and possess quite different knowledge bases. Since related variety can promote knowledge spillover between firms, cities with similar industrial structures are also more likely to have knowledge spillover, making urban network externalities stronger to benefit the economic growth of the region. Therefore, we derive the following hypothesis.

Hypothesis 3: Industrial structure similarity will strengthen the urban network externality.

Industrial structure similarity is the determinant of network linkage at the regional level, but the industrial characteristics of each city are the origin that generates industrial linkage between them. Therefore, the industrial characteristics of cities can affect the urban network externality. The industrial structure is an aspect of industrial characteristics, reflecting whether the city is dominated by manufacturing or service industry. It is because of the different organizations of firms in manufacturing and service industries that they have different spatial distribution patterns, and thus, different ways of interacting with surrounding cities.

Manufacturing and service industries are important driving forces for second nature. They have different regional spatial effects: the manufacturing industry appears as a trickle-down effect and contact diffusion, while the service industry appears as a polarization effect and hierarchical diffusion. The principal reason is that the manufacturing industry has a long industrial chain, and the upstream and downstream linkages make firms dispersed in different cities to carry out the division of labor and cooperation in production activities. There will be a trickle-down effect, presenting a spatial expansion pattern of contact diffusion in neighboring areas and driving the surrounding cities to grow together. The service industry, especially one that produces intangible products, presents a pattern of centralized production and networked transmission, which makes firms concentrated in higher-level cities enjoy the benefits of the diversified urban economy. Connections between cities mainly occur between higher-level cities. There will be a polarization effect, presenting the spatial centralization pattern and weakening the development of surrounding cities.

Moreover, according to the phenomenon of vertical disintegration in industrial organizations, when the market expands, the upstream branches of some companies will be separated from the downstream branches to take advantage of specialization and scale effects (Stigler 1951). This phenomenon has been tested by empirical data in the manufacturing industry (Holmes 1999). Each link in the vertical value chain, with large differences in the requirements of the quality and cost of production factors, has its own optimal geographic locations. Therefore, the manufacturing industry, especially firms' production with a high degree of standardization and modularization, has a significant trend of vertical disintegration. For a region, the industrial characteristics of the central city determine the interaction pattern of the whole region, thus influence the urban network externality. The following hypothesis is then derived.

Hypothesis 4: For the central city of a region, a higher ratio of the manufacturing industry will strengthen the urban network externality.

### 3. STUDY AREA

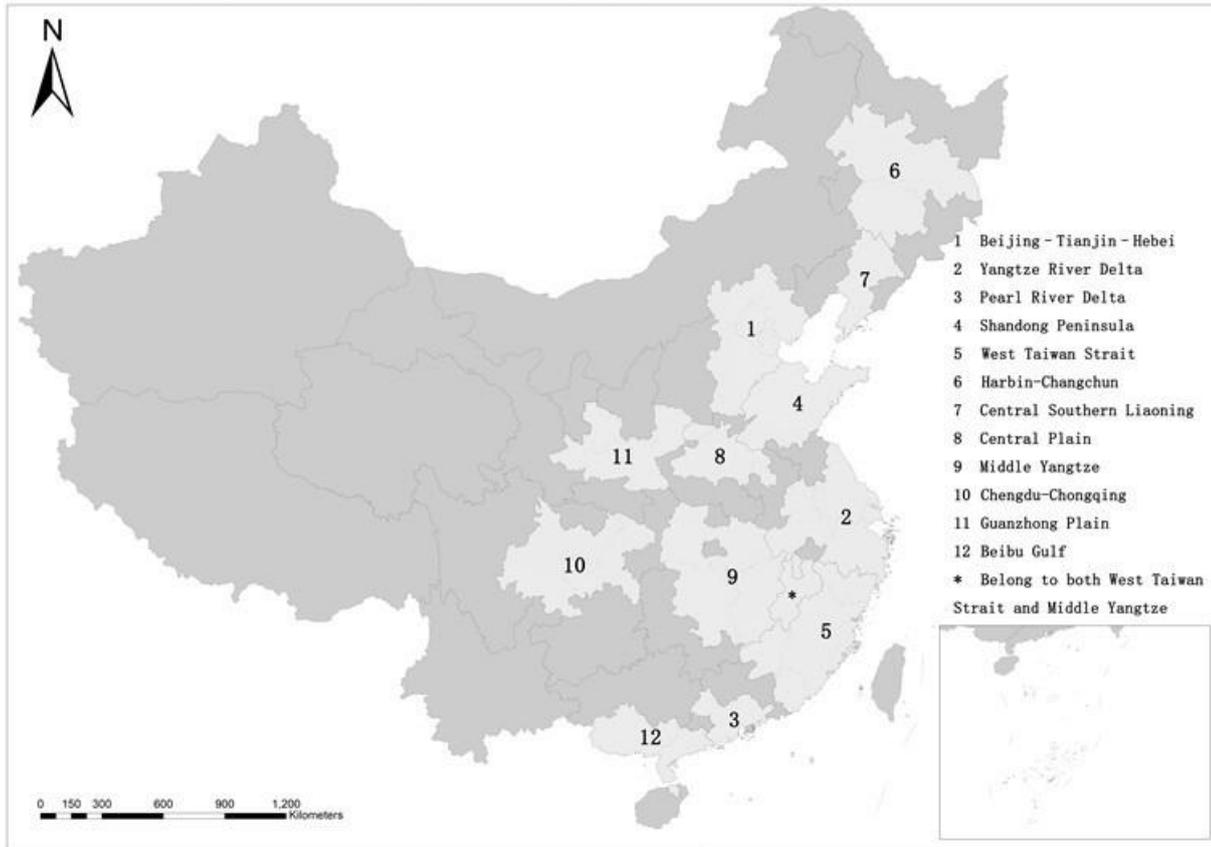
Our analysis takes urban agglomeration regions (UARs) as the study area, which are put forward by the Chinese government. The concept of urban agglomeration region we use here is the synonym for urban agglomeration, city cluster, city group, megalopolis, and mega-region in the literature studying China. Since urban agglomeration, though adopted by the majority, can be regarded as the city per se, we employ the concept of urban agglomeration region to emphasize the nature of the region composed of a group of cities.

China 14th Five-Year Plan (2021-2025) states that the development of urban agglomeration regions is the basis for advancing the new-type urbanization, and urban agglomeration regions are going to be the core areas of economic growth and high-quality development. The high importance of urban agglomeration regions has been gradually tested in practice, and the government has therefore kept clarifying its role in Plans. "Urban agglomeration region" was formally proposed in the 11th Five-Year Plan in 2005, which firstly regarded developing urban agglomeration regions as the main form of promoting urbanization. In 2016, the 13th Five-Year Plan first put forward the spatial scope of 19 urban agglomeration regions. Recently, 14th Five-Year Plan in 2020 emphasized that central cities and urban agglomeration regions are the source of high-quality development, which can promote the carrying capacity for the economy and population to enhance the national economic efficiency.

It is worth noting that the latest Five-Year Plan points out the significance of promoting the integrated development and optimizing the internal spatial structure of each region to form multi-center, multi-level, and multi-node urban networks within urban agglomeration regions. The network form is the basic feature of a mature urban agglomeration region, due

to the compact space organization and close economic ties. Most urban agglomeration regions in China, except the top three (Beijing–Tianjin–Hebei, Yangtze River Delta, and Pearl River Delta), however, have not formed a close network connection. This means that “urban agglomeration regions” in China is mostly a planning concept rather than a practical regional type. Urban agglomeration regions, including mature and immature ones, exactly provide the various samples to investigate the impact of urban networks on economic growth.

According to data availability, we select 12 out of 19 urban agglomeration regions that contain over 4 cities to study their advancement of urban networks. The 12 selected urban agglomeration regions are mainly distributed in the east and middle of China (Figure 1), which represents the geographical difference of economic development level in China.



**Figure 1: The distribution of 12 urban agglomeration regions in China**

These urban agglomeration regions consist of 181 cities (57.34% of the total in China) at the prefectural level or above, with a total area of 2233163 km<sup>2</sup> (20.91% of the total in China). In 2018, they carried a population of 948.73 million (60.6% of the total population), and they created a GDP of 74.3315 trillion yuan (73.19% of total GDP) with the per capita level 20.43% higher than the national level (Table 1). Urban agglomeration regions with only 20% land and 60% people produce 70% GDP because the close network linkages among cities increase the economic efficiency. These cities optimize resource allocation through urban networks, expanding the scope of agglomeration externality and creating urban network externality.

**Table 1: Socioeconomic status of 12 urban agglomeration regions in 2018**

UAR name	GDP (10 <sup>12</sup> yuan)	Population (10 <sup>6</sup> )	Area (km <sup>2</sup> )	GDP per capita (yuan)	Number of cities
Beijing–Tianjin–Hebei	8.4359	101.26	218545	83310	13
Yangtze River Delta	17.8642	131.75	214001	135592	26
Pearl River Delta	8.1048	35.86	54963	226014	9
Shandong Peninsula	7.6866	99.69	156160	77105	16
West Taiwan Strait	5.8728	96.50	272891	60858	20
Harbin-Changchun	2.5430	44.07	279380	57703	10
Central Southern Liaoning	2.1633	28.66	82348	75483	9
Central Plain	3.6454	78.46	99648	46462	13
Middle Yangtze	8.3201	131.23	343981	63401	28
Chengdu-Chongqing	5.7515	110.16	239548	52210	16
Guanzhong Plain	2.0617	45.24	161949	45572	11
Beibu Gulf	1.8822	45.85	109749	41052	10
Total	74.3315	948.73	2233163	77851	181
Percentage (%)	73.19	60.66	20.91	120.43	57.34

Notes: Yingtan, Fuzhou (Jiangxi), and Shangrao belong to both West Taiwan Strait and Middle Yangtze.

4. METHOD AND DATA

4.1. Complex network method

This paper uses complex network methods to evaluate the network development of urban agglomeration regions. There are two aspects of the urban network to measure: compactness and centrality. Traditional measures on social networks are designed for binary networks. Nevertheless, our networks of investment are weighted in nature, implying that the weights of ties are as essential as the number of nodes. In addition, the change of investment overtime should be captured. Therefore, measures for weighted networks are introduced.

The compactness of a network is the source of urban network externality, which has two indicators that reflect it in complementary ways. One is average investment intensity. The other is the clustering coefficient. The average investment intensity of an urban agglomeration region is the average value of the investment between all city pairs including ones with no investment data for some year, which can measure the contact strength produced by the entire urban agglomeration region. However, the average investment intensity is just a measure of interaction level that cannot consider network features, hence the need for an indicator to reflect the compactness in the view of the network.

The clustering coefficient refers to the density of triplets of nodes in a network. A triplet is defined as three nodes that are connected by either two (open triplets) or three (closed triplets) ties. A triangle contains three closed triplets, each of which is centered on a node. The clustering coefficient is defined as the number of closed triplets (or 3 times the number of triangles) divided by the number of all triplets (including open and closed). It was first proposed by Luce et al. (1949), and the formula of the standard clustering coefficient is

$$clu = \frac{\sum \tau_{\Delta}}{\sum \tau} \tag{1}$$

where  $\sum \tau$  is the total number of all triplets, and  $\sum \tau_{\Delta}$  is the total number of closed triplets. The coefficient takes values between 0 and 1. In a completely connected network, all triples are closed, and the clustering coefficient is 1.

One of the main drawbacks of the standard clustering coefficient is that it cannot be applied to weighted networks. As a consequence, networks with different distribution of weights, which reflects the different likelihood of nodes being connected, may turn out to be the same clustering coefficient, making the analysis of network structure biased. To overcome the limitation, Opsahl et al. (2009) generalized the clustering coefficient to the weighted network, explicitly capturing the weight attached to ties. The triplet value can be defined as the arithmetic mean of the weights of all ties that make up the triplet. This is the simplest way to calculate the triplet value. Therefore, the clustering coefficient for the weighted network can be generalized to

$$clu = \frac{\sum \tau_{\Delta} \omega}{\sum \tau \omega} \tag{2}$$

where  $\omega$  is the triplet value,  $\sum \tau_{\Delta} \omega$  is the sum of all closed triplet values, and  $\sum \tau \omega$  is the sum of all triplet values. This generalized clustering coefficient still ranges between 0 and 1. In a completely connected network, this generalized clustering coefficient is also 1. Accordingly, the generalization reveals the relative importance of triplets in a network after taking weights of ties into account. If the closed triplets have higher values, the clustering coefficient tends to be larger, which is more factual.

The above two indicators are measures for compactness of the network, but the network structure remains to be portrayed, which is also a factor to influence economic growth. To characterize the centrality of a network, the node centrality should be computed first. Then, a descriptive statistic of node centrality can be applied to obtain network centrality. The closeness centrality of one node reflects the distance of a node to all other nodes in the network. This measure depends on the length of the shortest paths among nodes in the network, so how to define the shortest distance determines the measure of closeness centrality. In a binary network, which treats all edges equally (Freeman 1978), the length of the shortest path is defined as the minimum number of ties linking two nodes. Newman (2001) used the shortest path algorithm proposed by Dijkstra (1959) to generalize close centrality to weighted networks. Opsahl et al. (2010) further suggested that both the tie weights and the number of intermediary nodes should be incorporated at the same time, thereby proposed the length of the shortest path  $dis_{ij}$  between two nodes  $i$  and  $j$  as

$$dis_{ij} = \min \left( \frac{1}{(w_{ih})^{\alpha}} + \dots + \frac{1}{(w_{hj})^{\alpha}} \right) \tag{3}$$

where  $\alpha$  is a positive tuning parameter. When  $\alpha = 0$  or  $\alpha = 1$ , the proposed measure is the same as the one obtained in the binary network or with Dijkstra's algorithm. For  $0 < \alpha < 1$ , a shorter path with weak ties is favored over a longer path with strong ties, where the number of intermediary nodes is relatively more important. Let  $\alpha = 1/2$  here. The closeness centrality of node  $i$  that generalized to weighted networks is

$$cloc_i = [\sum_j dis_{ij}]^{-1} \tag{4}$$

In binary networks, the graph centrality can be obtained by the sum of differences between the largest value of point centrality and all others over the possible maximum of such sum (Freeman 1978). The extreme example of this possible maximum is the graph that takes the form of a star. Hence, the standard measure is a comparable ratio. Unfortunately, there's no possible maximum in weighted networks. Then, we proposed a similar comparable measure that utilizes closeness centrality mentioned above, which captures the average level of differences between the maximum and others. The formula is expressed as

$$cen = \frac{\sum_{i=1}^n (cloc_{max} - cloc_i)}{n-1} \tag{5}$$

where  $n$  is the number of nodes in the network,  $cloc_{max}$  is the maximum of closeness centrality.

**4.2. Empirical strategy**

Using urban agglomeration regions in China as the empirical setting, we will test the theoretical hypotheses in Section 2 with a panel model.

To test hypothesis 1, our baseline model estimates the impact of network linkage on economic growth among urban agglomeration regions. The baseline model is a fixed effect regression model that is as follows

$$\ln Y_{it} = \alpha_0 + \alpha_1 \ln Net_{it} + \alpha_2 \ln X_{it} + \mu_i + \varepsilon_{it} \tag{6}$$

where  $\ln Y_{it}$ , as the dependent variable, is the logarithm of output for urban agglomeration region  $i$  at time  $t$ ,  $\ln Net_{it}$ , as the explanatory variable, is the logarithm of network linkage, and  $\ln X_{it}$  is the control variable including production factors and others. At last,  $\mu_i$  is the unit fixed effect, and  $\varepsilon_{it}$  is the error term.

To test hypothesis 2, the variable of network centrality needs to be added to the baseline model. Because the inverted U relationship will be tested, both the linear term and the quadratic term of network centrality should be added. Then, the model is

$$\ln Y_{it} = \alpha_0 + \alpha_1 \ln Net_{it} + \alpha_2 \ln Cen_{it} + \alpha_3 \ln Cen_{it}^2 + \alpha_4 \ln X_{it} + \mu_i + \varepsilon_{it} \tag{7}$$

where  $\ln Cen_{it}$  is the logarithm of network centrality for urban agglomeration region  $i$  at time  $t$ .

To test hypotheses 3 and 4, we need to generate interaction terms to capture the moderating effect. After interacting industrial structure similarity of urban agglomeration region and industrial structure of the central city with network linkage, we get these two models

$$\ln Y_{it} = \alpha_0 + \alpha_1 \ln Net_{it} + \alpha_2 \ln Net_{it} \times \ln Sim_{it} + \alpha_3 \ln X_{it} + \mu_i + \varepsilon_{it} \tag{8}$$

$$\ln Y_{it} = \alpha_0 + \alpha_1 \ln Net_{it} + \alpha_2 \ln Net_{it} \times \ln Ind_{it} + \alpha_3 \ln X_{it} + \mu_i + \varepsilon_{it} \tag{9}$$

where  $\ln Sim_{it}$  is the logarithm of industrial structure similarity for urban agglomeration region  $i$  at time  $t$ , and  $\ln Ind_{it}$  is the logarithm of the industrial structure of the central city in the urban agglomeration region  $i$  at time  $t$ .

**4.3. Data sources and variable definition**

City-level economic data is drawn from China City Statistical Yearbook from 2003 to 2018. The number of patents granted comes from the China National Intellectual Property Administration. The investment data is the newly-increased investment by firms from the industrial and commercial enterprise registration database, which can be aggregated to the city level. All the data is filtered to keep the cities within the urban agglomeration regions. Based on the above data sources, this study constructs balanced panel data of 12 urban agglomeration regions for 16 years from 2003 to 2018, with a total of 192 observations.

The dependent variable, the output of urban agglomeration regions, is obtained from the aggregation of city-level output. The core explanatory variables, including average investment intensity, clustering coefficient, and closeness centrality, are constructed with the complex network method introduced in Section 4.1 based on the investment data between cities. Other control variables that are also aggregated to the urban agglomeration region level comprise capital, labor, technology (represented by the number of patents granted), total college attendance, foreign direct investment, and the percentage of GDP of secondary industry.

As for industrial structure similarity, we adopt the indicator proposed by UNIDO (United Nations Industrial Development Organization), which is

$$sim_{12} = \frac{\sum_k s_{1k} s_{2k}}{\sqrt{\sum_k s_{1k}^2 \cdot \sum_k s_{2k}^2}} \tag{10}$$

where  $sim_{12}$  represents the industrial structure similarity coefficient of city 1 and city 2,  $s_{1k}$ ,  $s_{2k}$  represent the share of industry  $k$  in the total output of city 1 and city 2, respectively. Therefore, when the industrial structure of the two cities is completely the same, the value of  $sim_{12}$  is 1; when the industrial structure of the two regions is completely different, the value of  $sim_{12}$  is 0. We take the average of industrial structure similarity coefficient between all city pairs in an urban agglomeration region as the industrial structure similarity, which is

$$sim = \frac{\sum_{i \neq j} sim_{ij}}{n(n-1)/2} \tag{11}$$

where  $sim$  is the industrial structure similarity of an urban agglomeration region, and  $n$  is the number of cities in this urban agglomeration region. The proportion of secondary industry of central cities is represented by the percentage of GDP of secondary industry, where central cities selected are the cities with the highest average closeness centrality in their urban agglomeration regions in the sample period. As can be seen from Table 2, central cities in each urban agglomeration region are also the most developed cities, which control the resource allocation and act as the source of capital and investment.

**Table 2: Central cities in each urban agglomeration region**

UAR name	Central city
Beijing-Tianjin-Hebei	Beijing
Yangtze River Delta	Shanghai
Pearl River Delta	Guangzhou
Shandong Peninsula	Ji'nan
West Taiwan Strait	Xiamen
Harbin-Changchun	Harbin
Central Southern Liaoning	Shenyang
Central Plain	Zhengzhou
Middle Yangtze	Wuhan
Chengdu-Chongqing	Chengdu
Guanzhong Plain	Xi'an
Beibu Gulf	Nanning

Note: Descriptive statistics are generated for all variables as Table 3 presented.

**Table 3: Variables and descriptive statistics**

Name	Description	Mean	SD	Min	Max
<b>Dependent variable</b>					
ln_y	Logarithm of output	19.26	0.875	17.11	21.30
<b>Explanatory variable</b>					
ln_minv	Logarithm of average investment intensity	9.218	1.528	6.310	13.52
cluster	Clustering coefficient	0.734	0.194	0.136	1
closeness	Closeness centrality	0.045	0.026	0.006	0.113
<b>Moderating variable</b>					
gdp2p_cen_75q	Proportion of secondary industry of central city above 75 quantile	0.188	0.391	0	1
gdp2p_cen_80q	Proportion of secondary industry of central city above 80 quantile	0.141	0.349	0	1
simc_75q	Industrial structure similarity above 75 quantile	0.339	0.474	0	1
simc_80q	Industrial structure similarity above 75 quantile	0.271	0.446	0	1
<b>Control variable</b>					
ln_k	Logarithm of capital	18.68	1.049	15.82	20.79
ln_l	Logarithm of labor	6.659	0.612	5.435	8.116
ln_t	Logarithm of patents	8.121	1.536	4.382	11.51
ln_stu	Logarithm of College student	14.07	0.589	12.27	15.18
ln_fdi	Logarithm of foreign direct investment	13.63	1.199	10.45	15.75
gdp_2p	Proportion of secondary industry	0.480	0.054	0.335	0.588

Notes: Each variable has 192 observations.

## 5. EMPIRICAL RESULTS

### 5.1. Network characteristics of urban agglomeration regions in China

Network development is one critical criterion for evaluating the maturity of urban agglomeration regions. We will show the network characteristics across the year studied and the evolution to compare these urban agglomeration regions. The results of the compactness of urban networks are summarized in Table 4 and Table 5. As shown in Table 4 and Table 5, there's no doubt that the top three urban agglomeration regions, namely Beijing-Tianjin-Hebei, Yangtze River Delta, Pearl River Delta, keep the top 3 regardless of the indicator used. What's more, there's a huge gap between the top 3 and the fourth, which also demonstrates the development of these three urban agglomeration regions far surpasses the others. What is unexpected is that Yangtze River Delta ranks third place for both because the number of cities included is twice that of Beijing-Tianjin-Hebei and three times that of Pearl River Delta. As for others, we can divide them into two groups. One group is more compact, including Central Southern Liaoning, Shandong Peninsula, Chengdu-Chongqing, and Central Plain. The other group is less compact, including Harbin-Changchun, Guanzhong Plain, Beibu Gulf, and Middle Yangtze. Differing from the relatively stable ranks of these 8, West Taiwan Strait is less compact for average investment intensity but more compact for clustering coefficient. This implies that despite the weakness of the linkage strength, West Taiwan Strait has a more compact network structure. For the evolution of compactness, there is a clear trend of rapid growth for both of the indicators, suggesting the cities in urban agglomeration regions become progressively closer to form urban networks.

**Table 4: Annual mean of average investment intensity**

UAR name	Number of cities	Mean of 2003-2018	Mean of 2003-2007	Mean of 2008-2012	Mean of 2013-2018
Pearl River Delta	9	177416	18235	54902	412161
Beijing-Tianjin-Hebei	13	94354	13270	56792	193226
Yangtze River Delta	26	59013	6808	22010	133354
Central Southern Liaoning	9	21872	10306	13220	38720
Shandong Peninsula	16	19384	3254	7945	42359
Chengdu-Chongqing	16	12954	1821	9085	25457
Central Plain	13	11932	1929	7595	23884
Harbin-Changchun	10	9834	949	5516	20837
Guanzhong Plain	11	9788	1482	5713	20106
Beibu Gulf	10	5674	1372	2970	11512
Middle Yangtze	28	5449	903	3019	11263
West Taiwan Strait	20	5293	983	3734	10184

**Table 5: Annual mean of clustering coefficient**

UAR name	Number of cities	Mean of 2003-2018	Mean of 2003-2007	Mean of 2008-2012	Mean of 2013-2018
Pearl River Delta	9	0.8130	0.6545	0.8049	0.9519
Beijing-Tianjin-Hebei	13	0.7360	0.5223	0.7296	0.9195
Yangtze River Delta	26	0.6859	0.5088	0.6842	0.8348
Shandong Peninsula	16	0.5434	0.3666	0.4908	0.7344
Central Southern Liaoning	9	0.5379	0.4408	0.4640	0.6803
West Taiwan Strait	20	0.4637	0.3629	0.4650	0.5466
Central Plain	13	0.3341	0.2302	0.3086	0.4420
Chengdu-Chongqing	16	0.2942	0.0986	0.2380	0.5040
Middle Yangtze	28	0.1905	0.0934	0.1195	0.3305
Harbin-Changchun	10	0.1809	0.1026	0.1055	0.3089
Guanzhong Plain	11	0.1635	0.0635	0.1062	0.2947
Beibu Gulf	10	0.1328	0.0000	0.1355	0.2412

It's not enough to see the compactness of urban networks alone, since network centrality is still an essential part of the assessment. The higher network centrality indicates the network development is more polarized, but the lower indicates the network development is more balanced. According to the theory illustrated in Section 2.2, there is an inverted U relationship between the network centrality and economic growth. It is in line with our expectations that the top three urban agglomeration regions rank 5th, 7th, and 11th respectively in the middle of Table 6. The measure of closeness centrality is also influenced by the number of cities. Urban agglomeration regions with more cities tend to present a lower level of network centrality. Nonetheless, ones with utterly high or low network centrality are indeed in poor economic status. For the evolution of network centrality, the top three urban agglomeration regions experience paralleled surge, implying that they were in the left part of inverted U. The group with higher compactness mainly presents the trend of first falling and then rising, while the group with lower compactness mainly displays the trend of declining all the way. The difference in the evolution of network centrality shows that various urban agglomeration regions have their own optimal network centrality base on their condition.

**Table 6: Annual mean of closeness centrality**

UAR name	Number of cities	Mean of 2003-2018	Mean of 2003-2007	Mean of 2008-2012	Mean of 2013-2018
Beibu Gulf	10	0.1264	0.2074	0.1146	0.0687
Harbin-Changchun	10	0.1097	0.2646	0.0541	0.0270
Guanzhong Plain	11	0.0743	0.1319	0.0608	0.0374
Central Southern Liaoning	9	0.0587	0.0623	0.0492	0.0637
Pearl River Delta	9	0.0574	0.0498	0.0574	0.0637
Central Plain	13	0.0526	0.0607	0.0401	0.0562
Beijing-Tianjin-Hebei	13	0.0467	0.0340	0.0386	0.0641
Chengdu-Chongqing	16	0.0399	0.0353	0.0324	0.0500
Shandong Peninsula	16	0.0386	0.0264	0.0330	0.0535
West Taiwan Strait	20	0.0327	0.0616	0.0252	0.0148
Yangtze River Delta	26	0.0232	0.0164	0.0216	0.0301
Middle Yangtze	28	0.0124	0.0191	0.0062	0.0120

Taking compactness and centrality both into account, we can exhibit a more explicit classification of these urban agglomeration regions. As can be seen from Figure 2, the clustering coefficient and the closeness centrality are both employed to show the diversity. Similarly, we can still divide them into three groups the same as above. The most

remarkable group locates in the bottom-right corner, composed of the top three urban agglomeration regions. This group not only has the most compact urban networks but also evolves with a relatively balanced pattern, indicating that the compactness and balance of the network are the signs of maturity for urban agglomeration regions. The second group, Central Southern Liaoning, Shandong Peninsula, Chengdu-Chongqing, Central Plain, and West Taiwan Strait included, locates in the middle-lower part, whose networks are also relatively balanced but less compact than the top three urban agglomeration regions. The economic development of this group is also better than the last group including the remaining urban agglomeration regions. The last group as the worst developed mainly locate in the upper-left corner, presenting a loose and polarized network.

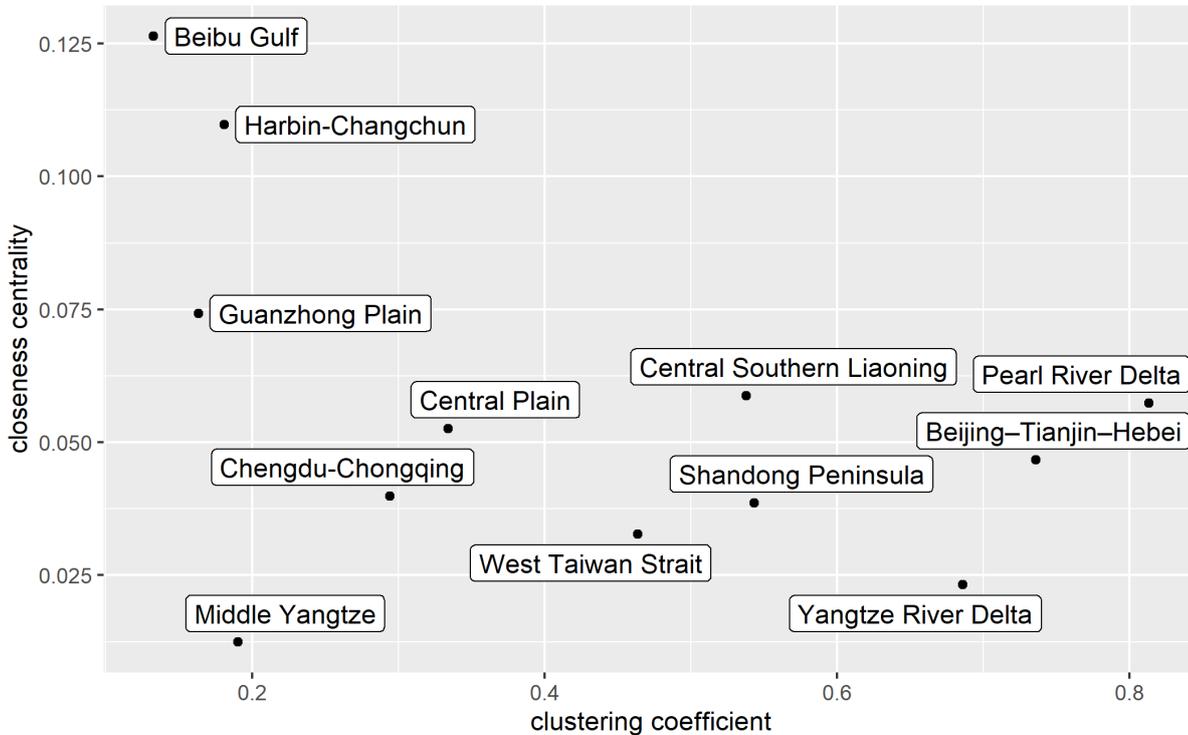


Figure 2: Classification of UAR by clustering coefficient and closeness centrality

5.2. Urban network externality of economic growth

The result estimated from the baseline model (Equation 6) is presented in Table 7. Average investment intensity and clustering coefficient both have a positive effect on economic growth at least at the 5% significance level, indicating that there are significant positive urban network externalities on the economic growth of urban agglomeration regions. Hence, hypothesis 1 is confirmed, which provides the foundation for further investigation.

Table 7: Estimates of urban network externalities

Dependent variable: ln_y	Average investment intensity	Clustering coefficient
ln_minv	0.0448*** (0.0138)	
cluster		0.1449** (0.0595)
ln_k	0.2096*** (0.0274)	0.2199*** (0.0277)
ln_l	0.0489 (0.0425)	0.0463 (0.0431)
ln_t	0.2369*** (0.0252)	0.2548*** (0.0242)
ln_stu	0.2267*** (0.0569)	0.2303*** (0.0578)
ln_fdi	0.0459*** (0.0164)	0.0449*** (0.0168)
gdp2p	0.4177* (0.2305)	0.3246 (0.2291)
Constant	8.6682*** (0.7105)	8.7040*** (0.7198)
Observations	192	192
R-squared	0.9823	0.9819

Notes: (1) \*\*\*, \*\*, \* indicate significance level at 1%, 5%, 10%, respectively. (2) Standard errors of parameter estimates are reported in parentheses.

Network linkage represented by average investment intensity and clustering coefficient is just one aspect of urban network externality. Network Centrality also influences the effect of urban network externality. From Table 8 we can see that the coefficients of network linkage are still positive at least at 10% significance level after adding the variable of network centrality expressed as Equation 7, implying that the compactness of network linkage is a different factor from network centrality. The linear term of closeness centrality is positive at 5% and 10% significance level respectively, while the quadratic term of closeness centrality is negative both at 10% level, indicating that there is an inverted U relationship between the closeness centrality and economic growth of urban agglomeration regions. Hence, hypothesis 2 is also confirmed. Considering the different significance levels, the coefficient of the linear term is more significant than the quadratic term, revealing that the majority of urban agglomeration regions in China are still on the upward slope at the present stage. In other words, urban agglomeration regions with a higher degree of network centrality tend to be more developed.

**Table 8: Estimates of urban network externalities with network structure**

Dependent variable: ln_y	Average investment intensity	Clustering coefficient
ln_minv	0.0510*** (0.0145)	
cluster		0.1200* (0.0609)
closeness	1.1009** (0.4602)	0.8760* (0.4838)
closeness2	-2.6142* (1.4926)	-2.6647* (1.5475)
ln_k	0.2277*** (0.0280)	0.2278*** (0.0287)
ln_l	0.0120 (0.0449)	0.0317 (0.0457)
ln_t	0.2334*** (0.0254)	0.2599*** (0.0243)
ln_stu	0.2328*** (0.0567)	0.2244*** (0.0581)
ln_fdi	0.0374** (0.0165)	0.0412** (0.0169)
gdp2p	0.5786** (0.2351)	0.4140* (0.2336)
Constant	8.4526*** (0.7107)	8.6802*** (0.7232)
Observations	192	192
R-squared	0.9831	0.9822

Notes: (1) \*\*\*, \*\*, \* indicate significance level at 1%, 5%, 10%, respectively. (2) Standard errors of parameter estimates are reported in parentheses.

### 5.3. The impact of industrial linkage

We have just confirmed that there are positive urban network externalities among urban agglomeration regions, but little is known about how urban network externalities work. Given urban networks are constructed based on the industrial investment between cities, the industrial linkage between cities is no doubt the underlying mechanism of urban network externality. In light of the concept of related variety, we will examine the moderating effect of industrial structure similarity among cities within urban agglomeration regions in Equation 8. As shown in Table 9, all the interaction terms of industrial structure similarity and network linkage are positive at least at 5% significance level, implying that industrial structure similarity has a positive moderating effect on the urban network externality. Hence, hypothesis 3 is confirmed. Moreover, viewing the change from 75 quantiles to 80 quantiles, we discover that the coefficient of the interaction term is decreasing, suggesting that the excessive similarity may lead to competition that damage the reciprocity for cities.

**Table 9: Moderating effect of industrial structure similarity**

Dependent variable: ln_y	Average investment intensity		Clustering coefficient	
	75 quantiles	80 quantiles	75 quantiles	80 quantiles
ln_minv	0.0371*** (0.0133)	0.0368*** (0.0137)		
simc_75q×ln_minv	0.0093*** (0.0021)			
simc_80q×ln_minv		0.0070*** (0.0021)		
cluster			0.0902 (0.0591)	0.1116* (0.0603)
simc_75q×cluster			0.1384***	

			(0.0363)	0.0875** (0.0360)
simc_80q×cluster				
ln_k	0.2157*** (0.0261)	0.2031*** (0.0267)	0.2285*** (0.0268)	0.2125*** (0.0275)
ln_l	0.0495 (0.0405)	0.0297 (0.0418)	0.0447 (0.0415)	0.0322 (0.0429)
ln_t	0.2183*** (0.0244)	0.2291*** (0.0247)	0.2346*** (0.0239)	0.2488*** (0.0240)
ln_stu	0.2499*** (0.0544)	0.2708*** (0.0570)	0.2539*** (0.0561)	0.2611*** (0.0584)
ln_fdi	0.0489*** (0.0156)	0.0485*** (0.0160)	0.0492*** (0.0162)	0.0494*** (0.0166)
gdp2p	0.2017 (0.2248)	0.2464 (0.2302)	0.2079 (0.2227)	0.2748 (0.2268)
Constant	8.4783*** (0.6775)	8.4619*** (0.6941)	8.3836*** (0.6983)	8.5169*** (0.7140)
Observations	192	192	192	192
R-squared	0.9841	0.9834	0.9833	0.9825

Notes: (1) \*\*\*, \*\*, \* indicate significance level at 1%, 5%, 10%, respectively. (2) Standard errors of parameter estimates are reported in parentheses.

Industrial structure similarity represents the possibility of industrial linkage, but the industrial characteristics of cities should be the final decisive factor that determines the industrial linkage between cities. Especially, the industrial characteristic of central cities will shape the pattern of the industrial linkage. It can be seen from the results in Table 10 that all interaction terms between the proportion of secondary industry of central cities and network linkage are positive mostly at 5% significance level or above, implying that proportion of secondary industry of central cities has a positive moderating effect on urban network externality. Hence, hypothesis 4 is confirmed. Interestingly, for average investment intensity and clustering coefficient both, the coefficients of interaction terms become larger and more significant from 75 quantiles to 80 quantiles, which manifests that central cities that specialize more in the secondary industry indeed form closer industrial linkages with surrounding cities.

**Table 10: Moderating effect of industrial characteristics of central cities**

Dependent variable: ln_y	Average investment intensity		Clustering coefficient	
	75 quantiles	80 quantiles	75 quantiles	80 quantiles
ln_minv	0.0431*** (0.0137)	0.0409*** (0.0134)		
gdp2p_cen_75q×ln_minv	0.0061** (0.0028)			
gdp2p_cen_80q×ln_minv		0.0110*** (0.0030)		
cluster			0.1224** (0.0606)	0.1035* (0.0600)
gdp2p_cen_75q×cluster			0.0917* (0.0538)	
gdp2p_cen_80q×cluster				0.1637*** (0.0566)
ln_k	0.1980*** (0.0276)	0.1883*** (0.0271)	0.2095*** (0.0282)	0.2012*** (0.0279)
ln_l	0.0477 (0.0421)	0.0441 (0.0411)	0.0464 (0.0429)	0.0426 (0.0422)
ln_t	0.2480*** (0.0255)	0.2587*** (0.0251)	0.2662*** (0.0250)	0.2751*** (0.0247)
ln_stu	0.2334*** (0.0564)	0.2409*** (0.0551)	0.2330*** (0.0576)	0.2400*** (0.0568)
ln_fdi	0.0437*** (0.0163)	0.0423*** (0.0159)	0.0427** (0.0167)	0.0408** (0.0165)
gdp2p	0.3254 (0.2321)	0.3431 (0.2236)	0.2576 (0.2312)	0.2657 (0.2253)
Constant	8.7860*** (0.7052)	8.8281*** (0.6878)	8.8332*** (0.7199)	8.8709*** (0.7073)
Observations	192	192	192	192
R-squared	0.9828	0.9836	0.9822	0.9827

Notes: (1) \*\*\*, \*\*, \* indicate significance level at 1%, 5%, 10%, respectively. (2) Standard errors of parameter estimates are reported in parentheses.

#### 5.4. Heterogeneous effects

It is validated that there are positive urban network externalities across urban agglomeration regions in China through the period of 2003 to 2018, but heterogeneous effects remain to be investigated. The primary distinction among urban agglomeration regions in our sample is the number of cities incorporated. As the number of cities troubles the comparison of the network characteristics mentioned in Section 5.1, urban network externality will work dissimilarly among urban agglomeration regions of different scales. To examine whether the scale will influence the urban network externality, we define that the ones with 16 or more cities are large scale and the others are small scale. Table 11 shows that the coefficients of network linkage in large-scale ones are positive at 5% significance level, while the coefficients in small-scale ones are below 10% significance level. The results, where coefficients in large-scale ones are larger and more significant, indicate that urban agglomeration regions with more cities tend to produce stronger urban network externalities. Although urban agglomeration regions with fewer cities seem to be closer from the network perspective, there is a threshold of scale that makes urban network externality works.

**Table 11: Heterogeneous effect of scale**

Dependent variable: ln_y	Average investment intensity		Clustering coefficient	
	Large scale	Small scale	Large scale	Small scale
ln_minv	0.0527** (0.0229)	0.0329* (0.0173)		
cluster			0.2444** (0.1189)	0.1032 (0.0717)
ln_k	0.3854*** (0.0553)	0.1947*** (0.0342)	0.4097*** (0.0542)	0.2011*** (0.0344)
ln_l	0.1712*** (0.0574)	-0.0385 (0.0630)	0.1674*** (0.0579)	-0.0353 (0.0636)
ln_t	0.1267*** (0.0426)	0.2359*** (0.0334)	0.1436*** (0.0414)	0.2486*** (0.0321)
ln_stu	0.1127 (0.0774)	0.3083*** (0.0843)	0.0903 (0.0763)	0.3144*** (0.0852)
ln_fdi	0.0185 (0.0257)	0.0487** (0.0220)	0.0018 (0.0290)	0.0488** (0.0221)
gdp2p	0.5608* (0.3268)	-0.1052 (0.3385)	0.6797* (0.3560)	-0.2058 (0.3314)
Constant	7.3871*** (1.0474)	8.6012*** (0.9672)	7.6664*** (1.0516)	8.5922*** (0.9772)
Observations	80	112	80	112
R-squared	0.9915	0.9781	0.9914	0.9778

Notes: (1) \*\*\*, \*\*, \* indicate significance level at 1%, 5%, 10%, respectively. (2) Standard errors of parameter estimates are reported in parentheses.

Since China has undergone great changes in economic development, the formation of urban agglomeration regions also takes time. We divide the period into two parts, namely period 1 (from 2003 to 2010) and period 2 (from 2011 to 2018), to investigate the time effect. As shown in Section 5.1, the compactness of urban networks is increasing gradually with time. A similar result is presented in Table 12 that the coefficients are not significant in period 1 but positive at 5% significance level. This implies that with urban networks become tighter, urban network externalities become stronger and more prevailing. From another point of view, urban network externality takes effect more obviously in the later period, suggesting that urban network externality is more critical to the economic growth of urban agglomeration regions in recent years.

**Table 12: Heterogeneous effect of time**

Dependent variable: ln_y	Average investment intensity		Clustering coefficient	
	2003-2010	2011-2018	2003-2010	2011-2018
ln_minv	0.0219 (0.0145)	0.0309** (0.0149)		
cluster			-0.0491 (0.0606)	0.1331** (0.0606)
ln_k	0.3883*** (0.0430)	0.1538*** (0.0247)	0.3883*** (0.0436)	0.1561*** (0.0246)
ln_l	0.1934* (0.1027)	0.1224** (0.0511)	0.1831* (0.1036)	0.1335*** (0.0505)
ln_t	0.1267*** (0.0377)	0.2334*** (0.0330)	0.1498*** (0.0369)	0.2479*** (0.0308)
ln_stu	0.2214*** (0.0697)	0.0546 (0.1219)	0.2066*** (0.0701)	0.0622 (0.1215)
ln_fdi	0.0347 (0.0268)	0.0315 (0.0202)	0.0387 (0.0276)	0.0249 (0.0203)
gdp2p	-0.8810* (0.4592)	0.1937 (0.2936)	-0.8206* (0.4622)	0.1683 (0.2893)
Constant	6.3382***	12.1928***	6.5579***	12.1792***

Observations	(0.9761)	(1.5287)	(0.9832)	(1.5236)
R-squared	96	96	96	96
	0.9770	0.9456	0.9765	0.9459

Notes: (1) \*\*\*, \*\*, \* indicate significance level at 1%, 5%, 10%, respectively. (2) Standard errors of parameter estimates are reported in parentheses.

## 6. CONCLUSION

The main goal of this study is to determine the role of urban networks on the economic growth of urban agglomeration regions. The contributions of our study are twofold. On the one hand, we evaluate the development of urban agglomeration regions using the complex network method. From the view of compactness and centrality, the top three urban agglomeration regions are undoubtedly the most mature. Other urban agglomeration regions can be divided into two groups based on the network development. As time goes on, urban networks in urban agglomeration regions become increasingly compact, but network centrality presents various trends according to the property of urban agglomeration regions.

On the other hand, we established a theoretical framework of urban network externality, and empirically investigated the urban network externality on the economic growth. Based on the theory of agglomeration externality, we introduced the concept of urban network externality and proposed the relationship between network centrality and economic growth. Furthermore, we explained the underlying mechanism of urban network externality working through industrial linkage. The empirical results supported the hypotheses proposed, which can be summarized along the following four lines. First, there were positive urban network externalities on economic growth across urban agglomeration regions. Second, the inverted U relationship of network centrality and economic growth was found. Third, both the industrial structure similarity and the proportion of secondary industry of central cities could strengthen the urban network externalities. Finally, the larger and more significant urban network externalities were found in large-scale urban agglomeration regions and recent years.

These results suggest that urban networks play a significant role in regional economic growth. Accordingly, we will discuss the policy implication from three aspects as follows. First, embedding as many as possible cities into urban networks and intensifying the linkage within urban networks can be helpful to economic growth for both developed and developing countries, because urban network externality can exploit the unfulfilled potential of economic growth. The organization of cities in the form of a network is also efficient and sustainable. Governments should encourage the cross-city cooperation of firms, accelerate the flow of all production factors and break down the barriers between cities by increasing the input in transportation and information infrastructure. Second, keeping a certain degree of network centrality can make the best of urban network externality. More specifically, for underdeveloped urban agglomeration regions, it is beneficial to promote the dominance of central cities, since such a network structure will take full advantage of the agglomeration economy for the lack of resources. For urban agglomeration regions with more maturity, network centrality maintained at a moderate level can do best for economic growth, which should also be adjusted dynamically according to the status of urban agglomeration regions. Third, reinforcing the industrial linkage is one critical way to exert urban network externalities. Proper industrial structure similarity will facilitate industrial linkage due to the common knowledge base. Besides, central cities with a higher ratio of the secondary industry also tend to interact more with surrounding cities. Hence, central cities shouldn't concentrate on the tertiary industry excessively for fear of isolation from the surrounding cities.

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## **Regular Session: RS01.1 - Entrepreneurship**

**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/88466279359>**

**Chair Marina Van Geenhuizen**

## YOUNG HIGH-TECH FIRMS AND MARKET INTRODUCTION OF SUSTAINABLE ENERGY SOLUTIONS

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### ABSTRACT

The paper deals with a specific type of young high-tech firms, namely spin-offs from universities. Universities act as cradles of invention, and their spin-off firms attempt to bring (part of) these inventions to market. Increasingly, the new products, processes and services deal with sustainable energy solutions. However, the extent in which such solutions reach the market and the kind of risk-related factors young firms encounter and influence survival, are hardly known and understood. The paper aims to clarify market introduction by focusing on empirics of firms' risk-taking behavior related to strategic choices, competences and interaction with (national) ecosystem conditions. We use a unique dataset of almost 110 university spin-off firms in Northwest Europe and a small selected sample from this set. 60 per cent of the spin-offs are able to reach the market with their invention, most of them in the first five years of their lives. Wind-energy provides the best chances, as compared to e.g. solar PV and advanced biomass. In-depth results suggest high probability of quick market introduction in 'Innovation Leader' countries, like Sweden and Denmark, if combined with employing rich collaborative networks. A second set of favourable influences includes a practical mind-set of the entrepreneurs and accessing substantial investment capital. In contrast, strong risks tend to be connected to activity in fundamental inventions, highly specialized technology, weakly developed (sub) markets, poorly built networks and short refunding time of substantial investment. In the paper, such risks are connected to survival rates. The study contributes to literature on market introduction of sustainable energy solutions, risk-taking in rigid socio-technical systems, and firm survival.

## DETERMINANTS OF NEW FIRM FORMATION IN JAPAN: NEW METHODS FOR THE ANALYSIS OF ENTREPRENEURSHIP

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### ABSTRACT

There have been many studies conducted on the factors of the new firm formation because it is an economic activity that revitalizes the regional economy and is also one of the important factors for regional economic development. However, new analysis methods are required since the factors of new firm formation are generally divided into entrepreneurship and entrepreneurial environment, and entrepreneurship itself is difficult to be grasped directly. The purpose of this study is to capture entrepreneurship in the new firm formation rate in Japan and clarify its components through factor analysis. The analysis methods used in this research are as follows. First, we perform a factor analysis of the fixed-effect model using two-point panel data of the Economic Census to explain the new firm formation rate of each prefecture in the country. Secondly, the entrepreneurship is indirectly grasped by the measured fixed effect, and an index of entrepreneurship at prefectural level is created based on the analysis results. Thirdly, we create indexes of attitudes for new firm formation, social capital, diversity, tolerance, and business network at the regional level based on economic and social statistics. Fourthly, the components of entrepreneurship at the regional level are clarified by analyzing the relationship between entrepreneurship and the above indexes. Finally, we derive policy implications that contribute to the promotion of new firm formation based on the analytical results.

### KEYWORDS

Entrepreneurship, New firm formation, Panel data analysis

### 1. INTRODUCTION

The new firm formation is an economic activity that stimulates the regional economy and is one of the important factors for economic development, but there is a large regional disparity in the level of its activity. It is reported that the new firm formation rate is very low in Japan among developed countries internationally and that the disparity in the new firm formation rate among prefectures is more than twice as large as in Japan (Small and Medium Enterprise Agency 2020). The factors that determine the new firm formation rate can be broadly classified into demand, supply, and other factors for new businesses, and these factors are thought to bring about the regional disparity in the new firm formation. Amongst, entrepreneurship is regarded to be the main factor in the "other factors" and to play an important role in the startup of a new business. However, entrepreneurship itself is difficult to be grasped directly. In this research, after reviewing the previous studies, we propose a new analytical method to understand the impact of entrepreneurship at the regional level based on fixed effects in a panel data analysis of the new firm formation rate. In addition, we clarify the factors that influence the new firm formation and the components of entrepreneurship by applying the above method to prefectural level data and derive policy implications for promoting new business startups from the aspect of entrepreneurship.

### 2. SURVEY OF PREVIOUS STUDIES

#### 2.1. Quantitative studies on new firm formation

Many previous studies have focused on the regional disparities in entrepreneurship and attempted to identify the factors affect new firm formation. In particular, there has been a large body of quantitative analysis studies, mainly in the United States and Europe. Table 1 summarizes some of the variables, causal variables, and measurement methods for new firm formation in previous studies.

Armington and Acs (2002) conducted a multiple regression analysis of the effects of regional economic factors on new firm formation in the U.S.A. and found that firm sizes, industry groups, growth rates of income and population, management (management/labor force), unemployment rate, and education affect the number of new businesses per labor force. Parajuli and Haynes (2017) conducted a spatial panel data analysis for New England, U.S.A., and found that population density, deposit balance, firm size, income growth, public schools, and unemployment rate affect the rate of new firm formation. By estimating a spatial Durbin model for Italy, Piacentino et al. (2017) showed that population growth, innovation (patents), population density, age structure, withdrawal rate, unemployment rate, industry specialization, number of commuters, and national voting rate affect the number of new firms per capita. On the other hand, Lee et al. (2004) introduced indicators of creativity and diversity of the population in addition to general factor variables as factors affecting new firm formation.

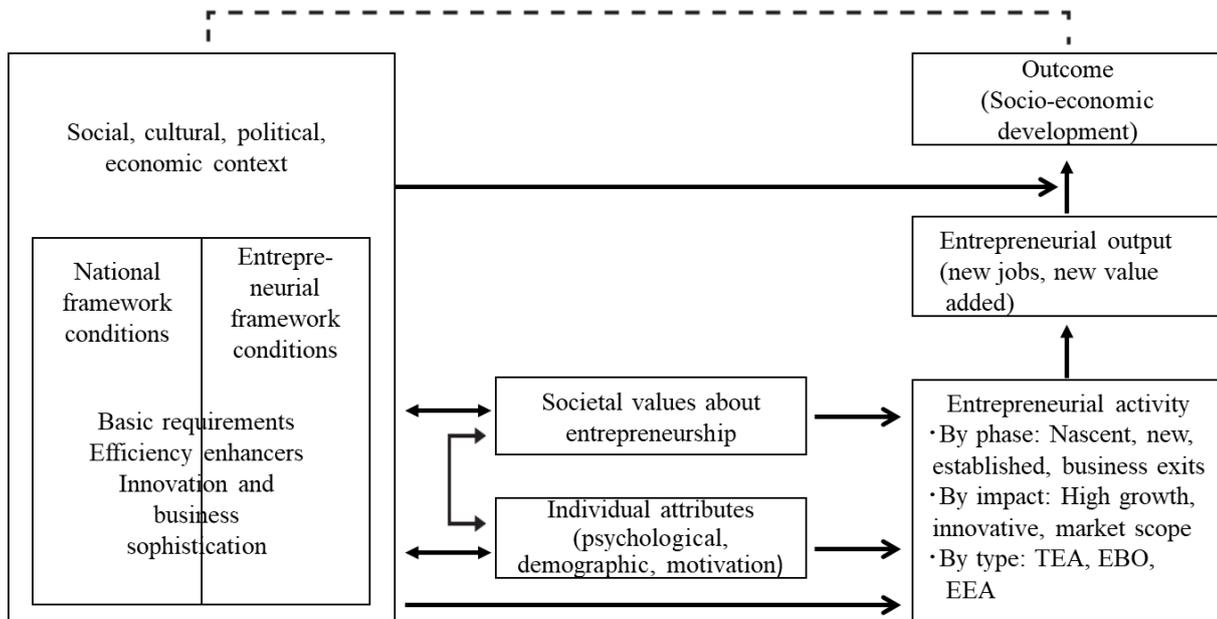
**Table 1: Examples of quantitative studies on new firm formation**

	Variable of new firm formation	Explanatory variables	Estimation method
Armington and Acs (2002)	New firms / labor force	Establishment size, Establishment size, Industry intensity, Income growth; population growth, Share of proprietors, Unemployment rate, No high school degree, College graduates	Multiple regression analysis
Parajuli and Haynes (2017)	Logarithm of single-unit firm birth	Population density, Public enrollment per capita, public enrollment per capita and savings institutions, , Ratio of establishments with 50 or CB more employees to establishments with less than 10 employees, Unemployment rate, Population growth rate, Per capital personal income growth rate	Spatial panel analysis
Piacentino et al. (2017)	New firms / Population	Population growth, Innovation (Patents per capita), Urbanization, Population density, Age distribution, School dropout rate, Unemployment rate, Industrial specialization, Endowment of services, Incoming workers, Voter turnout	Spatial analysis
Lee et al. (2004)	New firms / Population	Creativity Index, Diversity Index, Melting Pot Index, Human capital, Population, Income growth rate, Patents per capita, Population growth rate	Multiple regression analysis
Okamuro and Kobayashi (2005)	New firms / Total firms	Population growth rate, Manufacturing industry wage, Unemployment rate, Graduate rate, Professional-technical job ratio, Household with owned house ratio, Ratio of professional and technical workers, Firm density, Manufacturing industry ratio, Average size of firms, Transportation, Public services expenditure per capita	Multiple regression analysis
Komoto (2007)	New firms / Total firms	Firm closure rate, Unemployment rate, Household growth rate, Growth rate of taxable income, Ratio of aged 65 and over, Commercial land prices, Wages, Ratio of service industries, Ratio of professional and technical workers	Panel data analysis
Kiminami et al. (2019)	New firms / Total firms	Ratio of person who wants to startup ratio, Ration of person who wants to prepare for startup, Population density, Average income, Unemployment rate, Social capital	Structural equation modeling

In recent years, there has been an increasing number of studies on new firm formation in Japan. Okamuro and Kobayashi (2005) have developed a model that explains the regional new firm formation rate by demand factors, cost factors, human capital factors, financing factors, industrial concentration and structure factors, and other factors. Komoto (2007) found that the factors affect new firm formation are those as follows: firm closure rate, unemployment rate, growth rate of household income, growth rate of taxable income, population over 65 years old, land price of commercial land, wages, ratio of service industries, and ratio of professional and technical workers to workers, etc. Furthermore, Kiminami et al. (2019) introduced structural equation modeling to analyze the impact of the desire to startup, readiness to startup, population density, income, and unemployment rate on new firm formation using the data of Japanese prefectures.

**2.2. Studies on entrepreneurship and economic development**

Instead of focusing on the rate of new firm formation, some previous studies related to new business startups pay attention to people's entrepreneurial activities, entrepreneurial attitudes, and personal attributes. This type of studies usually use the data from Global Entrepreneurship Monitor (GEM) (Honjo 2015; Hundt and Sternberg 2016). In the GEM, global surveys have been conducted according to the framework shown in Figure 1, where entrepreneurship is viewed as an interrelationship of individual entrepreneurial activities (attitudes, behaviors, and motivations) and their social, cultural, political, and economic backgrounds. Among them, Honjo (2015) found that the weak awareness of entrepreneurship in Japan leads to the weak entrepreneurial activities, but as for those who have the necessary knowledge, skills, and experience, the likelihood of starting up a business is higher than others.



**Figure 1: Analysis framework of Global Entrepreneurship Monitor (GEM)**

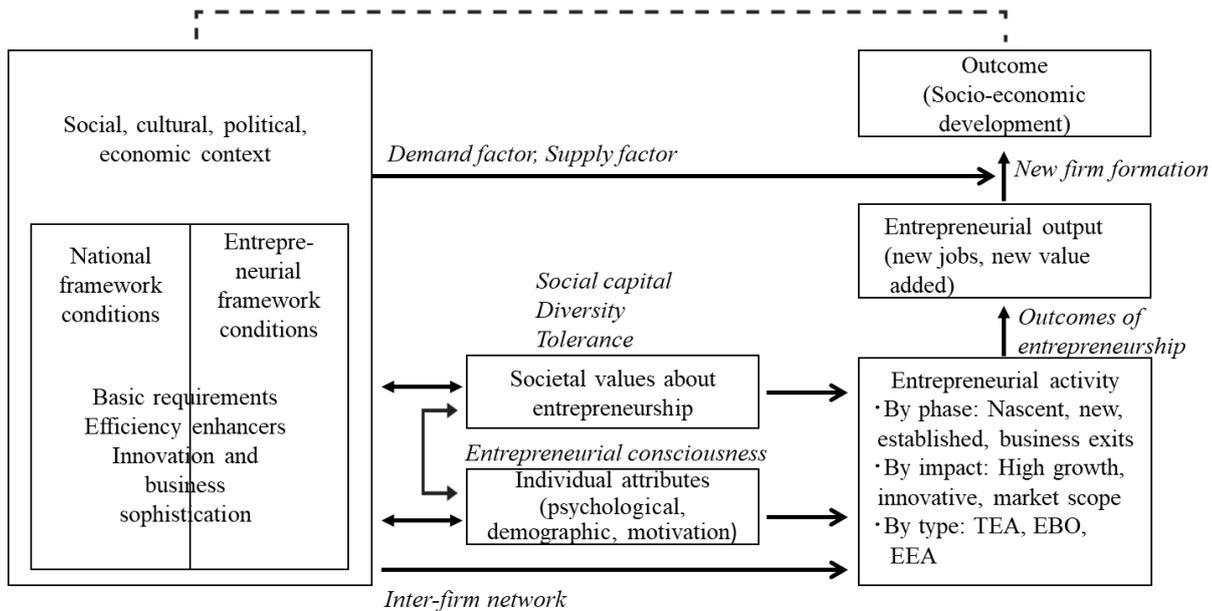
Source: Global Entrepreneurship Monitor (2019).

On the other hand, Harada (2005) analyzed the effect of economic variables on entrepreneurial consciousness called "latent entrepreneurship" in Japan, using the panel data by prefecture. Furthermore, using the individual data from "Employment Status Survey" (Ministry of Internal Affairs and Communications), Matsuda et al. (2016) analyzed the factors of entrepreneurial attitudes in Japan. However, the impact of economic conditions on entrepreneurship is considered to be a long-term rather than a short-term. Besides, there was few studies on the relationship between individual entrepreneurship and the actual startup of a new business.

Due to a new business startup is to produce new economic activities, the demand and supply factors that directly affect the creation of the business are undoubtedly to be focused. Furthermore, "other factors" that affect new business startups, especially entrepreneurship should be distinguished from the demand and supply factors. In this study, we conduct panel data analysis using the variables of demand and supply conditions for new firm formation and consider the fixed effects calculated from the analysis as the outcomes of entrepreneurship specific to the region.

Although, Komoto (2007) calculated the magnitude of the fixed effects of "support measures for business start-up by prefectural governments," "the awareness of residents toward business start-up," etc., the analysis from the view of entrepreneurship was not sufficiently conducted. Besides, Parajuli and Haynes (2017) used the panel data analysis for new business startups using the variables related to human capital, such as the proportion of professional and technical workers and education, as proxy variables for entrepreneurship. Another approach is to consider entrepreneurship in a broad sense as an outcome that cannot be explained by demand and supply factors, such as in the analysis of the factors that contribute to the diversification of farm management in Japan (Kiminami et al. 2020), in which they used the method of fixed effects of panel data analysis as the outcomes of entrepreneurship at the regional level.

And the outcomes of entrepreneurship are assumed to be determined by the factors such as social, cultural, political, and economic backgrounds, the awareness of residents toward startups and the social capital in the region. A modification of GEM framework and the variables used in the empirical analysis for explaining the differences in new firm formation among regions in Japan are shown in Figures 2.



**Figure 2: Areas of analysis in this study**

Social capital is "the features of social organization such as trust, norms, and networks that improve social efficiency by promoting cooperative behavior" (Putnam 1993). Due to different functions in connecting actors, social capital can be roughly divided into bonding type and bridging type. Bonding type of social capital has the functions of linkage between homogeneous actors in a social organization, which generates trust, cooperation, and unity within the organization. These functions are thought to promote new business, but they may also lead to exclusiveness and suppress new business. On the other hand, bridging type of social capital has the function to form a consensus by sharing and exchanging information among groups with various interests, and is thought to promote new business, which is a network of heterogeneous actors and social organizations.

Peir'o-Palomino (2016) measures the impact of social capital on economic growth for European cities and finds that the impact on economic growth is non-linear and that the effect varies by region and time. The results of Yodo (2005) show that "normality" has a positive impact on regional economic growth, while "trust" has no significant impact.

Kiminami et al. (2019) built a model assumed causal processes among the variables, different from most of previous studies that added various types of social capital to the factor variables for new firm formation without considering the complex interrelationships among them,

Diversity includes what is represented by statistics such as gender, age, nationality, and employment status, but also deeper things that cannot be represented by statistics such as values, personality, job attitude and ability (Ishikawa 2014). METI (2012) states that in order to break through the stagnation of the Japanese economy, it is important to increase diversity and create innovation.

As for gender diversity, World Economic Forum (2020) pointed out that gender parity has a fundamental bearing on whether or not economies and societies thrive and calculated Global Gender Gap Index of each countries in the world. In 2020, Japan ranks 116th out of 153 countries in terms of gender parity, making it a country with an extremely large gender gap. In particular, Japan's economic participation and opportunity index is not only low, but also shows a further decline in ranking in recent years. The European Institute for Gender Equality (2019) also states that closing the gender gap will create jobs, produce competitiveness, and contribute to economic development. Dai et al. (2019) reported that gender diversity has a positive impact on innovation, including the study on new venture teams. Also, the study on the relationship between creative class and sustainable development of regions by Furuzawa et al. (2019) has revealed that gender diversity and tolerance are important.

With respect to ethnic diversity, Jiang et al. (2020) found that ventures with ethnically diverse founding teams tend to realize higher returns in the U.S.A. On the other hand, Ramasamy and Yeung (2018) conclude from their international comparative study that ethnic diversity has a negative impact on innovation and that cultural diversity has a positive impact.

### 3. ANALYTICAL MODEL AND METHODS

From the results of the previous studies, the factors affect new firm formation can be classified into demand factors, supply factors, and other factors. While variables of demand factors include population density, income growth rate, etc., variables of supply factors include labor force, unemployment rate, capital, land price, firm size, and industry composition, and variables of "other factors" include individual and organizational entrepreneurship and social capital. As for the variables related to individual entrepreneurship, human capital such as educational background and percentage of professionals, as well as awareness of startup of a business are used. Moreover, we use firm density and

industrial agglomeration as variables of organizational entrepreneurship since they represent networks among firms and organizational activities.

Generally, theoretical model is rarely presented in most econometric studies on the determinants of new firm formation rate. However, the theoretical model for the choice between self-employed or employee by Talyer (1996, 1999) seems very useful in the study of new firm formation. It is assumed that an individual will take the one with a higher expected utility while facing the choice between becoming self-employed (SE) through starting up a business or becoming an employee (E) through getting a job, as shown by the following.

$$E(U_{SE}) = f(\theta, k, r, D, X)$$

$$E(U_E) = g(w, X)$$

Where, the expected utility from self-employed  $E(U_{SE})$  is a function of entrepreneurial ability  $\theta$ , available capital  $k$ , interest rate  $r$ , level of demand in the economy  $D$ , and individual preferences  $X$ . Similarly, the expected utility from employee  $E(U_E)$  is a function of wage  $w$  and  $X$ . If  $E(U_{SE}) > E(U_E)$ , self-employed will be chosen. And if  $E(U_{SE}) < E(U_E)$ , employee will be chosen. Among the variables that determine  $E(U_{SE})$  and  $E(U_E)$ ,  $k$ ,  $r$ ,  $D$ , and  $w$  are variables of the economic environment,  $\theta$  is a variable of entrepreneurship, and  $X$  is a variable of personal attributes. Besides, both self-employed and employee are facing risks affected by economic environment. For example, if unemployment rate is high, employees are facing the risk of losing job and  $E(U_E)$  becomes zero.

Therefore, it is assumed that changes in the economic environment affect the expected utility through  $k$ ,  $r$ ,  $D$ ,  $w$ , and risk in a short run, and affect expected utility through  $\theta$  and  $X$  in a long run. However, social and cultural environment is thought to have a long-run effect on entrepreneurship and a short-run effect on the expected utility for business startup. Moreover, it is supposed that there is also a feedback from individuals' choice for self-employed or employment to the economic environment. Replacing the choice of self-employed with that of the startup of a new business, we can set the economic model for the determinant factors of the startup of a new business.

#### 4. UNDERSTANDING THE OUTCOMES OF ENTREPRENEURSHIP

The explained variable used in the panel data analysis is the rate of new firm formation. The explanatory variables are the rate of income growth, the ratio of working-age population, population density, unemployment rate, the ratio of tertiary industry, and patents. The definitions and levels of each variable are summarized in Table 2. The data for explained variables are the years of 2014 and 2016. Since the data for the dependent variable is based on the number of new businesses startup in the past two years, the years of 2012 and 2014 were used for the explanatory variables.

**Table 2: List of variables used in panel data analysis**

Variable	Definition	Year	Average	Min.	Max.
NFR	New firm formation rate: Number of new firm/Total number of firm (%)	2014	7.9	5.9	12.2
		2016	5.5	4.1	8.3
POD	Population density: Population/Livable area (person/ km <sup>2</sup> )	2012	1,369	246	9,506
		2014	1,365	244	9,609
IGR	Income growth rate: Growth rate of per capita income (%)	2012	-0.2	-7.3	8.8
		2014	0.5	-3.3	4.4
WPR	Working-age population ratio: 15~64 years old / Population (%)	2012	61.2	57.3	67.5
		2014	59.6	55.6	66.2
UER	Unemployment rate: Unemployed/Labor force (%)	2012	4.0	2.5	6.8
		2014	3.3	5.4	2.3
TER	Tertiary industry ratio: Gross output of tertiary industry/ Total (2011price)(%)	2012	69.5	54.8	86.5
		2014	68.7	54.3	86.2
PAT	Patents: Number of patents registered/ 100,000 population	2012	72.1	5.7	874.2
		2014	57.5	3.8	706.9

NFR: 2014 Economic Census for Business Frame, 2016 Economic Census for Business Activity (Ministry of Internal Affairs and Communications); POD: Population Estimates (Ministry of Internal Affairs and Communications), National Survey of Urban, Town and Village Areas (Ministry of Land, Infrastructure, Transport and Tourism); IGR, TER: List of Japanese Prefectures by GDP (Cabinet Office); WPR: Population Estimates (Ministry of Internal Affairs and Communications); UER: Labor Force Survey (Ministry of Internal Affairs and Communications); PAT: Population Census (Ministry of Internal Affairs and Communications), Japan Patent Office Annual Report (Japan Patent Office)

The results of the panel data analysis for the rate of new firm formation are summarized in Table 3. As a result of testing the fixed effects model, the Pooled model and the random effects model, the fixed effects model was supported. According to the results of the fixed effects model, the ratio of working-age population, unemployment rate, and patents have a strong influence on the rate of new firm formation, and the signs of the coefficients are as expected. The coefficient of population density is negative, but not significant. In general, the higher the population density, the greater the demand, so the sign of the coefficient is expected to be positive, however Delfmann et al. (2014) pointed out that a higher population density also has a negative effect.

**Table 3: Results of panel data analysis (Explained variable: NFR)**

	Fixed effect model			Pooled model			Random effect model		
	coeff	t-value		coeff	t-value		coeff	z-value	
POD	-0.008	-1.567		0.000	-1.229		0.000	-3.061	**
IGR	0.033	1.253		0.040	-0.248		0.035	-0.997	
WPR	1.060	8.332	***	0.064	4.894	***	0.080	5.501	***
UNE	0.716	2.912	**	0.187	5.165	***	0.205	6.750	***
TER	0.038	0.722		0.018	0.641		0.022	0.121	
PAT	0.008	2.492	*	0.002	2.088	*	0.002	3.279	**
Const.				4.032	-4.115	***	4.983	-4.976	***
	R <sup>2</sup> : 0.965 Adj. R <sup>2</sup> : 0.920 F-value:187.455 on 6,41 DF, p-value < 2.22e-16			R <sup>2</sup> : 0.706 Adj. R <sup>2</sup> : 0.686 F-value: 34.866 on 6, 87 DF, p-value: < 2.22e-16			R <sup>2</sup> : 0.808 Adj. R <sup>2</sup> :0.795 Chisq: 367.018 on 6 DF, p-value: < 2.22e-16		

**5. FACTORS AFFECTING ENTREPRENEURSHIP OUTCOMES**

Next, we will analyze the factors that affect the fixed effects measured by the panel data analysis. In other words, instead of the demand and supply factors, "other factors" for new firm formation will be grasped. However, "other factors" discussed in this study are the individual entrepreneurship, inter-firm networks, social capital, diversity and tolerance, and the corresponding proxy variables are summarized in Table 4. Since the fixed effects are derived from the analysis of new business startups during the period of 2012-2016, the percentage of applicants for startups and firm density are based on the data of 2012.

Usually, proxy variables are used as variables for social capital by prefecture in previous studies, here we use an index created from the results of a large-scale questionnaire survey conducted in 2015 (Research Group on Mechanisms and Activation of Local Activities 2016).

**Table 4: List of variables used in the analysis of factors affecting fixed effects**

Variable	Definition	Year	Average	Min.	Max.
FIE	Score of fixed effect		-51.72	-62.00	6.56
ENT	Prospective entrepreneurs ratio: Person who wants to startup / Aged 15 years and over (%)	2012	0.83	0.54	1.62
FID	Firm density: Firms / Livable area (/ km2)	2012	63.1	10.9	516.5
BON	Bonding index	2015	0.33	0.23	0.42
BRI	Bridging index	2015	0.23	0.20	0.29
GEG	Gender gap: Male-female gap of self-employed and executive ratio (%)	2012	12.6	8.0	17.7
FOR	Ration of foreigner: Foreigners / Population (%)	2012	1.17	0.28	3.10
SUI	Suicide ratio: Suicides / Population (%)	2012	0.21	0.17	0.27

ENT, GEG: Employment Status Survey (Ministry of Internal Affairs and Communications); FID: Economic Census, Population Census (Ministry of Internal Affairs and Communications); BON, BRI: Study Group on Mechanisms and Activation of Community Activities (2016); FOR: Population, demographics, and number of households based on the Basic Resident Ledger (Ministry of Internal Affairs and Communications, Statistics on Foreign Residents (Ministry of Justice); SUI: Population, demographics, and number of households based on the Basic Resident Ledger (Ministry of Internal Affairs and Communications), National Center of Neurology and Psychiatry, "Regional Statistics of Suicide Deaths for Suicide Prevention 1983-2012.

Following trends in the percentage of prospective entrepreneur those who wish to start up a business by age, gender, and type of business are shown in Table 5. First, among those aged 25 and over, the order of the percentage of those who wish to start up a business is as follows: unemployed > additional job (employed) > job change (employed). However, in the case of those aged 15-24, the order is additional job (employed) > unemployed > job change (employed), and it is considered that many students are included in the unemployed.

Although, the percentage of men who want to start a business is higher than that of women in all age groups, in the age groups of 25-54, who are unemployed, the percentage of women who want to start a business is higher than that of men (Table 6). It suggests that gender gap in employment affects the awareness of startups.

**Table 5: Ratio of those who want to startup (%)**

	Additional job (employed)		Job change (employed)		unemployed	
	Male	Female	Male	Female	Male	Female
Total	1.44	0.53	0.96	0.39	1.23	0.58
15~24 years old	0.86	0.34	0.81	0.31	0.62	0.34
25~34years old	2.00	0.68	1.43	0.64	4.23	1.56
35~44years old	2.07	0.79	1.27	0.54	5.38	1.78
45~54years old	1.61	0.61	0.95	0.34	5.27	1.60
55~64years old	0.75	0.30	0.63	0.19	2.31	0.68
65~74years old	0.45	0.10	0.26	0.15	0.76	0.19
Over 75years old	0.14	0.07	0.06	0.02	0.28	0.03

Source: Employment Status Survey 2012 (Ministry of Internal Affairs and Communications)

**Table 6: Composition of those who want to startup (%)**

	Additional job (employed)		Job change (employed)		Unemployed	
	Male	Female	Male	Female	Male	Female
Total	34.92	9.73	23.37	7.14	13.48	11.35
15~24 years old	1.40	0.57	1.33	0.51	1.55	0.78
25~34years old	8.98	2.34	6.42	2.21	1.99	2.14
35~44years old	12.17	3.33	7.44	2.27	2.24	3.42
45~54years old	7.84	2.34	4.65	1.31	1.93	2.18
55~64years old	3.53	1.00	2.97	0.63	2.70	1.87
65~74years old	0.91	0.13	0.51	0.19	2.16	0.80
Over 75years old	0.09	0.03	0.04	0.01	0.91	0.16

Source: Employment Status Survey 2012 (Ministry of Internal Affairs and Communications).

The correlation coefficients among the variables are shown in Table 7. The ratio of prospective entrepreneurs (ENT), firm density (FID), and the ratio of foreigners (FOR) are positively correlated with fixed effects (FIE), with firm density having a particularly strong positive correlation. Bonding index (BON), bridging index (BRI), gender gap (GEG), and suicide rate (SUI) are negatively correlated.

Table 8 summarizes the correlations between each variable and the fixed effects. The results generally show the expected signs, but the bridging index and suicide rate were not significant. For the bonding index, both positive and negative signs were possible, but the sign was negative.

**Table 7: Correlation coefficient between variables**

	FIE	ENT	FID	BON	BRI	GEG	FOR	SUI
FIE	1.000	<u>0.635</u>	<u>0.975</u>	<u>-0.483</u>	-0.238	<u>-0.326</u>	<u>0.591</u>	-0.220
ENT		1.000	<u>0.650</u>	<u>-0.625</u>	-0.205	-0.245	<u>0.407</u>	<u>-0.309</u>
FID			1.000	<u>-0.495</u>	-0.226	<u>-0.297</u>	<u>0.621</u>	-0.201
BON				1.000	<u>0.523</u>	<u>0.368</u>	-0.143	0.190
BRI					1.000	<u>0.372</u>	-0.188	-0.012
GEG						1.000	<u>-0.540</u>	0.238
FOR							1.000	<u>-0.321</u>
SUI								1.000

Note: Double underline and underline mean statistically significant at the 1% and 5% levels, respectively.

**Table 8: Correlation coefficient with FIE (score of fixed effect)**

Variable	Expected sign	Result
ENT	+	+
FID	+	+
BON	+ / -	-
BRI	+	0
GEG	-	-
FOR	+	+
SUI	-	0

Note: +, -, and 0 in the result column indicate positive correlation, negative correlation, and no correlation, respectively, at the 5% level of statistical significance.

## 6. CONCLUSION

The following conclusions were drawn from the results of the above-mentioned analysis. First, it became clear that supply factors such as the working-age population, the unemployment rate, and patents have strong influences on new business start-ups. This implies that policies promoting new business start-ups should be combined with the policies promoting the availability of labor and innovation creation. On the other hand, demand factors do not have a significant impact, suggesting that the new firm formation that meets demand is not sufficiently progressing in Japan.

Next, the regional differences in the fixed effects as the level of entrepreneurship were larger than the regional differences in the rate of new firm formation. This means that the factors of entrepreneurial awareness, inter-business networks, social capital, diversity and tolerance that are inherent in the region are more important. In particular, the influence of inter-business networks is the strongest, which induces new business start-ups and lead to further agglomeration of firms. Therefore, when considering policies to promote new businesses, it is necessary to consider not only policies directly related to industries but also policies to increase the level of entrepreneurship in the region (Kiminami et al. 2020).

However, there remain several issues in the study. First, the interrelationships among the factors that constitute entrepreneurship need to be explored and clarified. Second, the variables related to entrepreneurship policies implemented in each region need to be introduced and evaluated, and the industry-specific analysis based on industrial characteristics need to be developed.

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## FACTORS THAT INFLUENCE ON THE ENTERPRENUERIAL INTENTION OF UNEMPLOYEES IN COVID-19 TIMES

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### ABSTRACT

Currently, the COVID-19 pandemic has caused many changes both in health and economic terms. In Ecuador, the existent harsh economic situation was agravated with an increase of the unemployment in 9 percentage points from 4% by 2019, to 13.3% by June 2020. Given this scenario, people who fell into unemployment and already unemployed people might see the entrepreneurship as a viable option to maintain or increase their income. In the Ecuadorian case, in which most of microentrepreneurs have a survival perspective, existent and new unemployees may have a defensive attitude to escape unemployment. Then, microentrepreneurship plays as a "refuge effect" (Vivarelli, 2004; Thurik et al, 2008). Therefore, the research question is: what are the factors that drive unemployed people to undertake their own business? Do these factors differ across types of unemployess, namely, existent unemployees and new unemployees due to COVID-19?. To answer to these questions, data from a national survey undertaken by the educational institution Escuela Politécnica Nacional of Ecuador during the pandemic is used. This database accounts for 3,868 observations. To determine the probability of enterprenuerial intention, a Probit model is estimated for two types of unemployed people, namely existent unemployees and new COVID-19 unemployees. Sociodemographic characteristics, family conditions and financial aspects are considered as explanatory variables. Among the sociodemographic variables, we have sex, age, level of education, income level, the nationality, whether the person accounts for medical insurance and civil status. Among the family conditions we have the number of members in the family and number of income perceptors. Regarding the financial conditions, we consider the debt, the savings, necessity of credit and financial knowledge. Finally, the variation of income level due to the pandemic is included. The results show that the underlying motivations of enterprenuerial intentions vary across existent and new unemployees. For instance, the level of education influences in opposite directions. As the level of education increases, the enterprenuerial intention also increases for COVID-19 unemployees but reduces for existent unemployees. This result could indicate that unemployees in the context of a crisis use their human capital in entrepreneurship to improve their situation. The number of income perceptors reduces the enterprenuerial intention for COVI-19 unemployees, as there exists more mechanisms of consumption smoothing. This aspect is not significant for existent unemployees. Interestingly, the necessity for credit increases the intention of entrepreneurship for both types of unemployees. In this sense, policies that boost enterprenuerial activity by generating differentiated credit products for identified groups of people, are needed. The variation of income due to the crisis influences only on the enterprenuerial intention of existent unemployees. In this line, it is important to create opportunities through training and promote an optimal environment for entrepreneurship.

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## **Regular Session: RS02.1 - Infrastructure, transportation and accessibility**

**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/83379645511>**

**Chair Evi Noor Afifah**

**CRIME AND CHINESE AID PROJECTS IN GHANA**

**Michael Appiah-Kubi**

School of Economics, Xiamen University, China

**ABSTRACT**

The impacts of Chinese aid in Africa have been the focus of recent studies, suggesting a high probability of elite capture and political patronage. It should make residents in the projects' vicinities feel neglected since the intended benefits that may accrue from the projects are not likely to trickle down to them. The paper examines the impact of Chinese aid projects on criminal activities in Ghana. Using a geo-referenced dataset of subnational allocation of Chinese projects which is geographically matched with 10,797 respondents of Afrobarometer surveys for Ghana, we implement a difference-in-difference identification strategy to capture the impact of living near vicinity of projects under implementation at the time of the survey against areas where a project will be implemented in the future. The results suggest that living near projects under implementation makes residents prone to be burglarized but less likely to be physically attacked. There is no equivalent pattern when considering projects financed by other donors.

## IMPACT EVALUATION OF VOCATIONAL TRAINING FOR PEOPLE WITH PHYSICAL DISABILITIES ON EMPLOYMENT OPPORTUNITIES

**Leni Marlina<sup>1</sup>, Evi Noor Afifah<sup>2</sup>**

<sup>1</sup>Government of Rejang Lebong Municipal, Bengkulu, Indonesia. <sup>2</sup>Department of Economics, Universitas Gadjah Mada, Indonesia

### ABSTRACT

This study examines the impact of vocational training, specifically for people with physical disabilities, who carried out in the Balai Besar Rehabilitasi Vokasional Bina Daksa (BBRVBD), also known as National Vocational Rehabilitation Center (NVRC), towards increasing employment opportunities for people with disabilities. By using pooled cross section data from 2014-2017 and probit model data analysis techniques, this study validates the hypothesis that there is a positive impact of vocational training on increasing employment opportunities for persons with disabilities, higher in 43.32% significant at alpha level 1 %. The level of education also has a significant positive impact on the level of 1% increasing the chance of being accepted to work for people with disabilities by 2.03%. There are 6 types of vocational skills held, the most accepted in work opportunities are sewing skills, followed by graphic design skills, computers, electronics, automotive, and metal work.

## EDUCATION EXPENDITURE AND ECONOMIC GROWTH IN SOUTHEAST ASIA

**Farisa Puspita Adila, Evi Noor Afifah**

Department of Economics, Universitas Gadjah Mada, Indonesia

### ABSTRACT

The purpose of this study is to analyze the influence and direction of the causality between education expenditure and economic growth in Southeast Asia. This study used panel data from 11 countries in Southeast Asia in a period of 17 years. The method of analysis used in this research includes unit root test, panel cointegration test, model panel, and error correction model test. The results of this study during the period 2000-2016 indicate that there is a positive and significant effect between education expenditure, physical capital, and labor on economic growth in Southeast Asia in the long term. In the short term, only education expenditure and physical capital has a positive and significant effect on economic growth. Meanwhile, based on the Granger causality test, it was found that there was a unidirectional effect of economic growth on education expenditure. Furthermore, this research proves that human capital plays an important role in influencing economic growth in Southeast Asia.

## **Regular Session: RS03.1 - Knowledge and innovation**

**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/85836987366>**

**Chair Lily Kiminami**

## STUDY ON THE ISSUES OF INNOVATION IN JAPAN'S RICE INDUSTRY: FOCUSING ON THE STRATEGY OF MARKET-CREATING INNOVATION

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### ABSTRACT

Von Hippel et al. (2011) proposed a new innovation paradigm that emphasizes the role of consumers as innovators. In this paradigm, innovation consists of three phases: consumers develop new products for themselves, other consumers evaluate and improve them, and producers enter when market potential is clear. Moreover, Christensen et al. (2019) categorized innovations into three types: sustaining innovations, efficiency and market-creating innovations. They pointed out that while all innovations are important to keeping an economy vibrant, one type in particular 'market-creating innovation' plays a significant role, providing a strong foundation for sustained economic prosperity because innovation is also a process of organizational learning with dynamic changes in collective cognition.

The current study examines the direction of innovation in Japan's rice policy and rice industry from a long-term perspective based on the consideration of 'backcasting' (Robinson 1982). To this end, we introduce the methods of SEM (structural equation modeling) and cognitive map based on questionnaire survey targeting Japanese consumers for hypotheses verification in the research. The following results were obtained from the analytical results.

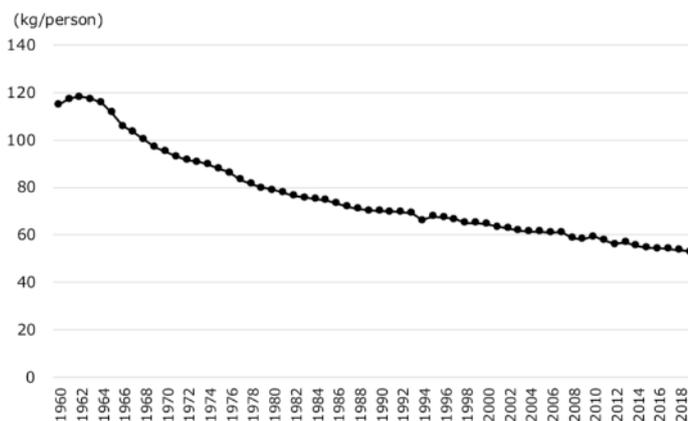
First, the demand conditions for market-creating innovation in Japan's rice industry are in place and rice consumption will increase if the innovation that meets the potential needs of consumers occurs. Second, innovation-oriented policies or market-creating innovation strategies to change the cultural beliefs, including the perception of producers and consumers about rice cultivation, rice products and the way of rice eating are required. Specifically, Japanese rice market should be transformed from a short tail to a long tail (Anderson 2006). In the long tail part, consumers who are oriented toward innovation will play a central role in discovering new types of rice products, inheriting the food culture related to rice, and creating shared value through communicating and organizational learning with producers and stakeholders.

### KEYWORDS

Market-creating innovation, Rice industry, Backcasting, Long tail, Japan

### 1. INTRODUCTION

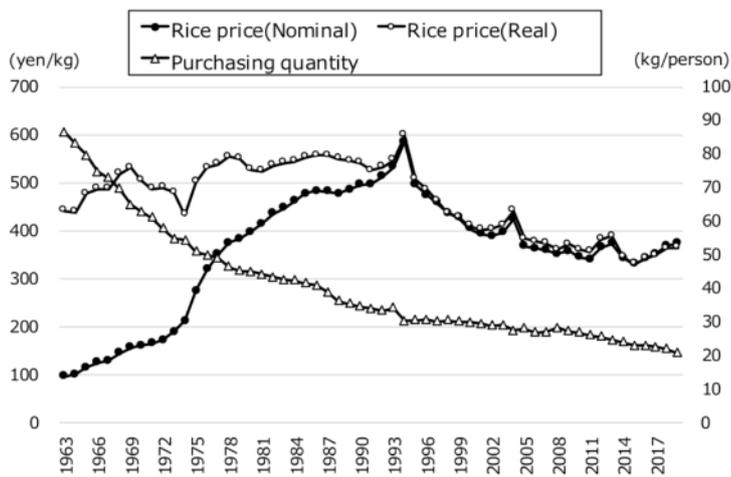
Generally, food demand is affected by prices, income, preferences (including food culture), information and policies (Hansen 2013). Figure 1 shows the long-term trend of rice supply per capita in Japan. It peaked at 118.3 kg/per capita in 1962 and has declined to 53.0 kg/per capita in 2019. Figure 2 shows the changes in the rice purchase volume per capita and rice price (both in nominal and real term) from 1963 to 2019. Rice purchase volume per capita has continued to decrease from 86.5 kg in 1963 to 20.9 kg in 2019, although the rate of decline has become gradual in recent years. Alternatively, the price of rice (in real terms) was on an upward trend while increasing and decreasing until the 1970s, and after having been flat in the 1980s, it has turned to a downward trend since the mid-1990s.



Note: Supply quantity (Net food).

Source: MAFF Food Balance Sheet. 2019 is a rough estimate value.

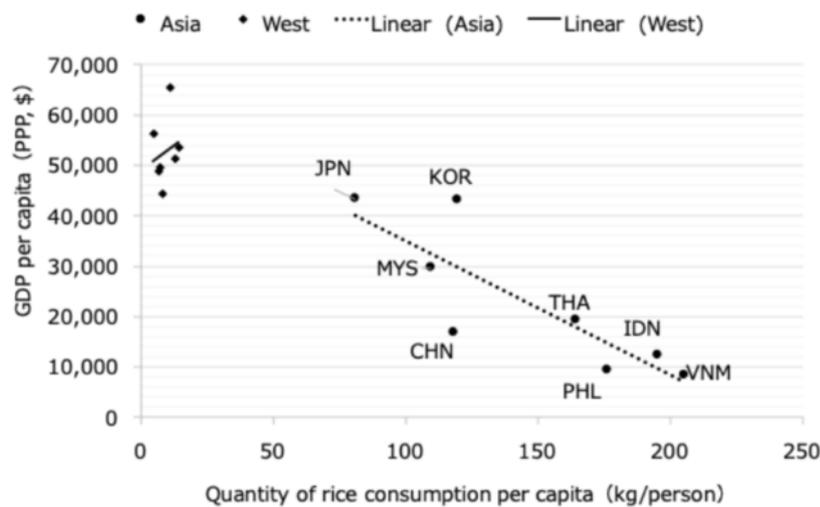
Figure 1: Annual rice consumption per capita



Source: Ministry of Internal Affairs and Communications “Family Income and Expenditure Survey”, “Consumer Price Index”

**Figure 2: Trend of rice price and annual purchasing quantity per capita**

Here, we give an overview of the current state of rice consumption in Japan from the perspective of international comparison. To consider differences in preferences (food culture), an analysis will be conducted using cross-section data by country for the two groups. That is, the Asian group whose staple food is rice and the Western group whose staple food is other than rice. Looking at the relationship between per capita rice consumption and income (Fig. 3), it is shown that rice consumption is lower in high-income countries than in low-and-middle-income countries in Asian group. However, rice consumption is slightly higher in high-income countries in Western group. In addition, Japan has the lowest rice consumption among Asian countries. South Korea, whose income level is almost the same as Japan, consumes more rice than Japan. From this, it is considered that besides income other factors such as prices, preferences, information, and policies give the influences on rice consumption in Japan and South Korea.

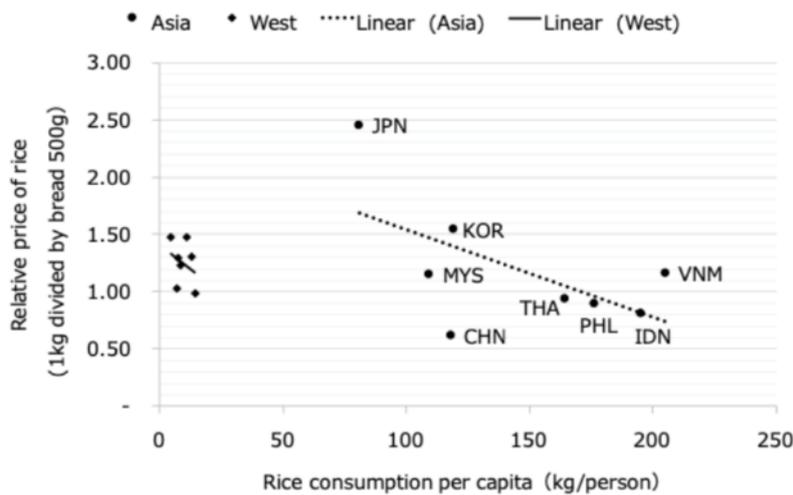


Note: Quantity of rice consumption is “rice and products”. Asia group includes Japan(JPN), China(CHN), Indonesia(IDN), Malaysia(MYS), Philippines, PHL), Korea(KOR),Thailand(THA), Vietnam(VNM). West includes USA, UK, Italy, Australia, Canada, Germany, France.

Source : Price (2019) is collected from NUMBEO HP.  
<https://www.numbeo.com/cost-of-living> (2020/12/28 Accessed)  
 Quantity of consumption (2018) is collected from FAO HP “FAOSTAT New Food Balances” <http://www.fao.org/faostat/en/#data/FBS> (2020/12/28 Accessed)  
 GDP per capita is collected from World Bank “World Development Indicators”.  
<https://data.worldbank.org/indicator/> (2020/12/28/ Accessed)

**Figure 3: Quantity of rice consumption and GDP per capita**

Next, looking at the relationship between rice consumption and rice prices, the variation in rice prices is small in Western group, while it is large in Asian group (Fig.4) . In addition, it is clear that the higher the rice price, the lower the consumption in Asian group. Moreover, the price of rice in Japan is the highest, and it deviates significantly upward from the approximate straight line. This could be considered that the level of rice consumption in Japan is affected not only by rice price but also by other factors such as food culture, information, and rice policies, etc.



Note: Quantity of rice consumption is "rice and products".  
 Source : Same as Fig.3

**Figure 4: Quantity of rice consumption and relative price of rice**

The purpose of this study is to examine the direction of innovation in Japan's rice policy and rice industry from a long-term perspective based on backcasting thinking<sup>1</sup>. First, in Chapter 2, selective literature reviews on innovation policy and market-creating innovation are conducted. It also explains the analytical framework, hypotheses, and analytical methods for the research. In Chapter 3, the hypothesis will be verified by the analysis of the results from the questionnaire survey to consumers. Finally, we derive policy implications for the sustainable development of the Japanese rice industry based on the analytical results.

## 2. LITERATURE REVIEW AND HYPOTHESIS

### 2.1 Innovation policy and market-creating innovation

Innovation policy is relatively new to the agenda of policy makers, and its interest has risen rapidly since the mid-1990s. It has been categorized into three types (Edler and Fagerberg 2017): "Mission-oriented policy" (Ergas 1986), which provides new solutions to specific political issues; "Invention-oriented policy," which focuses on the R&D/invention stage and leaves the exploitation and diffusion stage to the market mechanism; "System-oriented policies," which focuses on the interactions between different parts of the system recently. In Innovation Policy Review by the OECD (2020)<sup>2</sup>, it provides a comprehensive assessment of the innovation systems of individual members of partner countries and provides specific recommendations for policies that affect the performance of innovation.

However, as Edler and Fagerberg (2017) specified, the market failure argument, which is invoked as a rationale for public funding has the problems of policy failure, perfect knowledge, and the linear model. Hence, it is seen difficult to justify the design and implementation of innovation policies broadly. As the responsibility for the different components of the system is distributed across different areas of government, a 'holistic' perspective on policy (Edquist, 2011) as well as an effective coordination between different parts of government (such as the ministries responsible for knowledge creation, skills-production, finance, and so on) are necessary for understanding such a systemic innovation policy (Braun, 2008;Fagerberg, 2016a).

Alternatively, von Hippel et al. (2011) proposed a new innovation paradigm that emphasizes the role of consumers as innovators<sup>3</sup>. In this paradigm, innovation consists of three phases: consumers develop new products for themselves, other consumers evaluate and improve them, and producers enter when market potential is clear. Therefore, it is necessary to consider consumers as active actors in the processes of innovation creation and dissemination and conduct research and analysis starting from the consumption/demand side.

Moreover, Christensen et al. (2019) categorize innovation into three types: sustaining, efficiency, and market creating. It insists that "All innovations are important to keep the economy vibrant, but especially market-creating innovation plays an important role and is a strong foundation for sustainable economic prosperity" because market-creating innovations transform culture. The institution of a society reflects the culture and values of the people of that society, institutional change needs to be elicited by cultural transformation. Therefore, simply introducing a system is not effective in promoting economic growth and sustainable development.

### 2.2 Japanese rice industry and innovation

1 The backcasting method defines a desirable future (what it should be and what it should be), shares it with the people concerned, and thinks about what to do from the present to connect it to the desired future. It is one of the planning methods for identifying policy and programs and (Robinson 1982).

2 OECD Review of Innovation Policy (<https://www.oecd.org/sti/inno/oecd-reviews-of-innovation-policy.htm>)

3 Consumer innovator is defined as a person who had innovated in software products or physical products from scratch or improving an existing for non-work purpose within the last three years.

The pioneering study of Hayami and Ruttan (1985) presented an induced innovation model for explaining agricultural development from two aspects: technological innovation and institutional innovation. In the technological innovation of rice cultivation in Japan, the accumulation of technology and knowledge by the veteran farmers, the selection at the agricultural experimentation site, and the dissemination of the technology through the farmer's organization play a major role. In the institutional innovation, the function of the village that can realize the formation and maintenance of land improvement capital as a local public good (in the theory of social capital: the bonding-type of social capital) played an important role (Hayami 2000, Hayami / Godo 2002, pp. 106-107).

Uraki (1986) used the framework of complex science to analyze the changes in the Japanese social life surrounding rice. He emphasized that technological innovation in rice cultivation under the Basic Agricultural Law was "technological innovation without independence" (or blind technological innovation) by the old-fashioned peasants. He also pointed out that creative destruction had not occurred because the innovation in this period was not based on modern capitalist motivation and consciousness structure.

Alternatively, rice in Japan is being differentiated and branded according to various qualities. Although the quality of rice was strongly influenced by the grade depending on the place of origin and variety, it was formed by various factors (Fuyuki 2014). Saito (2010) clarified the characteristics of regional brands and mentioned strategic issues and the importance of brand management. Suzuki and Kiminami (2009) clarified the current status of regional collective trademark registration, and Takita and Kikuchi (2012) analyzed the effects of rice quality, production area, and variety on consumption by conjoint analysis. In addition, rice differentiated and branded by farming methods that take biodiversity into consideration has also appeared. Taie (2012) and Taie (2013) have described public goods as the quality of the environment with respect to "creature mark rice." In addition to clarifying the economic characteristics of rice, it analyzed price premiums from the perspective of product differentiation under monopolistic competition.

Moreover, the conventional consumer choice theory in economics has been extended to allow for factors such as the cost of gathering information, imperfections in the perception of information and limitations to consumers' cognitive powers in gathering and processing information. As argued by Anderson (2006) that e-commerce and other new technologies improve efficiency by encouraging the entry of new producers and innovations, creating a "long tail" of niche products while reducing the market share of previously popular products. According to the result from an empirical analysis conducted by Kiminami et al. (2021) on the rice retail market (especially the e-commerce market) in China, the retail rice market is undergoing dynamic change in which the externalities of consumption in the two-sided market are modernized and sustained through cumulative market feedback. Alternatively, Kendall and Tsui (2011) studied the strategic interaction between hits and niches in their pricing, entry, and innovation decisions using a model of competition under the product differentiation and generalized cost structure. They pointed out that industries in which firms innovate low variable/high fixed cost technologies tend to move toward superstar effects, while those where firms innovate low fixed cost/high variable cost technologies tend to move toward long tail effects. Therefore, the ability of policy to improve market efficiency is limited by the knowledge that policymakers hold regarding the cost structure and other parameters of the affected industries. Zilberman et al. (2019) addressed the importance of policy design that does not diminish entrepreneurship in the food and agriculture sector.

Although there have been increasing interest in the sustainable diets in the area of scientific research recently, there are few policy studies on it. Because the relationship between sustainable diets and adjacent social issues (eg, fair trade, animal welfare, sustainable agriculture, social acceptability etc.) is unclear, and it is difficult to uniformly evaluate and discuss eating habits. There can be various transitional routes in a specific diet because it is susceptible to individual tastes and cultural influences (Burlingame and Dernini 2012).

In addition, Kiminami et al. (2020) analyzed the relationship between Japan's rice policy and innovation in rice cultivation so far. It pointed out that rice prices maintained by the production adjustment policy suppressed consumers' original demand for rice and caused rice consumption decrease. In addition, major innovations are difficult to be created due to the existing cultural beliefs dominate the political and social domains of the system although rice production adjustment policy has been officially abolished.

### 2.3 Hypothesis and analysis method

Based on the results of the above literature review, the following hypotheses are set in this study.

*Hypothesis 1 "Innovation can stimulate Japanese consumers' demand for rice"*

*Hypothesis 2 "Consumers require a strategy to induce an innovation in the rice industry that contributes to the sustainable development of agriculture and rural areas."*

In the following chapter, to verify Hypothesis 1 and Hypothesis 2, the analysis of rice demand function, covariance structure analysis (SEM) and cognitive map analysis will be conducted using the data of household survey by the government and authors' original questionnaire survey. Furthermore, we will propose policies for the realization of sustainable development (SDGs) of Japan's rice industry introducing a backcasting model based on the analytical results.

## 3. HYPOTHESIS VERIFICATION

### 3.1 Measurement of rice demand function

The demand function of rice is measured to clarify the self-price elasticity of demand, cross-price elasticity, income elasticity, and trends in rice consumption by using time-series data. The demand function of rice is expressed by Eq. (1).

$$Q_r = f(P_r, P_b, P_n, P_o, Y)(1)$$

Here,  $Q_r$  is the annual purchase quantity of rice per capita,  $P_r$  is the rice price,  $P_b$  is the price of bread,  $P_n$  is the price of noodles,  $P_0$  is the price of market goods other than rice, bread and noodles, and  $Y$  is the amount of annual consumption expenditure per capita.

Of these, the annual purchase quantity of rice ( $Q_r$ ), rice price ( $P_r$ ), bread price ( $P_b$ ), noodles price ( $P_n$ ), and annual consumption expenditure ( $Y$ ) are collected in the Ministry of Internal Affairs and Communications "Household Survey." Data for workers' households from 1963 to 1999, and for two-or-more-person households from 2000 to 2019. The purchase quantity of rice and consumption expenditure are divided by the number of household members and converted to per capita. For the prices of other market goods ( $P_0$ ), the Ministry of Internal Affairs and Communications "Consumer Price Index" is used (2015 = 100). The descriptive statistics for each variable are shown in Table 1.

**Table 1: Descriptive statistics of variables**

	Variables	Unit	Mean	S.D.	Minimum	Maximum
Dependent variable	Annual purchase quantity of rice per capita	(kg/person)	40.7	17.0	20.9	86.5
Independent variable	Rice price (real term)	(yen/kg)	464.9	75.4	330.6	598.9
	Bread price (real term)	(yen/100g)	45.5	1.7	40.4	50.1
	Noodles price (real term)	(yen/100g)	53.1	5.8	38.8	64.8
	Annual consumption expenditure per capita (real term)	(yen/person)	1,021,878	200,796	508,215	1,210,546

Equation (2) shows the specification model that uses a log-log type to measure the rice demand function. To clarify the trend effect, the trend term (Trend: 1963 = 1, 1964 = 2, ... 2019 = 57) is used. In addition, Prais-Winsten AR (1) regression (GLS estimation) is used to deal with the problem of series correlation of error terms.

$$\ln Q_r = \alpha_0 + \alpha_1 \ln (P_r / P_0) + \alpha_2 \ln (P_b / P_0) + \alpha_3 \ln (P_n / P_0) + \alpha_4 \ln (Y / P_0) + \alpha_5 \text{Trend} + \varepsilon(2)$$

The measurement results are as shown in Table 2. R2 is 0.996 and DW value is 1.831 (the closer it is to 2, the better), and the model has high explanatory power and good results are obtained. The following four points can be mentioned from this result. First, the self-price elasticity of rice is negative and significant, so rice demand is elastic with respect to price. As the price of rice falls, the quantity of rice purchased may increase. Secondly, the elasticity of consumer spending is negative and significant, indicating that rice is an inferior good as a whole. Thirdly, the cross-price elasticities of bread and noodle were not significant, respectively. Regarding bread and noodles, it cannot be said that their price changes have not influenced changes in the amount of rice purchased, and it can be said that they are not substitutes for rice. Fourthly, the sign of the coefficient of the trend term was negative and significant. Rice purchase volume is declining as a trend.

**Table 2: Result of measurement of rice demand function**

	Coefficient	t-value	
Rice price: $\ln (P_r / P_0)$	-0.219	-3.760	***
Bread price: $\ln (P_b / P_0)$	-0.184	-1.460	
Noodles price: $\ln (P_n / P_0)$	-0.007	-0.100	
Annual consumption expenditure per capita: $\ln (Y / P_0)$	-0.418	-5.740	***
Trend term: <i>Trend</i>	-0.019	-16.740	***
Constant	10.102	15.040	***
rho	0.548		
R2	0.996		
DW value	1.831		

### 3.2 Questionnaire survey analysis

A web-based questionnaire survey was conducted to clarify the conditions for the increase in rice consumption and consumers' preferences for rice policy. The investigation was outsourced to Cross Marketing Co., Ltd., and conducted from September 8th to September 9th, 2020 after designing the original questionnaire. Samples in the survey are collected based on their ratio to the census in sex, age (7 categories from 18 to 79 years old), and place of residence (Hokkaido/Tohoku, Kanto, Koshinetsu, Tokai, Kinki, Chugoku, Shikoku, Kyushu/Okinawa). The number of collected samples is 1,805. In the following, 1,387 samples were used in SEM analysis, excluding 418 samples who answered "I do not know/do not want to answer" when asked about income.

As a variable preparation used in the analysis, principal component analysis was performed for the answers to the question regarding rice consumption motives (reasons for eating rice and related products as staple foods) (Table 3). The cumulative contribution ratio up to the second main component is 45.4%, which is generally a good result. Since the score of the first principal component is positive in all items, it can be interpreted as diversity-oriented (high-low). The second principal component can be interpreted as functionality-oriented (high-low) because positive and the large items

of the score are “because it is delicious,” “because it is easy to store,” and “easy to eat,” while the negative and large items of the score are “because I want to save time for cooking and tidying up,” “because it is a request of my family/cohabitants,” and “because it is cheap.” For the variable of rice consumption motive, the score of each principal component was used.

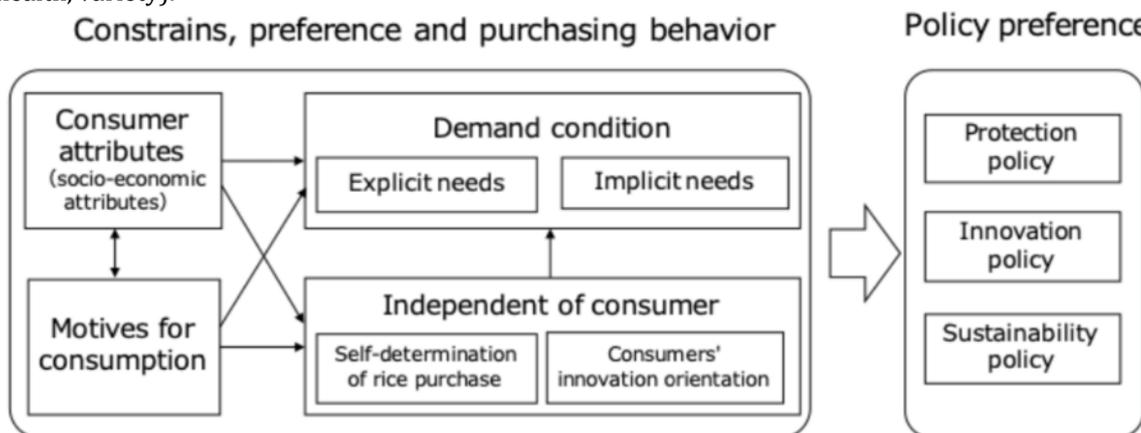
**Table 3: Results of PCA about motives for rice consumption**

	1st component	2nd component
Because it is delicious	0.22	0.52
Because it is a request of my family / cohabitants	0.23	-0.40
Because it is cheap	0.29	-0.38
Because it has a lot of eating way	0.48	0.03
Because I want to save time for cooking and tidying up	0.34	-0.54
Easy to eat	0.49	0.25
Because it is easy to store	0.48	0.27
Cumulative contribution ratio	29.0%	45.4%
Interpretation of components	Diversity oriented (high-low)	Functionality-oriented (high-low)

Here, we use Structural Equation Modeling (SEM or covariance structure analysis) to identify the relationship between consumers’ preferences, constraints, and purchasing behavior for clarifying the process of formation of the needs for rice, and their influence on consumers’ preferences for rice policy. Fig. 5 shows the framework of covariance structure analysis, and Table 4 shows a list of explanatory variables and descriptive statistics.

It is assumed that consumer attributes (social economic attributes) and consumption motives influence consumers’ independence (consumer’s innovation orientation, self-determination of rice purchase), and conditions for rice demand (conditions for increasing rice consumption) are affected by consumer’s independence. Furthermore, consumers’ independence and the conditions for rice demand also influence their policy preferences. However, socio-economic attributes such as sex, age, and income are set as control variables in the research.

Regarding consumers’ preferences for rice policy, three potential variables are assumed as: protection policy (production adjustment, customs duty), innovation policy (scale expansion, new technology, new usage method of rice) and sustainability policy (environmental conservation, communication between producers and consumers, human resource development of manger). Demand conditions for increasing consumption (excluding “do not increase”) are classified into two latent variables: the explicit needs (price, taste) and the implicit needs (information, environment, packaging, safety, health, variety).



**Figure 5: Framework of SEM analysis**

Table 4: Explanation and descriptive statistics of variables

Components of Variable	Name of variables	Explanation	Mean	Minimum	Maximum
Socio-economic attributes	Sex	Female: 0, Male: 1	0.51	0	1
	Age	18-19 years old: 1, 20s: 2, 30s: 3, 40s: 4, 50s: 5, 60s: 6, 70s: 1	4.51	1	7
	Income	0 to less than 3 million yen: 1, 3 to less than 5 million yen: 25 to less than 7 million yen: 3, 7 to less than 10 million yen: 40 to 10 million yen or more: 5	2.62	1	5
Motive for consumption	Diversity-oriented	Score of 1st principal component (Reason for eating rice and rice-related products as staple food)	0.65	0	2.53
	Functionality-oriented	Score of 2nd principal component	0.45	-0.94	1.07
Consumers' innovation orientation	Innovation	I don't like it at all: 1, I don't like it very much: 2, Neither: 3, I like it a little: 4, I like it very much: 5	3.01	1	5
Self-determination of rice purchase	Decision	I don't think so: 1, I don't think so much: 2, I can't say either: 3, I think so a little: 4, I think so: 5	3.59	1	5
Conditions for increasing rice consumption	Price	Condition: Price range goes down (not applicable: 0, applicable: 1)	0.39	0	1
	Taste	Condition: Tastes better (not applicable: 0, applicable: 1)	0.38	0	1
	Information	Condition: Information on production method is clarified (not applicable: 0, applicable: 1)	0.09	0	1
	Environment	Condition: Environmentally friendly (not applicable: 0, applicable: 1)	0.10	0	1
	Package	Condition: Packaging etc. becomes attractive (Not applicable: 0, Applicable: 1)	0.03	0	1
	Safety	Condition: Higher safety (not applicable: 0, applicable: 1)	0.16	0	1
	Health	Condition: Good for health (Not applicable: 0, Applicable: 1)	0.28	0	1
	Diversity	Condition: You can eat in diversified ways (not applicable: 0, applicable: 1)	0.15	0	1
	Not increase	No more increase (not applicable: 0, applicable: 1)	0.27	0	1
Policy preference	Production adjustment	Policy to adjust productions to keep prices high (Not good at all: 1, not very good: 2, neither: 3, a little good: 4, very good: 5) Same below	2.83	1	5
	Customs duty	Policy to impose tariffs on imported rice	3.34	1	5
	Scale expansion	Policy to encourage scale-up to reduce costs	3.53	1	5
	New technology	Policy to encourage the introduction of new technologies (ICT, etc.) to improve efficiency and stabilize quality	3.76	1	5
	New utilization	Policy to promote rice production for new utilization method (rice flour, etc.)	3.71	1	5
	Environmental conservation	Policy to encourage the introduction of environmentally friendly production methods (organic farming, etc.)	3.80	1	5
	Interaction	Policy to encourage interaction between producers and consumers	3.59	1	5
	Development of manager	Policy to promote the human resource development of managers for rice farms	3.86	1	5

Figure 6 and Table 5 summarize the path diagram and the estimated coefficients of the results. The model fit is relatively good (CFI = 0.766, RMSEA = 0.079). The results clarified that consumers' innovation orientation and self-determination of rice purchases influence each condition for increasing rice consumption, and these conditions affect consumers' preference for rice policy. Socio-economic attributes used as control variables here (sex, age, income) and rice consumption motives (especially diversity-oriented) also influence these processes to some extent. The following important points are obtained from the estimation results.

First, there are few answered that they will not increase rice consumption any further among consumers who are highly innovation-oriented and highly self-determined in purchasing rice. This means that consumers who are particular about rice and are innovation-oriented can increase the consumption of rice if some conditions are met. Second, consumers with explicit and implicit needs for rice prefer sustainability and innovation policies, and innovative consumers particularly prefer innovation policies. Therefore, Hypothesis 1 "Innovation can stimulate consumers' demand for rice" is supported.

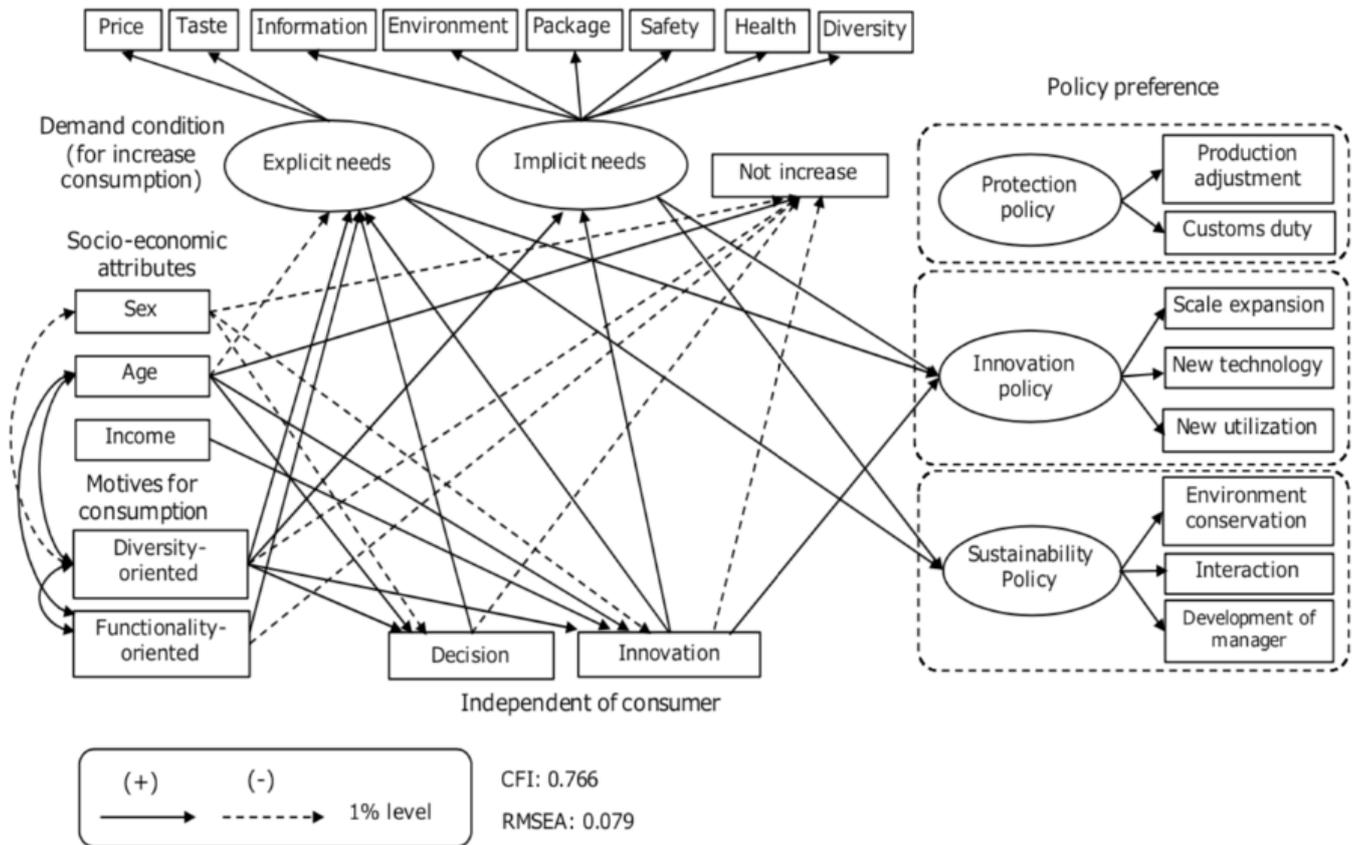


Figure 6: Path diagram of estimation result

Table 5: Result of the estimation

		Coefficient	p-value			Coefficient	p-value	
Protection policy	Explicit needs	0.115	0.049 **	Innovation	Sex	0.353	0.000 ***	
	Implicit needs	0.197	0.033 **		Age	-0.057	0.002 ***	
	Not increase	0.016	0.192		Income	0.102	0.000 ***	
	Innovation	0.003	0.555		Diversity-oriented	0.250	0.000 ***	
	Decision	0.004	0.271		Functionality-oriented	-0.105	0.249	
Innovation policy	Explicit needs	0.553	0.000 ***	Decision	Sex	-0.722	0.000 ***	
	Implicit needs	0.851	0.000 ***		Age	0.103	0.000 ***	
	Not increase	-0.051	0.169		Income	-0.068	0.020 **	
	Innovation	0.045	0.003 ***		Diversity-oriented	0.258	0.000 ***	
	Decision	0.002	0.873		Functionality-oriented	0.072	0.529	
Sustainability policy	Explicit needs	0.484	0.002 ***	Latent variables				
	Implicit needs	1.795	0.000 ***	Explicit needs	Condition: Price	1.000		
	Not increase	0.055	0.195		Condition: Taste	1.234	0.000 ***	
	Innovation	Decision	0.038	0.028 **	Implicit needs	Condition: Information	1.000	
						Condition: Environment	1.322	0.000 ***
Explicit needs	Sex	0.041	0.022 **	Condition: Package	0.416	0.000 ***		
	Age	-0.020	0.000 ***	Condition: Safety	1.998	0.000 ***		
	Income	0.005	0.407	Condition: Health	2.138	0.000 ***		
	Diversity-oriented	0.118	0.000 ***	Condition: Diversity	1.063	0.000 ***		
	Functionality-oriented	0.077	0.003 ***	Protection policy	Production adjustment	1.000		
	Innovation	0.031	0.000 ***		Customs duty	5.456	0.007 ***	
	Decision	0.017	0.008 ***	Innovation policy	Scale expansion	1.000		
Implicit needs	Sex	-0.010	0.173		New technology	1.274	0.000 ***	
	Age	-0.001	0.735		New utilization	1.186	0.000 ***	
	Income	0.001	0.713	Sustainability policy	Environmental conservation	1.000		
	Diversity-oriented	0.092	0.000 ***		Interaction	0.910	0.000 ***	
	Functionality-oriented	-0.008	0.454		Development of manager	1.038	0.000 ***	
	Innovation	0.016	0.000 ***	Covariance of error term				
	Decision	0.004	0.087 *	Sex	Age	-0.033	0.152	
Not increase	Sex	-0.072	0.002 ***		Income	0.011	0.538	
	Age	0.033	0.000 ***		Diversity-oriented	-0.022	0.004 ***	
	Income	-0.004	0.631		Functionality-oriented	-0.004	0.364	
	Diversity-oriented	-0.095	0.000 ***	Age	Income	-0.088	0.149	
	Functionality-oriented	-0.099	0.003 ***			Diversity-oriented	0.139	0.000 ***
	Innovation	-0.060	0.000 ***			Functionality-oriented	0.132	0.000 ***
	Decision	-0.036	0.000 ***	Income	Diversity-oriented	0.022	0.262	
					Functionality-oriented	0.018	0.167	
			Diversity-oriented	Functionality-oriented	0.078	0.000 ***		

### 3.3 Cognitive map analysis

In the next, we will analyze the data of free-form questions in the items of the questionnaire survey (see Appendix 2). Specifically, the cognitive structure of consumers is visualized using co-occurrence network analysis (3-5 keywords are given by each respondent to the questions about <what is required for Japanese rice> and <what is required for Japanese

rice cultivation and agriculture / rural areas>. The co-occurrence network is a diagram in which the relationships of words appearing in common (co-occurrence relationships) are displayed by circles and lines. It is thought to be effective to analyze the co-occurrence relationships of the keywords obtained from the free association method to structure the potential factors and concepts. The software of KH Coder (Higuchi 2014) was used in this research, and 1,805 samples were used for the analysis. A data cleaning was conducted in the analysis, such as the unification of notation fluctuations (conversion of hiragana into kanji), the designation of forced extraction of words (“local production for local consumption,” “new rice,” “pre-washed rice”), the designation of unused words (“none,” “nothing in particular” and “I can't think of anything”).

From the results of the analysis, the consumers’ cognitive structure regarding <what is required for Japanese rice> can be classified into four factors (Fig. 7-a): (1) economic efficiency (competitiveness), (2) environmental conservation, (3) sociality (safety/security, health), and (4) diversity. In addition, the consumers’ cognitive structure regarding <what is required for rice cultivation, agriculture and rural areas in Japan> It can be organized according to the four elements of (Fig. 7-b): (1) economic efficiency (competitiveness), (2) environmental conservation, (3) sociality (safety and security) , and (4) the attractiveness of rural areas. Taken together, these supported our hypothesis (H2) that “Consumers require a strategy to induce an innovation in the rice industry that contributes to the sustainable development of agriculture and rural areas”.

Furthermore, Fig. 8 shows the policy proposals for inducing innovation based on the ‘backcasting’ thinking. The goal of policies is set as ‘sustainable agricultural and rural development’, and the four long-term objectives are set as: ‘competitiveness’, ‘efficient use of resources/environmental conservation’, ‘quality improvement of food market’ (sociality/diversity), and ‘formation of local attractiveness’. These long-term objectives are also closely linked to medium-term targets such as ‘cost reduction’, ‘quality improvement/stability’, ‘market diversification’, ‘human resources development’, and ‘regional resource development’. In other words, it is important to embody each element in the actions when devising rice policy such as identifying the implicit needs of consumers and residents, cultivating entrepreneurs and managers, reviewing the direction of R&D, and trust formation through cooperation among stakeholders.

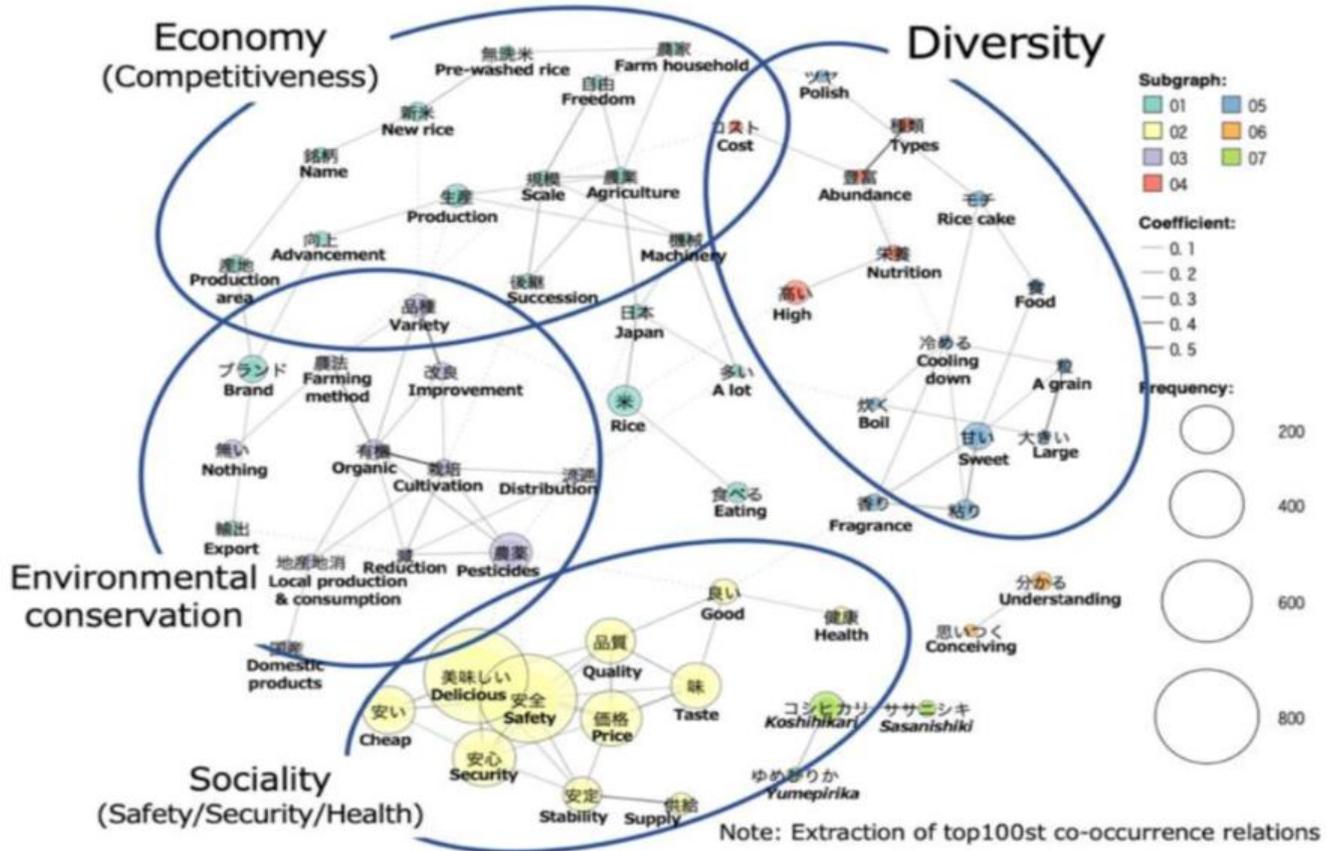


Figure 7-a: Co-occurrence network analysis about <What is required for Japanese rice>

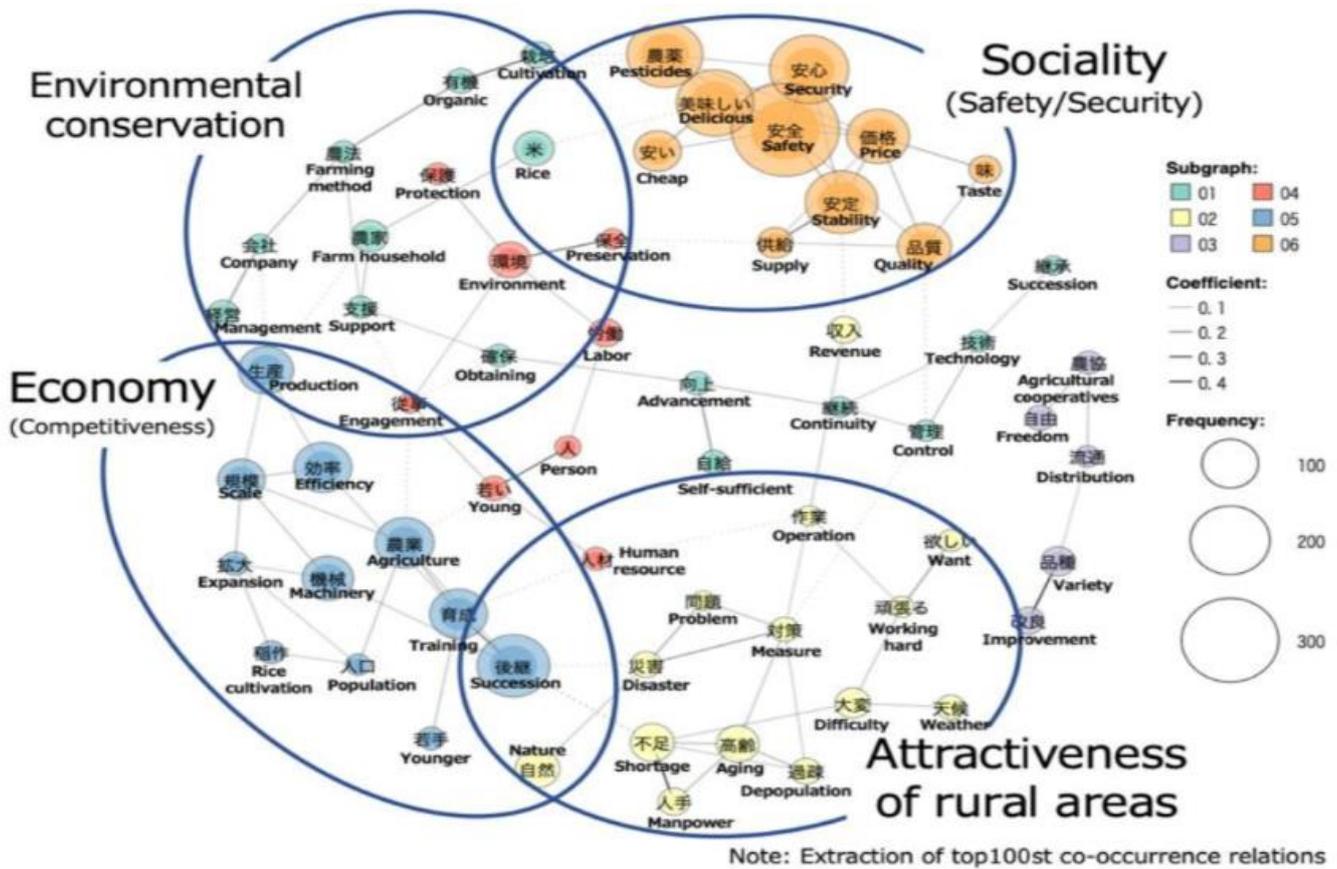


Figure 7-b: Co-occurrence network analysis about <What is required for rice cultivation, agriculture and rural areas in Japan >

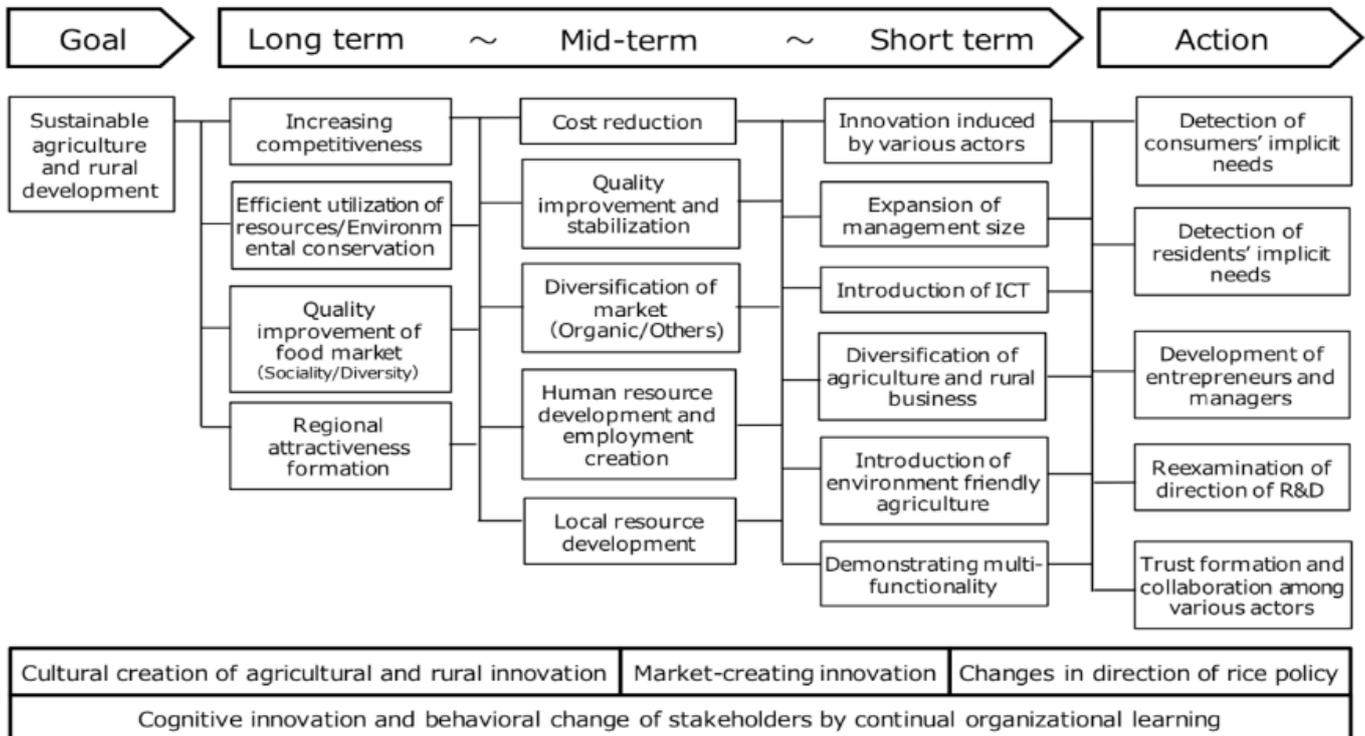


Figure 8: Policy proposals about rice policy for inducing innovation

#### 4. CONCLUSIONS AND POLICY IMPLICATIONS

This study draws the following conclusions based on the above analytical results. First, if the innovation that meets the potential needs of consumers occurs, it may increase rice consumption, and the demand conditions for market-creating innovation in the Japanese rice industry are in place. This means that innovation-oriented policies or strategies to change

their cultural beliefs (common prior expectations as mutual knowledge of social, economic and technical characteristics) for rice industry, agriculture and rural areas are expected by consumers.

Suppose, in the Japanese rice market so far, the head part is small and the tail part is not a long tail but a short one (Fig. 9-a). There are products in the volume zone that meet the actual needs such as deliciousness, savings, and brands, but they are not satisfied enough. In addition, the short tail part is the current niche market, which consists of implicit needs (health, safety, environment) and value-oriented (usage/experience) areas. It might be possible to develop the market by expanding the head and creating a long tail through the strategy of market-creating innovation (Fig. 9-b). In the long tail part, innovative consumers will play a central role in creating shared value and inheriting rice culture in addition to the values in use and experience, through communication with other stakeholders by discovering new types of rice products and new ways of rice eating. To that end, in addition to the market expansion related to actual needs, innovation policy for rice industry emphasizing on implicit needs such as health, safety, and the environment is important. Furthermore, attention to the viewpoint of consistency between individual element of targets and objectives related to sustainability, and the exertion of synergistic effects is also important in the innovation strategy.

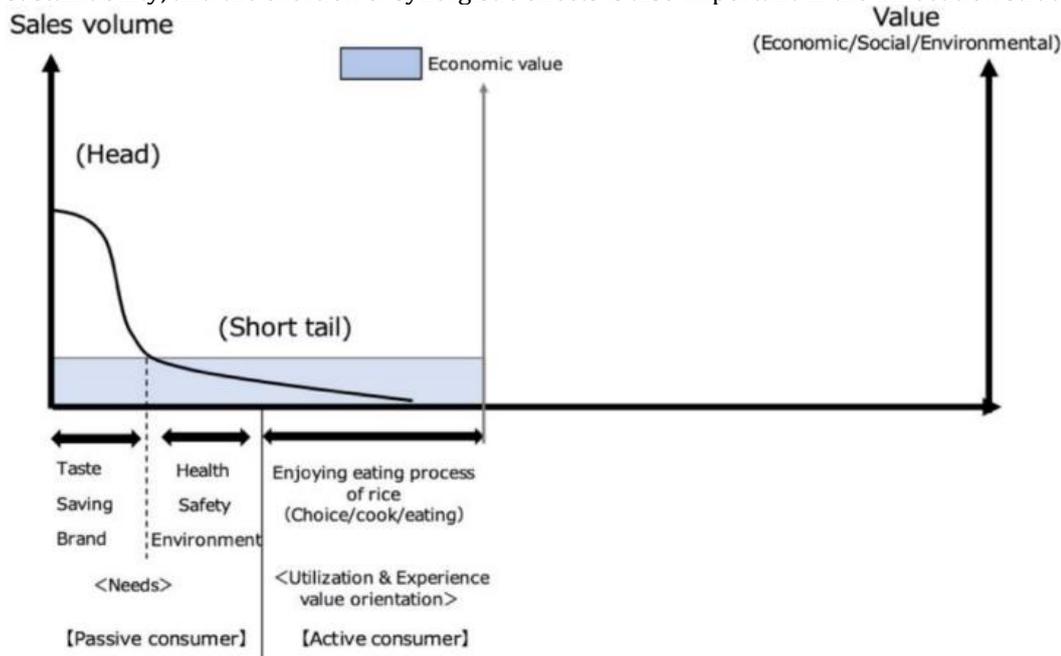


Figure 9-a: Current rice market in Japan

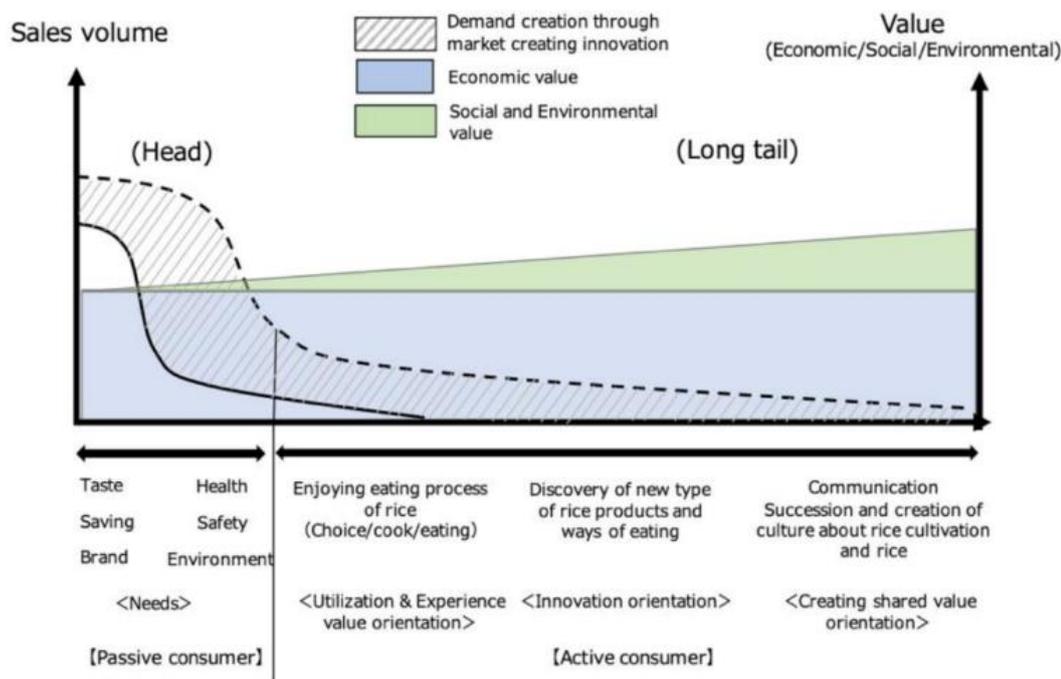


Figure 9-b: Development of rice market through market-creating innovation

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## EFFECTS OF INTER-ORGANIZATIONAL NETWORK ON SOCIAL ENTERPRISES: ANALYSIS AT ORGANIZATIONAL LEVEL IN JAPAN

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### ABSTRACT

Generally, social enterprises are facing with a trade-off between economic efficiency and sociality so called “duality” or “dual mission” problem. One of the management strategies to solve duality problems is considered to enlarge the effectiveness of the business, while complementing management resources through the formation of cooperative networks with external organizations.

The purpose of this study is to clarify the mechanism of social innovation induced by inter-organizational network of social enterprises in Japan. First, the analytical framework and hypotheses are set based on the selective literature review of existing studies on social enterprise theory and organizational network theory. Second, structural equation model (SEM) is applied to the piece vote data at organizational level in two prefectures of the “Social Business Network Survey (2010 METI Regional Revitalization Countermeasure Survey)”. Third, case studies are applied for the advanced intermediate organizations in the two prefectures to verify the hypotheses.

Based on the analytical results, the following three hypotheses are verified: the organizational attributes and business areas of social enterprises influence the formation of inter-organizational networks (Hypothesis 1), diversity and collaborative network formation promotes empathy with related entities and cooperation with social enterprises (Hypothesis 2), and intermediate organizations affect the structure and function of network and promote the induction of social innovation (Hypothesis 3). In other words, the formation of inter-organizational networks of social enterprises promotes the induction of social innovation through changes in the collective cognition of the region. Therefore, policy implication drawn from this research suggests enhancing the diversity and collaboration of social enterprise networks in order to promote sustainable regional development through the resolution of regional social issues.

### KEYWORDS

Social enterprise, Effect of network, Analysis at organizational level, Japan

### 1. INTRODUCTION

According to a survey by the Cabinet Office of Japan (2015), the number of social enterprises in Japan has reached 205,000, its value added is 16.0 trillion yen (3.3% of the total economy), and the number of its paid employees is 5,776,000(13.2%). In general, social enterprises face a trade-off between economy and sociality (called the “duality” or “dual mission” management problem). In order to solve these duality problems, social enterprises can enhance the effectiveness of their businesses while supplementing the management resources such as human resources, knowledge / information, and funds through the formation of a collaborative network with external organizations. However, most of the research on the influence of network formation in social enterprises is to grasp the actual situation by a qualitative approach, and research by a quantitative approach has not progressed.

Therefore, this study clarifies the mechanism by which network formation between organizations in social enterprises induces social innovation in Japan. First, we will set an analytical framework and hypotheses based on selective literature review on social enterprise studies and organizational network theory. Second, we will verify hypotheses through applying SEM (Structural Equation Modelling) by using a piece vote data of the “Social Business Network Survey (2010 Ministry of Economy, Trade and Industry Regional Revitalization Measures Survey)”, and also analyzing the advanced intermediate organizations. Finally, based on the above analytical results, we will derive policy implications for sustainable regional development through the development of social enterprises.

### 2. LITERATURE REVIEW AND HYPOTHESIS SETTING

#### 2.1 Previous research on social enterprises and inter-organizational networks

Kaneko (2013) stated that the development phase of social entrepreneurship in Japan can be classified into three periods from the beginning of the 20th century to the half of 1970s, from 1975 to 2000, and after the 2000s, and pointed out that recent development reflects a strong market orientation and innovation approach in addition to sociality. However, many social enterprises face economic problems such as financial management (Larrata et al. 2011). For example, the Ministry of Economy, Trade and Industry(METI) (2008) has clarified the issues faced by social enterprises: (1) lack of PR to consumers and users, (2) securing of working capital, and (3) unestablished operating system due to lack of human

resources. On the other hand, Suzuki (2009) has identified methods for improving profitability such as (1) improvement of customer value, (2) cheap procurement of management resources, and (3) expansion of business domain.

Regarding the quantitative analysis of social enterprises<sup>4</sup>, Hoogendoorn et al. (2010) reviewed 31 empirical analyses and pointed out that there are three shortages: (1) lack of robust hypothesis-testing analysis, and (2) lack of diversity in research design, and (3) analysis of a small sample size. On the other hand, Matsunaga (2012) clarified that social entrepreneurship and inter-organizational networks improve the management efficiency of social enterprises by using a probabilistic frontier model for Japanese social enterprises. However, it pointed out that there still analytical issues such as how to measure social entrepreneurship, the possibility of estimation bias due to under formulation, and the small sample size. Stevens et al. (2014) also found that, social missions are associated with interest in altruistic values, normative identities and social goals while economic missions are strongly associated with egoistic values, utilitarian identities, and interest in economic goals through a quantitative analysis of social enterprises in the United Kingdom. In addition, a trade-off between the level of social missions and that of economic missions was observed. Research on the measures to achieve both missions at a high level is called for.

In addition, Briggstock et al. (2010) clarified that diversity management especially with harmony and financing in social enterprises leads to organizational innovation and performance improvement through comparative analysis of cases. It also pointed out that network diversity is extremely important for small organizations usually having a low level of internal diversity. From the network with general companies, these small social enterprises can get the merit of searching for excellent practices, partners, human resources, funds, etc.

Although, exerting a collective impact through the formation of collaborative networks between organizations is important in order to induce social innovation (Kania and Kramer 2011)<sup>5</sup>, empirical quantitative analyses are scarce. On the other hand, the Cabinet Office of Japan (2016) proposes specific evaluation tools and describes the social impact as “social and environmental outcomes as a result of projects and activities, including short-term and long-term changes.” It also proposes to quantitatively and qualitatively grasp the outcomes, judge the value of the business and activities, and make improvements as necessary. Furthermore, in the evaluation of social impact, it is pointed out to be important to achieve the two objectives of (1) fulfilling accountability, (2) learning and improving (evaluation with wide participation and collaboration of stakeholders). Therefore, it can be said that it is effective to understand social innovation as a dynamic process that causes cognitive changes and further enhances the results of the innovation through social impact assessment together with the collaboration of various stakeholders<sup>6</sup>.

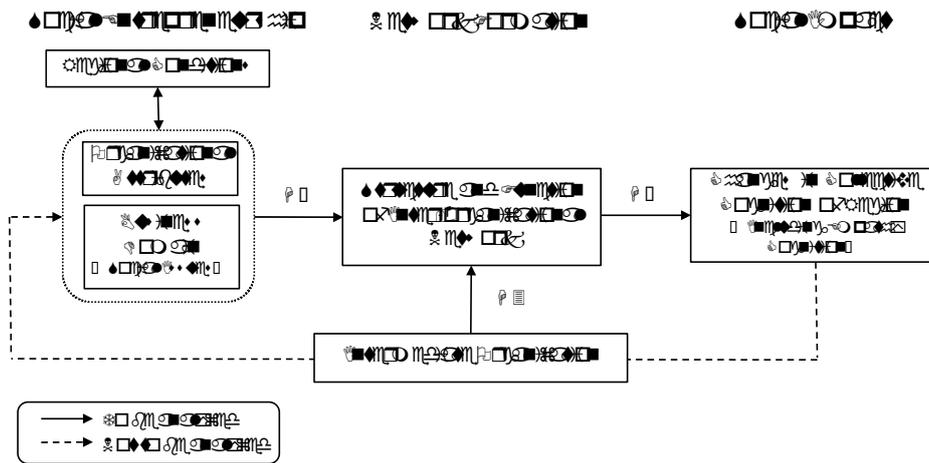
## 2.2 Hypothesis and analysis method

Based on the above literature review, this study sets the analytical framework and hypotheses shown in Figure 1. Hypothesis 1 is, “Organizational attributes / regional conditions and business domains (social issues) of social enterprises influence the formation of inter-organizational networks of social enterprises”. And, Hypothesis 2 is “Diversity of networks of social enterprises and formation of collaborative networks with related entities change the collective cognition of the region by promoting empathy and collaboration between actors”. Finally, Hypothesis 3 is, “The intermediate support organizations influence the structure and function of inter-organizational networks of social enterprises, and promote the induction of social innovation”. We assumed that the formation of inter-organizational networks of social enterprises promotes the induction of social innovation and contributes to the sustainable development of the region. In other words, in this research, the cyclic process of the three elements of social entrepreneurship, network formation and social impact and the self-reinforcement loop through the intermediate support organization is regarded as social innovation.

<sup>4</sup> For example, Furuzawa et al. (2021) compare the factors affecting the innovativeness of start-ups between social enterprises and general enterprises in Japan by focusing on the entrepreneurial motives, management ability, management strategy internal labor management system and network.

<sup>5</sup> Collective impact means that cross organizational activity belonging to multiple different actors work together to create impact by solving social issues. Kania and Kramer (2011) have the following five conditions: (1) Common Agenda, (2) Shared Measurement Systems, (3) Mutually Reinforcing Activities, (4) Continuous Communication and (5) Backbone Support Organizations.

<sup>6</sup> There are various definitions of social innovation, but in this study, it is regarded as a process through cognitive changes due to organizational learning. See, for example, changes in mental models in systems thinking in Meadows (2008) and organizational learning theory in Senge (2006).



**Figure 1: Analytical framework**

The data used to verify Hypothesis 1 and Hypothesis 2 is a piece vote data of the “Social Business Network Survey” (2010 Ministry of Economy, Trade and Industry Regional Revitalization Measures Survey) conducted by the Ministry of Economy, Trade and Industry as an investigation entity. The survey areas are Aichi prefecture and Niigata prefecture (The investigation period was from November 2010 to January 2011).

The main reason for selecting the two regions is that they are advanced regions of social enterprises in Japan. The features of each are as follows. First, Aichi Prefecture formulated the “Community Business Support Guidelines” in 2006 and is the first in the country for support measures related to the social enterprises. On the other hand, in Niigata Prefecture, there is a need to foster social enterprises in the recovery process from disasters (Chuetsu earthquake, Chuetsu-oki earthquake, flood damage). In addition, the socio-economic situation (population density, aging rate, per capita prefectural income, number of NPO certified) is close to the regional average outside the metropolitan area.

This survey is characterized by (1) a participatory survey involving intermediate support organizations in the survey process, (2) surveying the scope and content of social business networks, and (3) disclosure of the survey process. In this survey, three conditions are specified as the scope of social enterprises<sup>7</sup>. The first is sociality, with the mission of coordinating with the community, utilizing local resources, and solving social issues, and supporting or being supported by the community. Secondly, it is business-oriented, has year-round activities and independent business income, and employs one or more paid employees on a full-time basis. Thirdly, it is innovativeness (developing a new business model that does not exist in the area of activity).

Furthermore, to verify Hypothesis 3, a qualitative analysis will be conducted on the cases of representative intermediate support organizations from the viewpoints of financial sustainability and social impact. The organization on female entrepreneurship in Aichi prefecture, and the organization on the support for community businesses for regional planning in Niigata prefecture are analyzed respectively. For the analysis, we mainly use the business reports and financial statements, information on websites. For the case of Niigata prefecture, the results of interview survey with a representative in the organization are also used.

### 2.3 Analytical regions

Table 1 summarizes the statistical indicators for the economic and social environment<sup>8</sup> of Niigata and Aichi prefectures. For comparison, the average value of 47 prefectures is shown in the table. According to this table, compared to the prefectural average, it is low performance in Niigata prefecture in terms of demographics (high population decline rate, low birth rate, excess migration), opening / closing of business (low opening rate), human capital (low percentage of university / graduate school graduates), creative class (low percentage of professionals, engineers, and writers), and tolerance (low percentage of foreigners, high suicide rate).

On the other hand, Aichi prefecture has high performance in terms of demographics (high population growth rate, high total fertility rate, excess transference), economy (high per capita income), opening / closing (high opening rate), human capital (high percentage of university graduates and graduate school graduates), creative class (high percentage of engineers), and tolerance (high percentage of foreigners). However, there is a gender gap in both regions (the gender gap in regular salaries is large and the relative wages of female are low). In addition, the non-profit sector (number of certified NPO corporations per population) is below the prefectural average in both regions. Thus, Niigata prefecture relatively has many economic and social challenges.

<sup>7</sup> In addition, in this survey, if either sociality or business feasibility is not met, it is not considered as SB, and the target is set (preparation of the primary list of survey targets). In the questionnaire that SB is explained that “businesses trying to solve social issues by utilizing business methods (community business, social business, etc.)”.

<sup>8</sup> Furuzawa et al. (2020) analyzed the impact of creative class, tolerance and gender gap on the economic development of cities in major cities in Japan.

**Table 1: Economic and social environment of the target area**

Division	Indicator	Unit	年	Niigata Prefecture	Aichi Prefecture	Average of 47 Prefectures
Population	Total population	(person)	2015	2,304,264	7,483,128	2,704,144
	Ratio of population under 15	(%)		12.0	13.8	12.7
	Ratio of population aged 65 and over	(%)		29.9	23.8	28.3
Demographics	Rate of changes in population	(%)	2015	-0.68	0.26	-0.43
	Rate of natural increase and decrease	(%)		-0.52	0.02	-0.35
	Total fertility rate			1.44	1.57	1.53
	Im-migration rate (Japanese)	(%)		-0.29	0.11	-0.16
Urbanization	Population per habitable area	(person/km <sup>2</sup> )	2015	508	2,505	1,358
Economy	Prefectural income per capita	(1,000yen/person)	2015	2,778	3,677	2,874
Industrial Structure	Primary industry	(%)	2015	1.6	0.4	1.7
	Secondary industry	(%)		29.5	42.3	29.7
	Tertiary industry	(%)		68.9	57.2	68.6
Entry/Exit	Entry (Opening) rate	(%)	2015	3.1	6.1	4.7
	Exit (Closing) rate	(%)		3.4	4.0	3.7
Human capital	University /graduate school graduates (ratio to population)	(%)	2010	8.8	14.7	11.8
Creative class	Professionals (ratio to workers)	(%)	2015	1.3	1.6	1.7
	engineer( " )	(%)		6.8	8.6	7.9
	Writer / artist / entertainer ( " )	(%)		0.9	1.2	1.2
Gender gap	Gap of salary (25-29 years old)	(Female/Male)	2008	0.88	0.90	0.88
	Gap of salary (35-39 years old)	(Female/Male)		0.73	0.76	0.73
Tolerance	Ratio of foreigners	(per 100,000)	2015	502	2,220	994
	Ratio of suicide	(per 100,000 people)		22.0	16.0	18.8
Non-profit sector	Number of certified NPO	(per 100,000)	2015	30.1	25.6	38.8

Note: Due to data restrictions, data for university and graduate school graduates are used in 2010, and the ratio of female average regular salary to male regular average salary is for 2008.

The opening rate and closing rate are secondary quotes from Fig. 1-2-10 of the Small and Medium Enterprise Agency "Part 1: Trends of Small and Medium Enterprises in 2016" and "White Paper on Small and Medium Enterprises in 2017".

[https://www.chusho.meti.go.jp/pamflet/hakusyo/H29/h29/html/b1\\_2\\_1\\_2.html](https://www.chusho.meti.go.jp/pamflet/hakusyo/H29/h29/html/b1_2_1_2.html)

The original material is the Ministry of Health, Labor and Welfare "2015 Employment Insurance Business Annual Report", which is defined as follows.

1. Entry (Opening) rate = Number of establishments newly established in employment relationship in the current year / Number of applicable establishments on average in the previous year x 100
2. Exit (Closed) rate = number of business establishments whose employment relationship disappeared in the current year / average number of business establishments in the previous year x 100
3. Applicable business establishments are business establishments that have an insurance relationship for labor insurance related to employment insurance (Article 5 of the Employment Insurance Law).

Source: Ministry of Internal Affairs and Communications "Prefectures / Municipalities (Social / Demographic System)". <https://www.e-stat.go.jp/regional-statistics/ssdsview> (accessed January 25, 2021)

### 3. RESULT OF ANALYSIS

#### 3.1 Covariance structure analysis

##### 3.1.1 Data preparation and variable setting

In this study, 259 samples (78 in Niigata prefecture and 181 in Aichi prefecture), out of a total of 370 samples (115 in Niigata prefecture, 255 in Aichi prefecture) are used for the analysis because it can obtain information about the number of paid full-time employees, sales (previous year), ordinary income (previous year), business contents and importantly connected organization.

First, the principal component analysis was applied in order to make variables on the business domain (See Table 2). The cumulative contribution ratio up to the third principal component is about 38.0%. In the first principal component, the factor loading of "1. Insurance / medical / welfare", "2. Support for independence of persons with disabilities, the elderly, homeless, etc." and "3. Support for child-rearing" is positive and large. In the second principal component, the factor loading is positive and large in the order of "8. Safety and security", "7. Environment", and "9. Traffic". Finally, in the third principal component, the factor loading of "11. Industrial promotion", "10. Tourism", and "14. Support for other community business / social business" are positive and large. Thus, it can be interpreted that the first principal

component represents a welfare-oriented business domain, the second principal component represents an environment / safety-oriented business domain, and the third principal component represents a regional development-oriented business domain.

**Table 2: Results of principal component analysis about business domains**

	Ratio	1 <sup>st</sup> Component	2 <sup>nd</sup> Component	3 <sup>rd</sup> Component
1. Insurance / Medical / Welfare	37.5%	0.523	-0.053	0.086
2. Support for independence of persons with disabilities, the elderly, homeless, etc.	29.7%	0.468	-0.065	0.103
3. Support for child-rearing	18.9%	0.261	-0.084	-0.093
4. Education / Human resource development	25.5%	-0.195	-0.146	-0.452
5. Culture / Art / Entertainment	10.8%	-0.146	-0.367	-0.154
6. Sport	6.9%	-0.125	-0.207	-0.443
7. Environment	15.4%	-0.253	0.472	-0.190
8. Safety and security	9.7%	-0.102	0.595	0.097
9. Traffic	1.2%	0.048	0.277	0.135
10. Tourism	5.4%	-0.215	-0.321	0.412
11. Industrial promotion	7.3%	-0.237	-0.156	0.438
12. Regional revitalization and planning	44.8%	-0.377	-0.082	0.189
13. International exchange and cooperation	4.2%	-0.124	-0.010	-0.184
14. Support for other community business/social business	6.6%	-0.164	-0.006	0.233
Cumulative contribution ratio		16.9%	27.9%	38.0%
Interpretation of components		Welfare-orientation (high-low)	Environment& Safety-orientation (high-low)	Regional development-orientation (high-low)

Note: "Others" is excluded.

Next, the principal component analysis was applied to the response about the relationships with importantly connected organizations (See Table 3). The cumulative contribution ratio up to the second principal component is about 53.3%. In the first principal component, the factor loadings of all the related items are positive and have the same sign. As for the factor loadings of the second principal component, "2. Receiving the provision of opportunities to improve ourselves, such as learning places and consultations", "3. Receiving support about informational aspects such as bridging with the outside and providing know-how" and "1. having a collaborative relationship such as conducting a project together" are positive, while "7. Receiving financial supports such as subsidies, donations, and investments and loans", "6. Receiving physical support for goods and activity locations", and "5. Having a business relationship with suppliers, sales destinations, business outsourcing, etc." are negative. Thus, the first principal component can be interpreted as representing the level of network diversity(high-low), and the second principal component can be interpreted as representing the type of network (collaborative –economic).

**Table 3: Results of principal component analysis on inter-organizational networks**

	Ratio	1 <sup>st</sup> Component	2 <sup>nd</sup> Component
1. Having a collaborative relationship such as conducting a project together	54.1%	0.371	0.179
2. Receiving the provision of opportunities to improve ourselves, such as learning places and consultations	42.0%	0.422	0.425
3. Receiving support about informational aspects such as bridging with the outside and providing know-how	43.2%	0.470	0.375
4. Demonstrating specialized skills etc, and Receiving labor	19.6%	0.482	-0.086
5. Having a business relationship with suppliers, sales destinations, business outsourcing, etc	26.5%	0.191	-0.394
6. Receiving physical support for goods and activity locations	17.3%	0.336	-0.468
7. Receiving financial supports such as subsidies, donations, and investments and loans	16.7%	0.287	-0.514
Cumulative contribution ratio		33.2%	53.3%
Interpretation of components		Diversity of Network (high-low)	Type of Network (Collaboration-Economy)

Note: "8. Others" is excluded. For the analysis, "the number of selections of each relationship content from 1 to 7 / the number of organizations with important connections" was used.

The variable settings used for the covariance structure analysis (Structural Equation Modelling) are as shown in Table 4. Regional dummy variable (Niigata prefecture =1), and the number of full-time employees (paid) are used for regional attributes and organizational attributes respectively. For the variables of the business domains and the inter-organizational network, the scores of each principal component is calculated from the results in Tables 2 and 3. Finally, empathic cognition is taken up as an index showing changes in collective cognition in the region. Then, it is set that the

latent variable of empathic cognition is composed of two observed variables: the ratio of connected organizations that are recognized as social enterprises, and the ratio that strongly empathizes with them.

**Table 4: Variable setting**

	Variables	Content	Average	Minimum	Maximum
Regional conditions	Regionality (Niigata dummy)	0:Aichi Prefecture, 1:Niigata Prefecture	0.30	0.00	1.00
Organizational attributes	Full-time employee (person)	1:0~10, 2:11~30, 3:31~100	1.16	1.00	3.00
Business domain	Welfare-orientation (high-low)	Score of 1st component (Table 2)	0.05	-0.83	1.25
	Safety & Environment-orientation (high-low)	Score of 2nd component (Table 2)	-0.08	-0.77	1.07
	Regional development-orientation (high-low)	Score of 3rd component (Table 2)	0.01	-1.08	1.04
Inter-organizational network	Diversity of network (high-low)	Score of 1st component (Table 3)	0.83	0.00	2.56
	Type of network (collaboration-economy)	Score of 2nd component (Table 3)	0.15	-0.80	0.98
Empathy cognition: Latent variable	Social enterprise	0 to 1: Number of organizations recognized as social enterprises ÷ Number of organizations with important connections	0.29	0.00	1.00
	Empathy	0 to 1: I strongly sympathize with the efforts of the group ÷ Number of groups with important connections	0.43	0.00	1.00

**3.1.2 Results of covariance structure analysis**

Figure 2 and Table 5 summarize the path diagram and estimated coefficients of the results. The model fits well because the fitting indicators (CFI = 0.959, RMSEA = 0.039) shows good results. The following points can be seen from the results. For Hypothesis 1, the number of full-time employees has a negative and significant effect on network diversity. This can be interpreted that small scale social enterprises form an inter-organizational network because management resources are scarce. In addition, regionality (Niigata Prefecture dummy) has a negative and significant effect on the network type (collaborative-economic). As for the relationship between business domains and networks, the social enterprises of welfare-oriented and regional development-oriented have a positive and significant influence on the type of network. Furthermore, positive and significant correlations were observed between organizational size and welfare-orientation of business domain, between regionality (Niigata prefecture dummy) and regional development-orientation, and between welfare-orientation and regional development-orientation. On the other hand, negative and significant correlations were observed between regionality and welfare-orientation, and between welfare-orientation and safety & environment-orientation. Therefore, it can be said that the selection of business domains determines the type of inter-organizational network. From the above results, Hypothesis 1 “Organizational attributes / regional conditions and business domains (social issues) of social enterprises influence the formation of inter-organizational networks of social enterprises” was supported.

Next, with regard to Hypothesis 2, network diversity and network type (cooperative-economic type) have a positive and significant effect on empathic cognition. And a positive correlation is observed between the diversity and type of network. Therefore, it can be seen that the formation of inter-organizational networks of social enterprises promotes empathy and cooperation among social enterprises. Based on the above results, Hypothesis 2 “Diversity of networks of social enterprises and formation of collaborative networks change the collective cognition of the region by promoting empathy with related entities and cooperation with social enterprises” was supported.

**Table 5: Results of covariance structure analysis**

		Coefficient	p-value	
Diversity of network	Regionality (Niigata)	-0.045	0.480	
	Full-time employee	-0.124	0.073	*
	Welfare-orientation	-0.026	0.567	
	Safety & Environment-orientation	0.041	0.578	
	Regional development orientation	0.003	0.964	
Type of network:	Regionality (Niigata)	-0.083	0.073	*
Collaboration-Economy	Full-time employee	-0.035	0.490	
	Welfare-orientation	0.069	0.042	**
	Safety & Environment-orientation	-0.038	0.476	
	Regional development orientation	0.094	0.088	*

Empathy cognition	Diversity of network	0.205	0.000	***
	Type of network: Collaboration-Economy	0.148	0.004	***
Latent Variables				
Empathy cognition	Social Enterprise	1.000	Constraint	
	Empaphy	1.078	0.000	***
Covariance				
Diversity of network	Type of network: Collaboration-Economy	0.040	0.000	***
Regionality (Niigata)	Full-time employee	-0.017	0.148	
Regionality (Niigata)	Welfare-orientation	-0.093	0.000	***
Regionality (Niigata)	Safety & Environment-orientation	-0.003	0.808	
Regionality (Niigata)	Regional development orientation	0.022	0.040	**
Full-time employee	Welfare-orientation	0.060	0.000	***
Full-time employee	Safety & Environment-orientation	0.005	0.591	
Full-time employee	Regional development orientation	0.004	0.696	
Welfare-orientation	Safety & Environment-orientation	-0.025	0.091	*
Welfare-orientation	Regional development orientation	0.030	0.042	**
Safety & Environment-orientation	Regional development orientation	0.001	0.915	

Note: "\*", "\*\*", and "\*\*\*" indicate that there is a statistically significant difference at 10%, 5%, and 1%, respectively.

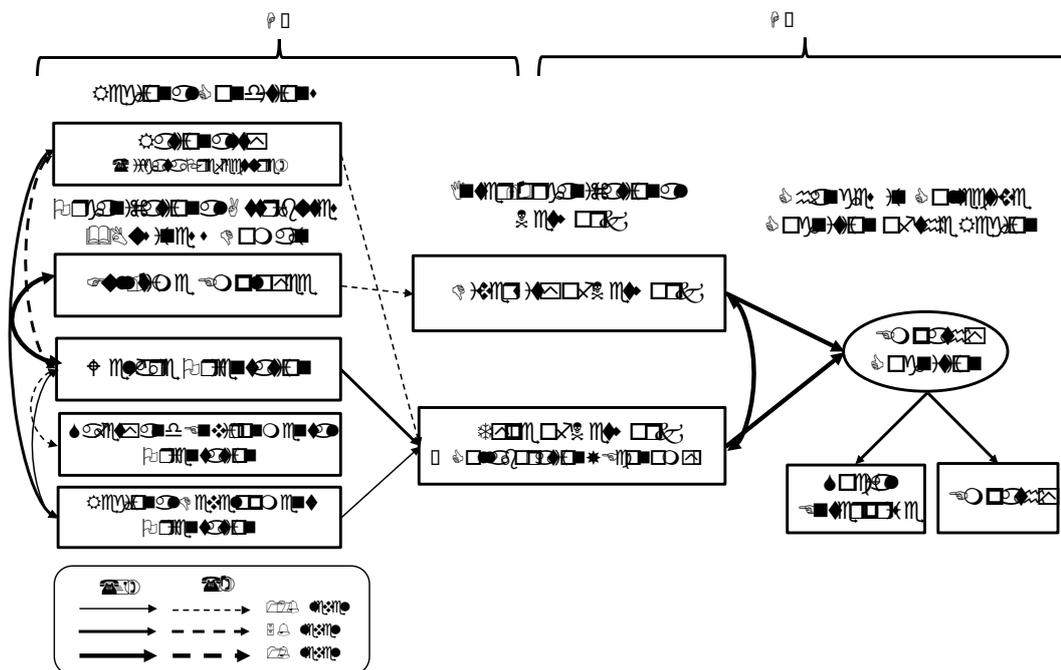


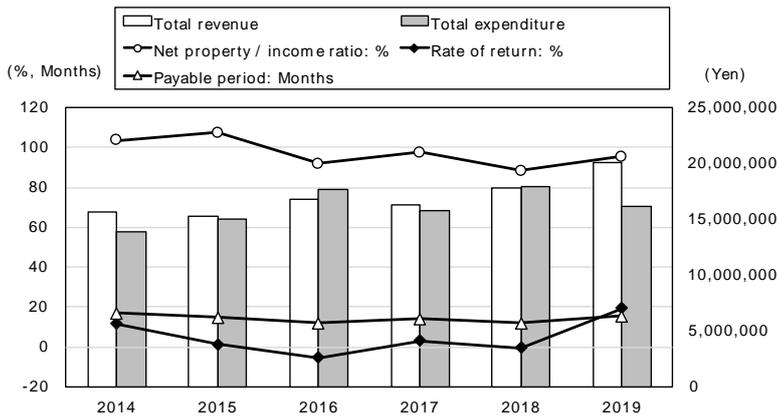
Figure 2: Path diagram of the impact of inter-organizational networks on social enterprises

### 3.2 Case analysis of intermediate support organizations

#### 3.2.1 Case of Aichi Prefecture

“Entrepreneurship Support Net” was officially established in 1998, and specified non-profit in 1999 for the purpose of supporting female entrepreneurship. Its predecessor organization had been established in 1992 by the late Mieko Sekido who was a high school teacher and a director of the Meikin Co-op (Consumer Cooperatives). As for the number of members, there are 26 individual formal members, 11 organizational formal members, and 23 supporting members (as of the end of R2.5). Its main business is to support entrepreneurial activity matching one’s situation through entrepreneurship education, consultations, lectures and training, etc.

Regarding the financial aspect (Figure 3), it has secured certain scale of revenue and various sources of income. The total income is on the rise, reaching about 20 million yen in FY2019. The main breakdown of the income (FY2019) is commissioned business revenue (87.5%), business revenue (9.7%), membership fee (2.7%), and donation (0.1%). In addition, contract consultation and business support accounts for about 80% of business revenue. Looking at financial sustainability, the rate of return fluctuates significantly, but remains positive (about 5%) for the entire period (6 years). Moreover, the net property / income ratio and payable period are high and the financial aspect is stable.



**Figure 3: Financial sustainability of Entrepreneurship Support Net**

Next, regarding social impact, it is important in three points in the efforts of “School of Entrepreneurship”, as a main business (see Table 6). The first is to support the start-ups of small business and social enterprises mainly for people who have difficulty in achieving self-actualization in the current social structure. For example, it is emphasized in the purposes of the organization “For those who have a handicap in financial independence and self-actualization under the current social and economic structure, including female to start a job as another unemployed way of working (start-up), to carry out a business to disseminate the necessary knowledge for the purpose of ... to support self-actualization, and to contribute widely to the promotion of the interests of society as a whole” (extracted from the purpose of the articles). Secondly, the entrepreneurial business fields of graduates cover various fields such as food, child-rearing, disability support, community development, specialized skills, and elderly support. It also focuses on creating networks between graduate entrepreneurs, and also expanding their social impact by supporting the formation of collaborative and highly diverse networks. Thirdly, from 2004 to the present, the “School of Entrepreneurship” has been held for 16 terms (16 years) and continues to produce a large number of entrepreneurs. Therefore, it can be judged that social and environmental changes and collective cognitive changes in the region are brought about to some extent in the medium to long term.

**Table 6: Social impact of “Entrepreneurship Support Net”**

Item	Main initiatives
(1) Support for network formation (high collaboration & diversity)	Involvement of various actors in entrepreneurial schools and seminars Publication of PR magazine “Yale” Collaboration by contract management of consortium
(2) Promotion of social entrepreneurship	Opening and management of entrepreneurial schools (multiple areas in Aichi and Fukushima prefectures, online) Creating diverse entrepreneurial fields and networks for graduates
(3) Medium- to long-term long term social impact	Accumulation of activities by opening 16th term of entrepreneurial school Creation and dissemination of “Community Business Guidebook”

Source: made from the entrepreneurship support net website (<https://npo-kigyo.net/>) and annual business report.

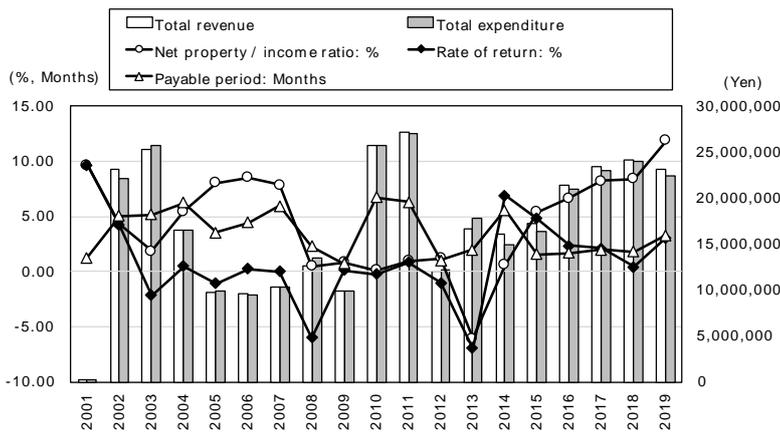
### 3.2.2 Case of Niigata Prefecture

The “Tsukisara Partners Center (hereinafter referred to as TPC)” located in the Iwafune area of Niigata Prefecture, is the intermediate organization for the purpose to support community planning through community business development. It is an organization that has developed based on the support window for residential activity established in June 1999 based on the “New Plan for Hometown Creation in Niigata”, a regional revitalization project by Niigata Prefectural government. It became a specified non-profit organization in March 2002. Currently, there are 35 regular members and 76 supporting members (as of the end of June, 2020). Based on partnerships with residents, companies, and government, TPC supports social entrepreneurs and NPOs by promoting various coordination, planning, research, etc. in seven main business fields: supporting residents’ activities, community business support, community development coordination, support and development for product and market development, and regional tourism, information transmission and reception, and inspection acceptance.

TPC has supported 79 individuals and groups in about 7 years after the start of the business, and half of them have started new businesses (e.g. facility to experience and sell traditional textiles, cafeterias at closed schools, doburoku brewing, etc.). Because of its high reputation, it has received the Minister of Internal Affairs and Communications Award in 2007, Hometown Creation Grand Prize and Group Award in 2015, and Regional Revitalization Grand Prize in 2017.

Regarding the financial aspect (Figure 4), it secures the various sources of income and the stabilized revenues. The total incomes of the TPC fluctuated significantly in the 2000s, but stabilized in recent years. It reaches about 23 million yen in FY2019. The main breakdown of income (FY2019) is business revenue (98.2%), membership fee (1.6%), subsidy revenue (0.2%), etc. (for specified non-profit activities). The community development support (about 60%), and instructor dispatching/inspection acceptance (about 30%) account for 90% of business revenue. Looking at financial sustainability,

the average rate of return had been almost zero in the 2000s, but has become positive since the latter half of the 2010s. At the same time, the ratio of net assets to revenue also improved. It is considered that the accumulation of the management know-how has improved TPC's financial sustainability.



**Figure 4: Financial sustainability of TPC**

Next, regarding the social impact, there are three important points: supporting the formation of collaborative and diverse networks and promoting start-up of social enterprises, continual business development, and presenting development model of intermediate support organization. First, it constructed a model house in Kajimachi, Murakami city as a collaborative activity space of citizens by collaboration with Togashi Works Co., Ltd. There are a large number of citizen groups and organizations to use this space (The number of people is 1,723, the number of groups is 26, and the number of uses is 180 in 2019). Residents' collaboration is increasing through its continuously dispatching instructors, planning and managing the meetings for training and exchanging as well as conducting and analyzing residents' questionnaires. In addition, through collaboration with local companies it promoted the diversity of networks by developing products that make use of art created by disabled people. Second, by opening and operating a contact point for supporting residents' activities for more than 15 years, the active participation of young people of the next generation is increasing, and medium-to long-term social impact is being created. Third, TPC initially started as regional promotion project in Niigata Prefecture, but has reached the stage where it can develop its business independently through the accumulation of management performance and accumulation of know-how. The growth process of such an intermediate support organization is of great valuable in that it presents one of the development models that can be referred to in other regions in fostering social enterprises and promoting network formation under the initiative of the government in the initial stage.

**Table 7: Social impact of TPC**

Item	Main initiatives
(1) Support for network formation (high collaboration & diversity)	Cooperation for the management of town bases Community development coordination Sending and receiving information
(2) Promotion of social entrepreneurship	Support for residents' activities with community business at the center of community development
(3) Medium- to long-term long term social impact	Continuous support such as consultation, mediation, and information provision by residents' activities support desk (grassroots activities continued for 15 years or more) Creation and dissemination of "Tsukisara-ryu CB training technique" and "Book on collaboration book" Promotion of youth participation

Source: made from TPC's website (<https://www.tsukisara.org/>) and annual business report.

Finally, Table 8 summarizes the strengths and weaknesses of each network entity as seen by TPC, based on the results of interview survey (interview for secretariat was conducted in August, 2014). Due to the characteristics of TPC as an intermediate support organization, it has networks inside and outside the region, and has accumulated know-how on regional development. However, while it faces the issue of securing stable operating costs, which is a common issue for many NPOs (at the time of the interview survey).

Next, regarding the evaluation of the strengths and weaknesses of the connected network destinations, the local government is evaluated as having creditworthiness, the small and medium-sized private enterprises are evaluated as have a strong awareness of regional contribution, and the residents are evaluated as the cohesion within each region. On the other hand, the weaknesses are the vertical administrative system and lack of participation from the planning stage in the government, obstacles in awareness of cooperation with NPOs in private companies, and lack of cooperation between regions. Therefore, there is a possibility that social impact can be enlarged by improving the quality of networks with increased diversity and collaboration.

**Table 8: Strengths and weaknesses of each network entity from the perspective of TPC**

		Strength	Weakness
Self-evaluation on TPC		[Inside and Outside network of the region] [Community development know-how] There is both quantity and quality of information. The ability of connoisseurs has also been gradually cultivated. Initially, we asked a well-known expert to teach, but now we can choose with our own eyes.	[Lack of stably securing operating costs] It is necessary to deal with supporters and revenue sources separately, but donations are not collected well (members). [Problems with how the organization Works] There are things I want to do and things I should do, and it is difficult to balance the two.
Network	Local government	[Creditworthiness (inside and outside the region)] The Prefectural Regional Promotion Bureau has a budget. However, since the key person has changed in recent years, the impact of the change in the person in charge cannot be ignored.	[Vertical administrative system] There are many cases where TPC is more familiar due to lack of information sharing and collaboration between departments. I try to play a bridging role. [Lack of participation from the planning stage] In some cases, even the projects commissioned by the local government may be refused, and in that case, a counter-proposal will be presented. We are working to promote participation from the planning stage.
	Private enterprises	[Many SMEs have a strong awareness of regional contribution] Although they think about the area well and shows their understanding, it cannot expect too much from the financial aspect because their business environment is harsh.	[Obstacles in awareness of cooperation with with NPOs] In some cases, they feel guilty about making money in collaboration with NPOs. Since it is difficult to encourage companies to contribute to the local community in terms of CSR, we are promoting private-private partnerships based on the idea of CSV (creating shared value).
	Residents	[Good cohesion within each region] There is active participation when holding workshops. In rural villages, residents cooperate with the voice of the president and ward mayor.	[Lack of cooperation between regions with different temperaments] The temperament is completely different among the mountains, the sea, and the town. In the center, the consciousness of samurai and tradesmen still remains in the elderly generation, and the consciousness of rivals is strong even among the villages.
	NPO	[Exercise of incorporation (partial)] The number of incorporated NPOs is 12 to 13, which is small. This is also because there are few merits of incorporation and it is not recommended so much.	<b>【Bipolarization】</b> Organizations with poor actual activities and organizations with poor activities are becoming more polarized.

**3.2.3 Summary of case analysis**

From the above, intermediate support organizations in both regions selected the business domain in line with the social issues of the region. And sustainable management is conducted through the accumulation of know-how and learning. And these intermediate support organizations contribute to increasing diversity and collaboration in the formation of networks between organizations. In addition, it promotes collective cognitive changes through organizational learning through fostering and collaborating with social enterprises as well as fostering empathy with related entities in the network. Therefore, “intermediate support organizations influence the structure and function of social entrepreneurship and inter-organizational networks of social enterprises, and promote the induction of social innovation (Hypothesis 3)” was supported.

**4. CONCLUSIONS AND POLICY IMPLICATIONS**

This study clarified the mechanism of social innovation through the analysis of inter-organizational networks of social enterprises. Specifically, through covariance structure analysis of inter-organizational networks of social enterprises, it is clarified that the organizational attributes and business domains of social enterprises influence the formation of inter-organizational networks (Hypothesis 1) and diverse and collaborative network formation promotes empathy with related entities and cooperation with social enterprises (Hypothesis 2). In addition, through the case studies of intermediate support organizations, it clarified that these organizations promote the induction of social innovation (Hypothesis 3) in the study regions. From this, it can be said that by appropriately designing the formation of inter-organizational networks of social enterprises, it is possible to promote the induction of social innovation as the exertion of social impact through changes in the collective cognition of the region. Therefore, in order to promote sustainable regional development through solving regional problems, policy that supports to enhance the formation of diverse and collaborative network is required.

However, to conduct research to evaluate the performance of social innovation in the region using the method of social impact assessment, and to analyze the impact of regional social institutions on the development of social entrepreneurship will be our future research agenda.

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**ON THE WORKING IN BORDER THINKING TO DIGITALIAN FROM  
“JIKOCHULIAN”:AN EMPIRICAL ANALYSIS IN “DIGITAL SOULFULLIAN”  
ERA**

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**ABSTRACT**

This paper is about border thinking to digital thinking and analog thinking in “the DIGITAL SOULFULLIAN” era that means people who survive the predicament era about digitization.

In the wake of the Corona(COVID-19) disaster, which is already a year old ( from the first wave to third wave or third silent wave means between third wave and next wave of the COVID-19), now, the use of ICT has been promoted in various aspects such as industry, medicine, and education. Japan is in the midst of a major change in social life with ICT technology. The significance of this paper is that Japan's social life is about to change drastically, and as a sustainable city, it is very significant for future digitized Japan to consider and analyze the turning point of innovative thought.

Digitization of information in all of its forms is one of the most developed things of the twentieth century. In Japan, Information as the business resource gets more important in addition to the conventional three business resources, human, goods, and money, trends. The era has begun when it is impossible to establish a business management strategy without an information strategy. The problems of "information literacy" and "digital divide" in the early days of information technology are the essence of relative disparities, and with the co-evolution of information and communication technology, business organizations, and business models, the boundaries of information disparities are advancing of information capabilities, it is important things. It has been fifteen years since the author has advocated the Novel theory “Information and Business Study” that the Information resource is as the core of four business resources since 2006. However, at least for this fifteen years, digital transformation is the biggest problem behind Japan's economy and companies, it still has not changed by leaps and bounds about digital in Japan. So in this paper discussed the question is Why hasn't this changed in the Japanese mind yet, whether we are now “ANALOGIAN” means pure analog thinking, “DIGITALIAN” means pure digital thinking or “JIKOCHULIAN” means the thought that both analog and digital information are important by interview survey and literature survey. This paper concluded that one person of United States appears to have DIGITALIAN thinking, but they are JIKOCHULIAN thinking in current Japanese citizen mind.

In the future, it is important to analyze other cases and when is the singularity from JIKOCHULIAN to DIGITALIAN, different of regional in the world,  $\min.0 \geq A$  and  $0 \geq B$ , and  $\max 1 \leq A, B$  and so on about after the third wave and third silent wave of COVID-19 on risk society by the General and Unification study perspective in the future.

## REGIONAL INNOVATION POLICY FOR INNOVATION UPGRADING OF LOCAL SEMS

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### ABSTRACT

This paper addresses the following two new perspectives on the innovation ecosystem in a region; (i) focusing not only on innovation, but also on upgrading innovation; and (ii) empirically analyzing the effectiveness of local innovation policy aiming promotion of innovation in regional SMEs. This analysis attempts to identify how policy affects internal innovation capability which creates innovation. Thus, the **RQs** are summarized: RQ1: What are factors inside the firm to promote innovation upgrading?; RQ2: Whether and how local innovation policy is effective to innovation upgrading?

This study is based on a questionnaire survey to 1,324 SMEs conducted in 2014 in the *Hanshin* area, Japan. The stage of innovation upgrading was classified into four depending on whether technology used and market targeted are existing or new. This study defines the stages of upgrading as follows: Stage 1: Develop products with existing technologies for existing markets; Stage 2: Develop products with new technology for existing market; Stage 3: Develop products with existing technologies for new markets; Stage 4: Develop products using new technologies for new markets.

Since the outcome variable is defined as four categories, an ordered probit model was employed for empirical analysis. The explanatory variables consist of firm's characteristics such as the number of employments, R&D investment ratio to sales, and practicing open innovation, and factors promoting innovation contains sources of ideas, problem solving ability, HRD, business development strategies.

This study also analyzes the effect of six policies of Hyogo prefectural government for upgrading; 1) Hyogo Manufacturing Academy; 2) Hyogo Industrial Cooperation Coordinator Council; 3) Industrial location Support System; 4) Hyogo Prefecture COE Program Promotion Project; 5) Financing System for SMEs; and 6) Support SMEs via the Internet.

An ordered probit model obtained the following factors and questions were significant to upgrading: Sources of idea; Invented inside the firm based on market trends; Problem solving; Ask advice or conduct joint R&D to universities or public research institutions.; HRD; Provides higher jobs to workers and aims to elevate their potential; Business development strategy; Emphasizing areas utilizing experiences of technology and R&D.

For policy evaluation, two cross terms became significant, which are (i) "Hyogo Manufacturing Academy\*Arrange the environment which provides higher jobs to workers and aims to elevate their potential" and (ii) "Hyogo Industrial Cooperation Coordinator Council\*Arrange the environment which provides higher works to workers and aims to elevate their potential." Thus, the policies enhance upgrading via the HRD of SMEs.

The Hyogo Manufacturing Academy has training courses to nurture workers of the next generation by succession of technical skills. SMEs also stress on HRD which includes various schemes combining OJT and OFFJT. The Academy provides OFFJT programs which are complimentary to the HRD schemes inside SMEs. This is a reason why the Academy plays an important role.

## **Regular Session: RS12.1 - Spatial implications of climate and environmental change**

**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/88538303825>**

**Chair Hicham Alaoui**

## MACHINE LEARNING APPLICATION TO PREDICT FOREST FIRES IGNITION RISK IN THE MEDITERRANEAN REGION (NORTH-WEST MOROCCO)

**Hicham Alaoui<sup>1</sup>, Assali Fouad<sup>1</sup>, Hicham Hajji<sup>2</sup>**

<sup>1</sup>Climatic and Forest Risk Management Center, Morocco. <sup>2</sup>IAV, Morocco

### ABSTRACT

This scientific paper explores the spatial predictability of forest fire ignitions in the mediterranean region (North- west of Morocco). The geographic information system was used to locate 704 forest fires recorded between 2002 and 2018. Using 20 human and biophysical variables, the building of dichotomous prediction model (Fire or No Fire) was developed using 3 classification models namely: the binary logistic regression, the random forest and XG-Boost. Data analysis provide relevant information to understand the human factors, climate, topography and vegetation type, affecting forest fire ignitions processes in the study area. A random sample of observations (60%) was used to build the model and external observations (40%) have been reserved for testing the ability of the model to predict forest fire ignitions. The explanatory variables included in the model, report on the impact of factors related to (1) human action represented by localities with high frequency of fires and accessibility (roads and trails), (2) topoclimatic, including, temperature, relative air humidity and slopes and (3) biological, namely the type of fuel, (pine and cork oak trees, Matorral, ...). The 3 types of machine learning models (binary logistic regression, random forest and XG Boost) have shown very interesting results in terms of forest fire predictability by correctly classifying an average of 85% of the sample reserved for the model training and data validation. The forest fire ignitions probability maps produced could operationally improve the alerts processes, the lookout posts positioning and the early intervention against fires by the units in charge of initial attacks.

**AN ASSESSMENT OF DROUGHT VULNERABILITY AMONG HOUSEHOLDS WITH TEMPORARY MIGRANT MEMBERS AND HOUSEHOLDS WITHOUT TEMPORARY MIGRANT MEMBERS: A COMPARATIVE STUDY ACROSS DIFFERENT INCOME AND SOCIAL GROUPS IN RURAL INDIA**

**Badsha Sarkar**

TERI School of Advanced Studies, India

**ABSTRACT**

In recent times, India is witnessing a significant growth in terms of both the vulnerability to climate change as well as the volume of seasonal migrants simultaneously. One of the several ways through which the climate change is supposed to impact India is the increasing frequency and intensity of droughts. India which to a large extent is dependent on the monsoonal precipitation pattern for recharging its vast drainage networks is also a country with a huge volume of workforce dependent directly on the rainfed agricultural system. A volume of field investigations has emerged which has shown a variety of migration behaviours among the different population groups, distinguished by their respective social and economic characteristics, under a given drought situation. At the same time there is also a debate between the narratives of migration as an adaptive strategy or a failure to adaptation during a given climatic hazard especially in the academic arena. Therefore, a policy choice between migration prevention and migration support under a drought situation needs to be properly backed by empirical evidences. These evidences are very small in size for the Indian population. In this direction, the present paper investigates the drought vulnerability among households with temporary migrant members and households without temporary migrant members in rural India across different income and social groups. Vulnerability is defined as a function of exposure, sensitivity and adaptive capacity following Intergovernmental Panel on Climate Change (IPCC) Assessment Reports. Household level sensitivity and adaptive capacity indicators are identified from India Human Development Survey 2011-12 (IHDS-2) which are merged with the district level drought exposure data collected by India Meteorological Department (IMD). Weights are assigned to the variables by principal component analysis and composite indexes are calculated for exposure, sensitivity, adaptive capacity and the overall drought vulnerability.

## **Special Session: SS18.1 - Urban Future in the Global South**

**09:30 - 10:45 Tuesday, 25th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/88394645535>**

**Chair Abdul Shaban**

## INTERDEPENDENCIES BETWEEN SPATIAL PLANNING AND THE MINING LAISSEZ-PASSER IN CITIES, THE CASE OF ECUADOR

[Karl Heinz Gaudry](#)<sup>1,2</sup>, [Danilo Ibarra](#)<sup>1</sup>, [Carla Carabajo](#)<sup>1</sup>, [Katty Marin](#)<sup>1</sup>

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### ABSTRACT

Addressing urban planning as shared-resource is tied with the 'tragedy of the commons'. Since UN-Habitat III, Ecuador has embraced the opportunity for urban sustainability. However, while the *right to the city* is constitutionally anchored since 2008, the integration of strategic sectoral plans and their spatial link remains unclear. Aiming at a better understanding on how sectoral plans, particularly mining, are spatially articulated to spatial planning instruments, we review the existing planning instruments as well as those from the mining sector. Next to the mining city of Zaruma, our desktop research combined with stakeholder and expert interviews, showed a vacuum in articulating sectoral planning with urban spatial planning instruments. Instead of interpreting wrong-will from the mining sector, we suggest further research on existing planning instruments that accommodate underground with surface land-use planning.

## POPULATION CONCENTRATION, SOCIO-ECONOMIC DEVELOPMENT AND PERCEPTION OF CORRUPTION IN THE CAPITAL OF LATIN AMERICAN COUNTRIES

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### ABSTRACT

The relationship between population concentration in the capital of a nation, where the powers that govern it are located, and the socioeconomic development of the region, is an issue that involves a double assessment, since this population can affect the country's decision-making center both positively and negatively.

The main work that seeks to investigate the influence of population concentration in capital cities in socio-economic development and, mainly, in corruption, is by Campante and Do (2014), in which the authors seek to answer whether the isolation of the capitals of the American states contributes to less control over public authorities and, consequently, a higher level of corruption.

For the authors, isolated capitals are associated with less accountability. For this, they investigate two spheres of accountability, which are the role of the media and the electoral process. With respect to the media, they show that newspapers provide greater journalistic coverage with regard to state policy when the population is close to the capital, that is, the spatial distribution influences this issue. With less media scrutiny and less voter involvement, an isolated capital paves the way for a stronger role for money in shaping political outcomes.

In addition, for Campante and Do (2014) the low degree of accountability affects the final provision of public goods. This is because states with isolated capitals seem to obtain unsatisfactory results in terms of education, public welfare and health. Thus, low accountability, as a result of the isolation of the capital and, consequently, of corruption, impacts on the quality of governance.

And it is precisely this aspect that we intend to deal with in this work: how much does isolated capital allow corruption and affect the socioeconomic development of countries? In this context, we want to assess whether the location of the capital in a region with a high concentration of the population can be an indication of greater public control, that is, less corruption, greater human development and less inequality, and, consequently, greater socio-economic development. The region of analysis is Latin America and the data are for the years 2017 and 2018.

Analyzing the results, it was possible to notice variations in the correlation coefficients of the different socioeconomic development indicators with the population concentration in the countries' capital.

The issue of social inequality measured by the GINI index is the most distant in terms of the correlation of population concentration in the capital. The intermediate factor is the Human Development Index, which is weakly correlated with population concentration in the capital. Finally, the index of greatest significance is the corruption perception index. The results seem to indicate that the population concentrated in the same city as the policy makers, are subject to more significant scrutiny, and thus corruption tends to be milder.

## URBAN STRUCTURE TO DETERMINE A EQUITABLE REGIONAL GROWTH TOWARDS HUMAN EQUITY: CASE STUDY IN CHÍA-BOGOTA, COLOMBIA

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### ABSTRACT

The evolution of land use occupancy at present in the different cities of the world is very high. Particularly, in developing countries, large cities are the main attractor centers of activities, therefore, the social component associated with this trend is very important. Thus, the constant modification of land uses, economic instability and environmental factors, as also social behaviour changes of big cities' inhabitants characterize the current urbanism. So the question arises how does the urban spatial structure and organization contribute to an inclusive and equitable socio-spatial evolution, considering the challenges of urban growth with climate change?

The case study is located on the northern limit of Bogotá's city, characterized by large volumes of mobility especially of a functional type (work-study-residence). Due to the rapid expansion of the peripheral areas in Global South, this research will help to understand and manage two urban areas that tend to come together in the future as an urban continuum. Therefore, the aim of this research is to define optimal locations and adequate urban growth areas, ensuring socio-spatial equity and mitigating impacts on climate change.

As a methodology, is proposed an analysis of urban morphology and an analysis of the (social) intensity on uses of activities and infrastructure, which allows characterizing the urban structure itself and identifying the appropriate mobility corridors for the implementation of new growth areas. The space syntax analysis is focused on the logic of urban space based on human behaviour (Hillier, B., 2005) which allows to know the connectivity, integration, choice and intelligibility parameters, to understand the global structure of the urban network (Ahmed et al, 2014; Liu et al, 2018). This method could be applied to other urban areas, however, some adjustments to the spatial context are necessary. The (social) intensity analysis of spatial structure, integrates the mobility flows and the social characteristics of the study area with environmental factors (Ericson et al, 2020). The main data to be used will be the urban mobility axes (vehicle and pedestrian) through transformation into axial maps, land uses and classification of the social strata based on plot structure of the urban space.

As a result (based on the relationship between urban structure and social infrastructure), they are expected to consider the degree of entropy and spatial asymmetry, as well as to determine the optimal urban growth areas and to fit the United Nations urban development goals. One of the main discussions should be the identification of social urban structure that could be helpful to public policy of land use planning, as a new finding. This public policy on a municipal scale, as an instrument is one of the most important in urban space and the results obtained can support the policy in a more equitable and adequate management when it is necessary to select or delimit new areas of urban growth. The study should conclude with evidence of suitable allocating urban expansion areas which will allow better efficiency of urban land as a limited resource.

## OVERCOMING MARGINALITY: GRASSROOTS REDEFINITIONS OF URBAN FUTURES IN THE LATE SOCIALIST HAVANA

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### ABSTRACT

The aim of this paper is to explore competing and uncertain urban futures of Havana constituted through small grassroots initiatives and infrastructures, as well as large scale commercial-investments. Recent years have brought a proliferation of community projects that tend to be small grassroots initiatives aimed at helping marginalized communities and creating opportunities within the respective neighbourhoods for work, leisure and improving the quality of life.

On the basis of ethnographic fieldwork conducted in the course of 9 months between 2018 and 2020 I intend to answer the questions on how competing through grassroots initiatives and navigating the informal economies *habaneros* envision and create their futures. At that time I spoke to various community leaders and inhabitants of informal settlements regarding their everyday lives and opportunities, problems that the communities were facing etc. Rampant rise of inequalities and limited possibilities of accessing hard currency outside of the tourist economies forces many Cubans, especially younger ones to seek possibilities outside of Cuba and longing to emigrate in order to make a living. Others choose to work in the informal economies, also engaging in the illegal activities. This is where community projects come in with the intention of creating opportunities for other futures within Cuba.

The position of Havana as an economic, political, cultural and touristic hub of Cuba constitutes it as a city of contested futures. As a result of the need to readjust Cuban economy after the fall of its main trade partner, the Soviet Union, Havana has become a place of massive investments geared mostly towards improving tourist infrastructure. This shift along with nation-wide economic crisis led to massive migrations towards the Cuban capital that the neglected through decades urban infrastructure was not able to sustain, producing a rampant rise of informal housing, as well as informal economies, that were only reinforced by the dismantling of socialist economies in the 1990s.

At the same time, Havana is experiencing consequences of environmental decline with water reserves drying out, pollution of rivers, deforestation and rising amount of waste. Although the Cuban government was fast to jump on the bandwagon of environmental protection through actions of reforestation, promotion of alternative sources of energy, permaculture schemes etc. these discourses were not always put into practice. In many cases it is community projects and other non-state actors that fill the void created by the state and engage in urban gardening, environmental care and social help.

The paper takes a closer look about how such projects employ global and local discourses and practices of overcoming marginalization and fostering development into the broader ideological debate of defining socialist Cuba in a late socialist setting. This approach broadens the existing body of work that focused primarily on the emerging entrepreneurial markets by taking a closer look of construction of new "solidarities" and community work in the context of the absent state increasingly market-reliant Cuba.

## THE AICOVID19 PANDEMIC VULNERABILITY INDEX FOR BRAZILIAN MUNICIPALITIES: A MACHINE LEARNING APPLICATION WITH GRADIENT BOOSTED TREE MODEL

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### ABSTRACT

This study approaches the spatial distribution of the deaths of COVID-19 pandemic to valAICovid-19 Pandemic Vulnerability Index for the Brazilian municipalities. We focus on COVID-19 deaths of March 01 to April 25, 2020, to build the index and the spatial probability distribution for deaths in the municipalities. We use artificial intelligence in a machine learning process, called the Gradient Boosted Tree method. The data was collected in the Health Ministry of Brazil and the results show that the coronavirus largely will affect the southeast, south, and Midwest, however, others hotspots will expect in a few regions.

### KEYWORDS

Covid 19, Vulnerability Index, Machine Learning.

### 1. INTRODUCTION

The coronavirus surprised the world in 2020, reaping countless human lives, and driving a lot of researchers to forecast the deaths for many regions of the world. One method to predict some of the consequences of this sickness is the Pandemic Vulnerability Index because it permits the prediction of the spatial probability distribution of deaths. At the moment, this initiative innovates a lot because will be possible to calculate for the first time the index using the number of true deaths to COVID19.

Assuming this objective, we build the AICOVID19 Pandemic Vulnerability Index for Brazilian municipalities, adapted from DeCAPRIO (2020). First, we collect the aggregated coronavirus deaths for the period of March 20, to April 25, 2020, and next elaborate the Pandemic Vulnerability Index by one artificial intelligence, called to Gradient Boosted tree method. We collect some mortality risk variables of the illness, proxies of the wealth, and the health system in the cities (AHMAD et al (2020); AHMAD et al (2020a); and, DECAPRIO (2020)). We suppose that the structure of urban city's and the industrialization process may reflect the path of the coronavirus infection will occur. It shows us that when larger is the infrastructure, likely more infectiously will be the region.

This study is organized into four main sections. In section 2, we provide a survey of the multiple health forecasting models. Section 3 deals with the analysis of the Vulnerability Index, assuming the artificial intelligence recommendations. Section 4, shows the main results; and in the last section, we present the final remarks.

### 2. THE HEALTH FORECASTING MODELS

The health studies of pandemic outbreaks looking for a medical perspective to control given illnesses, and attention is giving to the containment measures, the diagnosis, the treatment of patients, and the development of vaccines. Ferguson et al. (2020) assume that the information required by public health experts comes from a wide variety of epidemic models, where estimate transition rates between exposed (S) infected (I) and recovered (R) or dead. Then, these transition rates depend on the disease's features and your transmission processes, and the containment measures. To Wynants et al. (2020), there are many ways to structure these models: Markov frameworks (Liu, 2020), simulation models (Ferguson et al., 2006; Halloran et al., 2008), artificial intelligence estimates (Ozturk et al., 2020), multivariate analysis (Xie et al., 2020), vulnerability indexes (DeCaprio et al., 2020) or meta-analysis (Wynants et al., 2018).

According to Maher (2020), Shinde et al. (2020), and DeCaprio, (2020), the health forecasting techniques consider assisting governments in designing better strategies to confront pandemics. The studies on health focused on big and slow-moving health outcomes such as infant mortality. Given that the COVID-19 presents a fast-moving, sudden shock in the health systems [GREER et al. (2021)], the forecasting will be more difficult and doesn't exist some past knowledge about this viral pandemic. However, the results of these studies are useful for multiple purposes like controlling the spread of COVID-19 locally, reducing the spread of COVID-19 for a specific region, deciding its impact, building the vulnerability index, and/or establishing a correlation between the environmental conditions (metrological conditions) [MAHER (2020)]. These surveys together represent the main ways for assessing the health impacts of pandemic outbreak [SHINDE et al. (2020); ZHOU F. et al (2020); and, WANG, T. et al. (2020)].

Maher (2020) argues that the interplay of social and health risk factors will be important when considering where to focus relief efforts. Because COVID-19 is a novel disease that has evolved into a pandemic, then we shall focus our analysis

on the component to better understand the distribution of hospitalization and mortality risk, analyzing the industries and geographical space. To Greer et al. (2021), by spring 2020, COVID-19 exposed gaps in public health systems and social policy structures in different countries. The NPIs and TTIS systems were the core of the successful efforts of governments to manage the pandemic<sup>9</sup> 10.

Besides, Fekete (2009) assumes that the choice of variables to compound the vulnerability index needs some validation to find whether the Social Vulnerability Index without direct relation to disaster impact or hazard parameters is valid. Next, they indicate three advantages to use the validation when evaluating the social index of the pandemic. However, we believe that validation for the AICOVID19 pandemic vulnerability index seems difficult due the social-economic importance of the COVID19 outbreak deaths [ACHARYA and PORWAL (2020)]. Then, we assume that the pandemic vulnerability index appears more to the social economic costs to municipality returns at the same economic development background before the COVID19 deaths occurred.

These studies use features according to Acharya and Porwal (2020) in social, demographic, economic, health, and epidemiological aspects. They used a similar methodology developed by Flanagan, by the CDC to compute social vulnerability indices for each census tract in the USA. To both authors, Flanagan's social vulnerability index includes four domains: social-economic status (comprising income, poverty, employment, and education variables), household composition and disability (comprising age, single parenting, and disability variables), minority status and language (comprising race, ethnicity, and English language proficiency variables), and housing and transportation (comprising housing structure, crowding, and vehicle access variables). The authors remember that a similar methodology was also used by the Surgo Foundation to calculate their COVID-19 Community Vulnerability Index (CCVI). The objective here is the interpretation of the pandemic vulnerability index according to until Jun, 2021, COVID19 deaths. The graphic view shall be careful, looking for inconsistency.

Next, according to Maher (2020), approximately 80% of the US workforce has at least one health risk factor for the COVID-19, and approximately 11% of the US workforce is over 60 with at least one additional COVID-19 risk factor. Therefore, the hypothesis that better planning may also increase the return on investment for public policy seems to be the first best policy to follow, keeping essential businesses functioning in high-risk industries and preventing avoidable deaths from COVID-19 [SHINDE et al. (2020); ZHOU F. et al (2020); and, GREER et al. (2021)]. To Greer et al, (2021), countries that implemented swift responses such as robust testing and efficient contract tracing fared better in these first months of the pandemic.

On August 14, 2020, the pandemic resulted in 3,224,876 confirmed cases and 105,463 deaths in Brazil [GREER et al. (2021)]. The Global Health Security Index believe too that Brazil has a comfortable position in Latin America, been ranked with the best score between these countries (59.7 out of 100). However, Greer et al. (2021) affirmed yet that by the winter of 2020, the Infections were rising rapidly in the southernmost states and most regions of the center-west in the country, showing that Brazilian authority efforts to contain the virus to urban and other hotspots were failed.

### 3. METODOLOGY

The Gradient boosted tree models are a machine learning method that demonstrates fairly robust [MAHER (2020)]. The idea of boosting came out of the idea of a weak learner can be modified to become better, [BROWNLEE (2018)]. This author believes that the boosting hypothesis was the idea of filtering observations, leaving those observations that the weak learner can handle and focusing on developing new weak learns to handle the remaining difficult observations. To Brownlee (2018), the statistical framework cast boosting as a numerical optimization problem where the objective is to minimize the loss of the model.

Different authors assume that as possible to use the loss function of a mean squared error and the classification in the logarithmic loss form. The decision trees used to give us the output real values for splits and whose output can be added together allow subsequent model outputs to be added and next will be possible to correct the residuals of these predictions. These authors assume too that a gradient descent procedure can be used to minimize the loss when adding trees. To Brownlee (2018), gradient descent is used to minimize a set of parameters, where after calculating error or loss, the weights can are updated to minimize the next error term.

The Gradient Boosting method assumes to "teach" the model  $\hat{y} = F(x)$  to minimize the mean square error (SME),  $\frac{1}{n} \sum_i (\hat{y}_i - y_i)$ , where "i" is the training set, and "n" is the number of observations. This method uses the function  $F_m(x) = F_{m-1}(x) + \sum_{j=1}^m \gamma_{jm} 1R_{jm}(x)$  to permit the adjustment by adding the second term on the right side of the equation. Then, minimizing the mean square error (SME) imply that the algorithm solves  $\gamma_{jm} = \underset{\gamma}{\operatorname{argmin}} \sum_{x_i \in R_{jm}} L(y_i, F_{m-1}(x_i) + \gamma)$ . Therefore, we calculate the optimum, and removing the feature importance ranking.

9 Greer et al. (2021) assume that "NPIs are public health actions to slow or stop the spread of disease that do not involve vaccines or medicines; included hand washing, social distancing, travel restrictions, school closures, restrictions on businesses or closures of activity in places or sectors ("lockdowns"), mask mandates, and restrictions on working and socializing". To other hands, "the TTIS systems are a package of interventions: testing extensively (to find people with the virus), contract tracing (to find out whom they might have infected and from whom they caught it), isolation (keeping infected people away from the public and opportunities to infect others), and support (ensuring that infected people have what they need to isolate, e.g., income, food, support for dependents while their caregivers were in isolation, a secure place to live)".

10 The decisions about the official causes of death introduce discrepancies in the real data, which make it difficult to compare across contexts. Furthermore, "some metrics that are useful for epidemiological purposes have been misused during the pandemic", [GREER et al. (2021)].

We admit a proxy variable that assumes the municipality where occur deaths to coronavirus to be equal to one,  $y = 1$ , and 0, ever not occur deaths to the virus. Besides, we collect data containing 20 variables following DeCaprio (2020), Zhou et al (2020); Wang et al. (2020); Byhan and Fenichel (2020); and, Brownlee (2018). We use 10 % to the test sample, remaining 90% to the training sample. For the outliers' tests, we use the Z-count, removing 832 from the total of 5570 municipalities, which appear in color white in Figure 1. Next, the feature importance was calculated, for the test and training samples. Finally, we build the index of each municipality.

**4. MAIN RESULTS**

The AICOVID19 Pandemic Vulnerability Index uses the deaths and the number of cases of COVID19 registered adding up until April 25, 2020. All variables are presented in Table 1. The variables used follow Acharya and Porwal (2020). We use to the social-economic variables: the population proportion of firms in 2018; the per capita GDP in the year of 2019; the proportion of CNPJ registered firms in the year of 2018; the proportion of CEI registered firms in the year of 2018; the per capita taxes in the year of 2019; and, the proportion of CEApf registered firms in the year of 2018. To the Demographic variables, we choose: the population proportion of births in the year of 2019; the average of elderlies in Hospital Intensive Treatment in the year of 2019; and the average of black elderlies in Hospital Intensive Treatment in the year of 2019. To the Housing and hygiene conditions variables, we use only the population proportion of mothers with 15 years old 2019. For the Availability of a health care public hospitals variables, we adopt the Mortality rate of the year of 2019; the population proportion of General Hospitals in the year of 2018; the municipality population proportion of health professionals in the year of 2018; the population proportion of males death in hospitals in the year of 2019; the population proportion of health establishments in the year of 2018; and, the Mortality rate in hospitals in the year of 2019. Finally, the Epidemiological variables: the population proportion of COVID19 cases until April 2020; the population proportion of male deaths in the year of 2019; the municipality population proportion of COVID19 deaths in the year of 2020; and, the population proportion of individuals in Hospital Intensive Treatment in the year of 2019.

The feature importance ranking by the test and the training samples present in the Table 1 too. We observe that the share of new coronavirus cases is the first feature of ranking. Next, the features of the share of male deaths occurred in 2019, and the share of registered firms in 2018. If the locality produces spillover effects to the regional economy suggests that the COVID19 risk is high in this locality. The results point out that the strategies to the pandemic will be better evaluated by the regions where the productive activity presents. In these regions, the disease spread needs attention.

**Table 1. Variables and Importance Ranking for the AICOVID19 Pandemic Vulnerability Index: test and training samples**

Variables	Test	Training
# of COVID 2020 cases	0,87066425	1,58764069
# of 2019 male deaths	0,043044185	0,060209933
# of firms in 2018	0,038559674	0,069158036
Per capita GDP 2019	0,007627068	0,001966991
Mortality rate 2019	0,007592955	0,010599018
# of General Hospitals 2018	0,007538674	0,006598491
# of registred firms CNPJ 2018	0,004237273	0,005572857
# of COVID2020 municipality deaths	0,002974228	0,008240305
# of health professionals 2018	0,002963307	0,000727361
The average stay in Itensive Tretament 2019	0,002854627	-0,000266622
# of registred firms CEI 2018	0,002665598	0,006043014
Per capita taxes 2019	0,002489595	-0,002738958
# of males death in hospitals 2019	0,001662159	0,013781302
# of births 2019	0,000899987	-0,000362741
# of registred firms CEApf 2018	0,000893729	0,00190678
# of mothers with 15 years old 2019	0,000888549	0,001943169
# of health establishments 2018	0,000880937	-0,000116153
The average stay of elderlies in Intensive Treatment 2019	0,000869273	0,0014956
The average stay of black elderlies in Intensive Treatment 2019	0,000548456	0,00079853
Mortality rate in hospitals 2019	0,000145474	0,000215172

Source: IBGE Cidades, Ministério da Economia RAIS, Elaborated by Author.

The AICOVID19 Pandemic Vulnerability Index descriptive statistics are in Table 2. The average square error equal to 0.0148, and the regression score test, 0.921. These results indicate that the variables are adequate to the model.

**Table 2 Descriptive Statistics of the IACOVID19 Pandemic Vulnerability Index**

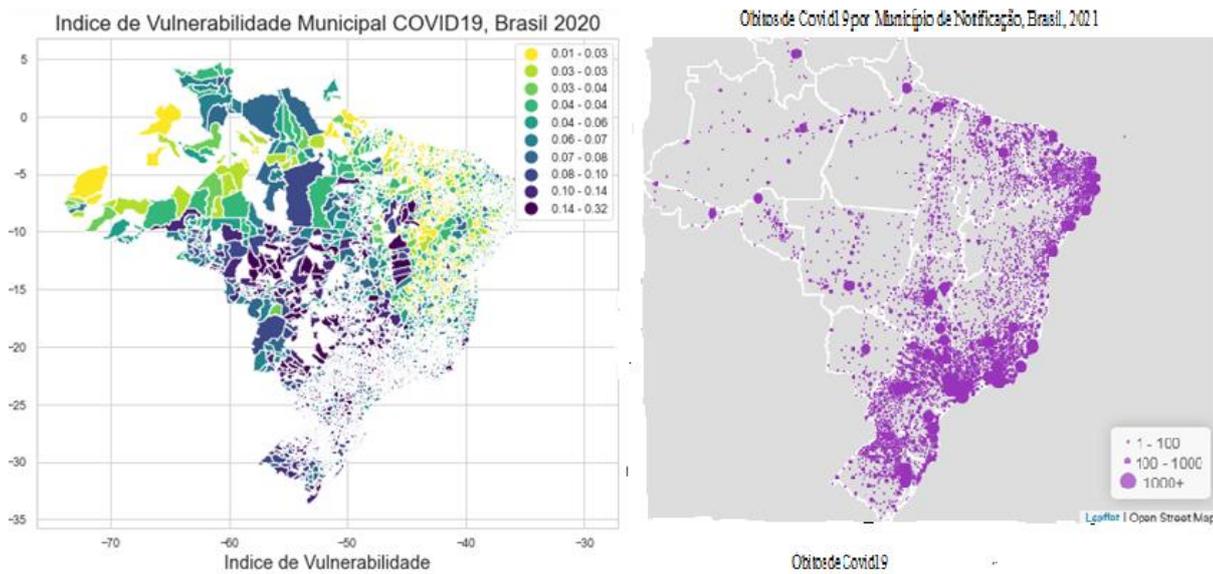
Descriptive Statistics	Value
Count	4738
Mean	0,070694
Standart deviation	0,048846
Min	0,010662
25%	0,032915
50%	0,056013
75%	0,093241
Max	0,3178
dtype:	float64

Source: IBGE Cidades, Ministério da Economia RAIS, Elaborated by Author

**5. SPATIAL DISTRIBUTION OF VULNERABILITY AND THE COVID-19 OUTBREAK**

The interpretation of pandemic vulnerability index distribution and the comparisons with the COVID19 deaths shall be careful. The spatial distribution of the AICOVID Index on April 25, 2020, is on the right side of Figure 1. This vulnerability index represents the economic costs that the locality will assume to recover the economy to the levels before the pandemic outbreak. The municipalities that present a high vulnerability index will suffer more to return to economic patterns before the pandemic for each new dead the location will have.

In the right side of the Figure 1, we shows the spatial distribution of COVID-19 deaths occurs until Jun, 2021, this is, one year after the spatial distribution of AICOVID-19. The states with more deaths until Jun, 2021, are Rio de Janeiro, São Paulo, Minas Gerais, Rio Grande do Sul, and Paraná (Ministry of Health of Brazil, 2021).



**Figure 1. The Spatial Distribution of AICOVID19 Pandemic Vulnerability Index (Apr 2020) and the Number of Deaths by COVID19 (Jun 2021) in Brazilian Municipalities**

Source: IBGE Cidades, Ministério da Economia RAIS, and Secretaria Estadual de Saúde, Brazil, 2020. Elaborated by Author.

There are four possible outcomes when comparing the vulnerability index and the number of deaths from COVID-19 in Brazil, 2020. First, the municipality has a low vulnerability, and there are few deaths. In Figure 1, we can see many locations in the northern region (Amazonas, Pará, Acre, among others) and others in the Northeast of Brazil. The states that have most municipalities in the North region are Pará (144) and Amazonas (62). In 2019, the average per capita GDP ranged between 10.11 and 21.99, and the mortality rate ranged between 0.002 and 0.004 in this region. The proportion of deaths among men in 2019 ranged from 0 to 0.002. The registered firms in 2018 ranged from 0.001 to 0.018 among municipalities. Besides, the general hospitals' proportion ranged from 0 to 0.000001. We conclude that the region does not present high values for the features of vulnerability.

In the second result, the municipality is highly vulnerable, and there are few deaths. This group seems to be a successful case of policies to contain the disease outbreak. Analyzing Figure 1, we observe that this is the case of municipalities in some states in the Midwest of Brazil (Mato Grasso, Mato Grasso do Sul, more precisely). The states that have most municipalities in the Midwest region are Goiás (245) and Mato Grosso (224). In 2019, the average per capita GDP ranged between 17.8 and 81.12, and the mortality rate ranged between 0.00 and 0.002 in this region. The proportion of deaths among men in 2019 ranged from 0.0007 to 0.004. The registered firms in 2018 ranged from 0.014 to 0.029 among municipalities. Besides, the general hospitals' proportion ranged from 0.00001 to 0.0001. We conclude that the region presents high values for features of vulnerability.

In the third result, the city has a low vulnerability, and there are many deaths. This result is the case in many of the locations in Northeast Brazil. The states that have most municipalities in the Northeast region are Bahia (417) and Piauí (224). In 2019, the average per capita GDP ranged between 9.41 and 18.89, and the mortality rate ranged between 0.00 and 0.003 in this region. The proportion of deaths among men in 2019 ranged from 0.002 to 0.005. The registered firms in 2018 ranged from 0.003 to 0.008 among municipalities. Besides, the general hospitals' proportion ranged from 0.00001 to 0.00004. We conclude that the region does not present high values for features of vulnerability.

Finally in the fourth and alarming result, the municipality is highly vulnerable, and there are many deaths. This result is the worst of all and fully alarming. The cities in the Southeast and South regions are in this group. The high AICOVID19 vulnerability is related to the fact that this region is highly industrialized and shows high per capita income (See Table 1). The states that have most municipalities in the South and Southeast region are Minas Gerais (853) and São Paulo (645). In 2019, the average per capita GDP ranged between 18.08 and 34.418, and the mortality rate ranged between 0.00 and 0.004 in this region. The proportion of deaths among men in 2019 ranged from 0.000 to 0.007. The registered firms in 2018 ranged from 0.019 to 0.032 among municipalities. Besides, the general hospitals' proportion ranged from 0.000023 to 0.000061. We conclude that the region presents high values for features of vulnerability.

The actual moment is not favorable to Brazilians. We believe that the future seems worst, according to the results: the pandemic vulnerability, the high number of deaths, and the spatial distribution between the municipalities. In addition to the high number of COVID-19 deaths, we assume that the location of occurrences will affect the country's economic final result. The situation presented by the AICOVID19 pandemic vulnerability study indicates that the Brazilian policymakers will need to be more strategic, strengthening the supply chains most important in the regions where deaths by COVID19 will most affect the productive activities. Besides, the results presented by Coronavirus contamination process may be reversed with the economic growth, if the damage caused by the COVID19 deaths becomes smaller in addition to new policies focused on economically resilient supply chains.

## 5. FINAL REMARKS

The present study suggests predictions about the progress of coronavirus in Brazil during 2020 and the first months of 2021. We observe that the spatial distribution of COVID19 deaths is closing to the spatial distribution of the AICOVID19 Pandemic Vulnerability Index. We focus the importance of this discovery for the pandemic progress in the country.

The strong urban industrial activity characteristics will be more prone to COVID19. The impact on the workforce will be large as possible in these cities. To Maher et al. (2020) similar occur in the EUA where the results show that the highest risk is in the Midwest and the lowest in the Intermountain West and West Coast.

According to Greer (2021), governments put their entire economies into the equivalent of a medically induced coma. In Brazil, the most vulnerable COVID-19 workers are found in the biggest urban centers, where the essential jobs are. Besides, "vaccination campaigns had yet to start in most places in the world, and there was great uncertainty about when vaccine clinical trials would be complete and the vaccines would be authorized for use" [GREER et al. (2021)]. Moreover, without social policies to support lower-income and vulnerable populations, health policies to promote social distancing cannot be fully effective and are likely not sustainable long enough to end the epidemic in a country. This is pointed here in the AICOVID19 Pandemic Vulnerability Index to Brazil. We conclude for more attentive to the large industrial centers are the public policy managers fewer impacts of the pandemic in Brazil will be noted. This seems to be the main conclusion drawn in the AICOVID19 Pandemic Vulnerability Index.

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# PARALLEL SESSIONS (2)

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## **National Session: SS16.1 - Smart, sustainable, resilient regions: Responses to pandemic challenges**



**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/87320775891>**

**Chair Daniela L. Constantin**

## CONNECTING SMART SPECIALIZATION, THE GREEN TRANSITION AND SOCIO-ECONOMIC RESILIENCE. AN EMPIRICAL TEST

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### ABSTRACT

Smart specialization (RIS3) has been formally introduced as integral part of the 2014-2020 programming period of the European Cohesion policy to enable each European region prioritize investments in research, development and innovation and develop the its unique place-based competitive advantages. For the 2021-2027 programming period, the Cohesion Policy has the ambition to take the smart specialization strategies "one step further" and contribute to a "smarter Europe", through innovation, digitization, economic transformation and support to small and medium-sized businesses. Meanwhile, smart specialization is now expected to embark into a process of widening and support the ambitions of the new European Green Deal and the global Sustainable Development Goals. Sustainability appears at the top of the Smart specialization agendas, while the "smart directionality" towards the green transition is recognized as an overriding strategic priority. The Covid 19 pandemic adds an additional layer in the prioritization process and a new narrative for smart specialization at the EU level. The post-Covid RIS3 is now expected to support socio-economic recovery and resilience and to reduce vulnerability to shocks; "no places and no people should be left behind in the EU". Within this frame of reference, the purpose of this paper is to question how a region can better mix, in an integrated smart specialization strategy, the ambition to move towards innovation-driven productivity growth, green transition (environmental protection), stability and inclusiveness. This is particularly challenging for the lagging-behind regions, with less developed research and development systems, where the impact of innovation on growth is estimated to be much weaker that in the core regions. To illustrate the case, we use empirical evidence from Romania, a "modest innovator" according to the European Innovation Scoreboard, which faces serious environmental pressures and social challenges. On this account, we intersect a measure of economic and technological specialization and an index of environmental and social pressures. The index will capture at least the following indicators: energy use and air emissions intensities by NACE Rev. 2 activity, structural change in employment (2010 - 2020) and the resistance to Covid pandemic (i.e. change in the number of employees between December 2019 and December 2020). Our investigation is meant to enhance understanding on how to manage the trade-offs between different sustainability dimensions and create synergies between policy objectives.

### ACKNOWLEDGEMENT

This work was supported by a grant of the Ministry of Research and Innovation, CNCS - UEFISCDI, project number PN-III-P4-ID-PCCF-2016-0166, within the PNCDI III project "ReGrowEU - Advancing ground-breaking research in regional growth and development theories, through a resilience approach: towards a convergent, balanced and sustainable European Union".

## ECONOMIC CRISIS AND NEW FIRM CREATION IN ROMANIA. INSIGHTS FROM STATIC AND DYNAMIC SPATIAL PANEL MODELS

**Zizi Goschin<sup>1,2</sup>, Mihai Antonia<sup>1</sup>, Horia Țigău<sup>1</sup>**

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### ABSTRACT

Entrepreneurship has a key role in the transformation of Romanian economy and society, influencing economic development by putting innovative ideas to practice and creating new jobs, and by enriching the quality of life and human existence as well. Entrepreneurship dynamics depends upon a series of local and national economic factors, but is also affected by the international environment, like the current COVID - 19 pandemic. Statistic data show that new businesses are created at a slower rate during an economic crisis, when the economic climate is harsh and business opportunities scarce. Nevertheless, there are local differences in the reaction to crises, and new business formation tends to decline with variable intensity from one region to another, even in the same country.

The crises are acting like a trigger for some opportunity-driven entrepreneurs and resilient regions can thrive even in times of crisis or recover faster after the depression. Given the scarcity of regional statistical data regarding the economic effects of COVID-19 pandemic, we draw mainly from the lessons of the precedent major crisis, namely the 2007-2009 Great Recession, for assessing the likely economic effects of the current crisis on new firm births. We focus on the interval between 2007 and 2020, aiming to investigate the impact of economic crisis and the difficulties generated by COVID-19 pandemic to new business formation in Romania, and to determine if the response to crises is shaped by location. This research extends the empirical debate in Țigău and Antonia (2020) on the determinants of new business formation in Romania.

In order to capture spatial interactions, as well as spatial short- and long-term effects, the method employed in our analysis relies on the estimation of various static and dynamic panel models. We tested the potential impact of a large variety of social and economic indicators on new firm creation and found that the most consequential factors of influence are the employment rate, unemployment and education. Our results convey a powerful policy message for both national and regional decision-makers. We believe that, while putting to test the entrepreneurial initiative, the current crisis might act like a catalyst that leads to innovation and reshaping our economy and society.

### KEYWORDS

Economic crisis, entrepreneurship, new firms, resilience, spatial panel data model

### ACKNOWLEDGEMENT

This work was partially supported by a grant of the Ministry of Research and Innovation, CNCS - UEFISCDI, project number PN-III-P4-ID-PCCF-2016-0166, within the PNCDI III project "ReGrowEU - Advancing ground-breaking research in regional growth and development theories, through a resilience approach: towards a convergent, balanced and sustainable European Union".

## THE IMPACT OF COVID 19 PANDEMIC ON HEIS – RESPONSE STRATEGIES FROM ROMANIAN UNIVERSITIES

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### ABSTRACT

The negative impact of COVID 19 pandemic on global health systems is a dramatic one. Nevertheless, the pandemic triggered plenty of vulnerabilities of the world economy, international labour markets, as well as educational systems. Moreover, important new trends should be identified, along with determinants that will certainly impact and reshape the future framework and economic environment related to educational processes and policies, labour force markets, consumer behaviour patterns, economic public policies, capital investments, etc. Despite the vulnerabilities revealed by the global health crisis, significant opportunities will occur, and sound interventions will be needed. That is why we consider that there is a stringent need for the educational systems to be able to adapt fast to the new realities and to implement correct, innovative and efficient response strategies in order to promote instruments and mechanism for flexible, dynamic and yet relevant, sustainable and trustworthy educational environment for all the implicated parties generating access, balance and equity for all the implicated parties to the process.

According to UNESCO's data, in March 2020, due to global lockdowns, 82.8% of total enrolled learners (pre-primary, primary, lower-secondary, upper-secondary and tertiary education levels) in 166 country-wide closures were directly affected by no access to in person education. One year later, in February 2021, the situation is improved, with 12.7% of total enrolled learners in 28 country-wide closures directly affected. Still, the international educational systems are confronted with problems related to digitalisation, access to support programs for vulnerable learners, reduced mobility for international students and teaching staff, reduced number of scientific events, reduced number of outreach activities in local communities, etc.

The present article aims to focus on the impact of the global health crisis on education, with a special attention paid to HEIs (higher education institutions) in Romania. We intend to identify and analyse response measures, as well as strategic approaches adopted by Romanian universities, in a comparative analysis with other models identified as being relevant for the investigated context, from the abrupt switch to online education, to support mechanisms for both students, teachers and administrative staff. We intend to sketch profile of those HEIs that are undertaking a responsible, accountable and resilient approach on the education in these challenging times.

**NEW FIRM FORMATION DURING UNCERTAINTY. A REGIONAL ANALYSIS OF ROMANIAN NEWBORN FIRMS DURING 2020**

**Alina I. Popescu**

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**ABSTRACT**

The paper investigates the regional dynamics of new firm formation in the Romanian counties during the 2020 year which was marked by the coronavirus pandemics. After an initial period of slowed down firm formation that ended with the sudden fall of the registration of newborn firms during the lockdown month of April, the new firm formation activity registered a significant increase in the months that followed until the end of the year 2020, at even a greater formation rate than that of same month of the previous year. We look at the economic activities by NACE code that attracted the most newborn firms during pandemics. Further on, we calculate a score of technological and knowledge intensity at county level based on the economic activity sector of newborn firms in 2020. Results show an average score of medium-low technological and knowledge intensity according to the main economic activity of the newborn firm in 2020 in Romania.

**FUNDING**

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## National Session: SS48B.1 – Regional Science in Russia



**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84686769452>**

**Chair Alexander Pelyasov**

## FISCAL RESILIENCE OF RUSSIA'S REGIONS

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### ABSTRACT

Currently, the Russian Federation does not have a methodology to determine the degree of fiscal resilience of regions. There are certain elements that make it possible to state the presence of problems in the regional budget system (high level of public debt, budget deficit, high share of intergovernmental fiscal transfers in budget revenues). However, these elements do not line up into a single system for assessing regional fiscal sustainability, or resilience.

The report was prepared as part of the implementation of the state task of the RANEPA for 2021.

The methodology for assessing the debt sustainability of Russian regions applied by the federal government reflects their creditworthiness, provides flexibility and correctly differentiates regulatory measures depending on the amount of debt. However, it does not fully take into account the institutional and economic aspects, which reduces the consideration of the risks of budgetary sustainability at the regional level.

Federal measures of influence against regions that have exceeded the established limits of debt sustainability go far beyond the immediate sphere of debt and affect the area of overall fiscal sustainability. They concern not only the issues of debt policy, but also the choice of directions and volume of expenditures and other parameters of the budget. This gives practical relevance to the search for an answer to the question of whether debt sustainability indicators adequately reflect the state of fiscal sustainability of Russian regions.

In order to quantitatively characterize the budgetary sustainability of the constituent entities of Russia and to test the hypothesis on the differentiation of the concepts of budgetary and debt sustainability, we have developed the corresponding indices - fiscal sustainability index (FSI), and debt sustainability index (DSI).

The regional fiscal sustainability index (FSI) developed by us has an integral character, includes 20 indicators and takes into account the institutional and economic aspects.

Grouping according to the calculated FSI data, carried out on the basis of one-dimensional cluster analysis, made it possible to distinguish three groups of regions of Russia. The results of the grouping indicate that it is undesirable to link federal regulatory measures that restrain the budgetary independence of regions with purely debt indicators.

At the same time, in the existing system of federal regulation of debt sustainability, it is more effective to focus federal measures at high debt levels exclusively on the sphere of debt policy. The absence of additional restrictions on regional spending could have a positive effect on the overall fiscal stability of Russia in the medium and long term.

## BETWEEN PATH DEPENDENCE AND INNOVATIONS: DETERMINANTS OF TECHNOLOGICAL ENTREPRENEURSHIP IN THE RUSSIAN REGIONS.

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### ABSTRACT

High-tech startups provide organic implementation of technological innovations in the contemporary economics. Through startups entrepreneurial ecosystems are adapting to the changes caused by technological progress. For the Russian Federation startup activity has brought an important opportunity to reduce regional socio-economic disparities and negative effects of resource extraction dependency. The coronavirus pandemic has made the importance of startup activity even more vital for future economic recovery.

Spatial patterns of high-tech startups in Russia show a tendency for a significant concentration in particular regions. The analysis of entrepreneurial statistics for the last decade shows us that technological entrepreneurship is partially related on factors typical for the majority of SMEs (local market volume, purchasing power, characteristics of entrepreneurial ecosystems) and partially for the high-tech economics (localization of other high-tech SMEs and special human capital). Some tendencies resemble more comprehensive specifics of Russian startups.

The paper aims to study the aspects of regional differentiation of startup activity in Russia and reasons which have formed its contemporary conditions. We use econometric analysis of quantity of new high-tech companies in combination with 22 statistical indicators representing different sides of regional socio-economic situation. It helps us to shed light on complex interrelationships among them and extinguish the factors of the most importance for the new high-tech firms, which include levels of human capital development, ICT infrastructure availability majorly corresponding with the phenomenon of "path dependence" of regional socio-economic development trajectories. Nevertheless, patent activity and availability of banking support have turned less significant.

According to the findings and the context of socio-economic disparities among Russian regions, we provide recommendations for the regional authorities in order to make the local conditions more suitable for technological entrepreneurs and increase the startup activity levels.

### KEYWORDS

Russian regions, technological entrepreneurship, startup activity,

### 1. INTRODUCTION

Startup activity is rightly considered one of the key elements of the innovative development of the modern economy. The venture capital sector contributes to the relatively rapid selection and diffusion of innovations in society, which significantly favors economic activity - for example, in the United States, about half of the total productivity growth is accounted for by startups (OECD, 2020).

The coronavirus pandemic has become a challenging test for the venture capital industry around the world. According to the international project Startup Genome, 72% of young hi-tech companies experienced declining revenues; 60% of surveyed firms responded to this challenge by reducing the number of employees or reducing wages (Startup Genome, 2020). The volume of transactions in the venture capital sector in the first months of 2020 in the world as a whole decreased to the level of 2018. In some developed countries, its decline turned out to be even more pronounced - for example, in the USA it reached a minimum over the past 7 years (Teare, 2020).

The researchers note that the socio-economic consequences of the coronavirus pandemic will not become critical for the venture capital sector - rather, they will lead to its reformatting. The growing difficulty of moving the founders of young companies, investors and business angels provokes some increase in the disunity of local entrepreneurial ecosystems; the combination of this trend with the globalization of the world economy allows us to conclude that these ecosystems will have more prerequisites for both cooperation and competition with each other. A special role in each of them will be played by the operating conditions, institutional environment, economic specialization of these ecosystems and a number of their other characteristics.

The Russian venture capital industry has not remained apart from global trends. Nevertheless, the Russian case is characterized by its own specificity of startup activity, which is well shown by the current research of the Startup Barometer. It is articulated that 50% of young companies surveyed by the vc.ru portal were unable to receive the desired assistance during the coronavirus pandemic, since their industry field was not included in the official list of the mostly affected economic activities. Nevertheless, 65% of startups in the sample plan to raise funds from investors in the near future, and 41% of companies intend to hire 1 to 5 new employees (Startup Barometer, 2020). In addition, due to the high heterogeneity of the country's socio-economic development, it can also be assumed that different constituent

entities of the Russian Federation will be able to adapt to new conditions to varying degrees. In general, it will be necessary to create new and rethink the existing mechanisms for supporting the venture capital sector, taking into account the factors that determine the degree of success of the emergence of such firms in different regions of the country. The purpose of this work was to highlight and analyze these factors taking into account the specifics of the socio-economic situation of the regions of the Russian Federation.

## 2. THEORETICAL FRAMEWORK

The theoretical side of the study of start-up activity in the regions of the Russian Federation is associated with the need to resolve several important issues presented below.

First of all, it is necessary to clarify what is meant by the concept of "startup". Despite its widespread use in journalistic and consulting publications, there is no single definition of this concept in scientific thought. As a rule, it means a newly created (in most cases - up to 1 year) firm, largely controlled by its immediate founders (founders), presenting a new high-tech product on the market and possessing intellectual property rights to it (Robehmed, 2013). An important distinguishing characteristic of a startup is usually its high growth potential in the short or medium term: it is assumed that the product presented by the startup can be relatively easily scaled up and implemented in the global market or the markets of other countries.

Another important characteristic of startups, as a rule, is the high riskiness of doing business. Risks can be either external (lack of funding or difficulty in obtaining it, lack of knowledge and competencies for doing business of this kind) or internal - lack of entrepreneurial experience, difficulty in teamwork, etc. (Gonzalez, 2017; Evers, 2003). According to statistics, about 80% of such companies are closed already at the initial stages of project implementation (Hyder, Lussier, 2016).

There is no official definition of the concept of "start-up" at the federal level in Russia these days. This concept, however, is found in departments supervising the activities of high-tech firms in certain regions: for example, the Government of the Moscow Region considers a startup to be "a legal entity that, within 3 years from the date of its registration, has implemented its innovative projects and whose main purpose of activity is the promotion of innovative technologies"

As an operational definition, it was decided to name as "startup" a firm of high- or medium-tech activities created during current calendar year and having a non-zero revenue volume. The last refinement is required to remove the so-called. "Fly-by-night companies", the goals of which are different from those positioned by the majority of "real" startups.

The second question concerns the factors that most significantly affect the success of a startup. Similar factors, like risks, are divided by many researchers into internal and external. The former include the personality traits of entrepreneurs (Stuetzer et al, 2013), as well as the various categories of skills required to run a company. The latter are related to the general context of the socio-economic situation in the country, region or city where the entrepreneur is located (Del Bosco, 2019; Partridge et al, 2019).

An important role is played by the ratio of "demand" and "supply" of entrepreneurial services in society. The first is usually formed by the presence and volume of a local market in which a potential entrepreneur can find his niche. The second is the desire of such a person to conduct business. It often depends on the culture of the business environment and aspects of the position of entrepreneurs in society (Verheul et al., 2002); sometimes the "offer" of entrepreneurial services is formed by force - during crises and other periods of rising unemployment for some people, such activities become an alternative to working as employees (Verheul et al. 2002).

Many researchers assign a fundamentally important role to the characteristics of the educational level of the population (Armington, Acs, 2002; Breitenecker, 2007). It seems that universities, research centers, and research departments of large companies, which require highly qualified personnel, are often places of birth for new firms (Novotny, 2008). Agglomeration effects are often referred to as important groups of factors (Beaudry, Schiffauerova, 2009; Audretsch, Fritsch, 1994; Fritsch, Kristalova, Wyrwich, 2019), in particular - the density of companies of firms from similar sectors of the economy, as well as the characteristics of the firms themselves - the average company size, the share of small and medium-sized enterprises in the economy, the presence and organization of entrepreneurial ecosystems (Quan, Acs, Stough, . Startups are particularly sensitive to formal and informal institutions and norms (Aparicio et al, 2016; Fuentelsaz et al, 2015) operating in the economy. Some researchers also highlight general patterns of the specifics of institutional conditions characteristic of developing countries, such as the severity of the "path effect" (Calá, 2014). The presence of specialized programs of state financial support and infrastructure - business incubators, accelerators, funds and other mechanisms for stimulating start-up activity - has a beneficial effect on the development of the venture capital sector (Breitenecker, 2007).

Based on a review of theoretical sources, three hypotheses can be proposed for an empirical study of startup activity in the context of Russian regions:

1. It is impossible to single out the factors that determine the differentiation of start-up activity in the regions of the Russian Federation. A possible reason for the implementation of this hypothesis may be the lack of data for building a representative model, the absence of a significant relationship between the considered indicators and the dependent variable, or, on the contrary, the complexity of the nature of this relationship.
2. The distribution of start-up activity by regions of the Russian Federation depends on factors similar for foreign countries (recall that these include the level of education of the population, agglomeration effects, general entrepreneurial activity, and characteristics of the institutional environment and the availability of financial support
3. The distribution of startup activity depends on some other processes that can be identified in the course of empirical analysis.

3. NEW HIGH-TECH COMPANIES IN RUSSIA: OVERVIEW OF THE CURRENT SITUATION

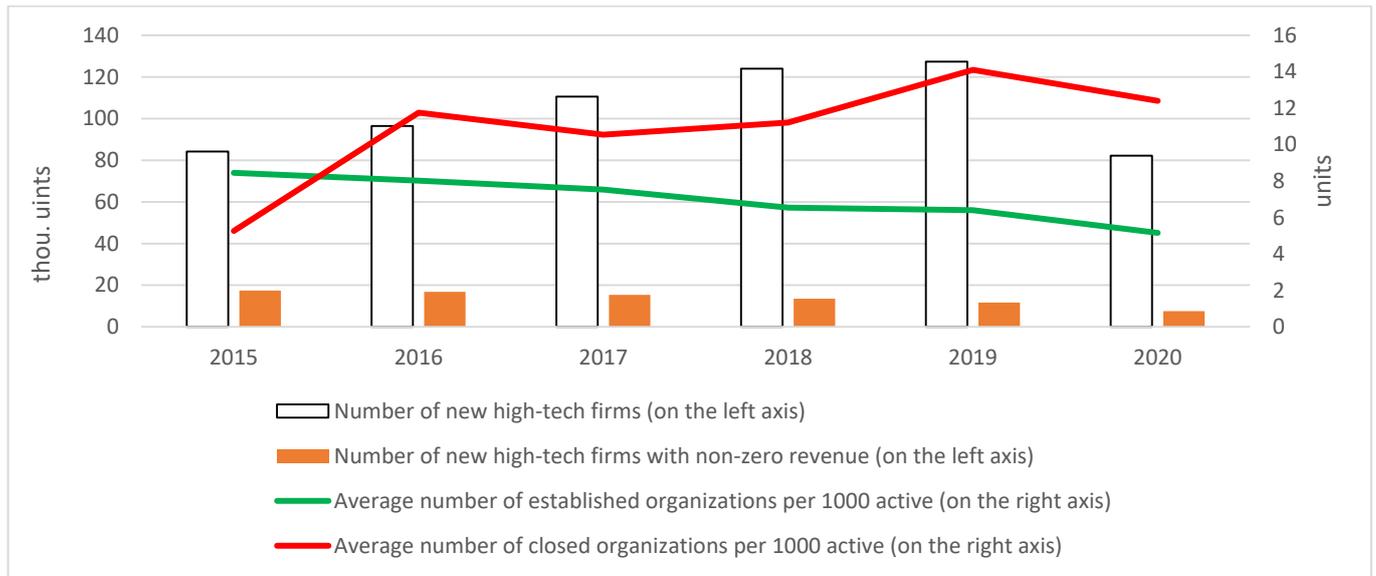


Figure 1. Dynamics of changes in the number of new high-tech firms in 2015-2020

Source: RUSLANA.

Generally, the dynamics of the number of new high-tech companies in recent years can hardly be called favorable (Figure 1). Since the mid-2010s, the number of such firms in Russia has been steadily decreasing - from 17.5 thousand units in 2015 to 11.6 thousand units in 2019. Since 2016, the rate of organization, or “fertility” of firms (the number of new companies created per 1,000 existing ones) has become less than the liquidation rate (the same rate as the closure of firms). In January-September 2020, the coefficients were just over 5 and 12 units, respectively. This situation can be called extremely negative for the country's economy: according to OECD statistics, even a one-time reduction in the number of new firms by 20% leads to a decrease in employment by 0.7% over the next three years.

The sectoral structure of the distribution of start-up activity is as follows (Figure 2). About half of Russian startups can be classified as knowledge-intensive services in the B2C and B2B categories. It seems that firms of this type have suffered quite badly during the coronavirus pandemic due to the significant importance of personal communication of employees for conducting business, but subsequently they were able to digitize most of the business processes.

On the contrary, the manufacturing sector accounts for less than 12% of new high-tech companies, although its share in the total revenue of Russian startups exceeds 45%. The information technology sector practically does not stand out against the background of other areas: it accounts for slightly less than a fifth of the total number of all startups, and about 8% of the total revenue.

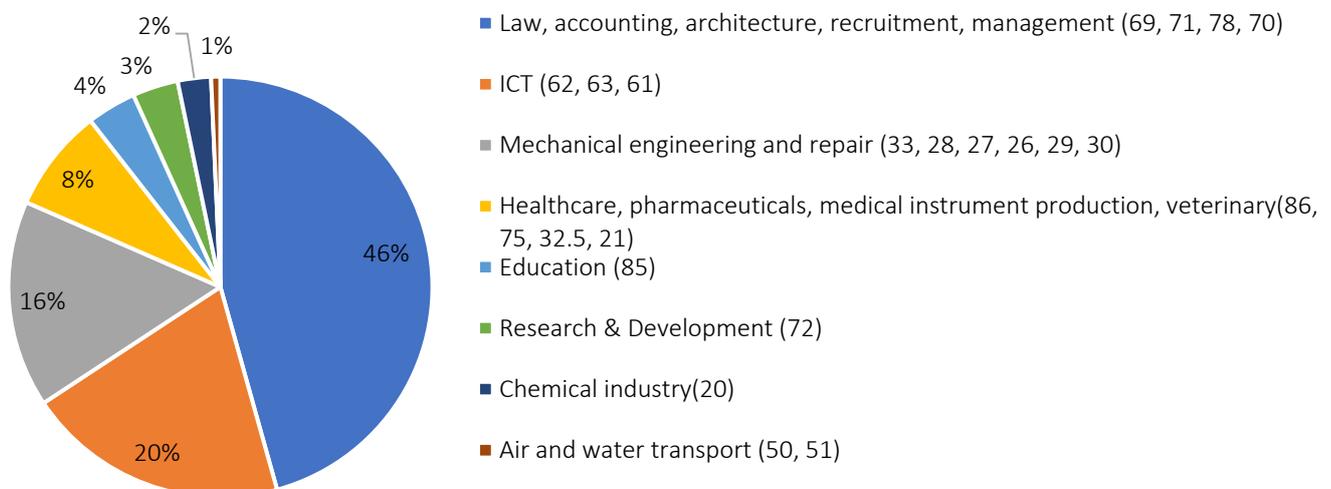
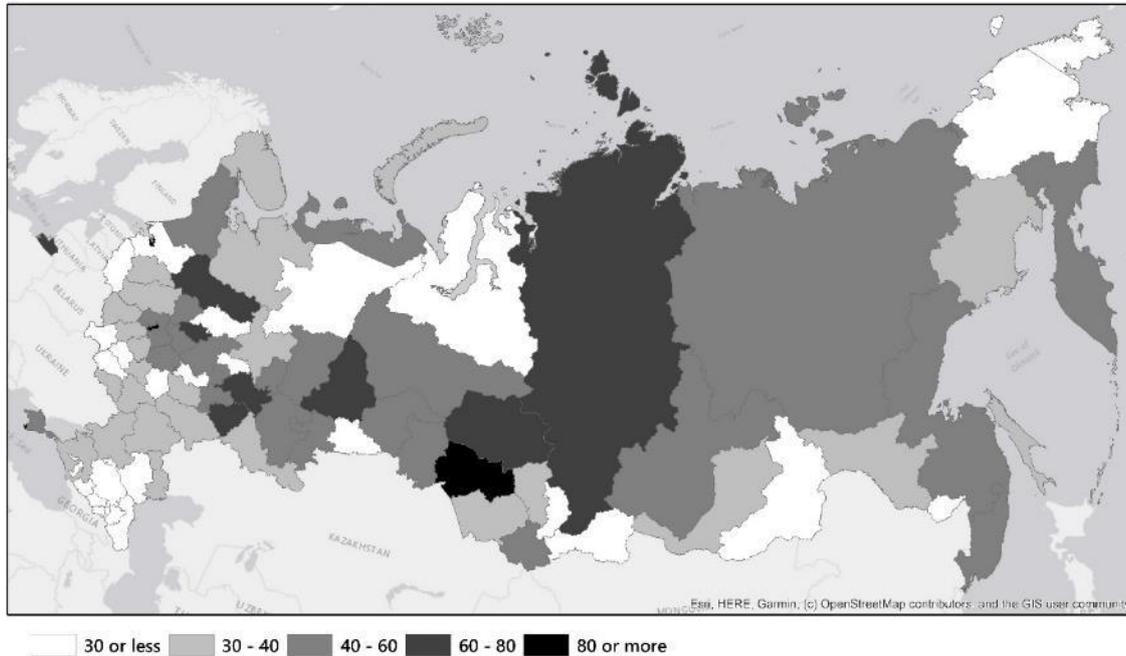


Figure 2: Sectoral structure of Russian startups according to – Russian classification of economic activities

Source: authors' calculations based on RUSLANA data.

Startup activity is extremely unevenly distributed in the regional context (Figure 3). Approximately every fourth new high-tech company emerging in the country is created in Moscow. Moscow, St. Petersburg and the Moscow region together concentrate about 40% of the number of such firms, and ten leading regions in terms of start-up activity (including the Sverdlovsk region, Novosibirsk region, Tomsk region, Nizhny Novgorod region, the Republic of Tatarstan, etc.) concentrate about 58% of such companies. By the number of new high-tech companies, the largest urban agglomerations (Moscow, St. Petersburg), regions of presence of important research centers (Novosibirsk and Tomsk regions) and the localization of large manufacturing companies (Vologda region, the Udmurt Republic) stand out in relation to the number of labor force.



**Figure 3: The average number of new high-tech firms in regions of Russia per 1,000 workforce in 2010-2018**

Source: RUSLANA.

#### 4. FACTORS OF REGIONAL HETEROGENEITY OF STARTUP ACTIVITY LEVELS

Basing on the hypotheses formulated earlier, we decided to compile a relatively broad list of seven factors that potentially explain the distribution of startup activity in the regions of Russia. The generalized equation of the econometric model has the following form:

$$startup = const + \beta_1 \times education + \beta_2 \times rndpot + \beta_3 \times inst + \beta_4 \times support + \beta_5 \times infr + \beta_6 \times market + \beta_7 \times economy$$

In which:

- *startup* - selected dependent variable;
- *education* - the level of education of the population (human capital);
- *rndpot* - scientific and technical potential;
- *inst* - characteristics of the institutional environment;
- *support* - characteristics of state support;
- *infr* - level of infrastructure provision
- *market* - market potential;
- *economy* - characteristics of the structure of the economy;
- *const* is a constant.

Each of the selected factors included one or two variables, depending on the results of the analysis of paired correlations of indicators. The list of variables considered in the work is presented in Table 1.

**Table 1. List of factors and variables used in the compilation of the models**

Factor	Variable
Education level of the population ( <i>education</i> )	Share of employed urban dwellers with higher education in the population,%
	Average number of years of education per person
	Number of students per 1000 people population, people
Scientific and technical potential ( <i>rndpot</i> )	Share of internal expenditures on research and development in GRP,%
	The number of potentially commercialized patents for inventions per 10 thousand employed people
Institutional environment ( <i>inst</i> )	RAEX investment risk index, points
	Aggregate index of provision of the region with banking services, points
Information and communication infrastructure ( <i>infr</i> )	Share of organizations using Internet access at a speed of at least 2 Mbps, in the total number of organizations,%
	Share of persons (households) with access to the Internet,%
State support of startup activity ( <i>support</i> )	The level of state financial support for start-ups by development institutions for 10 thousand employed people
Market potential ( <i>market</i> )	Income minus the subsistence minimum per month per person, rubles
	The amount of money income of the population minus the subsistence level, RUB billion
	Available markets, RUB trillion,
Economy structure ( <i>economy</i> )	Share of high-tech, medium-tech and science-intensive industries production in GRP,%
	Share of agricultural production in GRP,%
	Share of mining industry production in GRP,%
Entrepreneurial environment ( <i>sme</i> )	Average number of employees in the firms of the high-tech sector, people
	The share of organizations using the Internet to place orders for goods and services, in the total number of organizations,%
	Average annual unemployment rate,% according to the ILO methodology
	Micro and small enterprises per thousand workforce
Spatial aspect ( <i>spat</i> )	Interregional GRP, RUB million
	Population of the regional center, thousand people

Source: authors' calculations based on Rosstat, EMISS, Rating Agency "Expert" (RAEX) data.

The number of new high-tech companies was selected as a dependent variable in the work, reduced to a relative form by dividing by 1,000 people in the workforce, from 2010 to 2018.

**Table 2. Factors explaining regional differences in startup activity (OLS models)**

Factors	Models						
	1	2	3	4	5	6	7
Constant	3,352*** (0,28)	3,48*** (0,308)	3*** (0,31)	2,99*** (0,001)	2,987*** (0,001)	3,49*** (0,303)	1,94*** (0,36)
Number of students per 100 people	0,186*** (0,03)	0,185*** (0,03)	0,226*** (0,03)	0,215*** (0,001)	0,217*** (0,01)	0,187*** (0,03)	0,136*** (0,034)
The amount of income minus the subsistence minimum	0,01*** (0,01)	0,103*** (0,01)	0,087*** (0,021)	0,099*** (0,003)	0,081** (0,03)	0,103*** (0,02)	0,112*** (0,01)
Share of internal expenditures on research and development in GRP	0,07*** (0,01)	0,07*** (0,01)	0,085*** (0,013)	0,056*** (0,01)	0,052** (0,019)	0,07*** (0,01)	0,04*** (0,01)
Employed in the informal sector as% of the total employed population	-0,292*** (0,03)	-0,299*** (0,03)	-0,167*** (0,056)	-0,261*** (0,001)	-0,302*** (0,001)	-0,304*** (0,04)	-0,188*** (0,03)
Share of organizations using high-speed Internet access	0,186*** (0,05)	0,16*** (0,05)	0,205*** (0,05)	0,156*** (0,001)	0,158*** (0,001)	0,164*** (0,05)	0,073 (0,05)
Effective firm size in the market	-0,529*** (0,04)	- 0,54*** (0,05)	-0,515*** (0,05)	-0,423*** (0,001)	-0,444*** (0,001)	-0,53*** (0,04)	-0,38*** (0,04)
Share of high-tech products in GRP		0,01 (0,04)					
Share of extractive industries in GRP,%			-0,062*** (0,019)				
Banking service availability index, points				0,009 (0,452)			
Quantity of potentially commercialized patents per 10 thou. employed people					0,048 (0,23)		
Unemployment rate						0,01 (0,04)	
Entrepreneurial activity a year before							0,39*** (0,06)
R <sup>2</sup>	0,7066	0,7066	0,6671	0,6361	0,6496	0,7066	0,7567
Adj, R <sup>2</sup>	0,6092	0,6092	0,5716	0,6308	0,6444	0,6093	0,6759
Akaike criterion	214	261	207	158	134	216	124
Schwartz criterion	584	593	583	191	167	593	502

Notes:\*p-value<0,1; \*\*p-value<0,05; \*\*\*p-value<0,01. All variables are logarithmic. Robust standard errors.

Consider the results of empirical analysis in the context of the previously identified hypotheses. The first hypothesis can be rejected: despite the not very accurate explanatory ability of the models, during the analysis it was possible to identify a number of significant relationships. The third hypothesis can also be rejected: there is also no need to talk about some fundamental difference in the distribution of startup activity in Russia relative to foreign countries. In connection with the above, it would be logical to confirm the second hypothesis.

It seems that the following factors play a key role in the distribution of startup activity across the regions of the Russian Federation:

1. Concentration of human capital. A large number of start-ups appear in regions where the proportion of people potentially possessing the necessary worldview and skills necessary to found their own high-tech company is higher. This conclusion is confirmed by the high significance of such variables as the proportion of highly educated city dwellers and the number of university students per inhabitant.
2. The quality of the institutional environment. Startups are very sensitive to the formal and informal aspects of the regional specifics of doing business, which is confirmed by the high significance of the RAEX investment index variable.
3. Availability of external funding. It is often extremely difficult for a young high-tech company to develop at its own expense, and therefore needs access to external capital. It seems that bank borrowings are becoming a key source of external financing for many Russian startups.
4. Availability of effective demand. The purchasing power of the region's residents is becoming a significant factor in the development of start-up activity - recall that most Russian young high-tech firms operate in the B2C format or interact with companies whose clients are private households.

The results of the analysis showed that in order to increase the number of high-tech startups created, it is necessary to promote investment in research and development, as well as to increase the concentration of human capital by creating incentives in the field of education. Particular attention should be paid to aspects of commercialization of patents and R&D results. In addition, it is necessary to improve the institutional conditions for doing business at the regional level, for example, by reducing the barriers to registering firms, developing a specialized infrastructure to support start-up activities.

## 5. RECOMMENDATIONS FOR FURTHER STARTUP ACTIVITY SUPPORT

Basing on the identified factors of distribution of startup activity, the following recommendations can be proposed for adjusting measures to support the venture capital sector in Russia.

1. Wide implementation of the concept of "entrepreneurial universities". Since the level of human capital development is of particular importance for increasing start-up activity, it is necessary to improve the conditions for creating new firms in the places of its concentration. Potential measurements may include entrepreneurship training programs based on the concept of a three-tier university-wide elective in innovative entrepreneurship, helping students develop or form core competencies in the entrepreneurial sphere, expansion of forms of legal interaction between universities and businesses, and formation of a university entrepreneurship ecosystems in the most promising universities (including individual courses, MBA, entrepreneurship centers, business incubators, technology valleys, associated grants and innovation vouchers, patenting and commercialization centers, etc.)
2. Improvement of access to funding for startups. Generally speaking, grant support for start-up entrepreneurs through additional capitalization of relevant development institutions with the development of specialized competitions in the most important areas, similar to European initiatives, is particularly important for Russian case. Also, creation of cooperative programs of public and private venture funds is suggested, as well as assistance in establishment intrapreneurship (inner-corporate venture entrepreneurship) funds in large companies, especially state-owned ones.
3. Improvement of startup access to potential markets. Majorly, it requires further reduction of the "digital divide" in Internet access and digital skills, and support of entrepreneurial ecosystems in the digital field. It seems, especially in the context of coronavirus pandemic, that the development of the digital sphere will lead to the most favorable impact on the technology start-up sector.
4. Overall improvement of the doing business conditions. It is difficult to overestimate the importance of the team in the early stages of the startup's formation. Therefore, decisions related to attracting and retaining highly qualified personnel in Russia, increasing the number of students in key areas are especially relevant, as well as mentoring programs for startup founders. Particular attention should be paid popularization of start-up activities in society, especially among scientific communities: in many countries with the most developed venture capital sphere commercialization of patents has become one of the most important startup activity drivers, whereas in Russia, according to our calculations, the role of patent commercialization is low.

We suppose that measures proposed above can significantly improve the current position of Russian startups, especially during the coronavirus pandemic, and help to reduce interregional inequality in start-up activity in Russia.

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## FACTORS OF SMALL BUSINESS DEVELOPMENT IN RUSSIA

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## ABSTRACT

After the 2020 shock, many countries are looking for new sources of growth. Entrepreneurship has been declared one of the priorities in Russia; new support tools have been introduced since 2010. A significant interregional disparity of institutional environment and business development remains. Therefore, we aimed to identify determinants of small business development in the Russian regions. According to econometric results, household incomes, access to international and interregional markets, and capital availability can be the most significant factors. Small business density is lower in regions with a high crime rate because of greater investment risks. Internet-access is also positively significant for SMEs development as it provides new market niches. State support in the form of tax breaks and holidays can have a positive effect, but this impact is limited. Regional tax incentives, tax audits and special economic zones are insignificant if we consider the general institutional environment. The identified factors can help to understand the trends and policy opportunities of entrepreneurship policy in Russia.

## KEYWORDS

entrepreneurship, entrepreneurial ecosystem, institutions, market potential, unemployment, SME support, Russian regions, panel data.

## 1. INTRODUCTION

The unpredictability of macroeconomic processes is increasing in the world as shown by 2020. This is due natural, social and other risks, and global technological changes. In particular, accelerated automation and digitalization (industry 4.0) are leading to radical economic transformations and threatening an employment decrease in large manufacturing industries and public sector (*Schwab, 2017; Acemoglu & Restrepo, 2017; Zemtsov, 2020*). Many countries are looking for new sources of growth. Transition to entrepreneurial economic model can be one of the adapting tools (*Audretsch, Thurik, 2000; Zemtsov et al., 2019*). This requires appropriate policy changes, including business climate improvement, incentives for business cooperation, and more significant role of small and medium enterprises (SME) (*Djankov et al., 2002; Djankov et al., 2009*). This could form favourable conditions for the entrepreneurial capital to play an important role in the economic growth (*Audretsch, Keilbach, 2004; Urbano et al., 2019*).

Small business and entrepreneurship development in Russia were declared as one of the state priorities in the 2010s (*Arshed et al., 2020, p.100-118*). The relevant federal Strategy was adopted in 2016 although it didn't provide a full implementation plan but a short roadmap for a few years (*Kudrin et al., 2019, p. 543-563; Zemtsov et al., 2020*). Later the national project for SMEs development was introduced in 2018, updated in April 2021, and became a leading document till 2024 (*Kudrin et al., 2021, p. 279-290*). The goals set in the documents to significantly increase the share of SMEs in GDP and in employment seems too optimistic and unlikely to be achieved. However, a number of tools have been introduced on federal and regional level (*Arshed et al., 2020; Zemtsov et al., 2020*): the bureaucratic procedures reduction, the public services digitalization, different tax benefits, tax and other inspections reduction, special economic zones, regional tax incentives and tax holidays. As a result, Russia rose from 124th place in 2010 to 28th in 2020 in the Doing Business ranking. Unfortunately, the rating assesses the business climate for the whole country only in two regions: Moscow and St. Petersburg.

In Russia, a consistent interregional disparity of institutional environment and business development remains (*Baranov et al., 2015; Barinova et al., 2018*). The Russian regions differ significantly in geographic location, population density, welfare and economic situation (*Zubarevich, 2013*). In fact, these differences lead to formation of several stable types of entrepreneurial ecosystems with different levels of business costs, access to capital, markets and labour (*Zemtsov, Tsareva, 2018; Zemtsov, Baburin, 2019*). Corresponding differences in entrepreneurship development have persisted for decades and even centuries (*Zazdravnykh, 2019; Fritsch et al., 2019*). Nevertheless, regional business inequality is still weakly addressed in the policy (*Chepurenskiy, 2012; Yakovlev & Zhuravskaya, 2013; Chepurenskiy & Vilenskiy 2016; Arshed et al., 2020*). There is a lack of coordination of the regional SME support measures. Most of the regions are subsidized (*Alexeev, Chernyavskiy, 2018*) and don't have sufficient budget capabilities for entrepreneurship policy.

Therefore, the share of SMEs in the Russian economy remained steadily low and is unlikely to increase from 20,6% of GDP in 2019 to 32% in 2024 as planned (*Arshed et al., 2020; Zemtsov et al., 2020*). Despite the efforts and declarations, the role of public sector and state corporations is still much higher in Russia than in most similar post-socialist countries (*Abramov et al., 2017; Sauka, Chepurenskiy, 2017; OECD, 2018*). The prevalence of the informal economy, high crime rates remain acute in certain southern regions (*Rochlitz, 2017; Mannila & Eremicheva, 2018*). Moreover, the 2020 pandemic

and the corresponding anti-epidemiological measures, in particular the suspension of many service businesses, had a significant negative impact on SMEs in most of the regions (Parrot et al., 2020; Zemtsov et al., 2020; Kudrin et al., 2021). Shrinking household incomes in 2020 and in last 6 years also directly affected the decrease in demand for goods and services of small businesses (Kudrin et al., 2021; Barinova & Zemtsov, 2020). At the same time, pre-crisis and anti-crisis development of digital platforms, online services, and remote employment has contributed to SMEs persistence and stimulated start-ups activity in the Internet sector, especially in developed entrepreneurial ecosystems of large agglomerations (Kudrin et al., 2021; Zemtsov et al., 2019).

**The goal of this research** is to identify determinants for small business development in the Russian regions. Considering the above, we were interested in how persistent regional differences in access to markets, capital and labour, institutional disparities, digital inequality, as well as federal and regional support measures, affect small business density. Previous studies on the Russian case have rarely considered the whole complex of described factors, moreover, they paid little attention to the large set of new policy measures introduced in 2010s. Understanding the influence of these factors in the pre-crisis period may contribute to an efficient post-crisis entrepreneurship policy.

We reviewed relevant empirical studies, then, formed hypotheses; we tested them on available statistical data on the Russian regions and, at the end, discussed the results.

## 2. LITERATURE REVIEW

Numerous studies demonstrate two main approaches to assess the rate of entrepreneurship development in regions and countries. *The first approach* is based on identifying the share of entrepreneurs, entrepreneurial intentions and other characteristics of established business owners or nascent entrepreneurs (Reynolds et al., 2002; Verheul et al., 2002; Van Stel et al., 2007; Chepurensko, 2010; Bosma & Schutjens, 2011; Alvarez, & Urbano, 2011; Estrin & Mickiewicz, 2011; Estrin et al., 2013; Stenholm et al., 2013; Aparicio et al., 2016; Nielsen, 2014; Verkhovskaya & Aleksandrova, 2017; Dvouletý, 2018; Urbano et al., 2019). The data are based on population surveys. The disadvantage of this approach is the complexity of collecting primary information, inaccessibility of representative data for the Russian regions in dynamics. Moreover, the results of the polls are subject to various kinds of distortions (Bosma, 2013; Chepurensko, 2010). *The second approach* involves statistics on the number of small and medium-sized firms, new firms, self-employed, firms' birth rate, etc. (Storey, 1991; Reynolds et al., 1994; Storey, 2003; Fritsch, & Falck, 2007; Fritsch, 2013; Stephens, Partridge, 2011; Cravo, Gourlay & Becker, 2012; Yakovlev & Zhuravskaya, 2013; Barinova et al., 2018; Zemtsov & Tsareva, 2018; Zazdravnykh, 2019; Fritsch et al., 2019). The density of businesses per capita can be considered an indirect indicator of the entrepreneurship development. In general, more businesses are created by more entrepreneurs.

According to the second approach, we used the number of small businesses per 1000 labour force participants, or small business density, as a proxy for SME sector development and as an indirect indicator of entrepreneurial activity. Alternative measures have significant drawbacks. The dynamics of firms' birth rate can contain data on fly-by-night companies, at the same time, does not consider their mortality (Obraztsova, & Chepurensko, 2020). The data on business owners in the Russian regions is available only for one year (Chepurensko et al., 2017) and does not allow identifying dynamics factors. Moreover, in a number of regions there is a high proportion of necessity-driven entrepreneurs (Aleksandrova & Verkhovskaya, 2016), which distorts the results. An indicator describing small business development is also preferred for policy recommendations in Russia.

Cross-disciplinary researches of entrepreneurship have economical, sociological, psychological and other aspects (Bygrave & Hofer, 1991, Fritsch & Storey, 2014). Therefore, it is challenging to develop a theoretical model (Verheul et al., 2002, Nielsen, 2014, Denisenko, 2011, Blanchflower & Oswald, 1994, Carree & Thurik, 2003, Schmitz, 1989, Braunerhjelm et al., 2010). Usually several groups of entrepreneurship determinants are distinguished: demand for goods and services of SMEs (GDP per capita, incomes at al.), labour supply for SMEs (unemployment), general institutions and government support (Verheul et al., 2002; Nielsen, 2014; Fritsch & Storey, 2014). These factors are well studied in many countries (Bais et al., 1995; Verheul et al., 2002; Lee et al., 2004; Spencer & Gómez, 2004; Aidis, 2005; Van Stel et al., 2007; Sternberg, 2009; Alvarez & Urbano, 2011; Bosma & Schutjens, 2011; Fritsch, 2013; Stenholm et al., 2013; Stuetzer et al., 2014; Aparicio et al., 2016; Urbano et al., 2019). We have distinguished a separate group of studies on post-communist cases (Smallbone, & Welter, 2001; Aidis, 2005; Estrin et al., 2006; Estrin & Mickiewicz, 2011; Smallbone, & Welter, 2012; Sauka & Chepurensko, 2017), where special attention is paid to various trajectories of transition from a planned to a market economy, the influence of the state and informal sectors on business. The institutional environment of transition economies is characterized by the shortage, weak and uneven development of a necessary market and financial institutions, as well as the presence of obsolete norms. A number of studies are devoted to certain aspects of the entrepreneurship development in Russia: institutional environment (Djankov et al., 2005; Bruno et al., 2013; Aleksandrova & Verkhovskaya, 2016; Verkhovskaya & Aleksandrova, 2017), high regional variation (Chepurensko et al., 2017; Obraztsova, & Chepurensko, 2020), and persistence of firms and self-employed location choices (Zemtsov & Tsareva, 2018; Fritsch et al., 2019; Zazdravnykh, 2019; Jayet et al., 2021). However, there are significantly fewer works that investigate the impact of a wide range of regional characteristics, including government support, on the SMEs development (Yakovlev & Zhuravskaya, 2013; Barinova et al., 2018).

In recent years, significant differences in the interregional variation in entrepreneurship have been explained by the entrepreneurial ecosystem concept (Acs et al., 2017; Audretsch & Belitski, 2017). According to the systematic approach, business agents interact with each other in a specific environment and form sustainable networks (Stam, 2015). At the same time, agents perform different functions and occupy different market niches by analogy with natural ecosystems. Another approach involves identification of ecosystems' stakeholders: large firms, universities, research institutions,

venture funds, regional authorities, etc. Thus, the paper (*Isenberg, 2011*) explores the goals of business agents, their functions and connections. Another approach involves the study of the basic conditions and resources of business development (*Sternberg, 2009*). To conclude, the ecosystem approach involves the study of regional basic characteristics, business environment and agents' networks. The latter can be indirectly measured through the density of specialized institutions (venture capital funds, business incubators, special economic zones, etc.) that ensure the interaction of business agents. High business density can also be a proxy of high potential network connectivity.

To formulate research hypotheses and select variables, we consider several groups of determinants in more detail.

## 2.1 Unemployment or supply of labour

Unemployment is a traditional factor in empirical estimates. On the one hand, high unemployment is an indicator of disadvantageous economic situation, it leads to the lower demand and higher business risks. Therefore, the unemployment rate in a region may have a negative impact on SMEs. On the other hand, high unemployment rate may increase the number of small businesses as it exceeds labour supply, lowers labour costs, and encourages necessity-driven self-employment (*Storey, 1991, Verheul et al., 2002, Fritsch & Falck, 2007*). Necessity-driven entrepreneurs are those who start an enterprise, because they have no other income-generating opportunities. In this case, a variable with a lag of one year is most often used, as it takes time for the labor market adjustment.

## 2.2 Market access or demand for SMEs' services and goods

Studies on new economic geography demonstrate that size and concentration of economic activity significantly influence regional development (*Jacobs, 1969; Fujita et al., 2001; Hanson, 2005; Zemtsov & Smelov, 2018; Lavrinenko et al., 2019*). In areas with a high diversity and concentration, there are more opportunities for entrepreneurship due to proximity of new and diverse ideas, knowledge, technologies and larger markets. Average incomes and market potential, population density, are usually used in empirical studies.

Population density (particularly in urban areas) can have an ambiguous effect on the entrepreneurship (*Verheul et al., 2002*). On the one hand, high population density guarantees high demand and provides access to markets, business infrastructure, skilled labour, the possibility of cooperation between new and sustainable firms, the effect of knowledge spillovers (*Reynolds et al., 1994; Fritsch & Falck, 2007; Bosma & Schutjens, 2011*). On the other hand, a high concentration increases competition and creates higher entry barriers (*Bais et al., 1995*).

Access to markets is essential for the development of mass entrepreneurship (*Hanson, 2005; Zemtsov & Baburin, 2016; Zemtsov & Tsareva, 2018*). The traditional indicators of local demand are household's incomes or GDP per capita. The higher the average income is, the greater the demand for new SME's products and services is. *Brown et al. (2008)* analysed the dynamics of new enterprises' creation in the Russian regions. The results show that firms are created and are more likely to survive during 5–10 years, mainly in regions with high market potential. Isolated and hard-to-reach regions are losing businesses. Note that the literature usually considers almost exclusively domestic markets without the influence of other countries, although many businesses in Russia are based on importing goods.

## 2.3 Institutional factors of entrepreneurship

Institutions are 'game rules' in society, or restrictions that determine the interactions between people (*North, 1990*). Institutions can be formal (regulations, contracts, procedures, etc.) and informal (culture, values, social norms adopted in society). Formal institutions reduce transaction costs with officially established rules, while informal ones reduce the level of uncertainty in the individual decision-making (*North, 2005*). Formal institutions can be changed over a short period of time, as opposed to the informal ones (*Williamson, 2000*).

The institutional factors influence the individual decision making to become an entrepreneur (*Aparicio et al., 2016*). Baumol's concept of productive and unproductive entrepreneurship described a mechanism between entrepreneurial behaviour and institutional environment (*Baumol, 1993b; Belitski et al., 2021*). Favourable business climate encourages productive opportunity-driven entrepreneurship (*Aparicio et al., 2016*). Moreover, informal norms such as corruption, perceptions of success, social trust, may have even higher impact than the formal ones. The absence of many formal institutions in developing and transition countries stimulated the emergence of various informal ties, agreements (nepotism, corruption), which in turn opened the way for various types of crimes, political entrepreneurship, and shadow economy (*Tonoyan et al., 2010*). All of these factors reduce social trust and, accordingly, create insurmountable barriers to productive entrepreneurship. An enterprise requires significant investments in fundraising, competence and industrial relations (*Anokhin & Schulze, 2008*). It is unreasonable for entrepreneurs to develop complex businesses that can be easily lost. The studies on the Russian case revealed a significant negative impact of political institutions, including corruption, restrictions on media freedom, length of governors' terms on the entrepreneurship development (*Shurchkov, 2012; Yakovlev & Zhuravskaya, 2013; Bruno et al., 2013*). At the same time there is a lack of papers studying such factors as access to finance, legal environment, administrative burden, and SME support policy.

*Access to finance.* Many researchers (*Kuzilwa, 2005; Nielsen, 2014; Barinova et al., 2018*) underline the essential role of finance access, bank credits availability for SMEs development. The lack of funding or a high interest rate is the main obstacle for many potential entrepreneurs, especially in developing countries (*Aparicio et al., 2016*), and thereby it reduces SME's development. *Aparicio et al. (2016)* use the percentage of adult population that has at least one credit in a private bank as a proxy for finance access. *Nielsen (2014)* suggests to use the percentage of the population who personally provided funds for a new business. The alternative indicators are: the degree of financial instruments' diversity, the number of investment companies and the interest rate on loans.

*Legal environment.* The legal environment, considering protection of private property and other business rights, has a direct impact on small business density (Anokhin, Schulze, 2008; Xheneti, Bartlett, 2012; Yakovlev, Zhuravskaya, 2013). Deficiencies in legislation and weakness of law enforcement agencies create conditions for rampant corruption and high crime rate. These factors influence a decision to become an entrepreneur, the willingness to legalize business activity, and the likelihood of business expansion.

## 2.4 Government policy

Public policy may significantly affect small businesses (Spencer, Gómez, 2004; Djankov et al., 2002) through regulation, tax incentives, and different forms of direct public support.

*Regulations.* Many papers (Aidis, 2005, Djankov, 2009, Klapper et al., 2006, OECD, 2011, Nielsen, 2014, Djankov et al., 2002, Aparicio et al., 2016, Alvarez, Urbano, 2011, Van Stel et al., 2007) state that a large number of business registration and other procedures adversely affect the willingness of potential entrepreneurs to start businesses. The empirical evidence (Van Stel et al., 2007; Djankov, 2009) became the basis for policy changes all over the world. Governments reduced regulation and simplify it in order to stimulate new business development (Aparicio et al., 2016). Alvarez and Urbano (2011) emphasize that in 2007 and 2008, simplifying the new company's registration was the most popular reform. In Russia, the supervisory inspections of enterprises are a significant administrative burden to SMEs development (Barinova et al., 2018). According to (Russian Union of Industrialists and Entrepreneurs, 2016), 93.6% of surveyed companies underwent scheduled inspections and 54.2% of surveyed companies underwent unscheduled inspections.

*Taxes.* A high tax burden increases the cost of starting a business, thus reducing the willingness to become entrepreneurs (Djankov et al., 2010). For example, the introduction of a progressive marginal tax rate in the USA lowered the probability of becoming self-employed for upper-middle-income households by about 20 percent (Gentry, Hubbard, 2000). On the other hand, Bruce and Mohsin (2006) conclude that different kinds of taxes (federal income, payroll, capital gains, corporate income, and estate) have significant but small effects on self-employment activity.

*Public support.* To help entrepreneurs reduce the start-up risks, many governments pursue special SME support policy. This policy involves the adoption of legislation acts, protecting entrepreneurs, and establishment of special programs that provide financial support to entrepreneurs and create business friendly environment (Spencer & Gómez, 2004). The impact of state support on small business development is ambiguous, since empirical studies often underestimate the «screening effect» when the strongest firms are supported (Reynolds et al., 1994; Storey, 2003). As Chepurensko (2012) notices with the reference to Lerner (2009), the most adequate programs are often implemented in rich countries with the Anglo-Saxon legal tradition. Negative public opinion and low confidence in the state support in Russia and other developing countries may decrease possible positive effects of the SME' programs (Yakovlev & Avraamova, 2008).

One of the most popular support tools is the creation of territories with special entrepreneurial regimes, for example, special economic zones. In recent years, dozens of similar tools have been created in Russia (Sosnovskikh, 2017). For example, special economic zones provide tax incentives for their residents, the possibility of duty-free trade, and infrastructure. They can create a large number of new supplier companies serving residents. Until recently, there have been few assessments of the impact of such a policy on small business (Zeng, 2010).

## 2.5 Digitalization

Digitalization may be an important factor, influencing small business development at a regional level. The introduction of digital technologies during current technological change leads to a significant minimization of transaction costs due to electronic workflow, “uberization” of services. Digital platforms such as Uber, Alibaba, Airbnb, etc. dramatically expand market entry opportunities. For example, the development of the Alibaba platform for product distribution has allowed the creation and scale-up of millions of small firms worldwide (Jin & Hurd, 2018). In fact, enterprises now can reach subcontractors, suppliers and customers from all around the world. The resources of small firms for customizing products and services have significantly increased.

Thus, regional digital inequality rate (digital divide) can be one of the barriers for SMEs development (Nambisan, 2017; Zemtsov et al., 2019). There are several forms of digital divide (Scheerder et al., 2017), resulting in an uneven access to ICT infrastructure, uneven abilities for Internet usage and to business digitalization. The 2020 pandemic increased the role of digitalization, as many businesses that used to operate offline have been closed. On the contrary, those who have transferred their employees to remote work, have created webpages or use digital platforms to process orders online, are successfully developing (Kudrin et al., 2021). So, the government can influence the entrepreneurship development through services' digitalization, reducing digital divide and providing digital platforms expansion.

In 2020 the world got a new factor of SMEs development – COVID-19. A number of researchers try to predict the effects of pandemic. Forey et al. (2020) predict long term development of innovative entrepreneurship in medicine and the growth in R&D funding. Kuchler et al. (2020) highlight an ambiguous role of such institutional factor as social capital, as higher social interactions may increase business risks but higher business ties may help to adapt. Many researches were devoted to the government actions during pandemic. Anti-epidemiological restrictions on trade, tourism and other services had a strong negative impact on many businesses. In Russia, the number of SMEs decreased by 4.3% (Kudrin et al., 2021). Although governments sought to compensate it by concessional loans, payroll subsidies, tax breaks and other measures (IMF, 2020). (Zemtsov et al., 2020) provides a detailed overview of public measures, explaining why direct financial support can be used in developing countries only in emergency cases like pandemic. Traditional support measures require significant budgetary resources, but often do not solve the business problems, since a small number of firms are covered; support may not be received by those firms that are in need; supported firms may crowd out other

firms. In states with weak institutions of public control (independent media, NGOs, etc.) direct financial support can create new institutional traps: corruption, “privileged” companies, rental behaviour, business distrust to the state, etc. The review allowed us to determine the set of the most significant variables for analysis. Our data does not include the period of the pandemic, but we tried to relate our findings to the new situation

### 3. RESEARCH HYPOTHESES

According to the purpose of our research and literature review, we formulated the following hypotheses about the influence of institutional and other regional factors on small business in Russia. In our opinion, these factors lead to formation of different types of regional entrepreneurial ecosystems in Russia.

1. *Market access* (or size of potentially available markets) is a significant positive factor in determining the demand for small business services and products. It should be higher in the Russian regions near large metropolitan areas with higher population density and wealthier households, and in border and coastal regions near large countries with better export and import opportunities. At the same time, the density of small businesses can be lower in remote and sparsely populated areas (Northern Russia) due to high transport costs. The geographical position of the Russian regions differs significantly.
2. *Unfavourable regional business environment*, that is a set of institutions, such as legal environment, access to finance or administrative burden, may significantly reduce small business density. Entrepreneurs strive to reduce their transaction costs and potential risks, so they register their businesses in specific regions, regardless of real placing.
3. *Proactive regional authorities* are able to affect entrepreneurial ecosystem development through various incentives, primarily related to lower taxes. Entrepreneurs tend to start and maintain businesses in more favourable tax conditions, which increase small business density in certain regions.
4. In recent years, the number of small businesses has been growing due to digital economy expansion, or *digitalization*. For instance, digital platforms provide access to any consumers in the world. A higher level of Internet access in a region provides more digital opportunities for small businesses and better access to new markets, as well as stimulates the development of new online services and start-ups.

### 4. ECONOMETRIC MODEL AND DATA

To test our hypotheses, we proposed the following econometric model (Eq. 1).

$$SBdensity_{it} = const + \alpha_1 * market_{it} + \alpha_2 * institutions_{it} + \alpha_3 * support_{it} + \alpha_4 * digital_{it} + \alpha_5 * controls + \varepsilon_{it}, (1)$$

where

*i* – a Russian region (from 1 to 83; the Republic of Crimea and Sevastopol are excluded; but in some specifications more regions are skipped due to missing data); *t* – year (2008-2018);

***SBdensity*** – number of micro and small businesses per 1,000 economically active population, or workforce participants, in a region;

***market*** – availability of markets;

***institutions*** – institutional factors (legal environment, access to finance, administrative burden);

***support*** – federal and regional support measures for SMEs (tax benefits, reduced tax rates, special economic zones, tax holidays);

***digital*** – percentage of individuals with access to the Internet;

***controls*** – income per capita (or one-year lagged GDP per capita) and one-year lagged unemployment (as control for demand, economic situation in general and supply of potential nascent entrepreneurs).

Numeric variables are log transformed. We use panel data: annual values of indicators for the period 2008-2018 in 83 regions of Russia. The main source of data is the Federal State Statistics Service (Rosstat). The open data of the Central Bank of the Russian Federation and the authors' calculations are also used. Description of variables and data sources are given in Table 1. See descriptive statistics and correlation matrix in table 2 and 3.

**Table 1. Description of the variables and data sources. Data on 83 regions, 2008-2018, unless otherwise specified**

Factor	Variable	Description	Source
<b>Dependent variable</b>			
Entrepreneurship development	Small business density	Number of micro and small businesses (legal entities with full-time employees up to 100) per 1,000 economically active (employed) population (in other words: per labour force participants)	Rosstat <sup>11</sup>
<b>Control variables</b>			
Demand, economic situation in a region and supply of potential nascent entrepreneurs	Income per capita	<b>Monthly</b> income minus subsistence minimum (average value for the 12 months), rubles per person *82-83 regions. Data on the Chechen Republic is available since 2010.	Authors' calculations according to Rosstat <sup>12</sup>
	GDP per capita	Gross regional product per capita, thousand roubles in constant 1998 prices *82 regions. No data on the Chechen Republic.	Authors' calculations according to Rosstat <sup>13</sup>
	Unemployment	Unemployment rate on average per year according to the methodology of the International Labour Organization, in percent	Rosstat <sup>14</sup>
<b>Independent variables</b>			
Market access (or agglomeration effects)	Market potential	The volume of available markets, trillion rubles in constant prices	Authors' calculations
	Population density	Population per 1 square km, individuals	Rosstat <sup>15</sup>
Institutional factors	Banking Index (Access to finance)	Index of regional banking services availability *79-80 regions. No data on the Nenets Autonomous Okrug (AO), Khanty-Mansi AO, Yamalo-Nenets AO. Data on the Chechen Republic is available since 2012.	Central Bank of the Russian Federation reports <sup>16</sup>
	Crimes (Legal environment)	Number of crimes per 1,000 economically active (employed) population in a region	Rosstat <sup>17</sup>
	Tax inspections (Administrative burden)	Number of field tax inspections by the Federal Tax Service (FTS) per 1 thousand of the total number of enterprises in region	Unified Interdepartmental Statistical Information System in Russia <sup>18</sup>
Support for SMEs	Tax benefits	The total amount of tax benefits (for income tax, property tax, transport tax and land tax) per one organization, rubles. *Data on SME support (subsidies) are available only since 2012. Accordingly, we use them for the period 2012-2018.	Federal Tax Service <sup>19</sup>
	USN reduced tax rates	Presence of regional tax incentives (reduced tax rates) for USN payers. USN is a simplified taxation system for SMEs in Russia. A binary variable that takes on the value 1 if additional reduced rates for USN taxpayers were introduced in a region and 0 otherwise (0 if "there weren't any USN tax incentives in the region" and 1 if "there were USN tax incentives in the region").	Data on Regional Legislations <sup>20</sup>
	Tax holidays	Presence of tax holidays for Sole Proprietorship in a region. A binary variable that takes on the value 1 if tax holidays for Sole Proprietorship were introduced in the region and 0 otherwise (0 if "NO tax holidays" and 1 if "tax holidays were introduced").	Data on Regional Legislations <sup>21</sup>
	SEZ	Number of special economic zones in a region. A discrete variable that takes on the values 0, 1, 2, or 3, depending on the number of SEZs in the region, i.e 0 if "No SEZ" and 1 or 2 or 3 for the number of SEZ if "SEZ exists".	Special Economic Zones <sup>22</sup>
Digitalization	Internet	Percentage of individuals (households) with access to the Internet *82-83 regions. Data on the Chechen Republic is available since 2014.	Rosstat <sup>23</sup>

11 <https://rosstat.gov.ru/folder/210/document/13223>

12 <https://rosstat.gov.ru/folder/13397>

13 <https://rosstat.gov.ru/accounts>

14 [https://rosstat.gov.ru/labour\\_force](https://rosstat.gov.ru/labour_force)

15 <https://rosstat.gov.ru/folder/210/document/13204>

16 [https://cbr.ru/about\\_br/publ/nadzor/](https://cbr.ru/about_br/publ/nadzor/)

17 <https://www.fedstat.ru/indicator/36224>

18 <https://www.fedstat.ru/indicator/42571>

19 [https://www.nalog.ru/rn77/related\\_activities/statistics\\_and\\_analytics/forms/](https://www.nalog.ru/rn77/related_activities/statistics_and_analytics/forms/)

20 <https://www.glavbukh.ru/art/55851-tablitsa-ponijennyh-stavok-usn-v-2021-godu-po-regionam>

21 [http://www.consultant.ru/document/cons\\_doc\\_LAW\\_190568/](http://www.consultant.ru/document/cons_doc_LAW_190568/)

22 <http://eng.russeze.ru/>

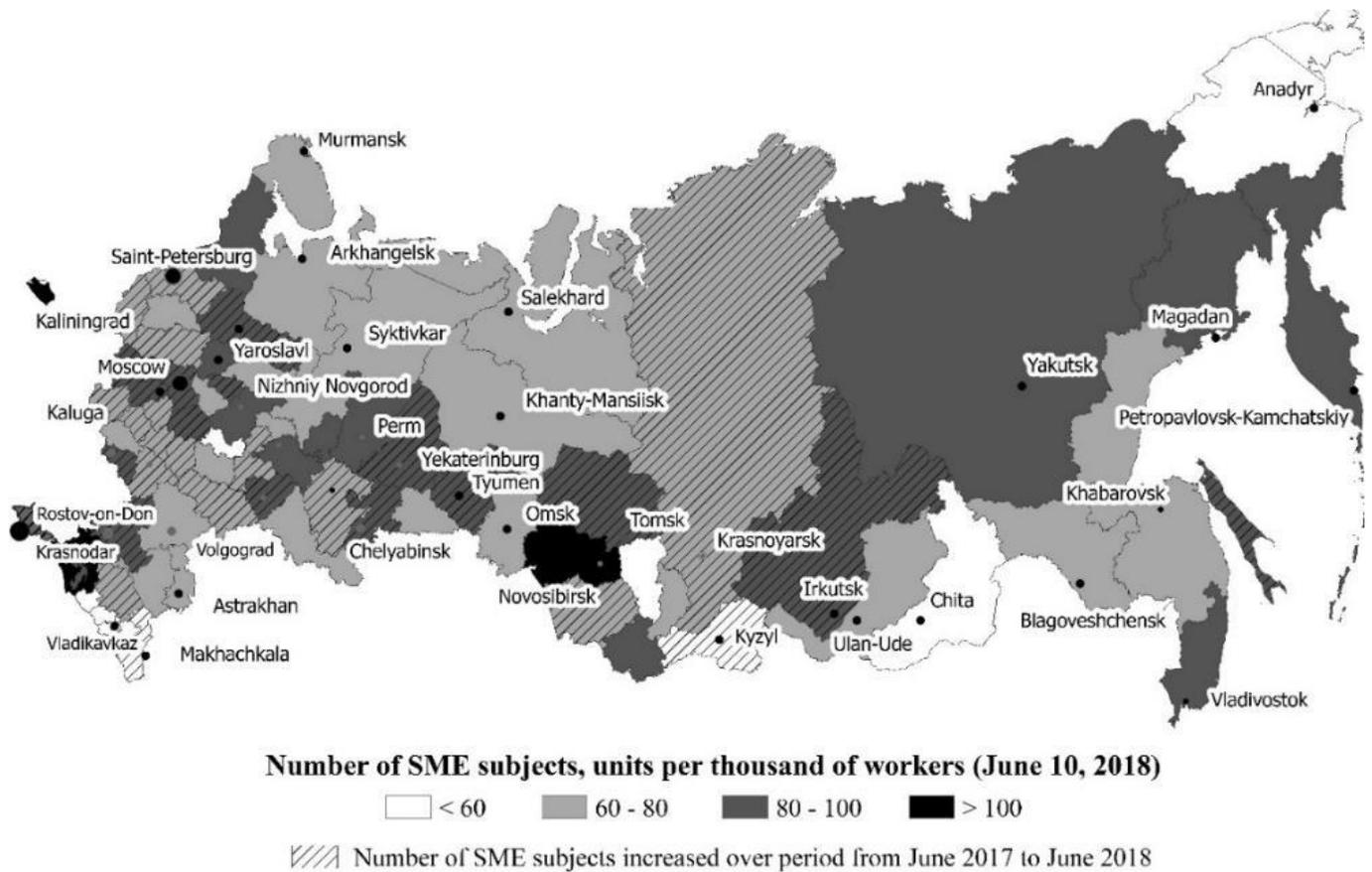
23 <https://www.fedstat.ru/indicator/34078>

Table 2. Descriptive statistics

	Variable	Obs	Mean	Std. Dev.	Min	Max
1	Small business density, enterprises per 1,000 people	913	23.215	11.003	2.453	77.604
2	Income per capita, rubles per month	911	14982.101	8918.925	1608.3	64395.571
3	GDP per capita (1 year lag), thousand rubles in constant 1998 prices	902	35.285	41.281	3.974	355.548
4	Unemployment (1 year lag), %	913	7.565	5.63	.8	53.3
5	Market potential, trillion rubles	913	20.356	10.865	4.134	58.582
6	Population density, individuals per 1 square km	913	126.732	632.122	.069	4831.105
7	Internet, % of population	907	50.206	20.113	0	88.7
8	Banking Index, Index from 0 to 2	876	.801	.218	.15	1.94
9	Crimes, per 1,000 people	913	31.981	11.698	5.293	92.258
10	Tax inspections, per 1,000 enterprises	913	12.115	9.956	.458	105.116
11	Tax benefits, rubles per one organization	913	62404.25	179076.17	0	4128604.8
12	USN reduced tax rates, binary variable	913	.496	.5	0	1
13	Tax holidays, binary variable	913	.313	.464	0	1
14	SEZ, discrete variable	913	.242	.475	0	3

The geographical distribution of small and medium-sized enterprises (SMEs) in Russia has been developing for the last 30 years. During this period several sustainable types of entrepreneurial ecosystems have formed (Zemtsov & Tsareva, 2018; Zemtsov & Baburin, 2019). Small business density is higher in the regions with the largest agglomerations: St. Petersburg, Novosibirsk, Perm, Moscow, Yekaterinburg, Kazan, Tyumen, etc. (Zubarevich, 2015) (Fig.1), with favourable institutional environment: Tatarstan, Moscow, St. Petersburg, Krasnodar, Tyumen regions (Baranov et al., 2015; Barinova et al., 2018), as well as with an advantageous geographical position near large foreign (Kaliningrad and Sakhalin regions, Primorsky, Khabarovsk and Krasnodar regions, Karelia) and regional markets (Yaroslavl, Ivanovo and Ryazan oblast) (Zemtsov & Tsareva, 2018; Zemtsov & Baburin, 2016). It is lower in the northern and the far eastern part, where transport and energy costs are high, as well as in the south, where the share of the informal economy is higher and the business environment is worse.

A proactive support policy is being pursued in regions with lower risks for investors, and better access to markets and capital for small businesses: Moscow, St. Petersburg, Novosibirsk, Samara, Belgorod, Kaliningrad, Voronezh regions, Tatarstan and others. In regions with mostly manufacturing SMEs (Tomsk, Ulyanovsk, Ryazan, Tula, Krasnoyarsk regions), there are prerequisites for the formation of high-tech clusters. In several southern regions, the high share of the informal sector is related to a low development of formal institutions, low level of trust between agents, and corruption.



**Figure 1. The number of small and medium-sized businesses per labour force**

Therefore, when conducting entrepreneurial policies in large developing countries, such as Russia, it is essential to consider inter-regional differentiation and local factors. We used a wide range of variables to assess the determinants of the above-mentioned differences.

First of all, we were interested in the influence of demand on SME's products and service in a region on SMEs development. Households income or GRP per capita were used to estimate it. We used income per capita minus subsistence minimum because of the significant differences in living wages between the Russian regions. Besides it is important for business development to estimate how much consumers can spend additionally on the purchase of new goods and services, entertainment, tourism, etc. But in some specifications, due to the strong correlation between the variables of interest and income per capita, we had to use the alternative indicator, GRP per capita. It was one year lagged to solve potential endogeneity problem (*Dejardin & Fritsch, 2011*).

We included the unemployment rate (one year lagged) into regressions to control on labour supply and necessity-driven entrepreneurship. Note that in the 90s many businesses were founded due to high unemployment and lack of other alternatives; it can be the case for many regions nowadays. For example, more than 70 thousand workers were fired from 'AvtoVAZ', the largest car manufacturer in Russia, after the automation of production in 2010s (*Zemtsov, 2020*); a large part of them became a necessity-driven self-employed: taxi-drivers, car repairmen, retailers, etc. There was a government program to subsidize the opening of a new business. We had to omit the variable in some specifications due to the strong correlation.

We needed to assess total market access for SMEs in a certain region. Market potential was calculated as a cumulative indicator which includes gross regional product (GRP) of a region as well as weighed by distance GRP of other Russian regions and weighed by distance GDP of other countries (*Zemtsov & Baburin, 2016*). This approach implies that the market access can increase, if the neighbouring regions or countries are developing, even if the domestic region is not. In other words, the closer a firm is to a larger market, the higher is its ability is to sell products, services (export) and to buy equipment, components, raw materials, goods and services (import). In Primorsky Krai (Vladivostok) (Figure 1), high small business density can be explained by import and trade of Chinese (light industry products, electronics) and Japanese (automobiles) goods. Market potential strongly correlates with tax inspections and tax holidays that is why in some regressions we had to replace it with another market concentration indicator - population density, which measures only intraregional market access.

In Russia, banking capital remains the main source of SME's additional cash flow (after its own profits) because of weak development of venture financing. To assess the access to finance we used the cumulative index of bank services availability. The index characterizes regional bank infrastructure density per capita: credit institutions availability, deposits' volumes, etc. (*Barinova et al., 2018*). The higher the density of banking institutions and bank capital in a region are, the lower the credit interest rates for small businesses can be. Note that the interest rates have dropped significantly since the crisis year of 2015 in Russia, but bank loans are still less affordable for small companies than for the large ones

(Kudrin et al., 2021). In recent years, the formation of a system of state guarantees for obtaining loans, as well as subsidizing interest rates, could play a certain positive role in reducing rates for small businesses (Zemtsov et al., 2020). To assess the informal rules and formal regulations in a region, we used the ratio of a number of crimes to labour force. Crime is higher in regions with a high proportion of the informal sector, with a weak state. Crime increases the risks of a business and reduces its density.

We used the number of tax inspections per organization to assess administrative burden and related business costs. The number of tax audits has been declining in Russia as a result of a series of legislative acts, but differences between regions are still serious (Zemtsov et al., 2020). In some cases, inspections are used as a tool to put pressure on business and even as a form of political entrepreneurship.

We used a set of variables, primarily related to a reduction in the tax burden, to assess the efforts of federal and regional authorities to improve the business climate. For many years, high taxes were mentioned by entrepreneurs as one of the main barriers to small business development, along with low demand (Kudrin et al., 2021). The total amount of tax benefits (for income tax, property tax, transport tax and land tax) per one organization shows federal and regional tax breaks for businesses. Regional tax incentives (reduced regional tax rates) for a simplified taxation system for SMEs (USN) and tax holidays for Sole Proprietorship shows to what extent the regional authorities are interested in stimulating small business. It is well known from a literature review that countries and regions compete through tax regimes (Djankov et al., 2010).

We also considered special economic zones. We use the number of such zones in a region as an indicator of proactive regional policy. Distribution of special economic zones was determined by the choice of the federal government, but depended on proactive actions and the persistence of the regional authorities. The attraction of large corporations was supposed to facilitate the formation of small service companies around special economic zones.

Going back to econometrics, the basis of our model contains three variables: income per capita (or GRP per capita), unemployment and market potential (or population density). Due to the high correlation (see Table 5 in Appendix), we did not simultaneously include the following variables in the model:

- Income per capita and Internet. To test the significance of the Internet, we will include GRP per capita instead.
- Market potential and tax inspections. To test the significance of inspections, we use population density to control for agglomeration effects, instead of market potential.
- Market potential and tax holiday. To test the significance of tax holiday, we use population density, instead of market potential.
- Unemployment and banking index. We don't insert these variables into one model.
- Audits and Internet. We don't include them into one model.
- Audits and Tax holidays. We don't include them into one model.

**Table 3. Correlation Matrix. All variables are log transformed except binary and discrete.**

Variables	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)	
(1) ln Small business density	1.00														
(2) ln Income per capita	0.45*	1.00													
(3) ln GRPpc(t-1)	0.32*	<b>0.73*</b>	1.00												
(4) ln Unemployment(t-1)	-	0.51*	0.54*	0.46*	1.00										
(5) ln Market potential	0.35*	0.28*	-	-0.23*	1.00										
(6) ln Population density	0.29*	0.26*	0.10*	-0.44*	0.11*	1.00									
(7) ln Internet	0.55*	<b>0.62*</b>	0.35*	-0.40*	0.49*	0.11*	1.00								
(8) ln Banking Index	0.68*	0.33*	0.35*	-	0.13*	0.31*	0.42*	1.00							
(9) ln Crimes	0.21*	-	0.19*	-0.08*	-0.43*	-	-0.03	0.33*	1.00						
(10) ln Tax inspections	-	0.62*	0.47*	0.16*	0.40*	-	0.12*	-	0.06	1.00					
(11) ln Tax benefits	0.16*	0.36*	0.48*	-0.32*	0.00	0.06	0.18*	0.17*	0.00	-0.08*	1.00				
(12) USN reduced tax rates	0.19*	0.30*	0.13*	-0.15*	0.31*	0.10*	0.37*	0.12*	-	0.10*	-0.30*	0.11*	1.00		
(13) Tax holidays	0.32*	0.33*	0.09*	-0.14*	<b>0.70*</b>	0.01	0.46*	0.10*	-	0.07*	0.32*	1.00			
(14) SEZ	0.14*	0.16*	-0.04	-0.10*	0.15*	0.26*	0.06	0.00	-	0.11*	<b>0.59*</b>	-0.06	0.13*	0.07*	1.00
									-	0.20*					

Note:\*\*\* p<0.01, \*\* p<0.05, \* p<0.1.

## 5. RESULTS

We evaluated models with fixed and random effects (table 4-5) for verification purposes. According to the Hausman test, we should give preference to fixed effects estimations<sup>24</sup> but we also used a number of time-invariant variables, which required random effects.

<sup>24</sup> The random effects model is useful when it is possible to believe that all objects are extracted randomly from some general population. This assumption is not entirely correct for a sample of the Russian regions. For country or regional samples fixed effects estimation are commonly used (Dougherty, 2011).

According to our estimations, if household incomes in a region is lower by 1%, then the number of small enterprises per workforce participants is lower by 0.35-0.58%, depending on other regional factors. The local markets demand is one of the most essential factors, because most SMEs sell their goods and services in local markets. Effect of alternative measure, GRP per capita, has a similar effect – 0,27-0,44. The self-isolation regime, introduced due of the coronavirus pandemic in April 2020, has led to a serious loss to the SME sector, because of the demand decline (*Kudrin et al., 2021*).

The impact of unemployment on the small business density insignificant, as its effect on lower incomes is already directly considered in the model. However, a 1% increase in unemployment in previous year may lead to an 0.1-0.16% increase in the number of small firms this year but mostly in regions with constantly better access to capital and markets. If corresponding variables are not included in the models, then unemployment becomes a negative factor. This is the effect of necessity-driven entrepreneurs (unemployment push). The unemployment rate in Russia in 2020 increased by 20% from 4.7 to 5.9% (*Kudrin et al., 2021*). During the crisis, employment centres in Russia actively offered various programs for starting a business and learning entrepreneurship. This could help increase the number of small businesses and self-employed in 2021.

It always seemed that foreign markets would not affect small enterprise development in such large countries like Russia because most of the small firms are oriented to local markets. However, a 1% reduction in market potential, which considers the global market influence on demand, may lead to a decrease in the number of small firms (per workforce participants) by 0.16-0.31%. In 2020, the borders of Russia and most other countries were closed for a significant period of time, which limited the possibilities of export-import operations, especially in the service sector. The global economy declined by 4,3% in 2020 (*UN, 2021*), which may corresponded to similar market potential reduction. It may accordingly lead to 0.36-0.45% decline in small firms' density.

**Table 3. Fixed effects estimation results for 2008-2018**

Fixed effects estimation results. Included 83 cross-sectional units. Time-series length = 5-10. Dependent variable: Small business density – Number of micro and small businesses (with full-time employees up to 100) per 1,000 economically active (employed) population in a region. Robust (HAC) standard errors. All variables are log-transformed.

Variables\models	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)
Average income per capita minus subsistence minimum	.461*** (.066)	x	.38*** (.064)	.351*** (.066)	.582*** (.063)	.456*** (.066)	.296*** (.065)	.445*** (.064)	x
<b>OR</b> GRP per capita (t-1)		.272 (.25)							.090 (.216)
Unemployment (t-1)	.164*** (.054)	.097* (.055)	x	.159*** (.053)	.147** (.056)	.166*** (.055)	x	x	x
Market potential	.178*** (.044)	.251*** (.04)	.163*** (.044)	.18*** (.037)	x	.179*** (.043)	.166*** (.038)	x	.229*** (.035)
<b>OR</b> Population density					.000 (.000)			.000 (.000)	
Index of regional banking services availability			.306*** (.092)				.266*** (.084)	.270*** (.094)	.301*** (.077)
Number of crimes per 100 000 inhabitants				-.315*** (.074)			-.259*** (.07)	-.236*** (.071)	-.317*** (.09)
Field tax inspection by FTS					-.053* (.029)			-.031 (.025)	
Tax benefits per one organization						.018** (.008)	.015* (.008)	.014* (.008)	.020** (.008)
Percentage of individuals with access to the Internet		.157*** (.056)							.092* (.046)
const	-2.149*** (.566)	.647 (.752)	-.926* (.515)	-.033 (.75)	-2.676*** (.671)	-2.29*** (.559)	.575 (.662)	-.398 (.766)	2.714*** (.617)
Observations	911	900	876	911	911	906	871	871	862
Within R <sup>2</sup>	.535	.524	.563	.557	.513	.533	.577	0.555	.580
Between R <sup>2</sup>	.019	.150	.480	.053	.147	.021	.160	0.236	.158
SIC	-526.926	-495.888	-574.585	-563.897	-478.329	-522.256	-594.395	-542.622	-589.076

Notes: Robust standard errors are in parentheses. \*\*\* p<.01, \*\* p<.05, \* p<.1.

**Table 4. Random effects estimation results for 2008-2018.**

Random effects estimation results. Included 83 cross-sectional units. Time-series length = 5-10. Dependent variable: Small business density – Number of micro and small businesses (with full-time employees up to 100) per 1,000 economically active (employed) population in a region. Robust (HAC) standard errors. All variables are log-transformed except tax incentives for USN payers, number of SEZ and tax holidays because they are discrete or binary variables.

Variables\models	(10)	(11)	(12)	(13)	(14)	(15)	(16)
Average income per capita minus subsistence minimum	x	x	x	x	x	x	x
<b>OR</b> GRP per capita (t-1)	.303*** (.116)	.356*** (.118)	.448*** (.131)	.300*** (.116)	.340*** (.122)	.251*** (.097)	.259*** (.1)
Unemployment (t-1)	.034 (.048)	.064 (.048)	-.026 (.056)	.0370 (.048)	-.042 (.049)	x	x
Market potential	.316*** (.032)	.361*** (.031)	x	.310*** (.032)	x	x	x
<b>OR</b> Population density	x	x	.0002*** (.000)	x	.0001*** (.000)	.0001** (.000)	.0001** (.000)
Index of regional banking services availability						.483*** (.089)	.476*** (.086)
Number of crimes per 100 000 inhabitants						-.148* (.083)	-.175** (.086)
Tax benefits per one organization						.017* (.010)	.018* (.010)
Tax holidays in a region in year t (0 if «No» and 1 if «Yes»)			.247*** (.025)		.183*** (.024)	.110*** (.022)	.114*** (.022)
Regional tax incentives for USN payers (0 if «No» and 1 if «Yes»)	.144*** (.031)	x	x	.141*** (.031)	.221*** (.031)	.017 (.03)	x
Number of special economic zone in a region (0 if «No SEZ» and 1 or 2 or 3 if «SEZ exists»)		.077* (.04)	x	.061 (.038)	.096** (.041)	.059 (.045)	x
Percentage of individuals with access to the Internet						.164*** (.045)	.169*** (.043)
const	.999** (.405)	.690* (.399)	1.507*** (.474)	1.005** (.405)	1.788*** (.434)	2.010*** (.292)	2.062*** (.301)
Observations	902	902	902	902	902	862	862
Within R <sup>2</sup>	.503	.477	.330	.414	.415	.544	.542
Between R <sup>2</sup>	.069	.101	.206	.152	.152	.567	.555

Notes: Robust standard errors are in parentheses.\*\*\* p<.01, \*\* p<.05, \* p<.1; \*\*\*, \*\* and \* mean that the coefficient is significant at the 1%, 5% and 10% level, respectively.

The access to finance is another essential factor. The banks, facing high risks of non-return in 2020, may decrease its activity, which leads to bank service availability decline. According to our estimates, if a region has 1% higher banking accessibility index, it may lead to a 0,26-0,48% higher small firms' density. There are no available data for 2020, but the portfolio of SME's loans in 2020 grew by 22.6% compared to 2019 - up to 5.8 trillion rubles (Kudrin et al., 2021) because of the need for money during the period of self-isolation and income decline. The interest rate on a loan decreased from 12% in 2019 to 7.6% in 2020 for microbusiness, from 9.12% to 6.4% for small businesses due to government subsidies for banks. Note that the development of banking services has a positive effect on the density of small businesses only with expanding markets, which was not observed in 2020. Therefore, in this case, the growth of lending should be considered as a forced measure to avoid bankruptcy of small businesses, and if the economy does not recover in 2021, these bankruptcies and outstanding loans will be more difficult to avoid.

A low crime rate can also act as a proxy to the average level of trust in a region (highly correlated variables). And trust determines the possibilities of using new banking and other online technologies; it helps to build a sustainable entrepreneurial ecosystem with various connections. If the crime rate in a region is 1% lower, then the density of small businesses will be higher by 0.23-0.31%.

The number of field tax audits per firm turned out to be insignificant if we consider other institutional variables. There has been a substantial reduction in the total number of inspections in the recent years (Zemtsov et al., 2020), so they may no longer have a significant impact on small business density but still may affect established medium-sized companies. The tax support is positively significant. In a region with tax holidays, small business density is 0.11-0.25% higher. And 1% growth in regional tax incentives may increase small business density by 0.14-0.22%, but it is insignificant considering other characteristics of business climate. Tax breaks are less important: a 1% increase in the amount of tax benefits per firm may lead to a 0.014-0.018% increase in the number of small firms. This is due to the fact that many of these concessions are targeted at large business, and its development, in turn, can stimulate the growth of the number of small firms in a limited way.

In general, the density of small business is higher in regions with special economic zones, but if we consider all the institutional characteristics, the variable turns out to be insignificant. This is due to the fact that special economic zones were created in regions with already better conditions and proactive regional authorities.

Another important factor for small business development is Internet access in a region. The online sphere includes e-commerce, online services, and digital platforms for retailers. The Internet access will be especially important during and after the pandemic. A 1% increase in the proportion of households with the Internet access may lead to a 0.1-0.16% increase in the number of small firms (per workforce). Moreover, this value was calculated for previous periods, when only 42% of firms used the Internet to sell goods, and the online market accounted for 2% of the total retail. After the 2020 crisis, these figures are supposed to grow significantly.

## 6. CONCLUSION AND DISCUSSION

The regional factors of SMEs development are usually underestimated. Most politicians and researchers share the opinion about their importance. However, in practice, some government initiatives, e.g. setting up online cash registers or issuing anti-crisis subsidies through an online application, are implemented without considering regional costs and availability difference. Therefore, there is a need for differentiated and diversified regional SME policy.

In our work, we confirmed the influence of factors traditionally used in the literature (demand, unemployment, population density), but also proposed a number of new significant variables.

In confirmation of the first hypothesis, we showed that better potential access to regional and foreign markets is a positively significant factor for SMEs development. Accordingly, a decline in the global economy or trade barriers can have a disastrous effect on entrepreneurship, for example, through a reduction in imports. This influence will be especially high in the border and coastal regions.

The institutional environment is especially relevant SME development factor for transition economies, such as Russia. Firstly, small companies are more vulnerable due to their lack of substantial financial, human and other resources; there were no entrepreneurs and open markets in the USSR. Secondly, entrepreneurs in Russia often lack business experience. Thirdly, they do not have consistent access to all essential formal institutions. Consequently, small firms are often forced to use their family ties or friends of their co-founders, and are not always perceived trustworthy. According to the second hypothesis, we have shown that the high crime rate in a region reduces small business' density, while wide access to banking capital, on the contrary, increases it. High crime rate can be perceived by entrepreneurs as a threat to their security from both criminals and unscrupulous officials. The availability of banking services can be an indicator of low interest rates due to bank competition. It is a proxy for the capital access, which contributes to entrepreneurship development.

State support in the form of tax breaks and holidays may have a positive effect on small firms' density, but this impact is limited. The administrative burden and special economic zones are not significant factors compared to the general business climate. Note that, according to earlier estimates, only 9% of entrepreneurs have ever received government support in Russia (*Kudrin et al., 2018*). It can be argued that the general conditions of an entrepreneurial ecosystem are significantly more important than state support measures, and, accordingly, these measures are not able to radically change the situation in regions with weak ecosystems in the south, north and east of Russia (*Zemtsov, Baburin, 2019*). Moreover, many Russian firms usually move to the shadow economy during a crisis and large firms are split into small ones for the tax optimization and to regulatory reduction. This begs the question, if state support does not usually have a significant impact on the SMEs' dynamics in Russia, can it influence it during the crisis.

Previously, it was believed that Internet access cannot be a significant factor of SME's development, since the share of online retail does not exceed 2% in Russia and most of the companies do not sell products and service online. Our calculations show the significant role of digitalization in the 2010s. And it can be a survival factor for the companies in 2020 and after. Online businesses in Russia demonstrated growth or the smallest rate of decline even during the period of self-isolation (*Kudrin et al., 2021*).

An attempt to forecast the development of small business in a crisis period based on previous trends is debatable, since these trends and dependencies could radically change. However, our results appeared to be close to real estimates. According to our calculations and factors forecasts for 2020, with a 4,3% reduction in world markets (*UN, 2021*), a 3.5% drop in household incomes (*Kudrin et al., 2021*), a 3.3% decrease in the number of small firms is possible. According to the Federal Tax Service of the Russian Federation, there were 4.3% decline in the number of SMEs during 2020 (*Kudrin et al., 2021*). Substantial decrease in the number of small firms may lead to a long-term decline in regional development (*Reynolds et al., 2002; Wong et al., 2005; Gonzalez-Pernía & Peña-Legazkue, 2011; Acs et al., 2012; Sadyrtidinov et al., 2015; Urbano et al., 2019*). According to (*Zemtsov, Smelov, 2018*), a 4,3% decrease in the number of small firms may lead to a 0.22 to 0.67% decrease in GRP, which explains part of 3,35 drop of Russian GDP in 2020 (*Kudrin et al., 2021*). Nevertheless, it is necessary to clarify that these estimates are rather speculative in nature, and their verification is possible only after several years, when the corresponding statistics will be available.

Despite these limitations, the identified factors in a general sense may help to verify the measures taken by the governments. First of all, it would be advisable to pursue a demand support policy. This implies provision of "salary" bank loans, subsidies to cover the salaries, etc. The digitalization of all public services becomes relevant, including the online access to tax payments, subsidies, access to public procurement, etc. It is also important to support the business digital transformation. It is essential to maintain favourable institutional environment and the level of trust, especially among the entrepreneurs, to keep them motivated and encouraged to do business. In the long term, improving market access by developing infrastructure, lowering transport tariffs and removing institutional barriers at the border will also help small business development.

In our opinion, the proposed model considers the most significant factors, but it requires expansion and further verification. There are some determinants which are not reflected in the current paper. We used some indicators of

human capital (for example, average number of education years of workforce) that were found to be insignificant or led to multicollinearity. It seems to us that this is due to the fact that the indicator does not consider the quality of education. A search for alternative metrics is needed. We have not found a suitable indicator for assessing the connectivity inside an entrepreneurial ecosystem. It is also necessary to search and test other indicators of entrepreneurship.

However, the results obtained allow us to see general patterns for Russia and create the basis for future discussions. For example, to what extent identified relations are typical for all regions? How well can the proposed model predict the decline (or growth) in the number of small companies in a specific region? The models (Tables 4-5) describe well the situation on average (LSDV  $R^2 > 0.98$ ), but for each specific region there is a large share of other factors (Within  $R^2 = 0.51-0.58$ ). At the same time, some variables of state support worsen the quality of the models, which may be a reminder of manual or stochastic mechanisms of its distribution between regions. Anyway, there are a few questions here for further research.

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## THE SANDWICH OF RUSSIAN SPACE: HOW DIFFERENT SPACES DIFFERENTIATE THEMES IN REGIONAL SCIENCE

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### ABSTRACT

The paper shows the inseparable connection between the topics of the main centres of Russian regional science and the properties of the space that they are studying. The diversity of the thematic structure of research centres is derived from differences in economic geographical and geopolitical position, sectoral structure of the economy, age of economic development of the studied areas of the Russian space. However, the most important factor differentiating Russian space is the density of economic activity, which determines the level of development of the territory. Within the Russian space, significant undeveloped territories of the North, the Arctic, Siberia, and the Far East are of particular interest, in which extensive buffer zones are distinguished between the main settlement zone and low-density periphery. They constitute the essential specificity of the Russian space. Another feature is the presence of colossal “ownerless” spaces that are outside the influence of any nearby major centre and therefore are forced to focus on the federal capital, Moscow.

## **Regular Session: RS07.1 - Migration and regional labor markets**

**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/88466279359>**

**Chair Wahyuningtyas Puspitasari**

## EFFECT OF TARIFF LIBERALIZATION ON MEXICO'S WAGE DIFFERENTIAL

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### ABSTRACT

This paper studies how the North American Free Trade Agreement (NAFTA) affected wage differentials within Mexico considering internal migration. In low-skilled, labor-abundant developing countries, trade liberalization should theoretically increase the wage of low-skilled workers, decreasing income inequality. However, anecdotal evidence indicates that NAFTA increased the gap between rich and poor in Mexico, and empirical evidence is mixed (Hirte et al., 2020; Brühlhart, 2011; Bosch and Manacorda, 2010; Nicita, 2009; Chiquiar, 2008 & 2005; Hanson, 2007; Gonzalez-Rivas, 2007). Because trade may affect wages differently across regions within the country, accurate measures of wage effects must incorporate internal migration, otherwise apparent wage convergence or divergence might only reflect a geographic resorting of workers.

To study the effect of NAFTA on migration we first predict the probability that an individual will migrate based on the potential growth in municipal Gross Value Added (GVA) associated with tariff reductions from NAFTA. Because migration and wage outcomes are jointly determined, and likely both related to unobservable individual characteristics, we instrument for migration using local crop yield shocks, specifically corn, which have been shown to influence migration yet are unlikely to affect wages in the manufacturing, retail or service sectors in urban areas except through labor supply. Next, in a second stage, we estimate a wage equation as a function of trade, demographic and household characteristics, together with the previously instrumented probability of migration. By analyzing trade openness and distance to the border, we find that workers closer to the US-Mexico border get a higher wage than their counterparts far away. But this spread diminishes as tariffs fall, after NAFTA. Further, we find that men with low wages get a boost from NAFTA in their wages while NAFTA has a negative effect for those with high wages. Thus, trade liberalization appears to have decreased wage differentials.

This paper offers the following contributions: First, to our knowledge, this is one of the first studies to consider the effect of trade on wages while explicitly controlling for migration. Second, we correct for the potential endogeneity of internal migration and wages by using a two stage least squares (2SLS) instrumental variable estimation. Third, by comparing low vs. high wage earners, we explore which workers gained and lost from trade. Fourth, we include the latest population census (2010) to observe long-run wage changes after NAFTA and ask whether wage differentials persist as the economy adapts to trade. The results of this research can help identify those barriers facing individuals and regions that limit their ability to benefit from trade. Thus, this research can help identify the areas of social investment and infrastructure investment that may help smooth wage inequality. Further, by identifying those regions and individuals who have benefited and lost from trade, this information can be used to target compensation. Finally, using this estimation approach, regional governments can anticipate migration and wages in their region, and adjust local development plans accordingly.

## ASPIRATION OF MIGRANTS AND RETURN TO HUMAN CAPITAL INVESTMENT

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### ABSTRACT

Migrants are known having higher aspiration than non-migrants. In the previous studies, migrants are believed adjusting their aspiration to the new income to that of a new reference group. One conventional explanation stated that if the gap of aspiration is higher than the change of income, migrants will be trapped on hedonic treadmill phenomenon. Furthermore, migration can be viewed as a process of human capital investment. Migrant assume cities can be viewed as a place to accumulate human capital. So that by doing migration, migrants will be experienced an increase of aspiration. This study will test the phenomenon of changes in migrant's aspiration through both theoretical approaches using IFLS data 2007 and 2014. This study uses a variable that constructed by the different of migrant's current perception welfare level with 5 years to come perception and estimated using OLS, Ordered Logit and Village Fixed Effect method. The result show that the phenomenon of change in migrant's aspiration can be explained through both theoretical approaches. This study also proved the existence of hedonic treadmill phenomenon in migration activity.

## WOMAN SHOULD NOT BE AFRAID TO WORK: THE STUDY OF MATERNAL EMPLOYMENT'S IMPACT ON CHILDREN'S EDUCATIONAL ACHIEVEMENT IN INDONESIA

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### ABSTRACT

As the increasing of women participation in labour market for the last 20 years, many women in Indonesia have double status, being a mother and a worker at the same time. The effect of maternal employment to their children still becomes a debatable issue around society and researcher. This study analyses the effect of Indonesia maternal employment on the children's achievement in primary education. Using the 2nd-5th wave of IFLS (Indonesian Family Life Survey), about 1445 children have been used as sample research. National exam score of mathematics and Indonesia language from grade 6 (elementary school) and grade 9 (junior high school) has been used for the dependent variables. Maternal employment status is taken when children in elementary school entry age. Pooled cross section regression model is used to analyze this dataset. This study found that maternal employment status has a significant effect on children's achievement on Indonesian language score both of elementary or junior high school but it doesn't have a significant effect on mathematics regardless of any grade. Working mothers at this age have changed the quantity engagement time with children to the quality engage time. Internal factors such as higher motivation or existence of role model also become the reasoning of the positive result. Government and the private sector should formulate a regulation that can increase the parenting room and expand the development early education. Except asking help from the grandparents or relative's help to substitute their role, enrolling children to the kindergarten or early education could be a solution for working mother to avoid the disadvantage of their maternal employment status.

## THE IMPACT OF INCOME GAP TO MIGRATION DECISION IN INDONESIA

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### ABSTRACT

Migrants make their decision whether to move or to stay are based on various motives such as financial or non-financial motive. Todaro, in his migration model said expected income of migration take a big part in migrants decision making. They are tend to move if their expected income after migration exceed their income in current place. The higher is this income gap, the higher migrants propensity. We are trying to test the prediction of Todaro model for Indonesian study case. But, this research model have several problem like selection bias because information about expected income are available only after individual has already migrated. To overcome this problem, we use two-step Heckman to correct selection bias in the model. The main objective of this research is to analyze the determinants of migration in Indonesia and the impact of income gap on migration decision. This study shows that income differences affect the decision to migrate by households in Indonesia based on IFLS data.

## **Regular Session: RS08.1 - Real estate and housing**

**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/83379645511>**

**Chair Elena Semerikova**

## CITY AUGESCENS: WHEN HOUSING MATTERS

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### ABSTRACT

Housing has always been a constant of the morphology of cities, whose presence is the scenario against which urban life gains visibility. Housing has implications with the definition of social relations and the standardization of cultural values on the growing urbanization process, in which housing corresponds to the highest percentage of the housing market supply and is one of the main local, regional and national economies. Housing is a matter both local and global.

According to World Cities Report 2016, the housing function corresponds to more than 70% of land use in most cities and determines density and urban form. For this reason the housing issue must be placed at the heart of urban policies, especially with regard to the phenomenon of urban sprawl, which is seen as one of the biggest challenges for sustainable planning of the territory.

In view of the dichotomy between the constraints of urban expansion and the benefits of scale economies, strongly anchored in housing production, it is today required that city public policies be able to adapt housing production to transformative processes resulting from the accelerated growth of cities, taking into account the following key factors:

- a) The concept of urbanization simultaneously as a process of urban self-expansion and as a way of life, in the context of a new socio-spatial order;
- b) The awareness that the city where we will live in the future is already being modeled by spatial planning and the building of the present;
- c) The city as space-time creation and the urbanization as a way of life result both from man's ability to transform the environment that he inhabits, so the attributes of the built environment are key considerations, which require the most high architecture design standards of buildings and public spaces.

In the very deed of the construction, we must have present the social and cultural references that intervene in the relationship between space and man. If house building emerges as inevitability, what we build and how we build has currently reflected the preferences of the Real Estate industry more than the views of an architecture and urbanism committed to issues related to the social cohesion and the right to the city.

The New Urban Agenda UN-Habitat III (2016) puts us in charge of the idea that building and making cities are inseparable actions. For this reason, spatial planning acquires a growing role as a reference instrument for new governance structures to deal with problems and divergences of conduct in real estate markets.

### KEYWORDS

Architecture, housing, space as commodity, urbanization.

### 1. INTRODUCTION

For the Romans the concept of the city is a "mobile" artifact in its essence. The reference to a Roma *mobilis*, forming the representation of an *imperium sine fine*, of which Virgil spoke, finds today full correspondence in the macro-territorial typologies of contemporary cities.

This mobility can only succeed if it is associated with the idea of *civitas augescens*, an ever-growing city, which is to say, "the programmatic characteristic of the *civitas* is to grow, there are no *civitas* other than *augescens*, which expand, which "de-lire" (Cacciari 2009: 15-16)". It should be noted here that the world 'lira' corresponded to the ceremonial groove, traced as a sign that delimited the Roman city. *Delirium* means, consequently, to leave the lira, to go beyond the city limits. This vision of a city in constant growth is of interest to our study, since European cities - as a place to live and a place of business - continue to develop from the Roman position, since we conceive the city as a place where people come to live and accept the same law, i.e. the same urban policy.

The progressive concentration of population in our cities, the result of demographic dynamics translating changes in social contexts, has been directly reflection in the expansion and complexity of urban tissues. One of Jane Jacobs (1961) seminal contributions "was the conception of the contemporary cities as «problems of organized complexity», namely problems with many variables that nevertheless interrelated into an organic whole (cfr. Theodosis 2015: 288)".

The interrelationship of these variables and the understanding of the phenomenologies associated with them can find an explanation in Christopher Alexander's article "A City is not a Tree". In his classic article, Alexander argued for the need to understand the city as a semi-lattice instead of a tree structure. "The tree structure was identified with the hierarchical

organization, functional zoning, and the separation of land uses. (...) The semi-lattice structure instead represented the complexity of the overlapping activities in mixed-use urban areas, an urban model that Alexander strongly advocated against the simplicity of the tree structure (Theodosios 2015: 288)".

To explain the functioning process of each one of these systems, Christopher Alexander gives as an example the relationships of personal knowledge that are established in a traditional society and those that characterize the current social structures, saying that "In a traditional society, if we ask a man to name his best friends and then ask each of these in turn to name their best friends, they will all name each other so that they form a closed group. (...). But today's social structure is utterly different. If we ask a man to name his friends and then ask them in turn to name their friends, they will all name different people, very likely unknown to the first person; these people would again name others, and so on outwards. There are virtually no closed groups of people in modern society. The reality of today's social structure is thick with overlap - the systems of friends and acquaintances form a semilattice, not a tree (Alexander 1965)".

In addition to the idea of a *civitas augescens*, characterized by its morpho-social *delirium*, we need to add the idea of a *civitas mobilis*, to which we previously referred. It is no longer about addressing the mechanism of urban expansion that evolves without limit and is confused and mixed with the rural territory itself that it progressively occupies, but brings to our theme of study another characteristic of our current societies - that most human activities generate mobility.

Mobility has become a key element of human activity, particularly in urban areas by playing a central role in prosperity and social cohesion. Its relationship with the housing production is crucial due to the infinite number of variables that as to be introduced in to the city planning.

Indeed the articulation between the two concepts, *civitas augences* and *civitas mobilis* finds in the production of housing a common denominator that must be taken into account in the planning of our cities. According to World Cities Report 2016, the housing function corresponds to more than 70% of land use in most cities and determines density and urban form. For this reason the housing issue must be placed at the heart of urban policies, especially with regard to the phenomenon of urban sprawl, which is seen as one of the biggest challenges for sustainable planning of the territory.

## 2. HOUSING PUBLIC POLICY AND REAL ESTATE

Despite all the negative social and economic impacts resulting from the 2008 financial crisis, according to eurostat housing statistics 2019, housing ownership, using indebtedness, has remained the main option and today represents the most common form of occupation in the European Union (EU-28).

When the people occupying the dwellings are also their owners, the investment usually corresponds to a significant part of their income and is a determining factor in the financing of their habits. In turn, "real estate financing represents a significant amount of financial institutions in many European countries (...) and investments in residential properties have a great weight in the investment portfolios of real estate companies (Suarez 2009: 8)".

In addition to speculation, the rise in house prices, which in the Portuguese case has been occurring since 2014, it has given rise to a new Real Estate boom and an increase in demand by investors (national and international) especially in the central areas of Lisbon and Porto cities, which may be related to several other factors:

- i. The housing rental market liberalization in 2012, mainly as a result of the publication of Law No. 31/2012 of August 14, which revises the legal regime of urban leases, liberalizing it and amending the Code of Civil Procedure and Law No. 6/2006 of February 27.
- ii. The publication in 2014 of the new exceptional and temporary regime applicable to the rehabilitation of buildings, Decree-Law No. 53/2014 of April 8 (meanwhile repealed by Decree-Law No. 95/2019 of July 18), which came from the compliance with some rules provided for in special regimes related to construction, such as accessibility, energy efficiency, structural security, etc.;
- iii. The significant increase of tourists using the Local Accommodation, strongly encouraged by the publication of Decree-Law No. 128/2014 of August 29, which approves legal regime for the operation of local accommodation establishments. In view of the reduction in tourist activity, due to the situation, many local lodges are currently being transferred to the traditional rental market;
- iv. And yet the creation of a very favourable tax regime for non-habitual residents, which contributed to increase the demand for housing properties.

The above is revealing the complex relationship between the Real Estate market and public housing policies. This relationship depends, to a large part, on the process of urban system recomposition and the different stages of the cyclical model of changes that occur in cities, namely the relationship between housing and the urban fabric, given that it is its most constant element (Marques 2021).

### 2.1 Real Estate as a protagonist

The media are revealing support of the almost daily transformations that come to occur in the housing production and its strong link to Real Estate markets, highlighting in their advertisements or opinion articles, the most diverse types of relationship between supply and demand for housing or the city. Let's look at some examples.

In THE IRISH TIMES de 5 May 2021, an article of Ciarán Hancock entitled "**Evidence does not support case for shared-equity housing scheme**", refers "It is one of the curious things about life in Ireland that property developers and the construction industry here openly tell us that it's just not financially viable for them to build houses that people can afford to buy".

In another article, published in *Yahoo!finance* (5 May 2021), Ethan Wolff-Mann hypothesizes that "**High demand for housing combined with low inventory has heated up the market - boosting property values and leading some to**

*wonder if we're in bubble territory*". The answer is given in the same article by Vishwanath Tirupattur, Morgan Stanley strategist, who wrote in a note to clients this week informing that "We have strong conviction that we are not experiencing a bubble in US housing".

Another news item published in The Guardian de 8 May 2021, with the title *"White-hot housing market has Merseyside suburb at fever pitch"*, special emphasis is given to the suburban single-family housing market: "The Merseyside town of Wallasey has over the past year recorded a bigger rise in asking prices than any town or city in Britain, according to the listings site Rightmove. And it's family homes with gardens – a popular choice during lockdown – that have become must-have assets."

On June 18, 2017 Vítor Andrade, economics coordinator of the newspaper Expresso, published an article entitled: *"There are 60 to 70,000 houses in Portugal that do not sell for the simple reason that no one wants to buy them"*. The justification for this situation was given by the article's author: "They are located mainly in suburban areas of large cities, inserted in a poorly achieved and poorly functional urbanism, in neighbourhoods served by poor quality accessibility and with severe parking difficulties. The buildings are of poor quality, the interior of the houses is poorly divided and the areas are generally ungenerous."

Several other examples could be presented here on housing and city issues. It is important, however, to retain how clearly this news matched with the statistical data, such as those presented in the next chapter.

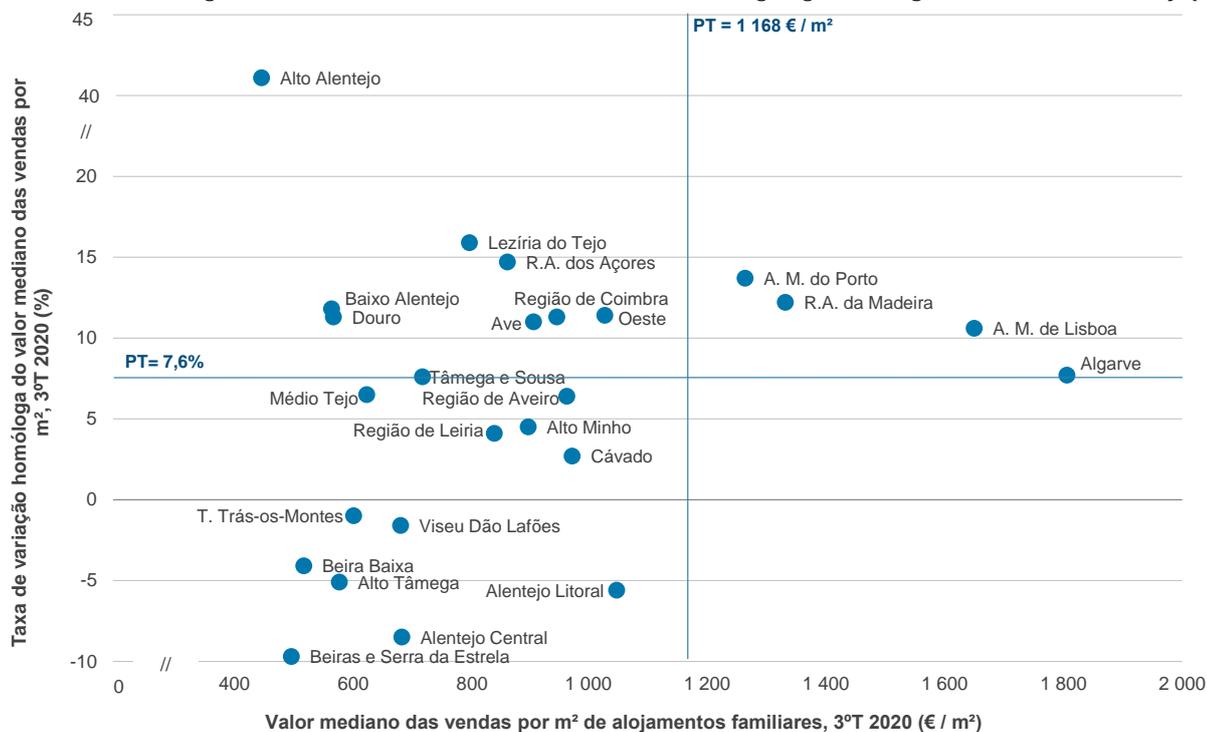
## 2.2 The Portuguese case: statistical data

The Portuguese National Institute of Statistics (INE) regularly publishes an edition of the Housing Price Statistics at the local level based on data of an administrative nature (see [www.ine.pt](http://www.ine.pt), option Products, Statistical Data, Data Base). The published figures refer to the median of the sales prices/square meter of family accommodation (€/m<sup>2</sup>). Unless otherwise indicated, the median is determined in the annual period ended in the reference quarter of this publication, eliminating possible seasonal effects on price behavior and thus allowing to increase the geographical detail of the presentation of results.

### 2.2.1 Quarterly results 2020

In the 3<sup>rd</sup> quarter of 2020, the median price of family accommodation in Portugal was 1168 €/m<sup>2</sup>. This represents a reduction compared to the 2<sup>nd</sup> quarter (-1.6%) but an increase compared to 3<sup>rd</sup> quarter of 2019 (+7.6%). The evolution of the annual rate of change between the 2<sup>nd</sup> and 3<sup>rd</sup> quarter of 2020, from 9.4% to 7.6%, shows the slowdown in the pace of growth in house prices, as in the previous quarter. Figure 1 shows that the most common pattern recorded in 12 of the sub-regions was a median value of house prices and an annual rate of change lower than the country's values, noting that, in this group, seven sub-regions recorded a reduction in prices in the 3<sup>rd</sup> quarter of 2020, compared to the same period of the previous year.

As a result: *Seven NUTS III recorded annual reduction sums of house prices, but sub-regions with prices higher than the national value – Algarve, AML, Madeira and AMP – recorded homologous growth higher than in the country (+7.6%).*



**Figure 1: Median value and annual homologous rate in median value of sales per m<sup>2</sup> of family accommodations, Portugal e NUTS III, 3<sup>o</sup>T 2020**

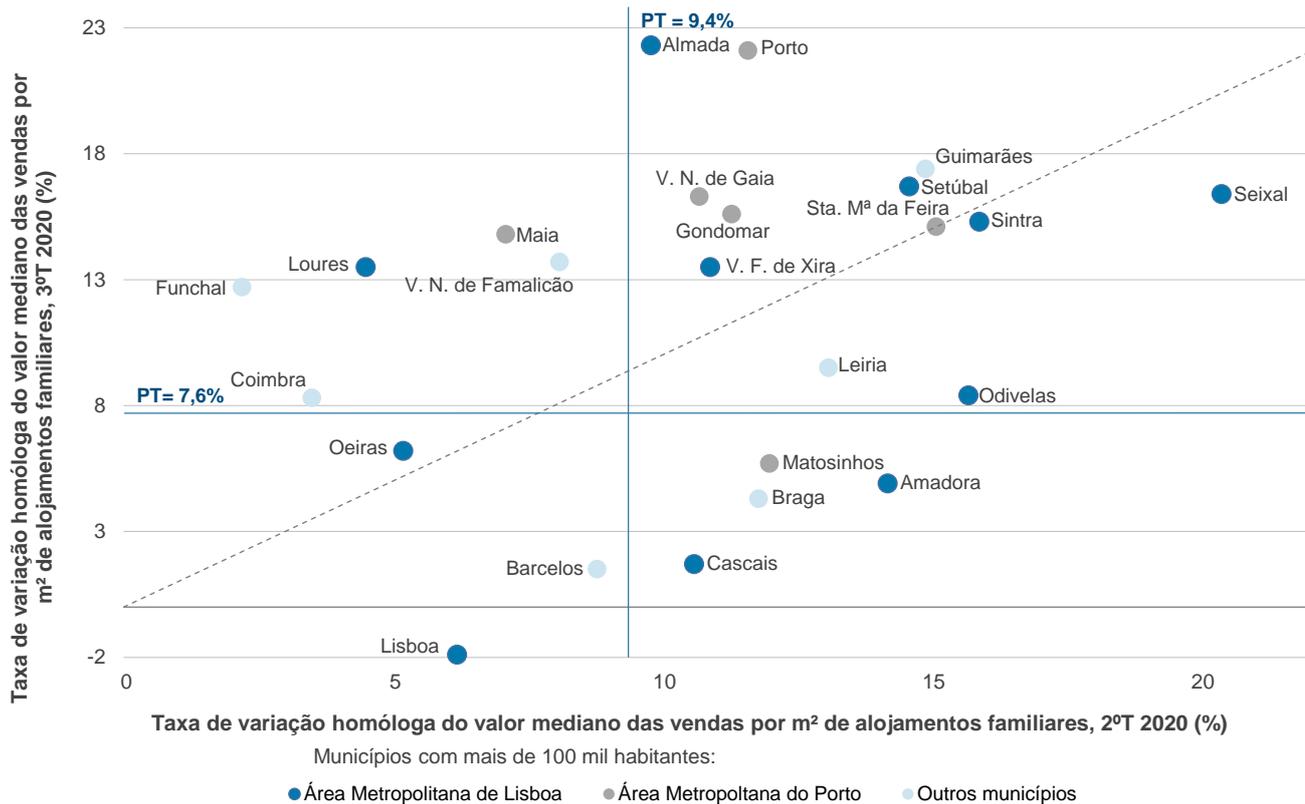
Fonte: INE, I.P., Housing price statistics at the local level.

Figure 2, representing municipalities with more than 100,000 inhabitants, shows that for 10 of the 24 municipalities there was a slowdown in housing prices (municipalities below the bisector of the annual growth rate in the 2<sup>nd</sup> and 3<sup>rd</sup> quarter of 2020). Of these 10 municipalities 6 belonged to the Metropolitan Area of Lisbon and only one to the Metropolitan Area of Porto (Matosinhos). In the case of the municipality of Lisbon, the homologous variation in the 3<sup>rd</sup> quarter of 2020 was even negative (-1.8%).

In nine of the 24 municipalities with more than 100,000 inhabitants, the price slowdown between the 2<sup>nd</sup> and 3<sup>rd</sup> quarter of 2020 was higher than the national standard (-1.8 p.p.), having been particularly marked in Amadora (-9.3 p.p.), Cascais (-8.9 p.p.) and Lisbon (-8.1 p.p.). Between the 1<sup>st</sup> and 2<sup>nd</sup> quarter of 2020, 10 municipalities had recorded a homologous slowdown higher than in the country (-5.0 p.p.).

Above the bisector, stand out among the 13 municipalities that verified an acceleration of prices between the 2<sup>nd</sup> and 3<sup>rd</sup> quarter of 2020, Almada (+12.5 p.p.), Porto and Funchal (both with +10.5 p.p.).

As a result: *Lisbon was the only one of the 24 municipalities with more than 100,000 inhabitants with a homologue contraction in house prices (-1.8%) and nine others also recorded a slowdown in prices.*



**Figure 2: Change rates in the median value of sales per m<sup>2</sup> of family accommodation, Portugal e municipalities with more than 100,000 inhabitants, 2ºT 2020 e 3ºT 2020.**

Fonte: INE, I.P., Housing price statistics at the local level.

**2.2.2 Quarterly results (last 12 months ended in the reference quarter)**

In the 3<sup>rd</sup> quarter of 2020 (last 12 months), the median price of family accommodation in Portugal was 1160 €/m<sup>2</sup>, increasing +2.0% compared to the previous quarter and +10.1% compared to the homologous quarter. The median house price remained above the national value in the Algarve (1711 €/m<sup>2</sup>), Lisbon Metropolitan Area (1586€/m<sup>2</sup>), Madeira Autonomous Region (1307 €/m<sup>2</sup>) and Porto Metropolitan Area (1192 €/m<sup>2</sup>). In the period under analysis, 47 municipalities presented a median price higher than the national value, located mostly in Algarve sub-regions (14 in 16 municipalities) and Lisbon Metropolitan Area (15 out of 18). The municipality of Lisbon (3375 €/m<sup>2</sup>) recorded the highest price in the country. There were also values in excess of 1500 €/m<sup>2</sup> in Cascais (2747 €/m<sup>2</sup>), Oeiras (2312 €/m<sup>2</sup>), Loulé (2226 €/m<sup>2</sup>), Lagos (2018 €/m<sup>2</sup>), Porto (2016 €/m<sup>2</sup>), Odivelas (1958 €/m<sup>2</sup>), Albufeira (1951 €/m<sup>2</sup>), Tavira (1924 €/m<sup>2</sup>), Faro (1758 €/m<sup>2</sup>), Loures (1753 €/m<sup>2</sup>), Lagoa (1720 €/m<sup>2</sup>), Almada (1695 €/m<sup>2</sup>), Funchal (1686 €/m<sup>2</sup>), Vila Real de Sto. António (1656 €/m<sup>2</sup>), Amadora (1611 €/m<sup>2</sup>), Matosinhos (1584 €/m<sup>2</sup>), Aljezur (1578 €/m<sup>2</sup>), Portimão (1520 €/m<sup>2</sup>) and Silves (1512 €/m<sup>2</sup>), two more municipalities than in the previous quarter.

As a result: *Twenty municipalities, located mostly in the Algarve and Lisbon Metropolitan Area, recorded house prices above 1500 €/m<sup>2</sup>.*

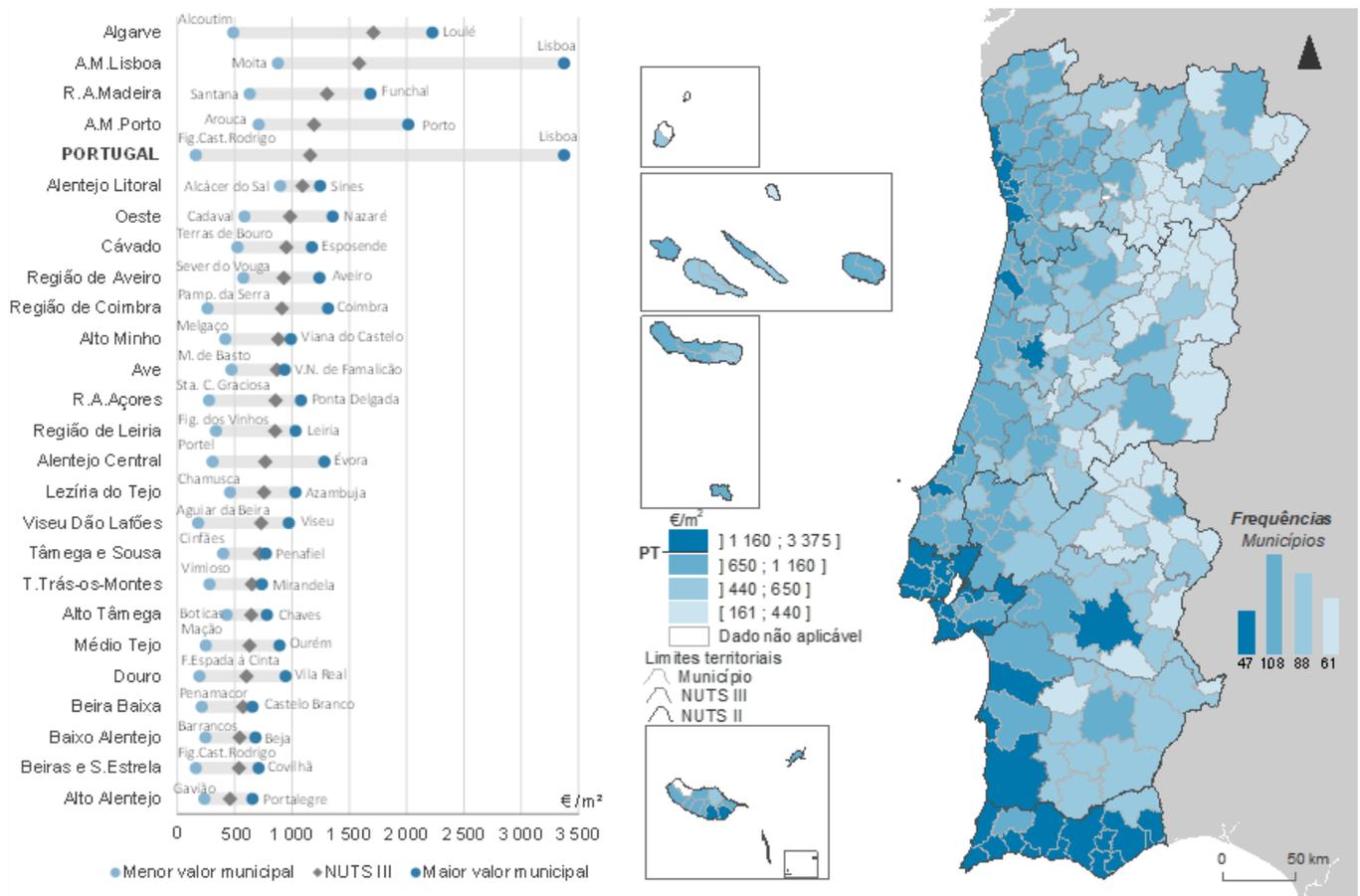


Figure 3: Median value of sales per m<sup>2</sup> of family accommodation, Portugal, NUTS III and municipalities, 3<sup>rd</sup>T 2020

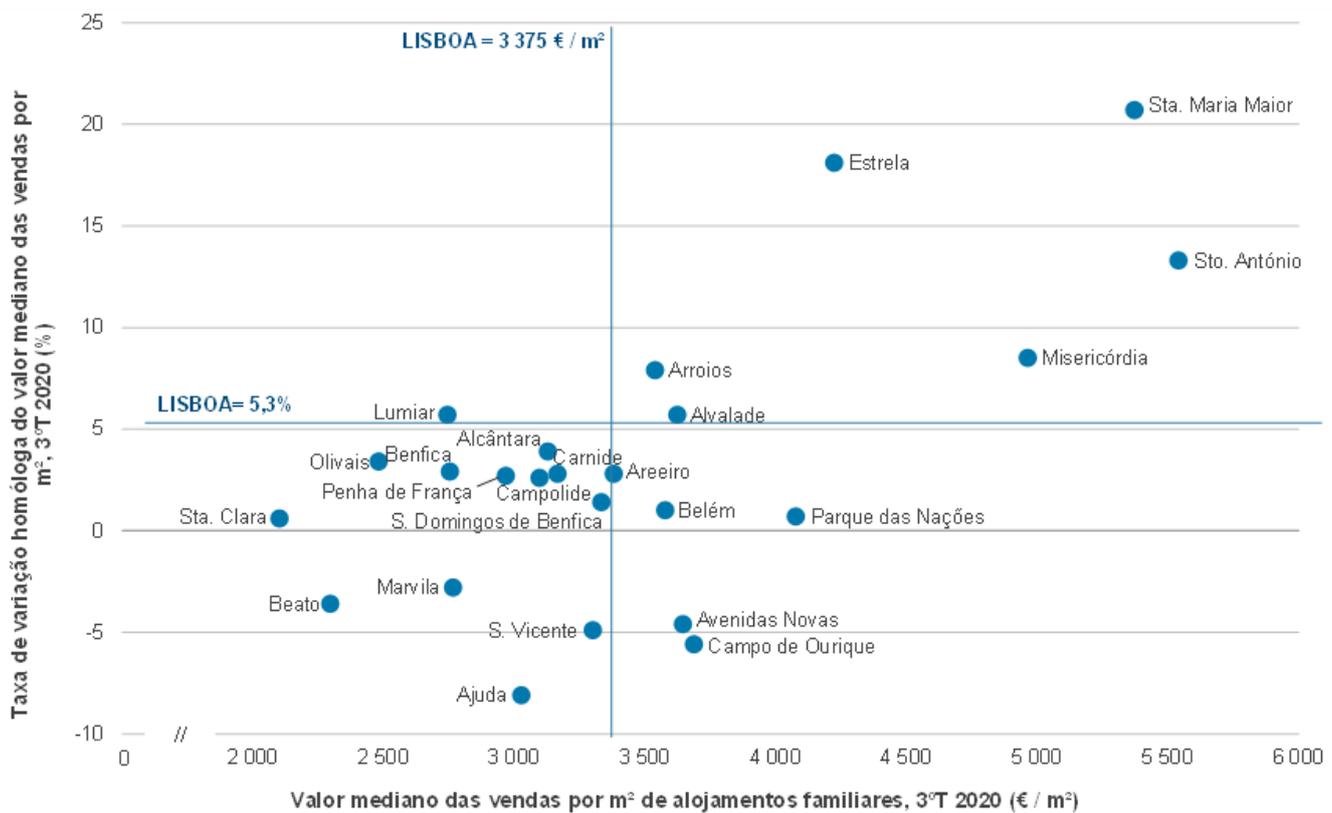
Fonte: INE, I.P., Housing price statistics at the local level.

### 2.2.3 Quarterly results, values per parish for cities with more than 200,000 inhabitants (Lisbon and Porto)

As can be seen in Figure 4, in the 3<sup>rd</sup> quarter of 2020, three of Lisbon's 24 parishes recorded median prices for the sale of accommodation in excess of €4,500/m<sup>2</sup>: Sto António (5540 €/m<sup>2</sup>) – which includes Av. da Liberdade and adjacent areas – Sta Maria Maior (5372 €/m<sup>2</sup>) – which includes the Castelo and Baixa/Chiado area – and Misericórdia (4963 €/m<sup>2</sup>) – which includes the Bairro Alto and Cais do Sodré area. The parishes Santa Maria Maior, Estrela, Sto António, Misericórdia, Arroios and Alvalade recorded a median price above the value of Lisbon city (3375 €/m<sup>2</sup>) and variation rates, compared to the homologous period, more expressive than that observed in the city (+5.3%).

The parishes of Sta Clara, Beato, Olivais, Benfica, Marvila, Penha de França, Ajuda, Campolide, Alcântara, Carnide, São Vicente and São Domingos de Benfica recorded, in the 3<sup>rd</sup> quarter of 2020, prices and variation rates lower than those of the city of Lisbon, highlighting this set the parishes of Ajuda (-8.1%), São Vicente (-4.9%), Beato (-3.6%) and Marvila (-2.8%) house prices compared to the homologous period. (See Figure 4 and 6)

As a result: *Only six of the 24 parishes of Lisbon with homologous contraction of house prices: Ajuda, Campo de Ourique, São Vicente, Avenidas Novas, Beato and Marvila.*



**Figure 4: Median value and homologous rate of median sales value per m<sup>2</sup>, Lisbon and parishes, 3<sup>o</sup>T 2020**

Fonte: INE, I.P., Housing price statistics at the local level.

In the city of Porto, in the 3<sup>rd</sup> quarter of 2020 (last 12 months), the Union of parishes of Aldoar, Foz do Douro and Nevogilde, the Union of parishes of Lordelo do Ouro and Massarelos and the Union of parishes of Cedofeita, Sto Ildefonso, Sé, Miragaia, São Nicolau and Vitória stood out, for presenting a median price (2787 €/m<sup>2</sup>, 2416 €/m<sup>2</sup> and 2326 €/m<sup>2</sup>, respectively) above the value of the city (2016 €/m<sup>2</sup>) and a year-on-year change rate (+15.5% and both +15.3%, respectively) higher than that observed in the city (+11.9%).

The Union of parishes of Aldoar, Foz do Douro and Nevogilde recorded the highest median price in the city. The parishes of Ramalde, Bonfim and Campanhã recorded a median price (1745 €/m<sup>2</sup>, 1972 €/m<sup>2</sup> and 1297 €/m<sup>2</sup>, respectively) and a homologous variation (+4.1%, +7.2% and +10.9%, respectively) lower than the values recorded in the city of Porto. The Paranhos parish recorded a lower median price (1847€/m<sup>2</sup>) and a rate of variation, compared to the same period (+17.9%), higher than that recorded in the city of Porto. In the period under analysis, and as in previous quarters, the Campanhã parish recorded the lowest median price (1297 €/m<sup>2</sup>) and the Paranhos parish stood out for presenting the highest rate of variation compared to the same period (+17.9%). (See Figure 5 and 6)

As a result: *The Union of parishes of Aldoar, Foz do Douro and Nevogilde recorded the highest median price (2787 €/m<sup>2</sup>) among the seven parishes of the city.*

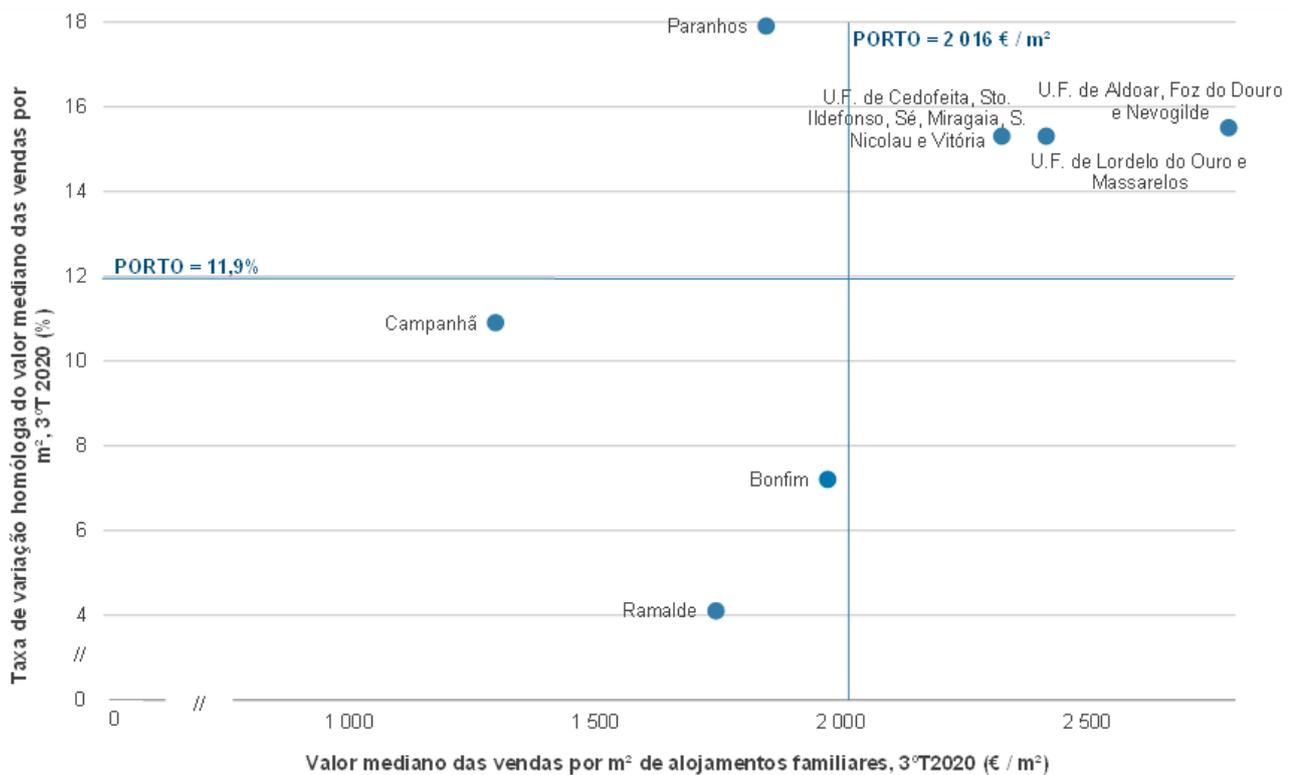


Figure 5: Median value and homologous rate of median sales value per m<sup>2</sup>, Porto and parishes, 3<sup>o</sup>T 2020

Fonte: INE, I.P., Housing price statistics at the local level.

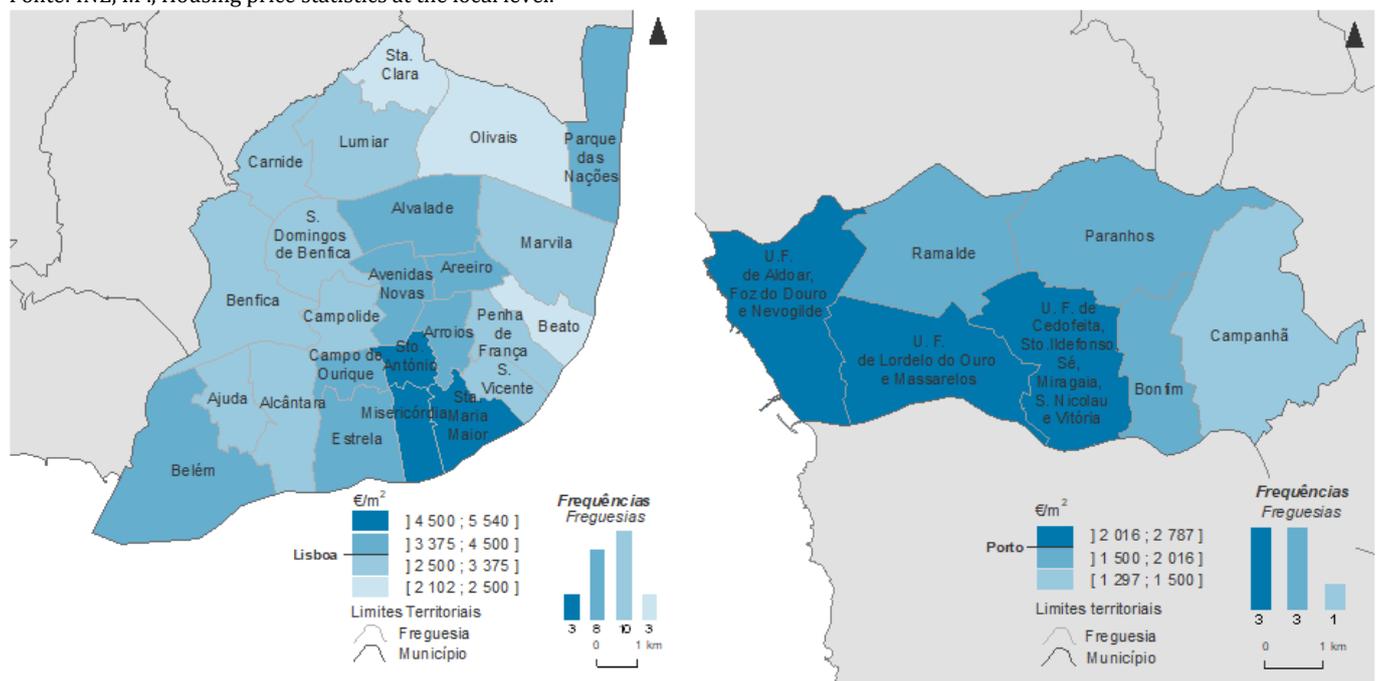


Figure 6: Median sales value per m<sup>2</sup>, Lisbon and parishes, Porto and parishes, 3<sup>o</sup>T 2020, geographical distribution

Fonte: INE, I.P., Housing price statistics at the local level.

### 3. CONCLUSIONS

Contrary to what it would be expected, the pandemic crisis that during 2020 led to a recession in economic activity on a global scale does not seem to have affected the housing market. Statistical data show the existence of increasing price inflation, even when compared to year-on-year values in 2019.

The idea of a city in continuous process of expansion, which expands beyond its limit, the *civitas augenses*, acquires a new dimension linked to the notion of a Real Estate market that expands over the cities and rural landscapes, establishing new logics of appropriation and organization of both urban and rural spaces which become part of its business portfolio.

The concept of urbanization simultaneously as a process of urban self-expansion and as a way of life, in the context of a new socio-spatial order appears to be the result of Real Estate activity and not so much of an urban planning based on technical bases or scientific theories.

The city as space-time creation and the urbanization as a way of life result both from man's ability to transform the environment that he inhabits, so the attributes of the built environment are key considerations, since the city where we will live in the future is already being modeled by the building forms of the present.

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## A SPATIAL QUANTILE REGRESSION ANALYSIS OF HOUSING PRICES IN GERMAN REGIONS

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### ABSTRACT

The aim of the paper is to identify and establish empirical facts on the determinants of real estate prices by analyzing spatial regional data. We provide empirical analysis on the panel data set of 401 German regions for the period 2004 – 2018 taking into account their relative geographical location and prices. The main contribution of our paper is the analysis of determinants and spatial effects in housing prices, taking into account whether regions belong to high-prices or low-prices cluster.

The panel dimension of the analysis allows to account for regional heterogeneity, whereas spatial regional dimension catches the interaction of close-located regions: how shocks in real estate price determinants in neighbouring regions affect the housing prices level and to what extent the shock in one region is expanded to other closely located regions. Finally, spatial quantile regression reveals the differences between the high-prices and low-prices regions. Taken together they provide a unique opportunity to analyze the fundamental factors affecting real estate prices from different perspectives.

First, we investigate whether real estate prices in German regions experience spatial correlation and whether this correlation is connected to the fundamental factors of the real estate prices. We find factors from the demand and supply side that affect housing prices. The prices may be influenced by socio-economic factors, such as the share of the population with higher education, purchasing power, the quality of human capital, which affect the level of development of the region's economy and in turn affects the real estate prices. Second, we perform spatial econometric analysis, applying SDM, SAR and SEM models, completing the estimation with the spatial quantile regression.

The results of the analysis suggest that the demand-side factors increase the housing prices in most cases, supply-side GRP per capita causes the decrease. At the same time, the magnitude of commuting flows may increase as well as decrease the prices depend on where the change is happening, inside the region or in neighbouring areas. Spatial allocation of regions plays an important role in real estate pricing: regions located close to regional centres benefit from it, which is easily accounted for by spatial correlation. We also find spatial effects for the determinants: a demand change in a region affects the price also in the neighbouring regions. From the spatial quantile regression analysis, we expect that regions with higher prices are more sensitive to infrastructural or policy changes, whereas low prices regions experience a more sluggish reaction. More than that, positive spatial dependence is higher between regions with high housing prices and lower for less attractive regions.

## A TERRITORIAL HOUSING COST OVERBURDEN INDEX: AN EXPLORATORY APPROACH FOR PORTUGAL

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### ABSTRACT

Housing needs have been increasing their analytical complexity since the concept tends to encompass multiple dimensions. The (human) rights to adequate housing should cover entitlements such as the legal security of tenure, availability of services, materials, and infrastructure or cultural adequacy. Simultaneously, the housing market has been assigned an increasingly important role: it is the device chosen to provide decent and adequate housing while public bodies assumed a low level of intervention.

The growth of housing market prices (purchase or rent) has been accompanied by territorial and socioeconomic transformations leading to a recognized emergence of overall housing provision imbalances. In this context, the measurement of housing affordability regained new importance. Despite the existence of official measures, that are used to support some housing policies, significant limitations can be found and need to be updated – see, for instance, the housing cost overburden of produced and used by Eurostat and by the National Statistics Institute.

A classical affordability approach combines measures of the housing cost (supported by the housing prices associated with them), the households income, and the adoption of a normative threshold (such as the 0,4) to classify housing provision as affordable or not. This straightforward measure does not reflect the diversity of needs that should be considered today on housing affordability analysis. Housing needs are complex and multiple dimensional phenomena that emerge at the local scale, but housing affordability is usually obtained through national inquiry to households with limited territorial detail at the sub-national level.

Based on the data provided by National Statistical Institute (INE), it is possible to estimate housing prices and household income at the local level. This work presents the methodology of this estimation process, grounded on the spatial econometrics framework, to obtain the housing cost overburden rate at the local scale (municipality and parish levels). Moreover, estimations of housing prices and household incomes will be combined with detailed census data on houses and families to provide exploratory guidance on the role of socioeconomic characteristics and general urban transformation phenomena as territorial explanations of the imbalances in housing provision for Portugal.

The results highlight the role of intense rural-urban transformations, shaping Portugal in the last decades, as an important source of the territorial housing provision imbalances as the population migrates for urban areas both on metropolitan regions (Lisboa and Porto) or the regional and local urban centers, increasing demand and pressing prices in that locations. Simultaneously, the quick shift of the demographic structure, where aging and population decrease spreads throughout the territory, required important housing readaptations or reconstructions to satisfy the needs of the new population structure (elderly). As markets and the housing market, in particular, tends to be more inefficient when ideal equilibrium conditions are far away, the territorial housing cost overburden index presented provides important insights on the multidimensionality of affordability and its connection with the new integrated concept of housing rights.

## **Regular Session: RS21.1 - Agriculture, fisheries and food security**

**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/85836987366>**

**Chair Roshini Jayaweera**

**IMPACT OF COVID-19 ON FOOD SECURITY IN SRI LANKA****Roshini Jayaweera, N.P Dammika Padmakanthi**University of Kelaniya, Sri Lanka, [roshinij@kln.ac.lk](mailto:roshinij@kln.ac.lk), [dammikap@kln.ac.lk](mailto:dammikap@kln.ac.lk)**ABSTRACT**

The global pandemic COVID-19 has created a massive range of adverse effects on many sectors including food security in many countries. COVID-19 leads it to a prolonged food crisis reflecting the importance of new methods to prevent the present and future food crisis. Therefore, this is a situation where we need to analyse our existing food system, identifying its drawbacks and suggest a solution to sustain and de-risking the system. Therefore, the major objective of this study is to analyse the impact of COVID-19 on household food security in Sri Lanka. This objective is achieved by analysing qualitative information using descriptive statistics where required. COVID-19 effect on Sri Lankan food security through two ways: supply and demand-side shocks. The supply-side shock will arise through international trade barriers, labour shortages, and the domestic market close down in the locked-down situation. The food supply chain is affected through lack of seeds, fertilizer, and agrochemicals etc. and it will affect food availability, one of the major pillars of food security, in the long run. Demand-side shocks are raised due to lower purchasing power since sudden income loss of informal sector workers, and panic buying. More importantly, food price hikes due to lack of supply may affect the demand side shocks. Impact on food affordability and availability may severe as consumers depend more on the food market than on producing their own food. Sri Lanka should meet the needs of the most vulnerable people and must keep the food supply flowing by prioritizing the health of the workers in the sector and their outputs. The main specific recommendations for meeting the needs of the most vulnerable people is the expansion of the existing social protection programs. It is important to ensure the continuity of the agricultural supply chain so that reduce inflation. Suggestions for keeping the food supply chains uninterrupted are facilitating farmers to market the food they produce, promoting e-commerce channels, keeping the food value chain alive by focusing on key logistics bottlenecks and health of the workers, addressing trade and tax policies to keep the global trade open, and managing the macroeconomic implications. As Sri Lanka battle the health and economic crises with massive public spending, it needs to control foodflations. Governments should assess the impact of their subsidies on the balance of payments and ensure they do not lead to deficits. And also, it must ensure adequate levels of foreign exchange reserves. In the case foodflation, the government should assess the fiscal policies.

**KEYWORDS**

COVID-19; Food Security; Sri Lanka; Vulnerability

**1. INTRODUCTION**

The global pandemic COVID-19 has created and will create a massive range of negative effects. The impact of COVID-19 on food security is significant among many as it is directly related to basic human needs. Further, this unexpected situation may adversely affect achieving the second sustainable development goal (SDG): end hunger, achieve food security and improved nutrition and promote sustainable agriculture.

According to the World Food Summit (1996), food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life. According to this definition, the concept of food security consists of four pillars: food availability, access, stability and utilization. Food availability refers to the availability of sufficient quantities of food of appropriate quality, supplied through domestic production or imports. Access by individuals to adequate resources for acquiring appropriate foods for a nutritious diet. The meaning of the third pillar is the utilization of food through adequate diet, clean water, sanitization and health care to reach a state of nutritional well-being where all physiological needs are met. Stability means access to adequate food at all time.

Senanayake and Premaratne (2014) identified four types of determinants of food security: determinants of the level of food acquirement, determinants of the level of food utilization, determinants of the ability to cope with shocks to acquirement and determinants of the ability to cope with shocks to utilization. Among these four types of food security determinants, the authors focus on the third type of food security determinant as it is related to the objectives of the current study. The outbreak of the COVID-19 severely affected Asian countries and Sri Lanka is no exception. Countries took many actions such as social distancing, travel restrictions, quarantine, and isolations of villages or lockdown the entire country. Among all of these preventive measures, locking down the country for a long period is critical as it affects all the economic activities of the country. Therefore, COVID-19 affects food security also in the affected countries in many ways. All four pillars of food security are vulnerable due to COVID-19, but access to food and availability of food may affect more compared to the other two pillars. In the short run, access to food may be negatively affected as consumers' income loss due to their job losses during the COVID-19 lockdown period. If food production is affected during this period, it may affect the long-run food security by creating a food deficit. COVID-19 may lead it to a prolonged food crisis

reflecting the importance of new methods to prevent the present and future food crisis. Therefore, this is a situation where we need to analyse our existing food system, identifying its drawbacks and suggest a solution to sustain and de-risking the system.

## 1.1 Research Problem

The impact of the COVID-19 on food security depends on the measures taken by different countries to control the viral spread and also on the economic situation of the country. Most countries are locked down as a responsive mechanism. It adversely affects the food security of all people in different ways. Sri Lanka also locked down on 22<sup>nd</sup> March 2020 as a preventive measure and step by lifting the curfew started only two months later on 11<sup>th</sup> May 2020. Therefore, the research problem of this study is 'what is the impact of COVID-19 on the short-run and long-run food security in Sri Lanka'?

## 1.2. Objectives

The major objective of this study is to analyse the impact of COVID-19 on household food security in Sri Lanka. This major objective will be achieved through the below sub-objectives.

1. Identify the current food security situation in Sri Lanka.
2. Understand the vulnerability of households to become food insecure.
3. Explain how COVID-19 affects food security in Sri Lanka
4. Suggest solutions to ensure the sustainability of future food security

## 2. LITERATURE REVIEW

Many researchers have analyzed the impact of COVID-19 on food security in different countries from a different perspective. Kansirime et al., (2021) have analyzed the impact of COVID-19 on household income and food security in Kenya and Uganda. Data were collected from 442 responders by conducting an online survey. The food insecurity experience scale was used to analyze the food insecurity and the Probit model was employed to estimate the impact of COVID-19 on sources of income. The results indicated that COVID-19 has a negative impact on food security especially consumption of nutritious foods. As well, COVID-19 has mostly affected income-poor people and those who depend on labour income. Farmers were less likely to affect food insecurity rather than those who rely on the market. The study revealed that National Social Security has less effect on income shock and food insecurity. They recommend ensuring an uninterrupted food supply chain, structural change in social security programs, and building strong financial institutions to support the recovery of the business.

Arndt et al., (2020) have analyzed the impact of lockdown policies for income distribution and food security in South Africa by giving special reference to the role of social protection programs in assuring food security using the input-output table that expands for Social Accounting Matrix to capture the income/ expenditure flows for all economic agents. The research found that labour with low education levels is strongly affected than labour with secondary and tertiary education and food security of those groups also badly affected by lockdown. Researchers indicated that the food security of low-income households are somewhat stable since the total income of the low-income households in South Africa mainly depends on government transfer and those transfers were continued during the lockdown period.

Mukiibi (2020) has explained the lockdown effect on people's ability to secure the food needs of the urban poor in Africa. This study emphasized the importance of developing rural small-scale producers and backyard gardens. As well, he stressed the importance of implementing the 'Slow Food Gardens in Africa' project to the resilience of food security.

Mottaleb et al., (2020) have investigated the COVID-19 induced lockdown effect on food security and welfare of daily wages of non-farm and farm sector in Bangladesh based on the 2016-2017 Household Income and Expenditure Survey in Bangladesh. According to the daily per capita food expenditure they estimated that the US \$ 1 per day per household should receive as the minimum compensation package to maintain minimum food security. They further calculated that a one-day complete lockdown generates US\$ 64.2 million economic losses according to the loss of wages of daily wage workers.

Wolfson and Leung (2020) have examined the early effects of COVID-19 on food security and COVID-19 related basic needs challenges of low-income adults in the US, one of the countries that massively affect by COVID-19. Data were collected from 1478 adults using the online survey method. They found that 36 per cent of low-income adults were food secure, 20 per cent were marginally food secure and 44 per cent were food insecure. They recommended implementing comprehensive policies to ensure food security if the pandemic continues.

Lal (2020) has mentioned that pandemic has caused food insecurity in urban centres because of disruption of the supply chain, restriction of import-export barriers, and food waste because of labour shortage. He emphasized the need for the adoption of a more resilient system, reduce food waste, and strengthen local food production by promoting home gardens and urban agriculture.

Erolehin and Gao (2020) have investigated the impact of macroeconomic fluctuations on food insecurity in 45 developing countries by grouping them according to income level. They attempt to explain this gap by considering the interaction between the food security status of people and the dynamic of COVID-19 cases, food trade, food inflation, and currency volatilities. Autoregressive distributed lag method, Yamamoto's causality test, and variance decomposition analysis were performed to analyzed COVID -19 effect on food insecurity. They found that the effect of COVID-19 is noticeable in upper-middle-income economies than in the least developed countries. In high-income, developing countries availability of sided food security risks (food track restrictions and currency depreciation) were more prevalent. This research has a

high contribution to the methodology development of health crisis effects on economic parameters of food availability and food security.

Zurayk (2020) has identified the different stress on food security systematically using the database Twitter account@food pandemic that has been tracking the impact of the pandemic on food security. This database especially focused on the Middle East, East Africa, and South. The impact of the pandemic on food security has been analyzed under four dimensions such as availability, accessibility, utilization, and stability. The results have pointed out that the effect of the pandemic on all countries and all citizens is not equal.

Hossain (2020) has described the effect of the COVID-19 pandemic on the agri-food sector in Asian Productivity Organization (APO) members. Further, this study has outlined the responses and policies imposed by each member country to prevent negative impacts on food security. To analyze those objectives publicly available information was synthesized and insights from 19 individuals working in agriculture or agri-food related areas in the public or private sector or academia in APO member countries. It concluded that medium and long-term food security challenges may vary among the APO member countries. Implementation of key policies regarding agricultural input such as fertilizer, safe and quality seeds to meet seasonal crop are essential.

Ruzczyk et al, (2020) have investigated the impact of the lockdown effect on food security and related coping mechanism in two cities in Bangladesh from March to May 2020. Data were collected through telephone-based semi-structural interviews with households and key persons in the government, non-government, and community. This study has pointed out that lockdown caused to lose or low income and quality and quantity of food consumed. Different coping mechanisms such as curtaining consumption, relay on inexpensive food, increase consumption expenditure, get a loan are used to get rid of food insecurity by households. Further, this study has indicated that people who have guaranteed income and adequate saving did not affect significantly.

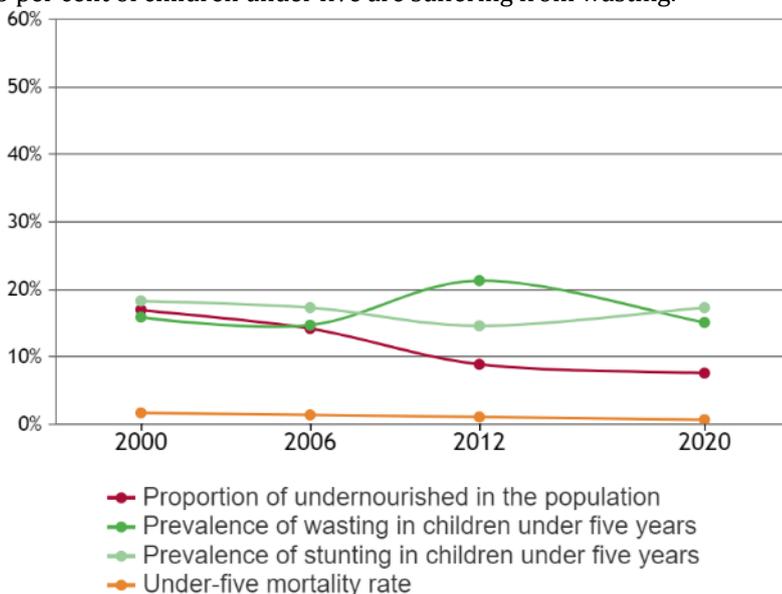
Marambe and Silva (2020) have analyzed the effect of the government policies implemented in the COVID-19 induced locked down period in Sri Lanka from 11<sup>th</sup> March to 11<sup>th</sup> May 2020. The policies were reviewed under three categories such as food availability, accessibility, and affordability that are the main three-part of food security.

Although many researchers have analyzed the impact of the COVID-19 effect on food security in various countries it is rarely found a study that focuses on food security in Sri Lanka. Hence, this study aims to fill this gap and find out the effect of COVID-19 on food security in Sri Lanka.

### 3. FOOD SECURITY SITUATION IN SRI LANKA

#### Food Security Situation in Sri Lanka

Food security is a concern in Sri Lanka. Sri Lanka was ranked the 64<sup>th</sup> place according to the global hunger index in 2020 with a score of 16.3 which indicates a moderate level of hunger (<https://rg/sri-www.globalhungerindex.lanka.html>). At the macro level, food security in Sri Lanka is high which records only 10.3 per cent of households were food insecure (Department of Census and Statistics (DCS, 2014). However, at the micro-level, food insecurity is a critical issue. In 2014, around 9.72 per cent of households had no food for consumption while around 4.2% of households went to sleep without having dinner (DCS, 2014). Moreover, there is a significant percentage of households who eat low-quality food (25.9 per cent) or eat inadequately (35.8 per cent) (DCS, 2014). Therefore, there are health issues such as malnutrition and stunting as a result of poor food security. As can be seen in Figure 1, a significant percentage of the Sri Lankan population is undernourished. Further, around 15 per cent of the children under five are suffering from stunting, while around another 15 per cent of children under five are suffering from wasting.



**Figure 1: Trends for Indicators - 2020**

Source: <https://www.globalhungerindex.org/sri-lanka.html>

This food security situation may be worsened by the COVID-19. Even though the food security situation is good in Sri Lanka, a large number of people may be vulnerable to food insecurity due to COVID-19 via less affordability and availability of food. This vulnerability is high due to several reasons. First, a significant percentage of households are not producing their own food. For example, only 61.5 per cent is doing home gardening and it goes down to 9 per cent in urban areas (DCS, 2014). Given this situation, access to food will be at risk when the food markets are closed down during the lockdown period. Second, although Sri Lanka is not highly dependent on imported food, some specific food items are imported such as wheat flour, potatoes, big onion, vegetable oil and sugar. The price of those imported foods may increase as shipments slow and their currencies plunge against the dollar. Thus, Sri Lankans' food security will be negatively affected during this global pandemic situation if the international food supply chain is disrupted. The third factor is the high food ratio. The food ratio was 34.8 per cent in 2016 and it is significantly higher in the estate sector (48.5 per cent) and among the first income decile (62 per cent) (DCS, 2016). Thus, a sudden income loss as a result of the lockdown situation will worsen food security especially in the estate sector and people in lower-income decile. Fourth is inflation. Based on the data provided by the Central Bank of Sri Lanka for the week ended 03<sup>rd</sup> April 2020, the Headline and Core inflation of the Colombo Consumer Price Index (CCPI) showed surprisingly a decline in March 2020. Based on higher food prices owing to tighter supply conditions and supply-chain disruptions is expected to drive inflation. However, weak demand and lower indirect taxes, are likely to counter inflation pressure.

## 4. METHODOLOGY

The impact of COVID-19 on household food security in Sri Lanka was analysed qualitatively using descriptive statistics where required. Some of the data sources are Household Income and Expenditure Survey (2016/17), labour force survey (2018, 2020), Central Bank annual reports etc. Our goal was to explore various scenarios associated with the current crisis and to then map vulnerabilities at the domestic level.

## 5. RESULTS AND DISCUSSION

### 5.1 Effect of Covid-19 on food security

COVID-19 affects food security at both the global and the domestic level. The impacts of COVID-19 effect on Sri Lankan food security through two ways: supply shocks and demand shocks. Supply-side shocks are arisen via the affected food supply chain due to international trade barriers, labour shortages in food production, processing and marketing in the locked-down situation. Further, food production will be affected by the lack of inputs such as seeds, fertilizer, and agrochemicals etc. due to trade barriers. These effects will lead to a food crisis in the future. These supply-side shocks will affect one of the most important pillars of food security. That is the availability of food. Availability of food in the short run as well as in the long run will be affected by the COVID-19. Demand-side shocks can be identified as the impact on accessibility. Demand-side shocks are related to the affordability of food due to income losses, the market closes down, long queues in the market which will create an extra risk of spreading the disease, food inflation etc. The next sections will discuss both of these supply-side and demand-side impact of COVID-19 in detail.

#### 5.1.1 Impact of COVID-19 on Food Availability

This section will discuss the impact of COVID-19 on food production, food importation and food distribution from the supply side angle. COVID-19 would affect the whole food supply chain from the farm to the consumer, including food production, processing, distribution, and demand. Further, due to the international food supply chain is also affected by COVID-19, food imports to Sri Lanka will also be affected by this pandemic.

##### Food Production and Distribution

In Sri Lanka, even though the country was locked down due to COVID-19, food supply was sufficient as the government adopted timely measures to minimize the impact on agriculture. Amid rising food security concerns, the government motivated people to start their own home gardening to increase food self-sufficiency. Under the programme named 'Saubagya' (prosperity) implemented by the Department of Agriculture (DOA) provided 2 million seed packets to households with the objective of promoting a million home gardens. Further, considering the importance of labour as the major input in the agriculture sector, the government exempted people's movement for agricultural activities from quarantine curfew. In addition to these measures, the Sri Lankan government took steps to assure food security by mitigating the financial constraints in the agriculture sector. A new comprehensive Rural Loan Scheme was launched to grow some food items such as paddy, chilli, cowpea, green gram, potato and sweet potato, etc.

However, the production of food was up to a satisfactory level, increased levels of food loss and wastage due to market closure, blockages to transport routes and declined demand were visible during the pandemic lockdown period in Sri Lanka. Some of the regional wholesale vegetables markets were closed to control the spread of the virus, resulting in heavy losses to the farmers. For example, short term close down of Dambulla economic centre was a reason for wasting food. The close down of the Manning Market was also a reason for food wastage. According to the President of the All Island Poultry Association in Sri Lanka, around 5000 broiler farmers and 3000 layer farmers in the country have been significantly affected during the lockdown period. Moreover, 12000 MT of poultry meat was stuck in cold storages while another 8000MT were remaining to be harvested. The price of the chicken eggs fell drastically. However, the government arranged alternative actions to reduce this food wastage and assure the availability of food in areas where agricultural activities are not the major economic activity. For example, Sri Lanka Railway deployed special trains to transport

vegetables, fruits, grains, rice and other essential commodities. Moreover, alternative arrangements were done to procure vegetables and fruits owing to the closure of the Manning market. The government's approval of the transport of vegetables during curfew hours was helpful to minimize such losses during the latter part of the lockdown. Rice being the staple diet of the country, rice mills were declared as essential service during this lockdown period.

Another impact of COVID-19 on food production is the issues in input supply. Some farm sectors are more dependent on (seasonal) labour than others. Paddy, fruits and vegetables are more labour-intensive. Limits on the mobility of people have reduced the availability of seasonal workers for planting and harvesting in the agriculture sector especially in fruits and vegetable farming. Though the lockdown exempted farming operations and food supply chains from the beginning, implementation problems caused severe labour shortages and price collapse in wholesale markets. Given these circumstances, the government initiated a programme to procure fruits and vegetables directly from the farmers to ease the problem of limited wholesale markets (<https://www.netherlandsandyou.nl/latest-news/news/2020/06/02/impact-of-covid19-on-food-supply-chains-in-sri-lanka>).

In addition to labour, other important inputs in the agriculture sector are seed, pesticides, fertilizers, and energy. Seeds supply was not a problem in Sri Lanka at the moment. However, the concern is about the fertilizer. Even though the global availability of fertilizer is not a problem, the transport of fertilizer will be problematic. According to the newspapers and electronic media report these days, farmers in several districts complain that they have been adversely affected as a result of not receiving fertilizer and paddy seeds. The major issue related to the distribution of fertilizer is twofold: not receiving on time and sufficiently. According to the chairman of the Ceylon Fertilizer Company, Sri Lanka has sufficient storage of fertilizer for the Yala season in 2021. However, the problem will be raised in the next season. Being a country that uses chemical fertilizer much, reduction of fertilizer usage can be seen as a good thing resulted from COVID-19. However, there should be a plan and sufficient quantity of organic fertilizer.

Moreover, even though there is no data, the government restrictions on imports could trigger a shortage of veterinary medicines and other inputs leading to problems in livestock production.

Even though current food production was not much affected due to COVID-19, a significant quantity of food was wasted due to issues related to transportation, marketing and food delivery related logistics. And also due to the problems in supplying inputs for agriculture such as fertilizer, future food production will be problematic.

#### Impact of COVID-19 on food imports in Sri Lanka

Amidst the foreign exchange crisis, the Sri Lankan government-imposed restrictions on 156 categories of products including essential food items such as rice, grains, pasta, bakery products and liquor. The government increased the levy on imported fruits and edible nuts in April 2020. Imports of apples, oranges, grapes, pears, cherries, plums, lemon, grapefruit, peaches and some dried fruits were affected by this rule. The Department of Animal Production and Health imposed restrictions on the import of live animals, animal products and by-products as a mean of overcoming the spread of the diseases. Restrictions on food imports have mainly been imposed due to the foreign exchange crisis during this period rather than supply shocks. Further, being a trade-dependent country, effects of destruction in the global food supply chains are also inevitable. To protect the domestic customer and assure food security in the country, a presidential task force was appointed to coordinate with relevant authorities to facilitate the import of essential food items and export of some food items such as tea.

Not only the food import was affected by the COVID-19, but also the export of the food items also was affected by this pandemic. The processed food industry in Sri Lanka is one of the emerging and lucrative industries in terms of production, consumption, export and growth prospects. Processed food sector consists of Dehydrated Fruits & Vegetables, Processed Gherkins & Cucumber, Herbal Tea, Frozen meat, Sauces and Tomato ketchup and prepared foods such as Ambul Thial, Katta Sambol, and Dried Sprats etc. The industry counts more than 110 manufacturing and marketing companies. In 2016 the industry's export value was close to US\$400 million, representing about 4% of total goods exports. About 40% of micro, small and medium enterprises nationwide are involved in the sector and EDB has estimated that the sector employs more than 2 million. (National Export Strategy of Sri Lanka 2018-2022 Processed Food & Beverages Strategy) With the changes in lifestyles, more and more supermarket appearing new opportunities have emerged for MSMEs to supply value-added agricultural products and processed food items. In the recent past, a considerable number of entrepreneurs have stepped into this subsector with innovative ideas. They have been guided by NEDA and IDB and many entrepreneurs have received assistance and are being supported through various projects of the Government, Ministry and NGOs which has shown positive results. The outbreak of COVID virus is a big blow that they had to face at this development stage (Gunawardena, 2020).

Also, the export of commodities such as tea, coconut, rubber, spices and food and beverages were heavily impacted due to the pandemic. Total exports were down 26 per cent in the first half of 2020 in comparison to last year. However, some sectors are starting to see some growth after the lockdown ended. For example, in the month of June, the export of tea, coconut-based products, spices and essential oils, fish and fisheries products were up (Economy Next, 2020).

#### **5.1.2 Impact of COVID-19 on Access to Food**

The current global health problem creates many economic problems such as income inequality, unemployment, economic frustration, food insecurity, and uncertainty. The effect of pandemic badly affects the Sri Lankan economy since many industries closed and other industries also do not operate in the usual manner. As well, many people lost their jobs or reduce their working days during this period. Because of this situation, people's income was reduced and this badly affects their consumption especially for food security. So the demand-side factors that affect food security can be

explained according to several factors such that reduction of income, food shortage, and effect of social protection and relief package.

## Reduction of Income

During the COVID-19 pandemic situation permeant, employees get their salary without any delay or any reduction. However, in some cases, temporary staff and daily wage workers in the public sector and the private sector lost their income or reduce their income. Informal sector workers are the highly affected group of workers. In Sri Lanka, most people are working in the informal sector. The informal sector can be defined as persons in employment who are not national labour legislation and income tax or entitled to social protection and employment benefits (DCS, 2020). Informal employment can exist in both the informal and formal sectors of the economy. In Sri Lanka, 57.4 per cent of people are employed in the informal sector (DCS, 2020). When disaggregate this according to the economic sector 89 per cent of people work in the agriculture sector and 46.7 per cent in the non-agriculture sector (DCS, 2020). Because of the lockdown situation, impose of curfew, and isolation, most people in the informal sector lost their job or reduce their income. Although it is allowed to continue agriculture activities, construction sector works according to the COVID-19 regulation because of pandemic situation people do not like to go for work or owners of agriculture sector and construction sector do not like to offer work for their workers. Because of that many people suffer from the lack of income. The following Table shows the distribution of informal sector employment by the main occupation.

**Table 1: Distribution of Informal Sector Employment by Main Occupation**

Occupation	Informal sector %
Chief executive, Senior official, Legislators	6.8
Administrative and commercial managers	15.7
Production and specialize services managers	44.4
Hospitality shop and related service managers	69.3
Professionals	13.8
Technical and associate professionals	23.0
Clerks and clerical support workers	8.2
Service and sales workers	41.2
Skilled agricultural forestry and fishery workers	97.2
Craft and related trade workers	72.6
Plant and machine operators and assemblers	59.0
Elementary occupation	62.6
Armed force occupations and undefined occupation	16.6

Source: DCS, 2020.

When considering the distribution of employment by the main occupation, most people work in the informal sector. Especially, most employed people in sectors such that skilled agricultural forestry and fishery, hospitality shop and related service, craft and related trade, service and sales are included for the informal sector. Since travel restrictions are imposed in most countries the workers in hospitality industries are lost their jobs since the tourism industry almost closed. Not only that many other related occupations related to the tourism industry such as craft and related trade, service that provide for hospitality industries and the person who works in executive-level are also lost their occupation. Daily wage workers also face difficulties because they lost their livelihood. As well, some companies reduce their working hours since those companies also have a negative effect. In some cases, some companies take out their labour. All these reasons affected for reduction of income of the informal sector workers.

Self-employed people are the other major category of people that suffer from negative economic impact from the COVID-19 pandemic. Self-employed people can be categorized as employers, own-account workers, and contributing family workers (DCS, 2020). The following Table shows the distribution of informal sector employment by employment status.

**Table 2: Distribution of Informal Sector Employment by the Employment States**

State of Employment	Informal sector
Employee	34.9
Employer	2.3
Own account workers	51.7
Contributing family workers	11.6

Source: DCS, 2020.

According to information of the above Table most of employee and self-employed are work in the informal sector. That means they are highly affected by the pandemic situation. In some cases, some self-employed industries have to be closed because of marketing problems and lack of input. Backward and forward industries also face negative economic effects because of the closure of the aforementioned industries.

A study that focuses on the effect of the COVID-19 pandemic has pointed out that approximately 60 per cent of households have lost entire last month's income and/or one-time income lost (University of Ruhuna, 2020). The negative income effect of the households causes many problems including food insecurity.

## Shortage of food

The shortage of food is one of the main factors that caused food insecurity during the pandemic. Panic buying reasoned for food insecurity during the COVID-19 pandemic. Because of the lockdown situation and fear of lack of food, people rush to collect food and this leads to a shortage of food and increases in foods price. This badly affected daily wages and informal sector workers who lost their employment or reduce their income. Those groups of people don't have enough savings to collect food.

Further, most economic centres that distribute fruits and vegetables and fish markets were closed. Hence, on the one hand, those people lost their income since they could not sales their production. On the other side wastage of food is high and people suffer from lack of food. Those factors negatively affected food security especially people who couldn't get nutritious food.

### Social Protection and Government Relief Package

The COVID-19 pandemic causes for loss of income of most households especially daily wage workers, informal sector workers, and temporary and contract basis employees in the private sector. Therefore, the government of Sri Lanka introduce a relief package and introduce extra social protection benefits while continue exist social protection programs to increase the purchasing power of mostly affected people and as a relief for people who affected their income-earning activities.

On 23<sup>rd</sup> March 2021, the government adviced to Central Bank Governor, and other relevant authorities including heads of all banks and leasing companies to offer these relief packages to the people. The relief package and responsible authorities as follows:

### Treasury/Government/Inland Revenue

- A grace period for the payment of income tax and VAT, driving license renewal fee, water bills, and assessment tax less than LKR 15,000, be extended until 30<sup>th</sup> April 2020.
- Graduates selected for the training at divisional secretariats are offered LKR 20,000 per month.
- The benefits of Agrahara insurance scheme are doubled for the people engaged in COVID-19 prevention activities.
- Lanka Sathosa and cooperative stores were exempted from VAT.
- Bank of Ceylon has opened a special account to raise the fund for health care activities. Those who contribute to this fund granted Tax exemption and relief of foreign exchange control restrictions.
- The Government of Sri Lanka donated USD 05 million to the SAARC COVID-19 Emergency Fund.
- LKR 5000 offer for two months for financially destitute households.

### Samurdhi Authority

- The Samurdhi Authority issues title certificates to Samurdhi and low-income families for issuing nutritious food items. Under this benefit rice, dhal and salt are provided on a weekly basis.
- Interest-free advanced of LKR 10,000 is offered for Samurdhi beneficiaries and Samurdhi cardholders through all Samurdhi Banks

### Central Bank and other banks

- Monthly credit card bills less than LKR 50,000, are extended until 30th April 2020.
- Leasing loan repayment of three-wheeler owners is postponed for six months period.
- Loans repayment from the salaries of government employees and private sector employees is postponed until 30th May 2020.
- Personal loan repayment of less than one million borrowed from banks and finance companies is postponed for three months.
- Debt moratorium will be offered to the tourism, apparel, and SMEs for six months period.
- A maximum of 15 per cent interest rate has been stipulated for credit card domestic transactions up to LKR 50,000 and a 50 per cent reduction in minimum monthly charges.

Source: University of Ruhuna, 2020

All these reliefs benefited all people to get rid of some financial problems and manage the day-to-day activities in a difficult period. Especially because these financial relief facilities cause enhances the food security of the households.

## **6. CONCLUSION AND WAY FORWARD**

The main objective of this paper is to analyse the effects of COVID-19 on food security in Sri Lanka using a descriptive method. The results of the study revealed that food security in Sri Lanka is moderate now and it will become worse if necessary timely actions are not implemented. Even though the food production was not affected, a significant quantity of food wasted due to marketing, transportation and other logistics. Future food security is also challenged due to the lack of input supply. Even though, food was available on the doorsteps; affordability was lower due to the reduction in the income of consumers. Income loss was mainly caused by the unemployment of the informal sector workers. Additionally, a short term food-deficit could be seen due to panic buying. To avoid all these issues related to food security in the country, the Sri Lankan government has taken several steps. Due to the effect of COVID-19, Sri Lankan households have started growing their own food at their home gardens. And the food utilization habit also changed. More homemade food is consumed and demand for outside food is reduced. In summary, availability, affordability and utilization of food—three main pillars of food security—is affected by the COVID-19.

Macroeconomic policies such as monetary policy, trade policy, fiscal policy and social security program should be changed according to the needs of the current pandemic situation to protect the food security of all consumers and the agriculture sector. Ensure the continuous supply chain, enhance the productivity of smallholders, maintain low foodflation, continues check on the health of agriculture sector employers are the other recommended policies that can

be implemented to ensure food security in a pandemic situation like COVID-19. Sri Lanka should meet the needs of the most vulnerable people and must keep the food supply flowing by prioritizing the health of the workers in the sector and their outputs. The main specific recommendations for meeting the needs of the most vulnerable people is the expansion of the existing social protection programs to assist those who didn't previously have coverage and who are extremely vulnerable due to COVID-19. It is important to ensure the continuity of the agricultural supply chain so that reduce inflation. Military mobilisation and available administrative structure can be an effective tool to distribute subsidies without spreading the virus.

Suggestions for keeping the food supply chains uninterrupted are giving smallholder farmers support to both enhance their productivity and market the food they produce, also through e-commerce channels, keeping the food value chain alive by focusing on key logistics bottlenecks, addressing trade and tax policies to keep the global trade open, and managing the macroeconomic ramifications. As Sri Lanka battle the health and economic crises with aggressive public spending, it needs to hold down inflations, especially to reduce the risk of inflating food prices. Governments should assess the impact of their relief and stimulus packages on the balance of payments and ensure they do not run deficits. And also, it must ensure adequate levels of foreign exchange reserves. In case food prices jump, they should assess the fiscal measures carefully when responding.

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**ROLE OF AGRICULTURE ON ENSURING FOOD SECURITY IN SRI LANKA****Moksha Samarakoon<sup>1</sup>, Roshini Jayaweera<sup>2</sup>, M.M.Gunatilake<sup>3</sup>**<sup>1</sup>MPhil Candidate, University of Kelaniya, Sri Lanka, [harinisamarakoon95@gmail.com](mailto:harinisamarakoon95@gmail.com); <sup>2</sup>Senior Lecturer, University of Kelaniya, Sri Lanka, [roshinij@kln.ac.lk](mailto:roshinij@kln.ac.lk); <sup>3</sup> Professor, University of Kelaniya, Sri Lanka, [gunatilake@kln.ac.lk](mailto:gunatilake@kln.ac.lk)**ABSTRACT**

Ending hunger and food security is a key challenge faced by today's world. Agriculture sector plays a major role to ensure food security of a country. Sustainable Development Goal 2 is about ending hunger, enhancing food and nutrition security and promoting sustainable agriculture. Country's agriculture and food security is strongly linked together. Examination of this link in case of Sri Lanka is important as both agriculture and food security are concerned. In one hand, productivity in the agriculture sector is decreasing and therefore the employment in this sector is also decreasing over time. On the other hand, although at the macro level Sri Lanka is food secured, image at the micro level is not good. Population growth, lack of economic and physical access to food, chronic poverty, climate changes and natural disasters, low labour in agriculture sector, lack of using technology in agriculture production, lack of infrastructure facilities, not having a proper marketing strategy, frequent pest attacks on crops, adversely affects the food security in Sri Lanka. Moreover, high dependency on import of essential food items also leads Sri Lanka into food insecurity. Severity of this dependence of imports was renowned during the Covid-19 pandemic situation. Improving agriculture is the key to combat food insecurity of the country. Increased agriculture productivity will also increase the food availability which is one of the four pillars of food security. Therefore, the objective of this research is to analyse the role of agriculture in ensuring long term food security in Sri Lanka. The research is mainly based on secondary data. Promoting investments in agriculture sector that increases food availability will have positive impacts on food security in Sri Lanka. Moreover, substantial investments in rural infrastructure facilities, new and modern technology, research and development based on agriculture productivity, using proper organized marketing strategies will contribute to the development of efficient methods of crop management and productive means of food production. National level policy on using harmless pesticides and pest control methods are also essential to secure agriculture products which will enhance food security. Improving urban agriculture, home gardening, and kitchen garden will also help to secure food security in urban areas especially during pandemics. A climate smart agriculture system is also very important to Sri Lanka as it faces frequent climate changes.

**KEYWORDS**

Agriculture, Agriculture Productivity, Food Security, Sustainable Development Goals

**1. INTRODUCTION**

Sri Lanka has been a rich agricultural country since history and it dates back more than 2500 years. The main occupation of the Sri Lankan from the ancient times was agriculture. The early agriculture were settled in the river valleys in northern and southern eastern plains and the main crop was paddy. Paddy cultivation was not only just an economic activity but also a life that shaped the society culture, religion and the economy.

Agriculture in Sri Lanka is not just composed with plantation and vegetation. There are 16 components in agriculture sector namely, growing cereals, rice, vegetables, sugar cane and tobacco, fruits, oleaginous products (coconut, king coconut, oil palm), tea, other beverage crops (coffee, cocoa), pharmaceutical crops and spices, rubber, other perennial crops, animal production, plant propagation and support activities to agriculture, forestry and logging, marine fishing and marine agriculture and fresh water fishing and fresh water agriculture (Central Bank of Sri Lanka, 2016).

Agriculture is the most important sector of the Sri Lanka which makes a significant contribution to the national economy, employment and food security. Agriculture is also the main livelihood of the majority in the rural sector and plays a key role in alleviating rural poverty of the country. A survey conducted by Sri Lanka's statistics office in 2016/2017 has found that 2.1 million households or 40% of the total was engaged in agricultural sector. (<https://economynext.com/only-1-7-pct-of-sri-lankas-farming-population-has-formal-training-survey-35078/>). Under Sustainable Developments Goals in Sri Lanka, goal no 2 is to end hunger, achieve food security and improved and promote sustainable agriculture (<http://www.statistics.gov.lk/sdg/index.php/sdg/target/2>).

Major changes to agriculture sector occurred during the colonial period starting from Portuguese, Dutch and British. During these periods different plantation crops such as tea, rubber, coffee, cashew, etc. were introduced. Before the colonial period, people in Sri Lanka were involved with cultivation of paddy and other crops that can be used for domestic consumption (Jayasinghe-Mudalige, n.d.). After gaining independence agriculture production accounted for over 30% of the Gross Domestic Product. At that time industrial activity was in its infancy and was largely confined to the processing of agricultural commodities for exports. With the independence Sri Lanka gave a good example for dual economy. Sri Lanka's resource endowment led the country to specialize in agriculture and emerged as an agriculture economy by the

end of the colonial period. Sri Lanka's agriculture sector consisted of two distinct sectors namely, highly organized plantation sector producing for exports and a peasant sector of relatively low productivity, depending on small scale cultivation of paddy

([https://www.cbsl.gov.lk/sites/default/files/cbslweb\\_documents/publications/otherpub/40th\\_anniversary\\_chapter\\_1.pdf](https://www.cbsl.gov.lk/sites/default/files/cbslweb_documents/publications/otherpub/40th_anniversary_chapter_1.pdf)). In 1948 there were more emphasis on cultivation of crops. First Prime Minister of Ceylon, late Mr. D.S. Senanayake and other leaders took actions to promote paddy cultivation and other food crops in Sri Lanka. Large extents of land were cleared and irrigation schemes such as Galoya were initiated to increase the food production of the country. ([https://en.wikipedia.org/wiki/Agriculture\\_in\\_Sri\\_Lanka#cite\\_note-:0-4](https://en.wikipedia.org/wiki/Agriculture_in_Sri_Lanka#cite_note-:0-4)).

At the present time, agriculture, including fisheries is a major contributor to economic growth and it is the only source that provides adequate food to prevent hunger and starvation. Sri Lanka agriculture sector mainly comprises a food crop sector and a plantation (tea, rubber and coconut). The food crop sector is mainly consisting of small-scale farmers growing rice, vegetables, fruits and other field crops. These are mainly for domestic consumption. Tea, rubber and coconut are the main export focused products in the country (Oxford Business Group, 2018). Sri Lanka also imports several essential food products including wheat, lentils, sugar, milk and milk products and fruits (International Trade Administration, 2019).

In present, Sri Lanka's agriculture sector contributes about 7% to the Gross Domestic Product (GDP). Even though the contribution of agriculture sector to the GDP declined substantially during the past three decades (from 30% in 1970 to 7.3% in 2020) it is the most important source of employment for the majority of the Sri Lankan labour force. Approximately 25.5% of the total employed population are engaged in agriculture sector including forestry and fishery. Especially, most of the rural population are employed in agriculture sector. Most importantly cultivating paddy is the main economic activity for the majority of rural people (Thanigaseelan, 2021).

Even though the main economic sector of Sri Lanka is agriculture, the United Nations Food and Agriculture Organization (UNFAO) estimates that 4.7 million people of 21 million population of Sri Lanka do not have sufficient food to sustain a healthy life (Institute of Policy Studies, 2017). This means that Sri Lanka is going towards food insecurity.

"Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food that meets their dietary needs and food preferences for an active and healthy life" (World Food Summit, 1996). From this world famous definition, four main dimensions of food security can be identified as physical availability of food, economic and physical access to food, food utilization and stability of the other three dimensions over time (<http://www.fao.org/3/al936e/al936e.pdf>).

Food security in Sri Lanka is mainly rely on food availability, domestic food production, food imports and access to food. Food availability of Sri Lanka is primarily dependent on local production and the import of food crops, livestock and fish products. Sri Lanka is nearly self-sufficient in rice. Local production of the main supplementary food items such as vegetables and green leaves, pulses, root crops, spices and fruits exceed 70% of total availability (South Asia Policy and Research Institute, Institute of Policy Studies, Medical Research Institute, Hector Kobbekaduwa Agrarian Research and Training Institute, Department of Census and Statistics, 2017).

According to Household Food Security Survey (2014), food security can be defined as the ability to have sufficient, safe and nutritious foods to ensure an efficient and healthy life of all people at all time.

National Nutrient and Micro Nutrient Survey in 2012 has identified that the lack food insecurity in Sri Lanka has led to development and growth issues measured in terms of stunting, wasting and weight which are known as the key indicators of a country's nutritional status. Moreover Sri Lanka suffers from high levels of stunting (17.3%) and wasting (15.1%) among children less than 5 years. (Global Hunger Index, 2020).

Sri Lanka as a country, has achieved a notable progress in several areas such as education, reduction in child birth rate and decreasing poverty levels. Though, the food insecurity of the country still remains a constant problem. Sri Lanka ranked poorly on the Global Hunger Index and Global Food Security Index which are known as the main indicators of food security in any country. According to the 2020 Global Hunger Index, Sri Lanka ranked 64<sup>th</sup> among 107 countries (<https://www.globalhungerindex.org/sri-lanka.html>), and according to the Global Food Security Index, Sri Lanka ranked 75<sup>th</sup> out of 113 countries in the world (<https://foodsecurityindex.eiu.com/index>).

Achieving food security has become a serious problem mainly due to less agriculture productivity, population growth, natural disaster and climate changes, higher food prices, poverty (Pawlak & Kolodziejczak, 2020). Another significant reason for food insecurity in Sri Lanka is climate change. This can result all aspects of food security including food access, utilization and price stability. These climatic changes severely threaten agricultural production and food security of the country. Steadily increasing temperatures and increased intensity and frequency of extreme weather events such as irregular rainfalls, tropical storms, floods and droughts negatively affect on Sri Lanka's agriculture. As an example, in 2017 Sri Lanka experienced the worst drought faced in 40 years in which the main harvest (known as Maha) was reduced by more than half of the secondary harvest (known as Yala) was also further impacted. Drought period that already started in 2016 was negatively affected the food intake, especially for the poorest families in the country (European Commission, 2018).

Increasing agriculture output is the most significant way to accommodate the growing population. The increase in the agriculture output is expected to come from producing more on existing farmland, and new farmlands will be also needed. Boosting crop yields and closing the gaps between actual and attainable yield can be achieved by implementing numerous practices and technologies as well as fertilizer technologies (Stewart & Roberts, 2012).

Long term food security is highly depend on the agriculture sector. Agricultural development is the key driver to achieve food security of the country (Pawlak et al., 2020). Therefore, the focus of the country should be on developing agriculture

productivity, increasing accessibility for nutritious and healthy food, adopting climate smart agricultural practices and to act as a driver of economic transformation for the rural people who are the most food insecure population in Sri Lanka (Institute of Policy Studies, 2017).

## 1.1 Research Problem and Research Objectives

Problem of the study is to identify the role of agriculture on ensuring the food security in Sri Lanka. The principal objective of the study is to identify the role of agriculture on ensuring food security of Sri Lanka. Other secondary objectives are to identify the productivity of agriculture, to identify the impact of food imports on food security, to identify the major issues in agriculture sector and finally to identify the solutions and strategies to enhance agriculture sector and food security in Sri Lanka.

## 2. METHODOLOGY

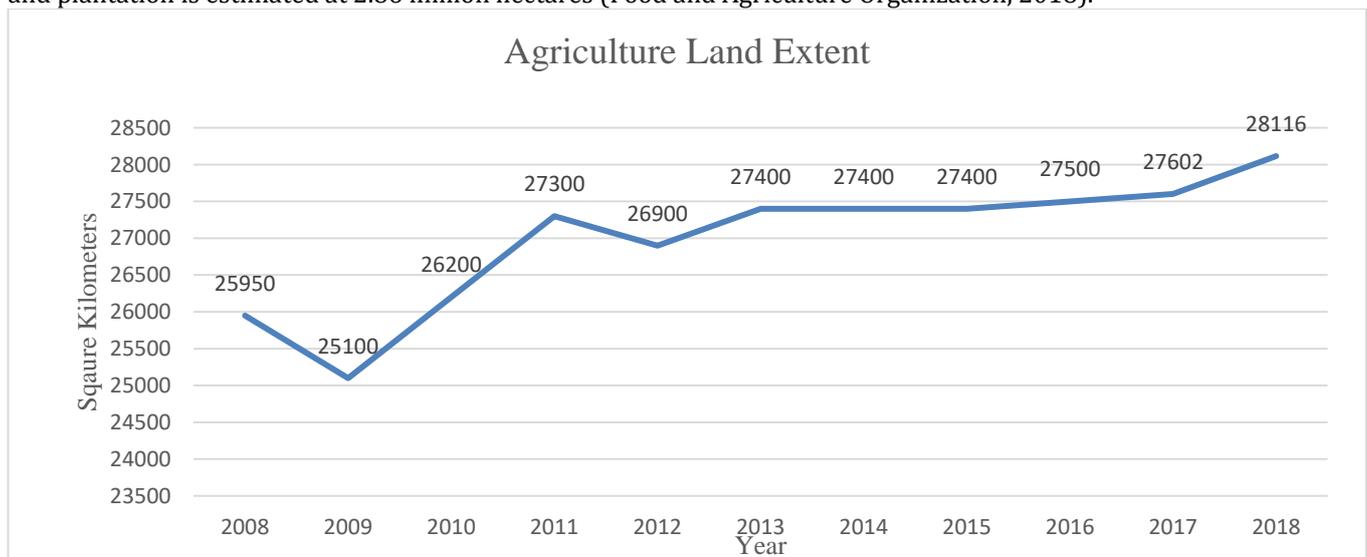
This research article is mainly based on secondary data which were collected through different annual reports, research articles and websites. Collected data were analyzed using descriptive statistics and presented using Figures and Tables.

## 3. RESULTS AND DISCUSSION

The main objective of the study was to identify the role of agriculture on ensuring food security in Sri Lanka. There are number of factors that influence the agriculture growth which has a direct impact on the food security of a country. Under this section several aspects of agriculture sector will be concerned.

### 3.1 Agriculture Land Extent

Land is the most important aspect of production, especially agriculture production. Food production and supply mainly depend on the amount of arable lands in the country. Out of total land area of 6.55 million hectares, 2 million hectares are agricultural lands in Sri Lanka, and 650,000 hectares are irrigated. The total cultivated area including home gardens and plantation is estimated at 2.86 million hectares (Food and Agriculture Organization, 2018).



**Figure 1: Agriculture Land Extent in Sri Lanka (Square Kilometers)**

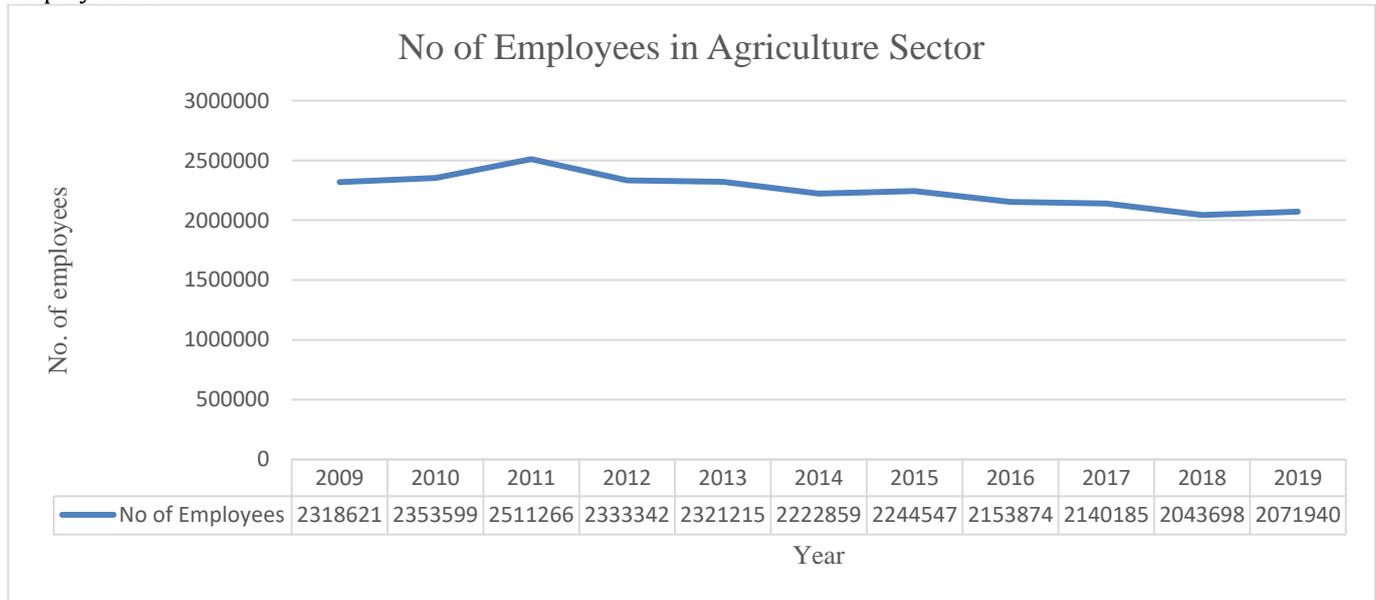
According to the above Figure 1, it shows that there is gradual increase in the agriculture lands in Sri Lanka. In 2018 according to the World Bank indicators, agriculture land in Sri Lanka was reported at 28116 sq.km. Agriculture land refers to the share of land area that is arable and includes land defined by the FAO as land under temporary crops, temporary meadows for mowing or for pasture, land under market or kitchen gardens, and land temporarily fallow (<https://tradingeconomics.com/sri-lanka/agricultural-land-sq-km-wb-data.html>). Increase in the arable land is very much important as there is a close link between the land extend and the food security. Land is the main thing that is needed for cultivating food crops. Protecting agricultural lands enables long term food security. It gives more access to fresh, healthy and local food which will directly impact on increasing food production and food security of the country.

### 3.2 Employment in Agriculture Sector

Agriculture was the mainstay of employment in the world until 2000. Since then employment growth in agriculture has declined (<https://blog.agrivi.com/post/employment-in-agriculture>). To achieve food security it is important to have more workers in agriculture sector as it directly contribute to produce food security. Moreover, the amount they generated from agriculture work determines the amount and quality of food that workers and their family can purchase. Further, more productive and decent employment in the agriculture sector can increase the local food availability by contributing to a sustainable increase in food production (Food and Agriculture Organization, 2012).

Nearly 80% of Sri Lanka's population lives in rural areas and the agriculture sector provides a major source of employment for the country's rural labour market (International Labour Organization, n.d). But in the recent years

number of employees in the agriculture sector is declining in Sri Lanka. The main reason for this matter can be identified as lack of participation of the youth generation in agriculture sector. Apart from this reason low return from agriculture, government's poor agriculture related market policies, land reform policies are also impact the decrease in the employment.

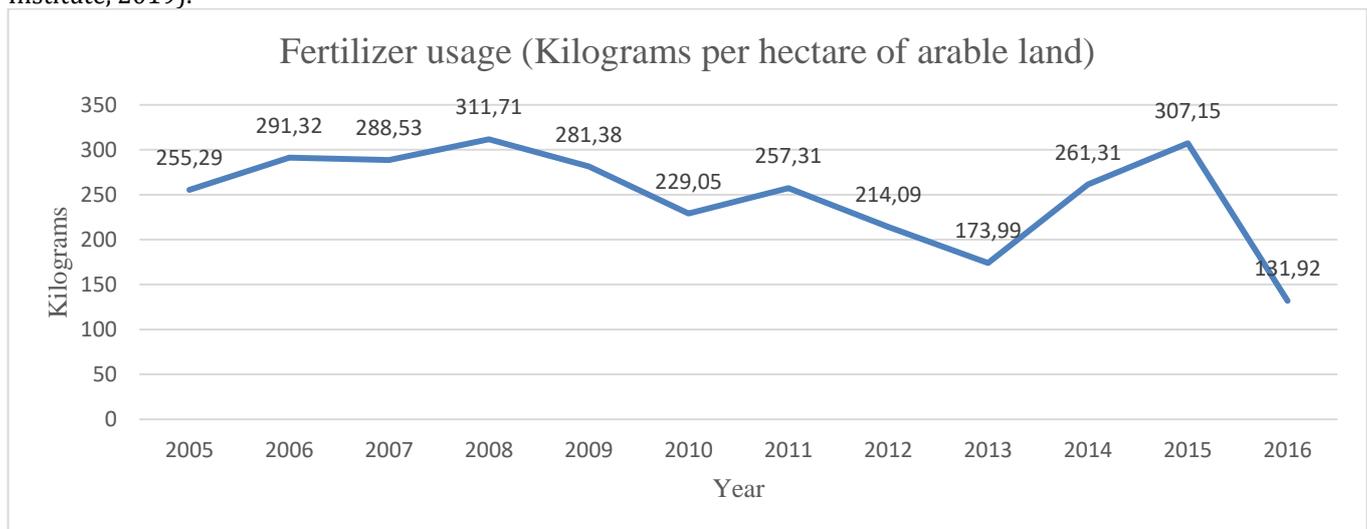


**Figure 2: Employees in Agriculture Sector**

According to the above figure it shows that from 2011 there is gradual decrease in the number of employees in the agriculture sector. In 2011 there were 2,511,266 employees in agriculture and in 2019 it shows that were only 2,071,940 employees. From this Figure we can predict that in future employees in agriculture sector will decrease further. This will directly affect the food security of Sri Lanka as employees in agriculture sector play a major role in cultivating food crops.

### 3.3 Fertilizer Usage in Agriculture

Crops need essential minerals and nutrients for strong, healthy growth as human beings. Fertilizer production and fertilizer usage is strongly connected with agricultural productivity and food production. Fertilizer is simply used to provide nutrients not available in the soil, replace nutrients removed at harvest and balance nutrients for better produce equality and higher yield (Yara, 2021). Fertilizer helps plants to become resilient against harmful plant pathogens, pests and weeds. Eliminating these diseases in plants will increases the value in the harvest. In present day synthetic fertilizers incorporate at least one of the three components that are most significant in plant sustenance and those are nitrogen, phosphorous, and potassium. Secondary significance are the elements are sulphur, magnesium and calcium (James Lind Institute, 2019).



**Figure 3: Fertilizer usage in Sri Lanka**

Fertilizer usage in Sri Lanka was 131.92 kg in 2016. Though Sri Lanka fertilizer usage fluctuate substantially in recent years it tended to decrease through 2009-2016. Highest value over the past 14 years was 311.71 in 2008, while the lowest value was 131.92 in 2016.

Using fertilizer plays and important role in increased crop production. There are several fertilizer subsidy programmes in Sri Lanka. It is widely accepted that the fertilizer subsidy has led to increase the land productivity and encouraged

farmers to expand the land under paddy cultivation (Weerahew, Kodithuwakku, & Ariyawardana, 2010). The first fertilizer subsidy programme in Sri Lanka was initiated in 1962, and its main objective was to induce farmers to adopt high yielding varieties with a view to achieving self-sufficiency in rice as well as to help farmers to defuse their financial liabilities. Another programme named Fertilizer Cash Grant was also introduced in 2016, and its main objectives were to cut down the high usage of inorganic fertilizer, encourage the usage of organic fertilizer and allowing farmers to make effective decisions regarding identifying and application of the most suitable quantities of fertilizer for their fields. Fertilizer subsidy has a positive impact on agriculture productivity and production (Edirisinghe, Amarakoon, & Kuruppu, 2019).

### 3.4 Imports of Food Products

Sri Lanka imports variety of agricultural products and food items including rice wheat, lentils, sugar, fruits, milk and milk products. The importation of foods and beverages account 7.2% of total imports in 2018 in Sri Lanka. Total agriculture, food and beverage imports were 1.6 billion dollars in 2018. Sri Lanka imported approximately 1.29 million metric tons of wheat in 2018 and annual imports of lentils is estimated at approximately 79 US dollars. Moreover, more than 150,000 metric tons of corn are also imported to country annually to supplement the local production. Further, Sri Lanka is a well-known dairy products importer. The country has imported 349 million dollars milk and mild products in 2018 (export.gov, 2019).

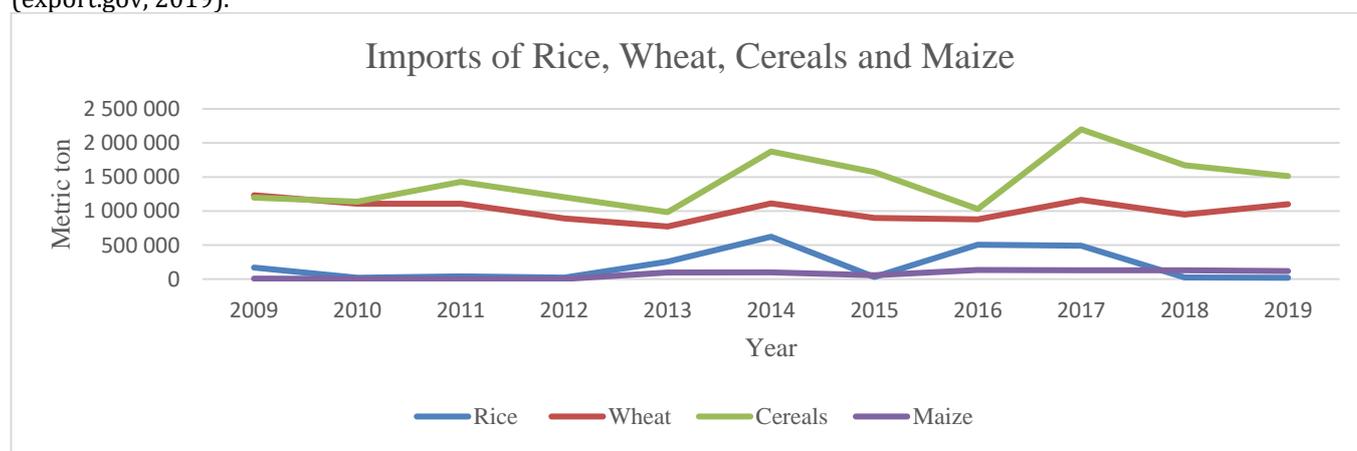


Figure 4: Imports of rice, wheat, cereals and maize

According to the above Figure its shows that there is a fluctuation in imports of different crops. The figure indicates that rice imports have gone down significantly when compared to the previous years. This is a considerable achievement of Sri Lanka since it helped saving a significant amount of foreign exchange earnings that were spent on importing rice.

#### 3.4.1 Import Dependency Ratio (IDR) and Self Sufficient Ratio (SSR)

Table 1: Import Dependency Ratio and Self Sufficient Ration for selected food items from 2013-2017

Food Group	Import Dependency Ratio (IDR)					Self Sufficient Ratio (SSR)				
	2013	2014	2015	2016	2017	2013	2014	2015	2016	2017
Cereals	23	42	32	24	56	80	60	70	78	46
Wheat	111	111	108	109	106	0	0	0	0	0
Rice	1	20	8	1	31	100	80	92	99	69
Starchy roots	18	23	21	32	24	83	78	79	68	78
Potatoes	61	59	60	61	65	39	41	40	39	35
Sugar & sweeteners	79	83	87	83	84	22	17	16	19	19
Pulses	85	96	90	89	89	21	17	15	15	16
Oil Crop	1	1	2	2	3	121	138	120	134	127
Vegetable oil	72	55	58	88	83	29	61	66	20	25
Vegetables	8	7	8	14	10	92	93	92	86	91
Fruits	7	5	7	6	9	96	98	96	96	93
Milk	45	49	52	55	56	56	51	48	45	45
Fish	12	12	18	17	16	91	92	85	85	88

Notes: \*SSR <100% production is insufficient to meet utilization, SSR>100% production exceeds utilization. IDR> 100% totally imported.

According to the data shown in the above table, the average IDR for cereals fluctuated between 23 and 56 percent. The SSR ratio of cereal also shows that the local production is not sufficient to meet the local utilization. IDR of wheat indicates that wheat are totally imported over time in Sri Lanka. The above table also reveals that potatoes, sugar and sweeteners, pulses and milk production is not sufficient to meet the local utilization. It means that Sri Lanka has to depend on imports

of those products to feed the people in the country. Some of the food items such as fruits, vegetables, fish, rice and starch roots are relatively self-sufficient.

High dependency on essential food items is a risk for the food security of the country. Therefore, it is crucial to reduce essential food imports and promote local production. The current Government's "Saubhagya" programme is mainly aimed at being self-sufficient in food. For making that aim possible, the Government of Sri Lanka is empowering villagers and small farmers by giving them sufficient technology, knowledge, planting material and seeds to enhance the capacity of the production. Moreover the Government also wishes to use all the arable land available in the country for cultivation. Another goal of the Saubhagya programme is to be self-sufficient in mils and stop imports of powdered milk. Further, this programme is also aim to reduce the dependency on imports and expanding and promoting the cultivation of high priority crops. The home garden programmes was also launched to improve vegetable security in urban and semi-urban households. The main goal of the home garden programme is to improve household food security by providing nutritious and healthy diet. Government also implement programmes to achieve self-sufficiency in locally produced crops to reduce the import dependency. This directly increase the local production and it will impact on securing food security of the country (<https://www.dailynews.lk/2020/11/02/features/232729/drive-prosperity-and-food-security>).

### 3.5 Major issues in the agricultural sector in Sri Lanka

As discussed earlier, there is no doubt that Sri Lanka is an agricultural country. Most of the domestic requirement of staple food: rice is grown in Sri Lanka. Apart from rice, vegetables, fruits and oilseed crops are also cultivated in the country.

Even though Sri Lanka is a fertile land that is potential for cultivating different crops including rice, issues such as low productivity and low profitability negatively affects the agriculture sector in Sri Lanka. Challenges of the agriculture sector can be divided into four areas namely, the food security needs of the growing population, recovering the growth potential of the export agriculture sub sector, renovation and sustained management of the fragile natural resources and threat of climate change (Institute of Policy Studies, 2017). Even though Sri Lanka is self-sufficient in rice and the import of rice have decreased over time other food import dependency is still significant. They include wheat, milk products and other essential food items. The import amount of Sri Lanka increased by almost 9% in 2017 (Wijesiri, 2018). These issues have serious impacts not only on the profitability of Sri Lanka's agricultural industry, but also on national food security. Depending too much on essential food imports badly affect food security, especially in a situation like COVID-19 pandemic.

Ineffective labour force is one of the main issues of the agriculture sector. Around 25.5% of the population of Sri Lanka is engaged in agriculture sector, but the sector's contribution to GDP is low and it accounts as 7.3%. It says that industrial worker and a service sector worker is four times as productive as someone working in agriculture sector in Sri Lanka (Thanigaseelan, 2021). Lack of interest shown by the youth generation for agriculture sector is another issue that affects the productivity of agriculture. Lack of employees in the agriculture field will create serious problem in future as it will eventually affects the food security ([http://static.dailymirror.lk/assets/uploads/image\\_de3a454179.jpg](http://static.dailymirror.lk/assets/uploads/image_de3a454179.jpg)).

The Ministry of Agriculture in Sri Lanka itself has identified some major issues in Sri Lanka's present agriculture sector. "Low productivity of crop and animal products for which demand is rising, poor match between food commodities that are promoted under agriculture development programs and those important for food security, inadequate attention to agricultural diversification in favour of crops that have better income prospects, heavy post-harvest losses, especially in the perishable products, failure to respond to growing concerns of food safety with appropriate responses through the full value chain, low priority given to processes food products to cater to demand shaped by changing lifestyles and inadequate attention on producing/developing nutrition rich food products" (Chadha, 2021).

Climate change and natural disasters are also serious problems that affect the agriculture sector in Sri Lanka, and the country is in 2<sup>nd</sup> in the Global Climate Risk Index. The rainfall pattern in recent years have emerged as a risk for the entire agriculture sector. Heavy rains and flood in 2015-2017 have caused adverse impact on agriculture. This problem seriously affects the food security in the country. ([http://static.dailymirror.lk/assets/uploads/image\\_de3a454179.jpg](http://static.dailymirror.lk/assets/uploads/image_de3a454179.jpg)).

Lack of market information is also another issue that agriculture sector face. This prevents farmers from accessing markets efficiently. Weak functioning of agriculture research and development programs also negatively affects the agriculture sector.

Post-harvest losses is another problem in Sri Lanka. Improper and non-scientific post-harvest practices cause losses in agriculture production specially, fruits and vegetable production. The annual loss of fruits and vegetables due to poor post-harvest practices accounted about 270,000 metric tons annually causing a great loss to the Sri Lankan economy of approximately Rs. 20 billion ([http://www.ft.lk/front-page/Post-harvest-losses-cost-SL-Rs-20-b-annually-COPA/44-716201#:~:text=An%20estimated%20270%20metric%20tons,Accounts%20\(COPA\)%20this%20week](http://www.ft.lk/front-page/Post-harvest-losses-cost-SL-Rs-20-b-annually-COPA/44-716201#:~:text=An%20estimated%20270%20metric%20tons,Accounts%20(COPA)%20this%20week)).

### 3.6 Strategies and solutions to increase agriculture production and food security

The first step should be modernizing the agriculture sector. This means that agriculture of the country should be transformed in to commercial agriculture from the traditional agriculture to face the global challenges, specially the food insecurity problem (Wijesiri, 2018).

Adopting technology to increase labour productivity, improving farm market linkages, investing in value chains and generating off farm employment to absorb excess labour in the rural areas is very much needed to enhance the productivity of agriculture sector. The new technologies can be introduced to enhance the agriculture productivity. Post-harvest handling and processing is essential to enhance the agriculture growth by: reducing post-harvest losses and

assuring food security through innovative technology development, increasing value addition, improving processing, packaging, quality control and value addition ([http://nastec.gov.lk/files/nrdf/2\\_Agriculture.pdf](http://nastec.gov.lk/files/nrdf/2_Agriculture.pdf)). Reducing post-harvest losses are also important to increase the productivity of agriculture (Thanigaseelan, 2021). Government should implement assistance programs to encourage modern technology for the whole production process from seeding to marketing.

Attracting youth to agriculture sector is very essential to combat the future labour problems in that will directly affect the food security of Sri Lanka. Enhancing youth involvement should be done through promoting scientific agricultural entrepreneurship training, encouraging scientific farming and promoting agro-enterprises (Wijeisri, 2018)

Increasing research and development is a must to enhance the agriculture sector. It will help to increase crop yields, improve productivity, reduce losses due to different diseases and pest attacks, develop high technology equipment, new storage methods, efficient marketing and to increase the food quality which is very much needed to ensure food security. Sri Lankan government has taken necessary actions to improve agriculture production and food security. According to the Sri Lanka Agriculture Policy, government has formed national policies related to improve agriculture production focusing on different sub sectors such as promoting agricultural production, seeds and planting materials, fertilizers, pesticides, agriculture machinery, irrigation and water management, land use, soil conservation, agriculture credit, agriculture insurance, agriculture research, agriculture extension and education, post harvesting technology, marketing, agro based industries, traditional agricultural crops and methodologies, home gardening, investments in agriculture, institutional development, utilization and sharing of plant genetic resources, youth involvement in agriculture and agriculture exports. Implementing these policies will improve the agriculture sector in Sri Lanka and it will impact positively on food security of the country (<http://www.agrimin.gov.lk/web/images/docs/1252389643AgPolicy4.pdf>).

#### 4. CONCLUSION

Sri Lanka has been a rich agricultural country since history. Paddy cultivation was not only just an economic activity but also a life that shaped the society culture, religion and the economy. Agriculture is the most important sector of the Sri Lankan which makes a significant contribution to the national economy, employment and food security. Major changes to agriculture sector occurred during the colonial period starting from Portuguese, Dutch and British.

Sri Lanka as a country, has achieved a notable progress in several areas such as education, reduction in child birth rate and decreasing poverty levels. Though, the food insecurity of the country still remains a constant problem. Achieving food security has become a serious problem mainly due to less agriculture productivity, population growth, natural disaster and climate changes, higher food prices, poverty. Food security is highly depend on the agriculture sector. Therefore, the focus of the country should be on developing agriculture productivity, increasing accessibility for nutritious and healthy food, adopting climate smart agricultural practices and to act as a driver of economic transformation for the rural people who are the most food insecure population in Sri Lanka.

Increasing agriculture productivity is a very much needed to ensure the food security in Sri Lanka. As Sri Lanka is highly depend on food imports, Sri Lanka as a country should focus on increasing local agriculture production which is essential to ensure food security especially in the situations like pandemics.

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## IMPACT OF SUBSIDY AND CREDIT SUPPORTS ON PRODUCTIVITY OF MARGINAL AND SMALLHOLDER RICE FARMERS: A PROPENSITY SCORE MATCHING APPROACH

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### ABSTRACT

In the agriculture of Bangladesh, marginal and smallholder farmers comprise the largest group, whose performance, in terms of productivity, plays crucial role in the growth of this sector. To increase the productivity of marginal and smallholder farmers, government has been providing direct subsidy and credit supports to selected farmers for last several years. While direct subsidy and credit expectedly have positive impacts on farm productivity, there are other factors also, which can affect agricultural productivity. Therefore, this study aims to analyze the impact of subsidy and credit on the productivity of marginal and smallholder rice farmers in Bangladesh. For the study, primary data are collected from 1270 marginal and smallholder farmers from five districts of Bangladesh. Considering the existence of endogeneity and self-selection bias in the covariates that generally occurs in a non-random experiment, the study employs Propensity Score Matching (PSM) approach to observe the net effects of subsidy and credit on productivity of the farms. The results show that after balancing the covariates, subsidy and credit have significant contributions to the productivity of rice farms as the average treatment effect on the treated (ATT) in both cases, *Boro* and *Aman*, are positive and statistically significant. The findings justify the government's decisions to support the farmers through channeling of subsidy and credit. This study came up with the suggestion that both horizontal and vertical expansions of subsidy and credit supports are needed to increase agricultural productivity in Bangladesh.

### KEYWORDS

Subsidy and Credit, Propensity Score Matching, Non-random Experiment, Rice Productivity, Bangladesh

### 1. INTRODUCTION

Agricultural production enhancement has been the major policy thrust in developing countries where cereals are the staple food of the population (Uddin and Dhar, 2018; Shelley *et al.*, 2016). In order to increase rice productivity, governmental and non-governmental organizations of developing countries give some direct supports to farmers (Linh *et al.*, 2019). The most common form of supporting farmers is to provide them with subsidy and credit facilities so that they can afford modern inputs such as chemical fertilizers, pesticides, irrigation and quality seeds in production (Quattara *et al.*, 2020). Many scholars observe that subsidy and credit provisions have an effective role in increasing farm productivity especially in the case of marginal and smallholder farmers (Khandker and Koolwal, 2016; Guirkingner and Boucher, 2008). Impact evaluation of subsidy and credit supports on agricultural productivity has always been one of the important issues of debate in the countries which possess lower resource base (Skreli *et al.*, 2015). Although, agricultural subsidy and credit play encouraging role in improving farm productivity, many economists have expressed doubt regarding the successes of such supports because of inconsistent and indistinguishable objectives of the farmers (Skreli *et al.*, 2015; Baltzer and Hansen, 2011). Mixed experiences are evident about the effectiveness of such incentive-based agricultural programs as some researchers found a positive association, while others revealed negative association of such programs with the productivity of the farms (Skreli *et al.*, 2015; Minviel and Latruffe, 2014). Moreover, agricultural productivity not only depends on subsidy and credit supports but also depends on many others farm specific attributes or covariates which often suffer from self-selection bias. In that case, attributing the increase in farm productivity only to subsidy and credit programs may not be acceptable.

Agriculture is the lifeline of Bangladesh economy and around 40.6% of the people of the country are directly or indirectly dependent on agriculture (BBS, 2019). As a lower middle income developing country, poverty remains widespread in the country and due to less opportunity of non-farm activities, people are increasingly getting dependent on agriculture (Dixon *et al.*, 2001). Therefore, the pledge to end poverty through increasing farm income is a top priority of the government, and subsidy and credit programs for marginal and smallholder farmers appeared to be a strategic policy in this regard. In Bangladesh, more than 65% farmers are marginal and smallholder farmers whose livelihoods are managed from agriculture (BBS, 2018). To increase the income of the people through increasing farm productivity, the government in the past decades has embarked on several schemes of credit and subsidies for the farmers (FAO, 2018).

Bangladesh is geographically a plain land delta, of which around 60% of the total land is arable. However, due to the odd of increasing non-agricultural use of land amid a large population, per capita arable land is only 0.0492 hectares in

Bangladesh (WB, 2016). The contribution of the sector to GDP of the country is 14.1% and the contribution of crop agriculture to GDP is 7.37% (BER, 2019). The agricultural land in the country has been fragmenting continuously over the years. Most of the farms operating in the country are very small in size caused by consistently rising population, and inheriting land ownership and regulations. Maximum of the crop farms in the country are subsistence in nature (BBS, 2018). In spite of having these backdrops, the agricultural sector of the country has been successful to touch a gratified position in the history of world agricultural statistics. The country is now second in jute production, third in rice, vegetable, and inland fish production, fifth in aquaculture production and seventh in mango production in the world (BBS, 2018). The most important matter is that the country is self-sufficient in rice and fish production.

As staple food for around 165 million people, rice is the dominant crop in Bangladesh which is cultivated in about 75 percent of the total agricultural land (UN, 2019; Nasim *et al.*, 2017). The country was the third largest rice producer in the world, and it has become possible as the climatic condition of the country is perfectly congenial to rice farming. The total amount of rice production in the country was only 10.59 million metric tons in 1991 which has increased gradually and reached to 36 million metric tons in 2020 enough to feed 165 million populations. This indicates that self-sufficiency in rice of the country has been achieved as the growth of rice production was much faster than the growth of population. As per Hossain (2019), with a production of 36 million metric tons of rice, Bangladesh places in third position globally in rice production after China and India with rice production of 146 million tons and 116 million tons, respectively. It is to note that rapid increase of rice production benefitted the country in two ways- first, saving of foreign currency for rice import, and second, diversion of resources for development activities which otherwise would have been spent for rice import.

Marginal and smallholder farmers in Bangladesh have the major role in rice production and the growth of rice production can be attributed to their performance during the cropping seasons. As farmers belong to these groups often lack operational capital in terms of money during the cropping seasons, they struggle to purchase inputs like fertilizer, seed, irrigation and pesticides (Linh *et al.*, 2019; Uddin and Dhar, 2018). To cover these costs, they mostly take credit from government and non-government agencies. In addition, the government also allocate agricultural subsidy to selected marginal and smallholder farmers. For last several years the government of Bangladesh gives special allocations for distribution of credit and subsidy for farmers involved in crop and non-crop agriculture towards increasing their productivity. Several studies have observed that credit extension and subsidy programs resulted in significant outcomes of the farmers in terms of increasing productivity of crops (Allotey *et al.*, 2019; Dlamini *et al.*, 2019). However, there are many other factors as well which also can have positive effect on the productivity of farmers, and increase in productivity may be an outcome of the joint influence of many variables including credit and subsidy.

In the empirical studies, endogeneity among the variable can exist and there can be self-selection bias arises among the subjects (Brookhart, 2006; Rosenbaum and Rubin, 1983). In such a situation, conventional quantitative techniques cannot disentangle the separate effect of one or more particular explanatory variables on the outcome variable. Rusenbam and Rubin (1983) suggests that in the presence of endogeneity and self-selection bias Propensity Score Matching (PSM) method can be applied to identify the separate effect of a variable on outcome variable. Thus, this study employs the Propensity Score Matching (PSM) approach to analyze the impact of credit and subsidy supports on rice productivity of marginal and smallholder farmers in the context of Bangladesh.

The paper is organized as follows: after giving a background of the research issue reviewing earlier studies, and setting the research objective in the introductory section, the scenario of subsidy and credit disbursement provided in the agriculture sector of Bangladesh is discussed in Section 2. Methodology and data collection issues are provided in Section 3. Section 4 presents the estimation results and core findings, and finally, Section 5 concludes.

## 2. AGRICULTURAL CREDIT AND SUBSIDY IN BANGLADESH

Bangladesh government has been continuously emphasizing on increasing agricultural productivity with a view to ensure food security, poverty eradication, increase income and employment generation, and by this way the government has been striving to make the economy more sustainable and stronger. This was manifested in various plans and policy documents of the Government of Bangladesh at different times. The need for agricultural credit and subsidy was felt seriously with the technological breakthrough which was incepted by the GR (Green Revolution) that resulted in increasing productivity of food crops (Mondal, 2010). In Bangladesh, agricultural subsidy and credit disbursements have been mostly targeted to attain higher productivity and yield of rice, the main crop typically produced by marginal and small farmers. The scenario of agricultural credit, subsidy and rice production in Bangladesh is shown in Figures 1, 2, 3, & 4.

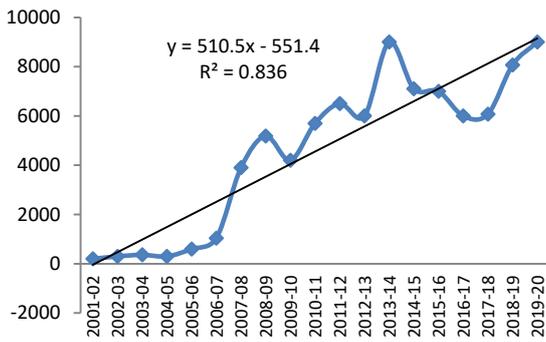


Figure 1: Trend in agricultural subsidy

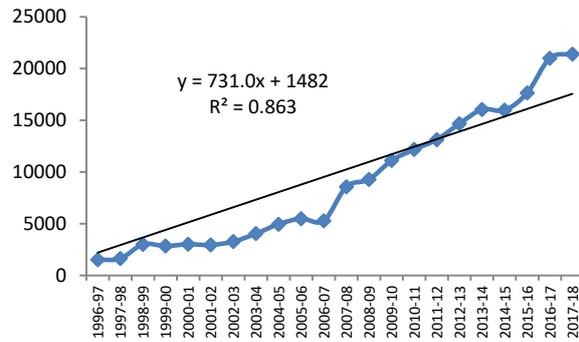


Figure 2: Trend in agricultural credit

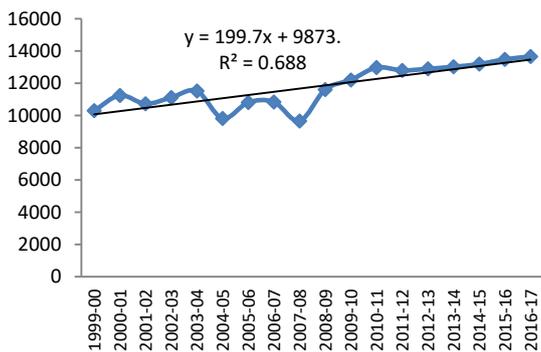


Figure 3: Trend in Aman rice production

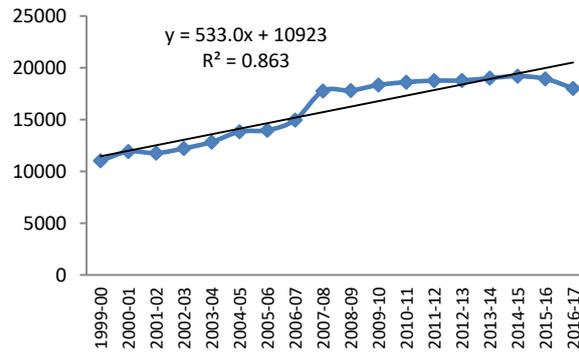


Figure 4: Trend in Boro rice production

Source: Bangladesh Bureau of Statistics (Several Years).

The graphs above show that both agricultural subsidy and credit disbursement have increased over the last two decades. Figure 1 shows that although subsidies given to the agricultural sector fluctuated markedly in different years, its trend has been increasing. Compared to subsidies, the increase in agricultural credit disbursement has been stable over the years with significantly increasing trend (Figure 2). Figure 3 and 4 show that over the year government's policy of increasing expenditures on subsidy and credit to agriculture sector has resulted in increased volumes of production of Aman rice and Boro rice, although a downtrend is observed in case of Boro rice production due to the occurrence of early floods in the years of 2016 and 2017, in the Haor areas of the north-eastern region. All the four figures give an insight that subsidy and credit have positively contributed to increase agricultural production.

### 3. RESEARCH METHODOLOGY

Rice farming in Bangladesh has been supported by subsidy and credit programs by the governmental and non-governmental organizations for many years. This study attempts to draw a precise impact assessment of agricultural subsidy and credit programs on rice productivity of marginal and smallholder farmers following a quasi-experimental research design, namely the Propensity Score Matching (PSM) approach, because farmers are not randomly assigned to both the programs. The methodological steps that are followed throughout this study are stated in the following sub-sections.

#### 3.1 Theoretical Framework of PSM

Propensity score matching method is becoming increasingly popular in impact evaluation studies as they afford researchers the ability to account for systematic bias related to self-selection. By controlling for variables related to self-selection into interventions, propensity score matching technique helps to render a more precise estimate of the effects of an intervention (Rosenbom and Rubin, 1984). Austin (2011) asserts that if variables related to participants' self-selected into an intervention are known, then the associated bias can be captured by using the propensity matching methods.

As a quasi-experimental method, PSM involves the conditional probability of getting treatment assuming pre-treatment or exogenous individual characteristics (Rosenbaum and Rubin, 1983). The process of conducting propensity score matching involves several steps. In these steps decisions must be made regarding the choice of covariates, models for creating propensity scores, matching distances and algorithms, the estimation of treatment effects, and diagnosing the quality of matches (Caliendo and Lopeing, 2008; Stuart and Rubin, 2008). In the beginning, propensity scores are created from covariates related to the recipients' self-selection into an intervention (treatment). The probability of treatment (i.e. propensity score) allows the researcher to balance the intervention and comparison group, conditional upon the multivariate distribution of the covariates. After creating the propensity scores, comparison groups are created by

making matches using different approaches and the quality of matches has to be assessed. Finally, treatment effects in terms of ATT and ATE are measured.

### 3.2 Selection of Target Group

In Bangladesh, marginal and small-scale farmers have been confronting disappointing constraints in case of using appropriate amount of necessary inputs during farming season because of not having enough resources which disheartens them, impedes their production activities, and finally reduces farm productivity (Bagchi *et al.*, 2019; Mondal, 2010). As a result, some of them are provided with credit and subsidy supports to continue their production process (Bangladesh Bank, 2014). Therefore, marginal and smallholder farmers who receive agricultural subsidy and credit from governmental and non-governmental organizations are the target group in this study.

### 3.3 Study Area

Rice is grown all over Bangladesh throughout the year as the agro-climatic condition is congenial enough to farming rice. This study is carried out in five purposively selected districts (namely, Gaibandha, Rajshahi, Naogoan, Dinajpur, Kushtia) of Bangladesh. The study districts are selected purposively on the basis of their degree of contribution to total rice production of the country. The selected districts are the most rice producing regions in Bangladesh. The survey for collecting required data is conducted between the time from February 2020 to July 2020.

### 3.4 Sampling and Data Collection

The required data for this study are collected using a structured questionnaire from a total of 1270 marginal and smallholder rice farmers (among them 70 farmers does not grow *Aman* rice) following a face-to-face interview method. Before using for data collection, the questionnaire was trialed through pilot survey and it was adjusted based on the suggestions found in the survey. The farmers of treated group were identified randomly based on the lists of farmers provided by the regional Department of Agriculture (agriculture extension service office) and the farmers of control group were selected following a systematic random (quasi random) sampling technique. Interviews were conducted by well-trained postgraduate students of Rajshahi University, Bangladesh. Their work and whole process of survey was coordinated and monitored by a research team.

### 3.5 Covariates Selection with Justification

Appropriate covariates selection, their measurement procedures and logical explanation of selecting each covariate in propensity score matching (PSM) analysis are imperative (Rosenbaum and Rubin, 1983). By controlling for all chosen covariates associated with the participants' self-selection into the intervention programs, the PSM technique helps us to sketch more trustworthy estimation of effects of interventions on outcome (Harris and Hosrst, 2016). During propensity score computation applying a suitable regression model, covariates act as predictors of participation into the intervention programs (Harris and Hosrst, 2016; Stuart and Rubin, 2008a). Considering the importance, all necessary covariates for this study have been selected carefully and sincerely. These covariates are chosen based on the conventional wisdom drawn from the studies done by Mottaleb *et al.*, (2016), Mondal (2010), Memon *et al.*, (2016) and Afrin *et al.*, (2017). The unit of measurement and description of covariates and interventions that have been chosen for this study are stated in Table 1:

**Table 1: Description of variables their measurement**

Variables	Measurement unit	Description
Land	Bigha( 33 decimal)	Cultivable land under rice cultivation
Rice productivity	Maund(40 kilogram)	Amount of rice in per <i>bigha</i> land.
Age	Year	Age of farmers
Education	Years of schooling	Education level of farmers
Occupation	Dummy	1 if main occupation is farmer, 0 otherwise
Experience	Year	Years of engagement of farmer in agriculture
Family size	Number	Total family members
Earned member	Number	Total members of family who earn
Agri. Member	Number	Total family members engaged directly in farm activities
Educated member	Number	Total family members who have formal education
Subsidy	Dummy	1 if farmers receive subsidy; 0 otherwise
Credit	Dummy	1 if farmers receive credit; 0 otherwise
Seed quality	5 point Likert scale	1 if seed quality is very bad, 5 if excellent
Seed amount	Kilogram	Amount of seed used in per <i>bigha</i> rice land
Social organization membership	Dummy	1 if have membership of any social organization, 0 otherwise
Fertilizer	Kilogram	Amount of fertilizers used in per <i>bigha</i> rice land
Rice price	Taka	Price of per <i>maund</i> rice
Durable asset	Thousand Taka	Total value of durable assets
Income	Thousand Taka	Annual income of farm household
Extension contract	Dummy	1, if farmer receive extension services from locally employed agricultural experts; 0, otherwise
Livestock asset	Number	Total livestock possess by farmer
Poultry asset	Number	Total poultry possess by farmer
Soil quality	5 point Likert scale	1 if soil quality is very bad, 5 if excellent

In this study, the single-factor productivity has been used as an outcome variable. We have computed per *bigha* rice productivity as follows:

$$Y_i = \frac{\sum P_i}{\sum L_i}$$

Where  $Y_i$  is the rice productivity of land of  $i^{\text{th}}$  farmer;  $\sum P_i$  is the total rice production (in maund) of  $i^{\text{th}}$  farmer; and  $\sum L_i$  is the total land under rice production of  $i^{\text{th}}$  farmer (in *bigha*).

### 3.6 Selection of the Model for Creating Propensity Score

Appropriate model selection for propensity score calculation depends on the level of intervention (dependent variable) (Harris and Hosrst, 2016; Rosenbaum and Rubin, 1983). In our study, agricultural subsidy and credit are interventions and both are taken as binary variables with the value of 1 if farmer receives subsidy (credit), and 0 otherwise. The propensity score in this study is the probability of receiving agricultural subsidy (credit) for growing rice given a vector of covariates covering socioeconomic, demographics, and farm related characteristics of farmers. The mostly used technique for computing propensity score is the Logistic regression model (Harris and Madison, 2016; Austin, 2011; Stuart, 2010). The form of the logistic regression model is as follows:

$$L_i = P(I_i = 1|X_{ij}) = \ln\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \sum_{j=1}^m \beta_j X_{ij} + \mu_i [i = 1 \dots n]$$

Where,  $L_i$  is log of odd ratio of  $i^{\text{th}}$  farmer,  $I_i$  is intervention (subsidy or credit) status of  $i^{\text{th}}$  farmer,  $P_i$  represents the probability of receiving subsidy or credit by  $i^{\text{th}}$  farmers,  $(1 - P_i)$  indicates the probability of not receiving the subsidy or credit by  $i^{\text{th}}$  farmer,  $X_{ij}$  represents the  $j^{\text{th}}$  covariate of  $i^{\text{th}}$  farmer,  $\beta_j$  stands for regression coefficients,  $\mu_i$  is stochastic error term.

### 3.7 Selection of Propensity Score Matching (PSM) Methods

Propensity score matching attempts to trace one (more) individual(s) with similar propensity score in the treatment and control groups (Austin, 2011). In our study, we have filtered out the farmers who have similar propensity score from subsidy (credit) receiving group and non-receiving group (Stuart and Rubin, 2008a) applying the following matching methods.

**Nearest neighbor matching (NNM):** NNM is the simplest matching technique in which individual from the control group is preferred as a matching associate for treated individual who is closest in terms of propensity score (Stuart, 2010; Smith, 1997; Rosenbaum and Rubin, 1985).

**Radius caliper matching:** Another matching technique is NN matching with the caliper adjustment. In this method, a specific distance is set to match treated and non-treated farmers. Each treated farmer  $i$  is matched with non-treated farmer  $j$  that fall within the specified distance.

**Kernel matching (KM):** In order to construct counterfactual outcome, KM is done on the basis of weighted average of entire entity of control group. As a result of applying this method, lower variance is found as it can capture more individuals from control group compared to other methods. In case of radius matching, all individuals remain within a pre-specified radius receive the same weights. The weight is given considering the distance between the propensity score of an individual of control group and an individual of treated group for which the counterfactual is expected (Caliendo and Kopeinig, 2005).

### 3.8 Estimation of Treatment Effects of Agricultural Subsidy and Credit on Productivity

In our study, propensity score matching approach is followed to assess the impact of agricultural subsidy and credit on rice productivity in Bangladesh. The method is used to compare the rice productivity of marginal and smallholder farmers who are assigned to agricultural subsidy and credit supports with the productivity of farmers not assigned to the supports. Under this approach, two ways can be applied to estimate the aggregate effects intervention: average treatment effect (ATE) and average treatment effect of treated group (ATT). We can compute ATE and ATT as follows.

$$ATE = E(R_{1i}|T_i = 1,0) - E(R_{0i}|T_i = 1,0)$$

Where  $E(.)$  indicates the expectation in population (whole sample).  $T_i$  represents the treatment (subsidy or credit) with the value of 1 for the treated group and the value of 0 for the control group,  $R$  is the outcome variable (productivity per unit of land). In other words, ATE is the average effect that would be observed if everyone in the treated and control groups receive treatment, compared with if no one in both groups receives treatment (Harder, *et al.*, 2010). On the other hand, ATT means the average effects that would be observed if everyone in the treated group receives treatment compared with if none of the individuals in the treated group received treatment. The formula for ATT is as follows.

$$ATT = E(R_{1i}|T_i = 1) - E(R_{0i}|T_i = 1)$$

## 4. RESULTS AND DISCUSSION

### 4.1 Socioeconomic, Demographic and Farm Characteristics of Farmers

The socioeconomic, demographic and farm related characteristics of farmers are assumed to have a correlation with the productivity of farms. For example, a farmer with higher level of education, training, extension contracts, farming experience, subsidy, credit etc. could have more productivity. Therefore, a short description of the features of farmers is

given in this section to have insights about marginal and small holder farmers of Bangladesh. The obtained features are shown in Table 2. From the table it is revealed that there the average cultivable land size of small and marginal is very small. On the average farmers are in middle age of their life with a long farming experience and the have completed only primary education.

An interesting fact is that although farmers are involved in farming on their land, farming is not the main occupation of all the farmers. It is revealed that less than fifty percent farmers grow crops as their as main occupation. It is found that farmers have a moderate family size with more than one earner members and more than two educated members. The average productivity of *Boro* rice is higher compared to *Aman* rice.

**Table 2: Basic features of the farms and farmers**

Characteristics	Boro			Aman		
	Mean	Stdv.	%	Mean	Stdv.	%
Land	2.65	1.68	-	2.61	1.62	
Age	44.66	13.65	-	44.45	13.66	
Education	5.87	4.29	-	6.52	3.91	
Occupation (1 = Farming as main occupation)	0.47	0.50	47.7	0.47	0.50	47.0
Experience	24.21	13.59	-	24.08	13.48	
Family size	5.35	2.32	-	5.26	2.21	
Earner member	1.66	0.98	-	1.64	0.98	
Agri. Member	1.36	0.74	-	1.38	0.72	
Educated member	2.82	1.77	-	2.89	1.72	
Productivity of rice	22.34	6.97	-	19.88	4.75	
Credit (1 = credit)	0.52	0.50	52.0	0.54	0.50	54.0
Subsidy(1 = subsidy)	0.46	0.50	46.0	0.52	0.50	52.0
Seed quality	1.89	0.64	-	1.99	0.60	
Seed amount	8.17	1.78	-	10.02	1.24	
Social organization membership	0.21	0.41	21.0	0.24	0.43	24.0
Fertilizer use	64.55	10.78	-	55.70	21.04	
Rice price	647.38	92.97	-	625.69	81.34	
Durable asset ('000' Tk.)	44.42	63.39	-	44.85.3	62.04	
Income	46.01	78.50	-	48.77	84.71	
Extension contract	0.70	0.46	70.0	0.68	0.47	68.0
Livestock asset	3.48	3.55	-	3.20	3.31	
Poultry asset	13.88	26.25	-	12.66	24.62	
Soil quality	3.96	0.39	-	3.97	0.36	

Source: Authors' own calculation based on field survey data.

It is found that 52% *Boro* and 54% *Aman* rice farmers have received credit for agricultural production activity. On the other hand, 46% *Boro* and 52% *Aman* rice marginal and smallholder farmers have received subsidy. The farmers reported that they are to use lower quality seeds. Membership of social organization helps farmers to know about different agriculture related problems and solutions through sharing each other although it is found that only 21% *Boro* and 24% *Aman* rice farmers are associated with social organizations. Agriculture extension services also promote productivity. It is revealed that 70% *Boro* and 68% *Aman* rice farmers received agriculture extension services. The average annual income of farmers is very small and they have lower durable, livestock and poultry resource base.

#### 4.2 Distribution of Propensity Scores and Covariate Balance

In Bangladesh, the aim of giving subsidy and credit supports to rice farmers is to increase rice production. Therefore, outcome variable used in our study is rice productivity (per *bigha* production of *boro* and *aman* rice varieties). As the study is done following PSM approach, first we discuss the distribution of our computed propensity score. Propensity score hold a good balancing property, if the scores of both groups are equally distributed. Figures 5, 6, 7 and 8 show the propensity score distribution of treated and control groups. From the figure it is clear that there is a substantial overlap in the distribution of propensity scores of treated and control groups. This result satisfies the balancing property of our computed propensity score and means that obtained propensity score is reliable enough to make control and treatment groups similar and comparable.

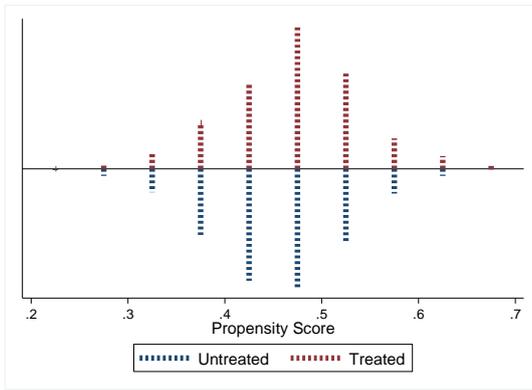


Figure 5: Boro and subsidy model

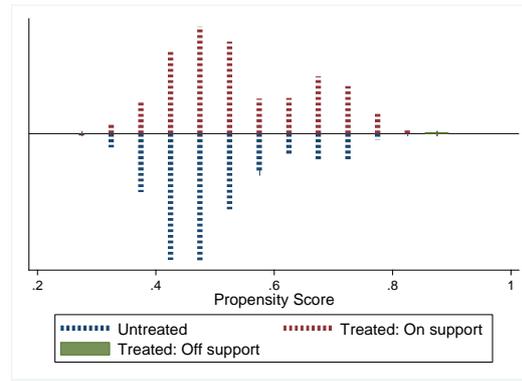


Figure 6: Boro and credit model

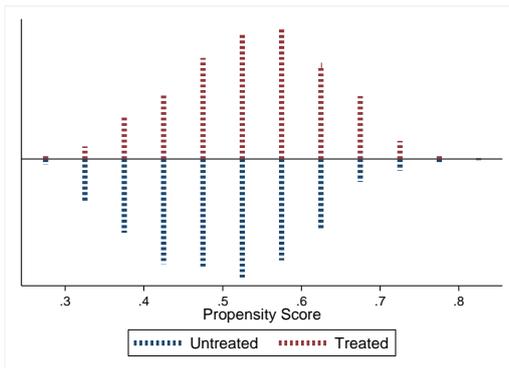


Figure 7: Aman and subsidy model

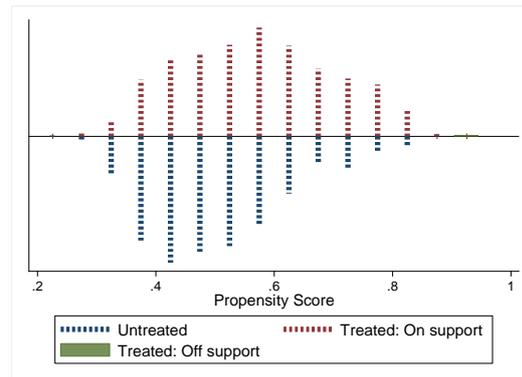


Figure 8: Aman and credit model

The propensity score balance can also be represented using boxplot of computed scores. From Figure 9, 10, 11 and 12, it is revealed that the medians, 25<sup>th</sup> percentiles and 75<sup>th</sup> percentiles of our estimated propensity scores are almost similar for both treatment and control groups after matching. This result indicates the strong balance of covariates selected for our study.

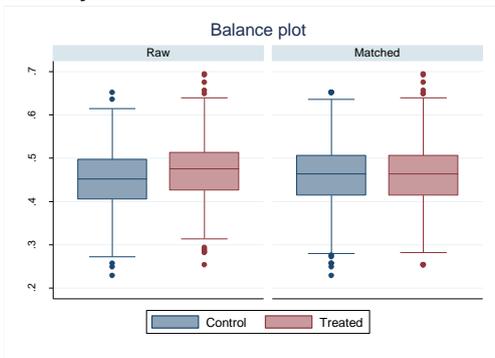


Figure 9: Boro and subsidy model

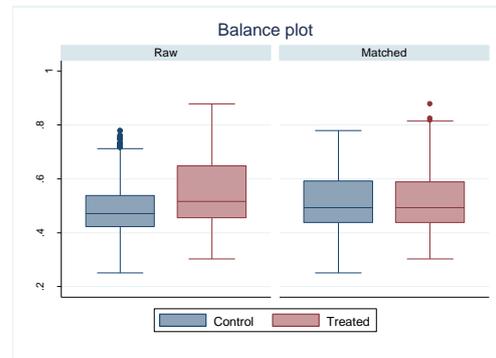


Figure 10: Boro and credit model

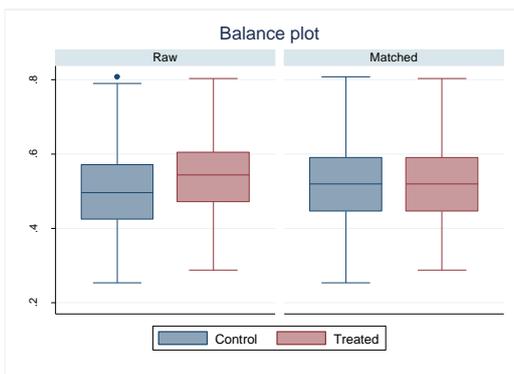


Figure 11: Aman and subsidy model

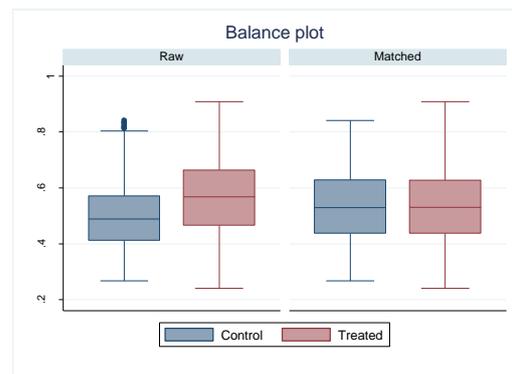


Figure 12: Aman and credit model

The covariate balance can be tested comparing the mean of all individual covariates of control and treated groups, which is termed as standardized bias. It is another standard test to assess the quality of propensity score matching. According to rule-of thumb, the standardized bias for an individual covariate should be less than 5% after matching (Rosenbaum and Rubin, 1985). From, the covariate balance test results shown in Table 3 & 4, we can see that the standardized biases are less than 5% in case of all covariates in the *Boro* and *Aman* model. It is also revealed that the mean bias is less than 5% in all the four cases. This result implies good covariate balance.

**Table 3: Covariate Balance Test Results (After Matching)**

<b>Boro Rice Model</b>										
Covariates	Treatment: subsidy					Treatment: credit				
	Mean		% bias	t-test	p> t	Mean		% bias	t-test	p> t
	Treated	Control				Treated	Control			
Land	2.48	2.51	-1.40	-0.25	0.81	2.61	2.63	-1.40	-0.26	0.80
Age	45.03	44.96	0.60	0.10	0.92	44.90	45.42	-3.90	-0.70	0.49
Education	5.84	5.84	0.00	-0.01	0.99	6.07	6.09	-0.40	-0.08	0.94
Occupation	0.47	0.47	-0.30	-0.05	0.96	0.49	0.50	-2.20	-0.41	0.69
Experience	24.53	24.47	0.50	0.08	0.94	24.22	24.60	-2.80	-0.50	0.62
Family size	5.25	5.24	0.40	0.08	0.94	5.43	5.44	-0.40	-0.07	0.95
Earnar member	1.62	1.61	1.10	0.19	0.85	1.68	1.69	-0.90	-0.15	0.88
Agri. Member	1.35	1.35	0.70	0.13	0.90	1.34	1.34	0.00	0.01	1.00
Educated member	2.81	2.81	0.10	0.02	0.99	2.82	2.87	-2.70	-0.49	0.62
Subsidy	-	-	-	-	-	0.46	0.47	-1.50	-0.26	0.79
Credit	0.52	0.52	-0.40	-0.08	0.94	-	-	-	-	-
Seed quality	1.89	1.90	-2.40	-0.41	0.69	1.88	1.88	-0.90	-0.16	0.87
Seed amount	8.26	8.24	1.10	0.18	0.85	8.20	8.13	3.70	0.68	0.50
Social organization membership	0.21	0.21	0.40	0.06	0.95	0.28	0.27	1.50	0.24	0.81
Fertilizer	64.64	64.66	-0.20	-0.04	0.97	64.02	63.79	2.20	0.38	0.70
Rice price	640.88	642.01	-1.20	-0.21	0.83	643.89	646.75	-3.10	-0.55	0.58
Durable asset	45.57	45.89	-0.50	-0.08	0.94	43.44	46.66	-5.10	-0.89	0.37
Income	48.48	50.81	-3.00	-0.43	0.67	45.84	45.94	-0.10	-0.02	0.98
Extension contract	0.68	0.69	-2.20	-0.38	0.71	0.69	0.71	-4.40	-0.80	0.42
Livestock asset	3.68	3.55	3.60	0.58	0.56	3.40	3.36	1.00	0.18	0.85
Poultry asset	14.61	14.00	2.30	0.39	0.70	14.18	13.62	2.10	0.39	0.70
Soil quality	3.97	3.97	0.20	0.04	0.97	3.95	3.97	-4.00	-0.71	0.48
Mean bias (%): 1.1, Rubin's B: 6.3, Rubin's R: 0.97						Mean bias (%): 2.1; Rubin's B: 11.7, Rubin's R: 1.47				

Source: Authors' own calculation based on field survey data.

**Table 4: Covariate Balance Test Results (After Matching)**

Covariates	Treatment: subsidy					Treatment: credit				
	Mean		% bias	t-test	p> t	Mean		% bias	t-test	p> t
	Treated	Control				Treated	Control			
Land	2.62	2.60	0.80	0.14	0.89	2.63	2.62	0.30	0.06	0.95
Age	44.89	44.85	0.20	0.04	0.97	44.52	44.63	-0.90	-0.15	0.88
Education	6.64	6.60	1.00	0.18	0.86	6.63	6.60	0.70	0.13	0.90
Occupation	0.46	0.47	-2.00	-0.35	0.73	0.50	0.51	-2.90	-0.52	0.61
Experience	24.57	24.47	0.70	0.13	0.90	24.25	24.27	-0.10	-0.02	0.98
Family size	5.36	5.33	1.40	0.25	0.80	5.33	5.35	-0.80	-0.14	0.89
Earnar member	1.69	1.67	2.50	0.44	0.66	1.66	1.69	-2.70	-0.47	0.64
Agri. member	1.42	1.40	2.30	0.40	0.69	1.40	1.40	-0.30	-0.06	0.95
Educated member	2.94	2.92	1.20	0.21	0.83	2.95	2.96	-0.70	-0.12	0.91
Subsidy	-	-	-	-	-	0.58	0.59	-0.40	-0.06	0.95
Credit	0.61	0.60	0.20	0.03	0.97	-	-	-	-	-
Seed quality	1.99	1.98	0.20	0.04	0.97	1.97	1.97	-0.60	-0.12	0.91
Seed amount	9.97	9.94	2.30	0.40	0.69	10.03	10.08	-3.50	-0.62	0.54

Social organization membership	0.25	0.25	0.50	0.09	0.93	0.31	0.31	0.00	0.00	1.00
Fertilizer	56.56	56.38	0.90	0.15	0.88	55.32	55.14	0.80	0.15	0.88
Rice price	627.41	626.80	0.70	0.13	0.90	632.21	632.05	0.20	0.04	0.97
Durable asset	46.35	43.38	4.80	0.84	0.40	43.54	44.96	-2.30	-0.43	0.67
Income	52.57	46.09	7.70	1.32	0.19	49.42	46.61	3.40	0.62	0.53
Extension contract	0.71	0.72	-2.50	-0.46	0.65	0.67	0.69	-4.20	-0.76	0.45
Livestock asset	3.16	3.15	0.30	0.06	0.96	3.14	3.07	2.30	0.44	0.66
Poultry asset	12.59	12.61	-0.10	-0.01	0.99	12.79	13.16	-1.50	-0.26	0.80
Soil quality	3.96	3.95	0.40	0.08	0.94	3.96	3.95	1.60	0.27	0.79
Mean bias (%): 1.6, Rubin's B: 9.0, Rubin's R: 1.4						Mean bias (%): 1.4, Rubin's B: 10.2, Rubin's R: 1.66				

Source: Authors' own calculation based on field survey data.

### 4.3 Impact of Agricultural Subsidy and Credit on Rice Productivity in Bangladesh

The calculated results of ATT are shown in Table 5 and ATE results are reported in Table 6. Both the ATT and ATE results confirm that the average effects of subsidy and credit supports to marginal and smallholder farmers are positive in all the cases. These results mean that both the subsidy and credit supports have positive role in increasing the production of both *Boro* and *Aman* rice in Bangladesh.

**Table 5: Effects of Subsidy and Credit on Rice Productivity**

Matching methods	<i>Boro Rice Model</i>			
	Treatments	ATT	S.E.	T-stat
Nearest neighbor	Subsidy	3.06***	0.53	5.77
	Credit	0.96*	0.55	1.75
Radius caliper	Subsidy	2.97***	0.40	7.37
	Credit	1.37***	0.42	3.23
Kernel k (biweight)	Subsidy	3.16***	0.39	8.01
	Credit	1.63***	0.41	3.98
Matching methods	<i>Aman Rice Model</i>			
	Treatments	ATE	S.E.	T-stat
Nearest neighbor	Subsidy	2.84***	0.32	8.99
	Credit	1.41***	0.37	3.82
Radius caliper	Subsidy	2.79***	0.27	10.19
	Credit	1.71***	0.31	5.5
Kernel k (biweight)	Subsidy	2.89***	0.26	11.02
	Credit	1.89***	0.28	6.67

Source: Authors' own calculation based on field survey data.

**Table 6: Effects of Subsidy and Credit on Rice Productivity**

Matching methods	<i>Boro Rice Model</i>			
	Treatments	ATE	S.E.	Z
Nearest neighbor	Subsidy	3.06***	0.47	6.55
	Credit	1.61***	0.47	3.44
Matching methods	<i>Aman Rice Model</i>			
	Treatments	ATE	S.E.	Z
Nearest neighbor	Subsidy	2.54***	0.29	8.87
	Credit	1.44***	0.30	4.77

Source: Authors' own calculation based on field survey data.

## 5. CONCLUSION AND POLICY IMPLICATIONS

As the economy of Bangladesh and the livelihoods of most of the people are agriculture centric, agricultural productivity is one of the most widely discussed and debated issues. Among the three groups of farmers- marginal, small and large farmers in the country, large farmers with more land asset, equipment, and capital enjoy additional privileges to raise productivity of their farms compared to marginal and smallholder farmers. Capital shortage among marginal and smallholder farmers during crop seasons impedes their production potentials at a considerable rate. Therefore, in order to raise the agricultural productivity, the government of Bangladesh allocates some budget as agricultural subsidy and credit in the national budget each year to be disbursed to the marginal and smallholder farmers. In this study, it is obvious that both agricultural subsidy and credit have positive effects on rice productivity in Bangladesh as the ATT and ATE is found positive and statistically significant in all the cases. As both agricultural subsidy and credit programs increase the productivity of rice of small holders and marginal farmers in Bangladesh, the government should continue and expand the programs horizontally and vertically with careful look over. Government should also ensure the access of all helpless farmers to these programs. To this end, government is urged to increase the share of agricultural budget and to make

strong the *upazila* agriculture office with substantial manpower. In addition, government has to inspect the programs with higher authority to ensure the accountably and transparency of works of all staff associated with the programs.

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## **Regular Session: RS10.1 - Regional development**

**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/88538303825>**

**Chair André Torre**

## COMMON GOODS AND TERRITORIAL DEVELOPMENT: REFLECTIONS ON GOVERNANCE ISSUES

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### ABSTRACT

Today is an upsurge in initiatives based on the concept of 'commons' in regional and urban planning, and territorial development. The use of this concept crystallizes several contemporary cross-cutting issues that mobilize local collectives, such as the energy transition, sustainable urban development, management of natural resources or public places, emergence of a circular economy, urban ecosystems, biodiversity, etc. Moreover, we observe a multitude of commons in contemporary society: more or less inclusive / excluding devices involve forms of pooling and shared management of resources (land, urban infrastructure, knowledge, etc.) that lie beyond the market and public management. They also refer in a more or less pronounced way of ethics and collective interest (cf. Thomas Aquinas) that exceed or add to the individual interest. In a context of shrinking public finances, these devices imply a redistribution of responsibilities structured largely around the user and the producer of the property for managing territorial resources. These emerging phenomena questions the way in which the development of territories is conceived today. The economic and competitiveness dimensions (creation of knowledge, productive resources, etc.) now also combine societal and non-economic aspects (improvement of well-being and quality of life). It tends to become increasingly explicit in development strategies. These phenomena are also signs of an evolution of our society towards more collective and participative modes of exploitation and management of territorial resources in which stakeholders and in particular users are involved. These approaches seem today to reflect an aspiration towards a more localized, inclusive, sustainable and equitable development model, without ignoring the tensions and conflicting dimensions of development. The objective of this paper is to identify what the notion of commons translates in terms of territorial development issues. In particular, it will identify the opportunities and importunities that it reveals in terms of governance. The first part proposes to return to the notion of common good in order to grasp the related conceptual issues. Then we present an analysis of the contributions of this notion to territorial development approaches. More specifically, we grasp the differences and similarities between commons and territorial resources, thus highlighting what the mobilization of this concept indicates in terms of issues. The third part addresses the challenges of territorial governance posed by contemporary forms of management in commons.

**CULTURAL AND CREATIVE CITIES AND REGIONAL ECONOMIC EFFICIENCY: CONTEXT CONDITIONS AS CATALYZERS OF CULTURAL VIBRANCY AND CREATIVE ECONOMY**

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**ABSTRACT**

Following the hype that has been given to culture and creativity as triggers and enhancers of local economic performance in the last 20 years, this work aims at assessing the impact of Cultural and Creative Cities (CCCs) on the development of their regions. In this sense, the cultural and creative character of cities is considered as a strategic strength and opportunity that can favor the economic system of the entire regions in which the cities are located.

Exploiting a regional production function and data from the Cultural and Creative Cities Monitor (CCCM) provided by the JRC, the effect of cities' cultural vibrancy and creative economy on the output of the regions they belong to is econometrically explored. The possible role played by the enabling environment in catalyzing the action of cultural vibrancy and creative economy is also considered.

The implications are thoroughly discussed: CCCs are a strategic resource for the sustainable development of their region since they contribute to feed a long-term self-supporting system, interpreted according to a holistic conception that includes economic, social, cultural, and environmental domains.

## PROXIMITY ANALYSIS OF LOCAL ACTORS' COORDINATION IN THE CIRCULAR ECONOMIC PROCESS A STUDY CASE ON METHANISATION BASED ON SOCIAL NETWORKS APPROACH

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### ABSTRACT

Our article aims to analyze the dynamics of social and economic interactions and proximity relationships. It is based on a theoretical framework combining the approaches of analysis of social networks and proximities, applied to the mechanism of methanisation of household and assimilated garbage of the Syndicat Mixte du Point Fort (SMPF) of the commune of Cavigny. This case study is symptomatic of the problems of connecting actors at the local level. Stakeholders with diverse functions and from different territorial scales coordinate around issues of waste mobilization, co-product flow, risk management and social acceptability. In our approach the social networks tool is coupled with an analysis of proximities (geographical and organized), in order to provide a better understanding of governance associated with the structuring of productive and social interactions. We first present the SMPF methanization project, then the theoretical framework and methodology used to analyze the territorial governance of this case study. We study, on the basis of our surveys, the technical and innovation trajectories and their evolution at the local level, by representing them in the form of flow networks. We then analyse the dynamics of social networks, which reveal the evolution over time of synergies and cooperative behaviors between the actors of the methanisation of Cavigny. The last part is devoted to the analysis of the importance and the role played by proximity relationships in the productive choices and relationships maintained by the actors of this process.

## **Special Session: SS18.2 - Urban Future in the Global South**

**11:00 - 12:15 Tuesday, 25th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/88394645535>**

**Chair Abdul Shaban**

## ASSESSING WATERSHED ENVIRONMENTAL VULNERABILITY IN CLIMATE CHANGE CONTEXT: CASE OF ARID WATERSHED FROM MOROCCAN ANTI-ATLAS

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### ABSTRACT

Climate change is global concern. Within Mediterranean region, it will highly affect Morocco with a perspective of higher temperature and variable rainfall patterns. As consequence, it will lead to high extreme events and to environmental hazards affecting food security and social stability. In arid mountainous lands, the scarcity of land resources, the expansion of human consumptive needs, in addition to the high pressure on natural resources and the emerging climate risks, natural capital will be highly threatened. This study focusses on Mountainous watershed located on Atlas Mountains. It aims to assess environmental vulnerability within climate change context. Vulnerability was assessed using Environmental Vulnerability Index (EVI). The index calculation of the EVI is based on the aggregation of indicators related to vulnerability components that includes risk, exposition and adaptation capacities. The indicators, providing information on the magnitudes and trends of several environmental vulnerability components, are then standardized on common scale according to EVI calculation methodology. Our results stress out that the studied area is highly vulnerable with higher EVI values. According to vulnerability components ranking, vulnerable sectors within study area could be classified, according to their priorities, as follow: i- human health, ii- water, iii- biodiversity, iv- agriculture, v- exposure to natural disasters, vi- climate change, and vii- desertification. The results of this work could be shown as a prerequisite for assisting decision- makers to establish an adapted management plan of the watershed and to enhance the contribution of landscape ecosystems to the hydrological functioning of the watershed in the context of climate change. Moreover, if the needs of promoting human capital development seems to be major priority, the degradation of natural resources requires restoration actions in order to maintain the ecological services provided by forest ecosystems. The conclusions obtained will be helpful for public action to strengthen the resilience of the natural environment.

## OPERATIONALIZING DISASTER RESILIENCE IN NORTHERN MOROCCO: A COMPARATIVE STUDY OF COMPOSITE INDICATOR EFFECTIVENESS FOR MEASURING FLOOD RESILIENCE

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### ABSTRACT

Serving natural disasters and risk management purposes, resilience approaches aim to understand characteristics contributing to managing the capacity of an urban system to adapt and cope with natural hazards such as floods. The identification of metrics for measuring flood resilience is becoming a robust area of several studies. Many purposes, variables and assessment methodologies were applied. Indices are frequently used as a measurement tool. While getting the same name many index-based approaches for assessing resilience to floods have differences in indicator selection and calculation methodology. Leading therefore for different output scores and different policy implications. These inconsistencies call for more critical reflection on index design and utility. In this regard, discussing and comparing index outputs is an effective approach. Here, the Flood Resilience Index (FRI) is developed and applied at Fnideq, M'diq and Martil coastal municipalities (Northern Morocco) within the same theoretical approach three times. While the Composite Indicator FRI (1) is calculated with a set of indicators and compensatory aggregation technique, the FRI (2) incorporates different indicators and two alternative methods on constructing composite indicators: Principal Components Analysis (PCA) and Self-Organizing Map (SOM), to measure flood resilience. Maps, class rank changes, and correlations are used to realize a visually and quantitatively comparison. Results show that different theoretical frameworks influence highly scores, and the methodology of index calculation used has an even effect on output. The growing trend on resilience assessment could tackle simultaneously the assessment frameworks and validation step of results with transparency and critical presentation of the whole process limitations.

## KIGALI AND THE SECONDARY CITIES AS A POLYCENTRIC GREEN STRUCTURE FOR RWANDA

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### ABSTRACT

The last decades have shown an African rapid urbanization's rate culminated with the appearance of extraordinary growing metropolises, a process that inevitably raises the need of preventing the cities' collapse and implosion re-thinking their urban future. In the East African Region, Kigali, the capital city of Rwanda, first responded to this issue through the adoption of a national and urban sustainable plan primarily directed to the achievement of the 11th Sustainable Development Goals (SDG). In fact, the country is structured according to a system of secondary cities – Musanze, Huye, Muhanga, Rubavu, Rusizi, Nyagatare, revolving around Kigali revealing the adherence to a polycentric planning model scaled at different levels. Starting from the assumption that the city builds and shapes itself over time, Kigali is experiencing an urban rebirth boosted by a series of master plans, 2007, 2013 and 2020, that are tracing its passage to a sustainable satellite city composed of green settlements. After the analysis of the transition to green architecture and an excursus on the adopted policies it is described the geographical and historical background and context. Furthermore, it is studied the use of a well-known urban development plan, the satellite city combined with the needs of “make cities inclusive, safe, resilient and sustainable” where tradition and modernity have to find the way to establish an architectural dialogue. The satellite city model was applied in the development plans of regional cities in adherence to the local environment providing interesting case studies for contemporary projects in the same area. Three settlements in the capital city – Kigali 2020, Kigali Vision and Green City Kigali are explored as urban examples of the green strategy together with the proposed master plans for the secondary cities. Therefore, the research explores both the capital city and national urban development as sustainable steps towards a green future, for a harmony between the natural and artificial environment, demonstrating the need of an adequate political action in order to guide the achievement of the Sustainable Development Goals.

### KEYWORDS

Kigali, Rwanda, satellite city, sustainable architecture

### 1. INTRODUCTION

#### 1.1 The African urban growth

The world in the 21st century is experiencing an unprecedented urban growth and the development prospects of the continent largely depend on how this process will be handled over the next few decades. In fact, the “urban population is expected to rise by 2.5 billion persons, from 4.2 billion to 6.7 billion, while the total world population is projected to grow by somewhat less, 2.1 billion, from 7.6 billion in 2018 to 9.8 billion in 2050!” “United Nations (2018)”. Most of the growth is occurring in developing Regions predicting that seven out of ten urban dwellers will be African or Asian in 2030 “World Health Organization (2010)”. The current global urbanization is not only purely a demographic phenomenon but is also a transformative force that continually shapes societies, their economies, political systems and environments both built and unbuilt.

The new cosmography of the African continent shows a diffuse macrocephaly, with seven megacities – with more than 10 million of inhabitants: Cairo, Kinshasa, Lagos, Accra, Johannesburg, Pretoria, Khartoum e Nairobi. In the next 15 years it is estimated that will be added also Dar El Salaam in Tanzania, currently around the 4.5 million and Luanda in Angola, currently around 2.5 million. Cairo is the most populous city on the continent and with a density that reaches even 1000 inhabitants / km<sup>2</sup>.

Sub-Saharan Africa is usually regarded as the world fastest urbanizing continent's area that will host two of the world largest megacities – over 20 million, in the near future: Kinshasa and Lagos. Kinshasa, the capital city of DR Congo according to the predictions “will count in 2050 a population of around 35 million of inhabitants and Lagos, the Nigerian Capital city around 32 million” “Hoornweg and Pope (2014)”. The development prospects of the Continent largely depend on how the process of rapid and vast growth will be handled over the next few years. In this regard the process has to be based on inclusivity, wide distribution of infrastructures, food and circular economies and nature-based solutions.

#### 1.2 The Rwandan case

Ranked as a rapidly growing city, Kigali accounts for almost 60% of the Rwandan urban population with an annual incremental rate of 9% “Government of Rwanda and GGGI (2015)” and the country's aim is to reach 35% of urbanization

by 2024 “REMA (2017)”. The “Rwandan population is expected to increase from 10.5 million in 2012 to 16.3 million in 2032” and in the same period also Kigali will register a large growth from 1.3 million up to 3.7 million inhabitants as predicted by the “Rwanda National Institute of Statistics (2012)”.

Kigali became the capital city in the early 1960s and is living today a fervent urban rebirth driven by the adoption of a sequence of master plans. The design process began in 2008 by the Singapore-based firm called Surbana with the first Kigali Conceptual Master Plan (KCMP). Thereafter, the municipality approved an integrated and detailed plan for the entire city as part of the Vision 2040, also named the Kigali Master Plan 2013 “City of Kigali (2013)”. Since 2018 the same Singaporean firm has been identified to lead the revision of the present master plan extending its validity under the strategic Vision 2050. Recently the municipality presented to the public the updated Master Plan identified by the motto *Kigali Yacu!* (Our Kigali!) that emphasizes the inclusive nature of the Master Plan approach and intent to work for and with the people thus strengthening the communitarian value of the project. The core characteristic of the developed plans is the construction of a polycentric city to be stretched in all four provinces and at the same time to strength the iconic value of Kigali as modern capital city.

## 2. RESEARCH METHOD

This study will focus on presenting the state of art regarding the actions adopted and put in place by the Rwandan Government in order to fulfil the engagement of becoming an adequate case study of green vision not only for the region but also for the continent. The Kigali and Rwanda development plans have to be divulgated from the national to a broader audience as well as to all organs and institutions interested to have a real series of projects successfully realized or references according to ad hoc policies and legal framework.

The research is not the ending point of a study but the continuation of a path that has begun in 2019 as result of the third National Urban Forum organized in Kigali in partnership with the School of Architecture and Built Environment (SABE) of the University of Rwanda located in the College of Science and Technology in Kigali. Main topic was the important issue of reshaping the capital city according to the master plan recently revised. Therefore, the study is mostly concentrated on topics related to Rwanda over the time with an historical investigation on case studies in the East Africa Region of satellite cities projects.

## 3. THE HISTORICAL CONTEXT

Rwanda achieved Independence on the 1st of July 1962. Two different colonizers – the Germans and the Belgian, occupied the territory that previously was under the domination of the local Kingdom.

### 3.1 The colonial period

The German East Africa (*Deutsch-Ostafrika*) was the German colony located in the African Great Lake Region and composed of the territories today occupied by Tanzania, Burundi and Rwanda. Rwanda formally became a German colony in 1885 first as a district as well as Burundi and later getting an autonomous civil administration upon the arrival of the Belgians in 1916. The Germans appointed in 1907 the Doctor R. Kandt -that already spent 6 years in the region seeking for the Nile sources, as administrator and giving him the task to identify a location for the new capital “Sirven (1984)”. The chosen area is placed about at the centre of the Country on the top of the Nyarugenge hill and surrounded by three mountains: Nyarurema, Jari and Kigali. At the beginning of 1908 R. Kandt realizes the very first building the *Boma* (fortress in Swahili), on the north-west side of the Nyarugenge plateau oriented to the valley of Nyabugogo the only practicable passage for the merchant caravans (Fig. 1).



**Figure 1: Boma site layout and view from south side**

The 9th of May 1916 the Colonel Molitor leading the Belgian troops occupied Kigali. The new administration placed its offices on the plateau of Nyarugenge close to the residential quartier *de facto* abandoning Boma. The military compound was moved in between the city for the Europeans and for the Indigenous that was extended to Nyamirambo. From 1916 up to the Second World War the urban spatial occupation was multiplied by four – 40 hectares that will become 200 in 1958. Three parallel roads are traced all along the Nyarugenge plateau from north to south guiding the construction of the administrative and dwelling edifices as well as in the lowest of the three hosting the commercial activities. The prison

built in 1930 is one of the few Belgian constructions still standing and visible in the modern Kigali. During the Belgian colonization Rwanda had eleven small cities: Butare, Gisenyi, Ruhengeri, Naybissindu, Cyanguu, Byumba, Kibundo, Rwamagana, Kibuye, Gikongoro. Normally built on the top of a hill they were expanded along the gentle sloped sides.

## 3.2 The post-colonial period

Kigali became officially the capital city of Rwanda the 1962 after the Independence, counting a population of 5.000 – the smallest Capital City on that époque and dislocated in two distinct areas, the plateau of Nyarugenge and Nyamirambo hill. The first Masterplan was set up in 1964 and in 1971 the city boundaries were extended to Kimihurura Hill within the creation of the very first industrial zone. In 1978, Kigali counted 90.000 people experiencing a regular growth that pushed the Government to adopt in 1982 the so called Schéma Directeur d'Architecture at d'Urbanisme (SDAU) that was set up under the vision of 20 years' urban development, and based on a prevision of reaching half a million inhabitants by 1995. Anyway, the tragic events occurred in 1994 determined a drastic and rapid fall in terms of the population, reduced at the end of the same year at around 50,000 inhabitants, a reduction that affected the entire nation. The Conceptual Master Plan of 2008 marks the definitive urban rebirth orienting the reconstruction along the direction of a polycentric shape.

## 4. THE POLICIES FRAMEWORK

### 4.1 Towards a green (tropical) architecture

In 2016, countries across the world adopted the *New Urban Agenda* (NUA) during the UN Conference on Housing and Sustainable Urban Development (Habitat III) in Quito, Ecuador “GGGI (2015a)”. Final text of the NUA has its emphasis “on promoting safe, inclusive, accessible, green and quality public spaces, mentioned in nine paragraphs through the lens of urban sustainability or as stand-alone commitments” “United Nations (2016)”. Rwanda also ratified the New Urban Agenda driving the architecture of Kigali and of the all country in a green framework organizing three National Urban Forums (NUF) in 2008, 2011 and 2019.

The building sector is one of the heaviest contributors to human-related greenhouse gas emissions but at the same time reveals a potential to lower its emissions. Urban areas are characterized by the concentration of built structures and infrastructures therefore, green building has become a major component of urban climate change strategies. Nonetheless, the governments' endeavour to reduce the carbon footprint of buildings and the related uses it's taking into account both the local context and the social dimensions of sustainability such as ideas of liveability and affordability. The process of growth in population density, socio-economic inequalities and infrastructure related problems are stressing the need for sustainable city planning to result in the efficient running of cities “Chrysoulakis, de Castro and Moors (2014)”.

Green building transitions means a long time and radical process supported from the new innovations in the construction sector and also from the adoption of dedicated policies. Objectives of smart growth, sustainable cities, sustainable urbanism and green cities are shaping urban agendas and commonly contribute to core objectives in cities around the world “Joss (2010)”. The motto of the recently approved *National Land Use Development Master Plan* is “Ensuring tomorrow's sustainability today!” that highlights the need of investing in green projects.

The Kigali Master Plan 2050 approved in 2020 provides a set of criteria to define and direct the transition: “Acknowledging the natural landscape of the city; protecting sensitive ecological areas from urban growth; restoring damaged natural elements like water bodies; adopting natural resource management system, green building initiatives; forest protection strategies; steep slope protection strategies and green and blue plan – hierarchy of parks, connectors etc.” “City of Kigali (2020a)”.

### 4.2 The 11<sup>th</sup> SDG

The World Green Building Council in 2018 declared that “progress towards sustainable buildings and construction is advancing, but improvements are still not keeping up with a growing buildings sector and rising demand for energy services” “World Green Building Council (2018)”. Unfortunately, the buildings sector remains the prime Greenhouse Gas (GHG) emitter as per Paris Climate Accord ratified in 2016. Hence, urban and building design, construction and operation – as observed by the Global Green Growth Institute in collaboration with the Republic of Rwanda, “have a significant effect on the chances of meeting the 2°C target and pursuing efforts to stay well below 1.5°C” “Republic of Rwanda (2019)”. The definition of green urbanism and green architecture is based on a precise design approach which focuses on increasing the efficiency of exploiting the resources but at the same time targeting a reduced urban and building impact on the human health and the environment during their life cycle.

Therefore, the definition of green embeds a variety of necessary actions: to promote energy & water efficiency; to benefit from the ambient climate; to reduce the use of air-conditioning; to implement the natural cross-ventilation; to maximise the use of local and sustainable construction materials; to provide superior indoor Environmental Quality (IEQ); to protect the natural environment and to promote biodiversity. Green Architecture is also relevant to several targets of the UN Sustainable Development Goals included in the Agenda 2030 for Sustainable Development that forms the Global Development Framework.

The concepts of sustainable development and sustainability are founded on the assumption of securing that there is an improvement in the life's quality, a substantial equity, a conservation of biodiversity as well as a promotion of human survival. In this respect, sustainable urbanization ensures that urbanites have a good standard of living through access to basic services and that there is equity in terms of allocation of services such that social justice is promoted.

## 4.3 The Rwandan adopted policies

The Government of Rwanda, through the Ministry of Infrastructure and the support of the Rwanda Housing Authority has elaborated and adopted a set of different policies designed to achieve the mentioned goals. The *National Green Growth and Climate Resilience Strategy for Climate Change and Low Carbon Development* adopted in 2011 and designed to support Rwanda's development into "a climate-resilient, low-carbon economy by 2050, the strategy suggests favouring the creation of high-density, walkable cities to avoid excessive sprawl and long commuting times" "GGGI (2019)" has been followed by the *National Urbanization Policy* (2015) that sets the framework for interactions between private and public sectors in the country's urbanisation process supporting as main objective the sustainable development. The *National Roadmap for Green Secondary City Development* (2015) that identifies building and construction as key pillars to achieve green urbanization in Rwanda. Then, the *National Housing Policy* adopted in 2015 based on a vision of enabling all income class people and their location to get adequate housing in sustainably planned and developed settlements. Moreover, it supports privates that want to invest in affordable housing thus, allowing a wide range of population to be appropriately dwelled at a reduced cost. The *Urbanization and Rural Settlement Sector Strategic Plan 2018-2024* is more focused on the achievement of good development management and spatial distribution of growth.

More recently Rwanda has adopted through a Ministerial Order a series of new regulations and policies set up in order to achieve a sustainable and green urbanisation. The *Urban Planning Code* determining the urban planning and building regulations, at the same time it provides a basis for forward planning, development management and plan implementation. The *Building Faults and Sanctions* that lists fines related to faults committed during construction of buildings and/or urban planning and the *Rwanda Green Building Minimum System* also approved in 2019. It is composed of green building indicators that address the basic green aspects the buildings should have: "appropriate orientation, day lighting, natural ventilation, rainwater harvesting, efficient plumbing fixtures, low-impact refrigerants, greenery protection and paints not harmful to the occupants" "GGGI (2015c)". Impressive is also the motto of the recently approved *National Land Use Development Master Plan* - "Ensuring tomorrow's sustainability today!", that highlights the green path paved toward sustainability. The overall objective of the mentioned policies and strategies is to support good urban development that can enhance both local and national economic growth ensuring a good quality of life for all citizens.

## 4.4 The green council building

"Rwanda guides urbanization and human settlement in a way to efficiently use and manage its natural resources while promoting sustainable development" "Ministry of Infrastructure (2015)". Conceived as a simple, effective and environmental performance-oriented regulation the *Rwanda Green Building Minimum Compliance System* collects a series of indicators that have been identified to foster in particular the energy & water efficiency, the environmental protection, a better IEQ for the inhabitants and green innovation "Republic of Rwanda (2019)". The approved System that is not yet targeting the residential buildings is composed –as said, by five main modules or focus areas. The first one is conceived to improve the energy efficiency with a special regard on the orientation given to the building, on the overall design, on the construction materials used and on the choice of equipment. Afterwards, the building has to optimize the water efficiency that is mostly based on appropriate devices to harvest the rainwater, on the installation of water efficient features and last but not least on the wastewater treatment plant that cuts down the use of potable water. The module named "environmental protection" is much more oriented to the reduction of the building impact to the environment through a contextualized design, the adoption of good practices and an accurate selection of materials to implement the project. Further, the IEQ enhances the fresh outdoor air provision and also the thermal and acoustic comfort. The last module – green innovation, targets the application of green practices and new technologies that are innovative and have potential environmental benefits.

## 5. THE POLICENTRIC STRUCTURE

### 5.1 An historical overview

The famous diagram of the *Three Magnets* coined in 1898 by Ebenezer Howard, was proposing a city-exit towards the promise of fresh air and nature, offering sufficient work and a new social life. Built on the idea of a polycentric Social City the Garden City of To-morrow was able to host 32,000 people, living in 1,000 acres of land and surrounded by a vast green belt. Once reached the limit of population another satellite would have been initiated a short distance away nonetheless, remaining all interconnected by a rapid transit system "Hall (2014)". Howard's idea of the satellite city was put into practice for the very first time by Barry Parker and Raymond Unwin in the design of Letchworth and Hampstead. A young German architect, Ernst May, in 1906 was working by Unwin at the translation of *Town Planning in practice*, Unwin's work on urban design theories.

### 5.2 East African references

The link between May and the development of the Satellite city in the East African Region is based on his decision to move from Europe before the clash of second world war buying a farm in Arusha, Tanzania. Afterwards, Ernst May worked for the Uganda Government in the definition of the Kampala Extension Scheme and in 1945 he signed a contract for the British colonial authorities in order to conceive "a plan for the rapidly growing post-war building market, the plan will stand out for its progressive idea to include large settlements for low and middle-income Africans, one of the first in East Africa to do so" "Gutschow (2009)". The German architect "started to design the plan with the observation that the existing city was a beautiful garden city" "Demessie (2012)". The founding architectural element is the so-called

Zielenbau or row house adapted to the tropical context: main axis facing east-west sides; use of local materials; employ of features to enhance the sun protection and the cross ventilation; a flourishing greenery surrounding the dwellings. In 1952 was offered by the oil company Shell the opportunity to design a settlement in Port Tudor, west of Mombasa in Kenya. Port Tudor was intended as a satellite for workers characterized by a large common green zone around which he located different housing typologies. Analysing these completed projects, the intention of May to introduce some architectural principles typical of the tropics is evident: orientation, wind and ventilation, shading, protection against heat transmission and large use of natural lighting. The climatic problem, connected with the composition of the constituent parts of the buildings, gave birth to an identity that must not forget that “simple life forms are the closest to perfection” “Dequeker and Kanene (1992)”. These features reveal also a sort of green approach or a sustainability before sustainability and around fifty years later in the same African Region the City of Kigali is building its urban future following the past traces. Therefore, the rediscovery of the Tropical Architecture seems to be the fundamental point to achieve the country Renaissance towards making cities inclusive, safe, resilient and sustainable.

## 6. KIGALI AS A PROJECT

### 6.1 The Kigali Master Plans

The paper aims to tackle the nature of the Kigali urban future. The starting assumption is to intend the city as an architecture that builds itself over time. In the book the Architecture of the city Aldo Rossi reminds that the city “is to be understood as architecture. By architecture, we do not only mean the visible image of the city and all its architectures. It’s more about architecture as construction. It wants to talk about the construction of the city over time” “Rossi (1982b)”. Therefore, the city built itself over time, a time that is becoming more and more sustainable in the sense of a continuous comparison with its history and its identity towards the future.

The Kigali Master Plan is a comprehensive long-term plan intended to guide growth and development of Kigali City “Republic of Rwanda (2013a)” and at the same time providing a road map for the future expansion. As previously mentioned the first Master Plan was developed by Surbana in 2008 revised in 2013. The Kigali City Masterplan from 2013 underlines the principles of sustainable development and its vision is to make Kigali the Centre of Urban Excellence in Africa. The master plan adopts a structure of a satellite city, with decentralized growth nodes and development meant to intensify along transit corridors mainly directed east and south, and with the Central Business District (CBD) being the centre point of the growth. The adopted satellite structure is meant to be extend to all country with a six secondary cities network revolving around the Rwandan capital (Fig. 7). Therefore, the country and Kigali have to be intended as parts of a unique plan designed to shape the built and unbuilt environment and also as the result of political intention. Architecture has to regain its fundamental role in shaping the city and paving the urban future. In fact, the project of Kigali as a green city begins from a peculiar model of city, the satellite model, composed by architectural projects, the green settlements (Fig. 2).

In 2020, the municipality approved the revision of the 2013 Masterplan. The new Kigali Master Plan 2050 is envisaged to integrate the old plans providing corrective measures to improve and adjust the Kigali urban development strategies to support the economic green growth positioning the country as the centre of excellence for innovative and inclusive urban planning in Africa. The plan aims to achieve eight main goals to direct the urban and economic growth as well as the land and urban management for the next decades.

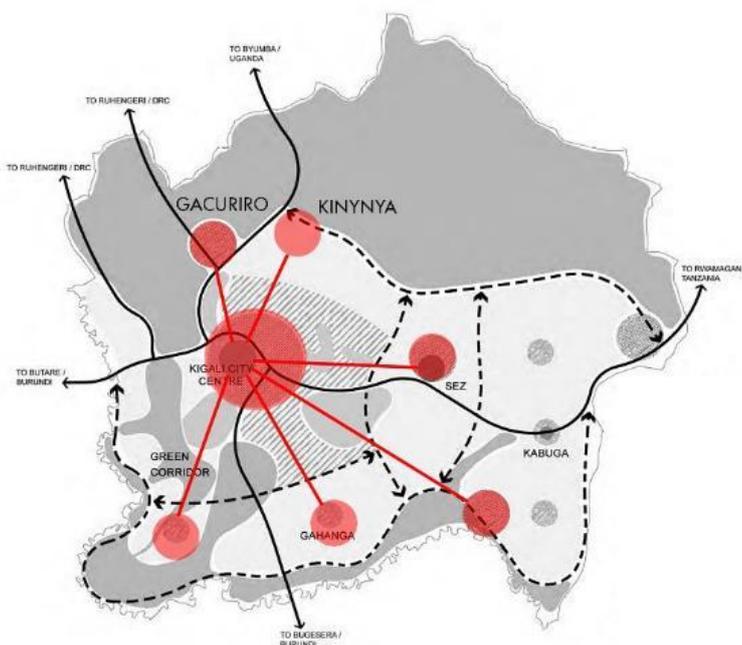
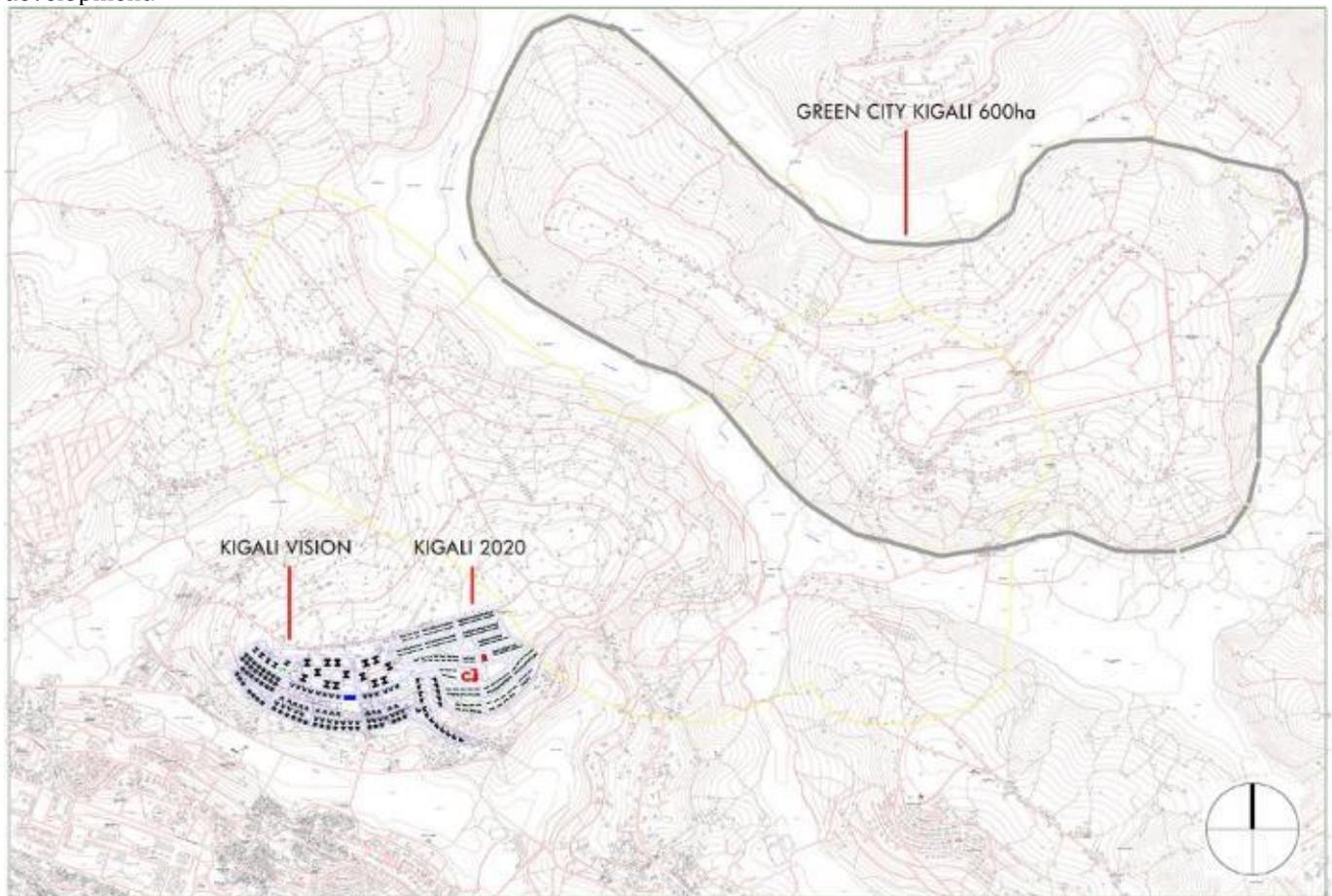


Figure 2: The satellite development of the City of Kigali

## 6.2 Satellites and settlements

Kigali builds itself and its green future over time. The 21st century has seen the re-shaping of the capital city directing its development through a very peculiar project: the satellite city. The paper is focusing on the analysis of three settlements, Kigali 2020, Kigali Vision and Green City Kigali that represent the quintessential green urban examples of the Masterplan. All located in the north- east side of the Capital, Kigali 2020 and Kigali vision are part of the Gacuriro area instead, Green City Kigali is a project under realization on the Kinyinya Hill (Fig. 3). In the Satellites the single-cell is articulated in different dwelling types and jointly with the public facilities constitute an entire settlement, and the three *imudugudu*, in Kinyarwanda, shape the whole City design. They seek also to address issues related to urban sprawl, poor connectivity, singular urban functions, poor allocation of social infrastructure, lack of socioeconomic mix and poor connectivity of movement, infrastructure and ecological networks. These principles are designed to ensure that socioeconomic and environmental sustainability is protected and promoted as urban growth occurs through controlled expansion and upgrading/densification of existing and future areas. In addition, the promotion of a sustainable economy via local production, employment and consumption is a key area of development within the Planned City Extension (PCE) principles "UN-Habitat (2015)". All these aspects are strictly connected with the initial assumption of a green urban development.



**Figure 3: Kigali 2020 and Kigali Vision in Gacuriro satellite; Green City Kigali project in Kinyinya satellite**

## 6.3 Kigali 2020

The Kigali 2020 represents the first compositional element of the satellite city. Located in the Gacuriro hill the settlement is characterized by the aggregation of 4 different semi-detached housing typologies placed along the contour lines in order to protect the existing context from invasive site works. The available public facilities – the church and the Schools, build the central green area that serves as community main space (Fig. 4). All the edifices are realised making use of locally produced materials thus augmenting the environmental protection such as granite stone for the foundations, fired bricks for masonry, tiled/pitched roof, timber ceiling and other details that guarantee high indoor environmental quality comfort. Moreover, the use of clay increases the thermal mass and at the same time decreases energy consumption. The main elevations of the units follow the north-south orientation while the east-west facades present few and small openings due to the more sun exposure during the day. The typical overhanging roof protects from the north side heat but unfortunately is not exploited to harvest rainwater thus reducing the water efficiency. Each unit is provided by a front and back yard, two traditional spaces that enhance the outdoor life and activities and residents should be able to enjoy the social and economic benefits of urbanization while minimizing ecological footprints.



Figure 4: Site layout of Kigali 2020 and exterior view of twin houses

#### 6.4 Kigali Vision

The *umudugudu* (settlement) Kigali Vision completes the second phase of the Gacuriro Satellite. It is made by a variety of dwelling typologies: apartment blocks, townhouses and villas. The 544 units composing the settlement are located in different areas of the hill side with the highest building at the top and the lowest at the bottom between a narrow green strip that physically connects the east and west parts of the project. Unlike the Kigali 2020 project where the common facilities are located in the middle of the settlement are grouped around a main green cluster the ones in Kigali Vision are scattered all along the green common area (Fig. 5). The whole settlement is surrounded by a fence, giving it a protected compound nature and at the same time rejecting the connection with the future urban expansions. The main goal of Kigali Vision is to bid for the modern citizen a modern lifestyle in a safe, quiet and natural environment, but despite these premises its construction reveals some criticality in terms of green innovation. First of all, the design of the houses does not comply with the basic principles of the tropical architecture found in Kigali 2020. The rule of orienting the main facades facing north-south and the shortest east-west dwellings is not always respected as well as following the contour lines of the slope in order to achieve adequate environmental protection. The fact of not orienting the buildings correctly affects the indoor environmental quality with an increase in temperature that required an inevitable increased trend in energy consumption. As seen for Kigali 2020 also the Kigali Vision settlement doesn't adopt a harvesting system for rainwater with the roof not adequately sized to protect the elevations.



Figure 5: Site layout of Kigali Vision and exterior view of villas and apartment buildings

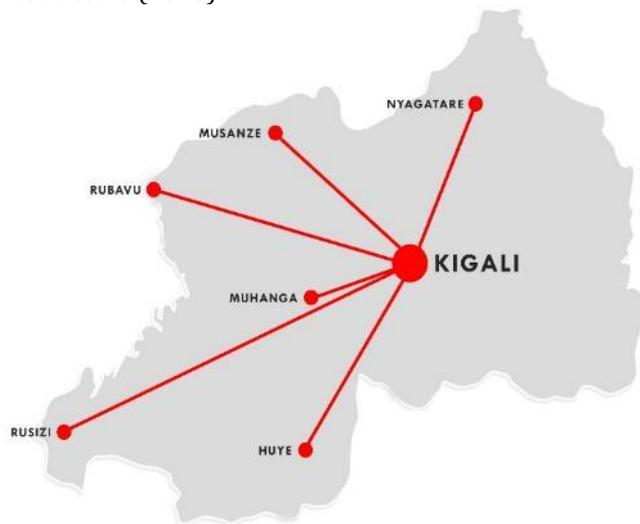
#### 6.5 Kigali Vision

Green City Kigali (GCK) is a 600ha project of sustainable community intended to be occupy the Kinyinya Hill site (Fig. 4) and that will be realized as part of the Vision 2050. The aim of the Green Vision Kigali project is to combine social, economic and environmental targets with strong governance to create a liveable and resilient urban community – a shining example of the future sustainable urban community in the East Africa Region. Residents of the updated Kinyinya Hill should be able to enjoy the social and economic benefits of urbanization while minimizing ecological footprint for environmental protection and optimizing green innovation. It will be mostly composed by affordable housing, that is linked with climate change adaptation and mitigation measures setting standards for sustainable urban development in Rwanda. The new city will assist also in healthy urban growth, maintaining Kigali's low carbon footprint by using local materials and resources both for the indoor environmental quality and for the construction of energy efficient buildings. Another goal is to promote a sustained and inclusive economic growth cycle for an economic wellbeing supported by a non-vehicular internal and external connectivity.

### 7. RWANDA AS A PROJECT

#### 7.1 Secondary cities structure

Rwanda is one of the most densely populated countries in Africa, with around 400 p/sq.km and “with a current annual growth rate of 2.4% the population in the Country may reach 25.8 Million in 2050, with gross density approaching 1000p/sq.km, one of the highest in Africa” “Republic of Rwanda (2020)”. The Six Secondary Cities Plan guides and orients the future urbanization according to a precise road map to reduce also the urban pressure on the capital city. First, the growth of Kigali will be limited to 3.8M in order to boost the decentralisation process focused on the secondary cities moving from the chronic issue of urban monocephalism. The majority of the population lives in the countryside and engage in agriculture and the Government of Rwanda has embraced urbanisation as a tool to further build the Country. Urbanisation process is supported by a stronger transportation system linking nodes and centres that is at same time also a prerequisite for the economic growth of Rwanda able also to unlock more financial and trade opportunities. The polycentric structure of Rwanda –as previously said, is articulated in six secondary cities (Fig. 6): Musanze (Northern Province), Huye and Muhanga (Southern Province), Rubavu and Rusizi (Western Province), Nyagatare (Eastern Province). Therefore, the government priority has become the development of cities as poles of growth and sites for pilot green projects based on experiences and case studies set in Kigali: “Behind the priority of supporting the development of chosen secondary cities is the idea that proactive development of secondary cities can mitigate the risks and construct a competitive national economy on the basis of sustainable city network, crucial for Green Growth of the Country” “Ministry of Infrastructure (2013)”.



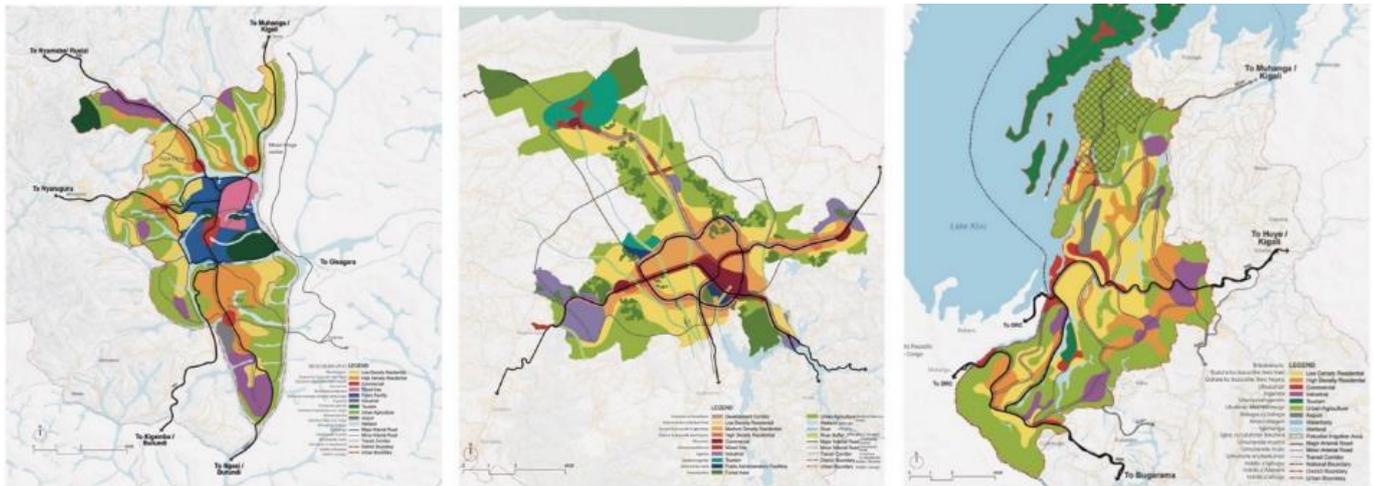
**Figure 6: Kigali and the six secondary cities**

In the Economic Development and Poverty Reduction Strategy II (EDPRS2) is mentioned the National Green Growth Strategy addressing the urbanization process as a key factor to “transform the economic geography of Rwanda by facilitating and managing urbanisation and promoting secondary cities as poles of economic growth” “Republic of Rwanda (2013b)”. The target was also to get for each of the city an Urban Master Plan and a Land Use Management able to appropriately resettle the population scattered in the rural areas concentrating it around the existing centres. The secondary cities have to be better served with infrastructure and services identified by a peculiar character.

Musanze is the major tourism hub in the country focused on the Gorilla attraction; Huye is the academic hub and the heart of cultural tourism due to the high concentration of historical sites; Muhanga is considered the centre of mining activity for Rwanda; Rubavu and Rusizi are the trade and lake tourism centres; Nyagatare continues to be the main reference for agriculture and processing.

## 7.2 Towards green Rwandan cities

So far, three out of six master plans have been presented and publicly displayed, the one of Huye, Musanze and Rusizi. Analysing the developed structure plans it’s possible to recognize the features that have inspired the green approach and how they have been applied. The structure plan of Huye (Fig. 8) in which the historical city centre is surrounded by green spaces intended as touristic sites. The administrative boundaries are delimited using areas for urban agriculture in the vision of a full sustainability but at same time limiting the expansion of the city. The plan of Musanze (Fig. 7), reveals the intent of shaping the development according to a renewed relationship with the natural context that to some extent control the urban growth. Buildings scale down from the centre moving to the peripheral areas. The case of Rusizi raises the issue of a green city placed and articulated along the Kivu lake shores. However, it is also identified by a wide green belt on the east side that has to preserve its sprawl (Fig. 8).



**Figure 7: Proposed master plans for Huye, Musanze and Rusizi**

## 8. CONCLUSIONS

The research depicted the state of art regarding the rapid rate of urbanization that the African continent is experiencing, a phenomenon that in the case of Rwanda has been tackled following a sustainable and green approach. The achievements envisaged by the 11th SDG and the other related goals focusing on technology, poverty and climate change are engaging the urban agenda and the new Masterplan of Kigali City and the six secondary cities are the foundations for a sustainable, inclusive, resilient, and safe urbanization. The country vision 2050 is built on the Green Growth and Climate Resilience Strategy and is mainly grounded on “a developed climate-resilient, low carbon economy, with a strong services sector, low unemployment and low levels of poverty” (Republic of Rwanda 2015). All these objectives reflect the orientation given to the urban and national development through the adoption of a precise structure: a polycentric regional plan composed by six secondary cities interconnected with the Capital City, Kigali. Kigali is shaped according to a satellite model that has been already applied in the Region and each satellite is made by green settlements. Starting from the assumption that the City builds itself over time it has been demonstrated that the green future began in the past and its proceeding through a series of architectural interventions: Kigali 2020, Kigali Vision and Green City Kigali. Even though Kigali 2020 reveals more sustainable features than Kigali Vision the two artefact represent the Government commitment to reach the targets of the Agenda 2030. New settlements have to focus on affordable housing and on how to integrate housing with climate change adaptation and mitigation measures. Paraphrasing the words of the Congolese writer Sony Labou Tansi, Kigali will never be New York, each city has its own soul, the genius loci that contextualizes the global green model to each specific environment. The green polycentric pattern has been stretched at national level providing a scheme composed by six secondary cities each of them developed through the adoption of single master plans. These master plans, as the ones for Kigali are based on the assumption of realizing a sustainable urban growth.

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# PARALLEL SESSIONS (3)

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## National Session: SS43 - Advances in Regional Science: Contributions of Italian Scholars



**AISRe**

Associazione Italiana  
di Scienze Regionali

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/87320775891>**

**Chair Roberta Capello**

**SPACE, LAND RENT AND INCOME DISTRIBUTION**

**Roberto Camagni**

Politecnico di Milano, Italy

**ABSTRACT**

The paper addresses an evident bias in the theoretical scientific trajectory of regional science: a bias towards a functional-geographic dimension, addressing mainly the production and demographic side of the economy, as opposed to a hierarchical distributive dimension, addressing the power and income distribution side. This neglect has generated in recent times the inability to foresee and even perceive the phenomenon of growing «uncertainty» and «discontent» in wide parts of the society. The geography of physical assets should merge with a geography of control through networks of power élites and the selective and cumulative learning role of places. The use of GDP statistics at constant prices should be replaced by current prices, pointing out disparities in monopoly pricing and unbalanced terms-of-trade between the large cities and the rest of territory. Income distribution should be intended in three senses: personal, functional (wages, profits and rents) and «territorial». Early results on these fields are shown, pointing out the difficulties of a part of the middle class, threatened by the automation of their occupations, and the command role of large cities. Evidence are shown concerning the increasingly unbalanced situation of Italian cities (with a widespread effect on entire macroregions as the Mezzogiorno: again!) and of European cities.

**OPENNESS AND REGIONAL GROWTH**

[Laura Resmini](#)

Università di Milano-Bicocca, Italy

**ABSTRACT**

The openness-growth nexus is an issue that has intrigued many scholars from different disciplines, like international economics, economic geography, regional economics, international business, for a very long time, difficult to date. While theoretical implications are quite clear, the empirical evidence is mixed and scarce, especially at sub-national level. Indeed, openness is not observable at regional level; therefore, it is difficult to identify a comprehensive and reliable set of quantitative variables measuring the different dimensions of the phenomenon. Despite this objective difficulty, much has been done and today we have a more comprehensive view of the nature of the phenomenon, as well as its trends and territorial impacts. This paper summarizes the theoretical milestones, i.e. the principles universally accepted by the literature, and the most recent empirical trends at territorial level, with special emphasis on the contribution of Italian Regional Scientists.

**KEYWORDS**

international trade, foreign direct investment, global production networks, openness, regional growth

**JEL classification**

F23, F10, F63, O30, O19, R11

**EVALUATION OF THE EFFECTIVENESS OF FIRM SUBSIDIES IN  
LAGGING-BEHIND AREAS: THE ITALIAN JOB**

**Augusto Cerqua, Guido Pellegrini**

Department of Social Sciences and Economics, Sapienza University of Rome, Italy

**ABSTRACT**

Since the late 1990s, Italian scholars have produced numerous studies in the field of regional policy evaluation, especially ones that have investigated the impact of financial incentives aimed at supporting the accumulation of private capital in underdeveloped areas. The number and innovativeness of these studies make it possible to define the presence of an Italian school for evaluating regional policies. This paper testifies to the importance and methodological advances of this school, putting it at the frontier of policy evaluation analyses. The presentation of the studies moves in two directions, historical and methodological, identifying the main themes and techniques addressed in recent years: the evaluation of Law 488 and negotiated programming policies, on the one hand, the advance in policy evaluation techniques in the presence of interactions and continuous treatment, on the other. The paper does not claim to be an exhaustive review; rather, it should be considered an overview of the historical path and the future prospects of what we call «the Italian school of regional policy evaluation».

## RESILIENCE AND CONVERGENCE: SHORT VS. LONG-RUN. REGIONAL EFFECTS OF ECONOMIC CRISES AND MACROECONOMIC POLICIES

Fabio Mazzola, Pietro Pizzuto

University of Palermo, Italy

### ABSTRACT

Within-country disparities in advanced economies have increased substantially during the past decades. They have become a major concern for policymakers since, beyond the direct social welfare and equity consequences of this rising trend, there is growing evidence that regional disparities may have important implications for economic outcomes.

Before the outbreak of the Great Recession, considerable attention was devoted to what makes a region successful, and why some regions grow faster than others, but researchers often overlooked how regions react to shocks and why this happens in a heterogeneous way. Furthermore, the classic literature on regional inequalities has mainly focused on the long-term relationship between economic growth and regional disparities and on the role of labor mobility, sometimes also as a mechanism of adjustment to labor demand idiosyncratic shocks. This literature trend has reversed since 2008, when investigation of the heterogeneous impact of shocks across areas became prominent in regional studies through the analysis of regional resilience. Moreover, the discussion on the asymmetric effects of macroeconomic policies, which was not a major concern in recent decades, has suddenly reemerged.

This paper surveys the recent approaches adopted to study regional disparities as related not only to the process of economic growth but also to economic downturns. The investigation focuses initially on the relationship between national business cycles and idiosyncratic regional shocks and then moves on considering explicitly the role of macroeconomic policies and dynamics in affecting, through the impact on specific local assets, the process of (unequal) long-run regional growth as well as short-run resilience to economic shocks.

## **Regular Session: RS14.4 - The spatial dimension of sustainable development**

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84686769452>**

**Chair Andrea Salustri**

## GEOSPATIAL TECHNOLOGIES FOR MONITORING THE SUSTAINABLE DEVELOPMENT GOALS

**Jozsef Benedek<sup>1</sup>, Kinga Ivan<sup>1</sup>, Ibolya Török<sup>1</sup>, Arnold Temerde<sup>2</sup>, Iulian-Horia Holobacă<sup>1</sup>**

<sup>1</sup>Research Centre for Sustainable Development, Babes-Bolyai University, Romania. <sup>2</sup>AROBS Transilvania Software, Romania

### ABSTRACT

In order to measure progress in achieving the Sustainable Development Goals by 2030, 169 targets have been approved globally. Even though interest in implementing these goals is high, many states have not yet established a set of subnational indicators to measure the implementation of the SDGs and have not completed their own assessment of progress in achieving these Global Goals. This study aims to measure the progress towards achieving the SDG at local and regional level in Romania by calculating the SDG Index. For the calculation of the SDG Index at subnational level we propose an integrated approach based on 90 indicators, stored and processed in a PostgreSQL object-relational database. This approach offers three novelties: the generation of a territorial database on local level, which includes both rural and urban areas; the large employment of earth observations methods in the measurement of the SDG indicators; and the development of a new data model for the measurement of the SDG index.

The results show the concentration of the highest performances of sustainable development in some specific geographical areas. The rural areas and the extended peripheral regions in the eastern and southern part of the country are the poorest performers.

We outline that the our model is an attempt to quantify the performance of each LAU (Local Administrative Units) on the SDGs, contributing in this way to calls for more progress in the operationalization of SDGs and in the evaluation of indicators' relevance. It will provide a policy-relevant assessment tool for the LAUs in establishing their position within each SDG, which in turn will help them to set up empirically sound and politically relevant Local Development Strategies. Moreover, understanding the differences in sustainable development across multiple scales and resources will enhance the ability of central authorities to balance sustainable development between national and various sub-national levels.

## INEQUALITIES AND SUSTAINABLE DEVELOPMENT: TOWARDS THE IDENTIFICATION OF A NEW INTERPRETATIVE MODEL?

[Andrea Salustri](#)

Sapienza University of Rome, Italy

### ABSTRACT

The ongoing COVID-19 Crisis is making manifest how the current development model driven by technological progress and market interactions may be structurally mis-specified with respect to the existence of societal needs that may trigger non-linear dynamics. Starting from these premises, this research deepens previous analyses framed within the broader international literature on the SSE, and on its interaction with private and public actors, particularly in the context of the implementation of the 2030 Agenda and of the activation of local development of marginalized groups in peripheral territories. However, contrary to a generalized tendency to prefer qualitative over quantitative approaches, qualitative issues are reframed within a quantitative framework of analysis. The research lacks empirical support as it is mostly the result of a theoretical investigation into the neglected structural fallacies of economic models (i.e., the omission of distance costs and the related lack of concerns for proximity, the adoption of the coeteris paribus assumption and lack of interest for the “unobservables”, and the absence of qualitative considerations). It is worth noting how the critique to the mainstream approach is functional to the identification of a more complex (and flexible) theoretical model. Results may lead to develop an epistemologically unbiased theoretical construct able to foster a more articulated interpretation of the SDGs and of their targets. A more in-depth analysis of the structural properties of the model may suggest new ways of tackling the COVID-19 crisis.

## **Regular Session: RS16.1 - Tourism**

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/88466279359>**

**Chair Éva Happ**

## SUSTAINABLE MEASURES IN HOTELS ANALYSED FROM THE DEMAND SIDE

Éva Happ, Júlia Nagy-Keglovich

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### ABSTRACT

Tourism, and especially the hotel industry has a huge impact on the environment. While revenues and the number of jobs in tourism are significantly increasing yearly, the negative impact on the environment is growing as well. Hotels have become more conscious over the last two decades, due to the legal obligations. In the point of view of marketing, it is very useful to introduce the guests to technological processes which a hotel operates. However, developing an environmentally conscious approach is a long-term process that must also function as an element of organizational culture. We can say that all tourism businesses have activities and impacts which are harmful to the environment. There are number of papers which investigated how, with which methods and tools the hotel industry could reduce its environmental footprint. The purpose of this study is to investigate the “green” hotel experience from a guest perspective, from the demand side of tourism. The aim of the research is to find out how much the guests are eco-conscious and responsible, if they take into account the negative environmental impacts of their travel. The research examines the extent of the guest experiences’ decline while using different eco-conscious tools in hotels and whether guests are supporting green solutions at the expense of the decreasing of guest experiences. A survey was conducted among the guests of a four-star city hotel to find out the importance and disturbance of sustainable measures at a hotel. Based on the responses of the questionnaire, it is clear that guests are rather eco-conscious and they also consider what green activities and actions the hotel is pursuing. Based on the research the following conclusions can be drawn: hotels have a great responsibility for the “green” hotel issue. The guests will always be more eco-conscious at home than at the hotel, but this can be changed on purpose. The first mission is to make “green” the hotel’s long-term strategy, which requires the commitment to the environment from the particular manager/owner.

### KEYWORDS

consumer profile, green hotel, responsibility, sustainability

### 1. INTRODUCTION

Tourism is the second fastest growing industry in the world economy. According to a February 2019 report by the World Travel and Tourism Council<sup>25</sup>, the GDP contribution of the travel and tourism sector to the total world GDP increased by 3.9% in 2018, while the total GDP grew by 3.2%. Today, one in five new jobs in the world is generated in this sector, resulting in 319 million people currently working worldwide in this industry and an additional 100 million jobs will be created over the next 10 years. On one hand, tourism makes a large use of resources and, on the other hand, its emissions are released into the environment. According to a 2018 survey, the tourism sector is responsible for 8% of greenhouse gas emissions. Between 2009 and 2013, CO<sub>2</sub> emissions increased by 15% worldwide in tourism, showing much higher growth than expected (Lenzen et al. 2018).

These figures show that tourism, and within that the hotel industry, has a huge impact on the environment. The parallel is visible: while the number of revenues and jobs is growing significantly from year to year, the negative impact of tourism on the environment is also growing significantly. This is why hotels have a great responsibility, as sustainability is an important area for everyone. Hotels have become more and more environmentally aware in the last decades, which is partly due to the obligations of the law, but from a marketing point of view, it is also useful to introduce the technological processes the particular hotel use to the guests. However, developing an environmentally conscious approach is a long-term process that should also function as an element of organisational culture. Happ (2014: 92) writes about responsible tourism, which is an “emerging approach to how the market players of tourism can take their share of responsibility”. More and more people are starting to live eco-consciously and pay attention to their environment, which also affects their travels. Hotels should therefore place as much emphasis as possible on the use of green activities.

According to the American Green Hotels Association, the concept of a green hotel is the following: green hotels are environmentally friendly facilities whose management is committed to programs that reduce water and energy use as well as the quantity of solid waste to protect the Earth while they also save money. ([www.greenhotels.com](http://www.greenhotels.com))

The Association of Hungarian Hotels and Restaurants (MSZÉSZ) also pays special attention to changing Hungarian hotels “green.” The work on this issue has been ongoing since 1993, and since 1994 hotels have been able to apply for a “Green Hotel” tender as well. It includes the following aspects: disclosure of information, energy, water, wastewater, waste management, ozone layer protection, green procurement and green office ([www.hah.hu](http://www.hah.hu)).

<sup>25</sup> World Travel and Tourism Council, wtcc.org.

The aim of the study is to examine the extent to which guests in hotels tolerate the use of various "green", environmentally conscious devices and the extent to which the guest experience is harmed during the use of these eco-friendly solutions. The research also examines whether guests are supportive when the the guest experience is damaged due to the processes to achieve sustainable development goals. The sample is not representative, but in the light of the results we can get a comprehensive knowledge of what the attitudes of guests are towards the use of green hotel facilities.

## 2. ENVIRONMENTALLY CONSCIOUS BEHAVIOURS BASED ON THE RESULTS OF FOREIGN RESEARCH

Consumer behaviour is also a key indicator of the quality and efficiency of work done in any industry, including tourism. Therefore, it is important for a given hotel to get to know the environmentally conscious behavioural attitudes of its guests as much as possible.

Individuals, including hotel guests, are becoming increasingly aware of the environmental impacts of hotel activities. An environmentally conscious consumer will exhibit environmental behaviour sooner than a guest whose motivational medium does not include eco-consciousness.

The 4 levels of environmentally friendly attitude are the following (Laroche et al. 2001):

- Who merely perceives environmental problems and gets stuck at the level of concepts such as declining drinking water supplies, limited energy, and shrinking forests.
- Those who feel uncomfortable due to the perceived problems are already able to perform basic green activities.
- Anyone who cares about environmentally friendly behaviour, recognises that green activities can reduce pollution.
- The last dimension is the level of corporate responsibility. Anyone who gets this far is confronted with the fact that companies are the ones who are really involved in the environmental impact.

Environmental awareness is usually associated with a positive attitude, which promotes environmentally friendly activities. This is based on cognitive consistency (Festinger 1957), according to which if an individual is involved in ecological issues, he or she will most likely be motivated to address and solve them as well. An environmentally friendly attitude and commitment to environmental protection help an individual to buy a green product or use a green service, which implies that they also seek the services of green hotels (Baker et al. 2014). According to the research of Lee et al., although an individual may be environmentally conscious, but if there is no immediate benefit from their purchase, the environmentally friendly attitude will not always prevail (Lee et al. 2010). Further research has demonstrated that an individual with an environmentally friendly attitude is willing to pay more for a green product or service (Han et al. 2009). According to social identity theory (Tajfel 1978), there is a positive correlation between the level of environmental awareness and how much an individual is willing to pay.

It is also a challenge for hotels to better understand guests' attitudes towards green consumption. While hotels are forced to take part in green activities under legal and social pressures, guests do not always accept this. There are three barriers to adoption:

- if the guest's sense of comfort is compromised, they immediately become dismissive of green initiatives.
- the guest is reluctant to give up their "right to luxury"
- if the cost reduction is to the detriment of the guest (Tzschentke et al. 2008)

Tzschentke-Kirk-Lynch's findings are supported by Tsai-Tsai's 2008 research, which concludes that there is a less positive correlation between environmental ethics and environmentally friendly consumer behaviour due to hotels' emphasis on promoting their luxury services (Tsai-Tsai 2008).

Further research has focused on whether there is a difference between environmentally conscious behaviour in hotels and at home. Dolnicar and Leisch sought an answer to this in their 2008 study. 92% of the respondents stated that they were environmentally conscious at home, while only 25% behaved in an environmentally friendly way during their stay at the hotel.

Thanks to TripAdvisor's GreenLeaders Program<sup>26</sup>, the correlation between the green activity of hotels and consumer behaviour were analysed based on 572 guest comments. The key findings are: eco-conscious nations behave in an environmentally conscious manner during their travels and this is reflected in their comments as well; environmentally conscious cities receive more guest reviews on this topic; and there is a deep gap between the green activity of hotels and guest information (Londono-Hernandez-Maskivker 2016).

Research from the University of Arkansas (Ogbeide 2012) sought answers to the following questions: the importance of the green hotel concept for guests; what guests would do to support the green hotel; what are the green practices that guests are still willing to endure. The result showed that, in theory, most respondents rather group the measures to the 'more important' category, but would not be willing to pay more for them. Half of the respondents would even expect to be rewarded with loyalty points (Ogbeide 2012).

In a 2014 research, Baker-Davis-Weaver looked for the answer, which group of people with different environmentally conscious attitudes are the ones who prefer to stay in a green hotel and are willing to pay more for green services; what are the barriers, such as the desire for comfort and luxury, and how much they influence guests in their decision making; and whether guests behave as environmentally conscious in hotels as at home. The most important results of the research are:

<sup>26</sup> <https://www.tripadvisor.com/hc/en-us/articles/200614147-What-is-the-TripAdvisor-GreenLeaders-Program>

- those who care about eco-friendly behaviour prefer to stay in a green hotel
- who is only at the level of perception in environmental awareness, prefers not to choose a green hotel
- who is only at the level of perception will not pay more for a green hotel
- comfort expectations negatively affect greater willingness to spend
- luxury expectations negatively affect the choice of a green hotel
- green cost-cutting measures have a significant impact on willingness to pay
- cost-cutting measures have a significant impact on green hotel choices
- individuals theoretically expect green activity from the hotel, but do not take it into account during the decision making process
- individuals are much more environmentally conscious in their homes than in hotels (Baker et al. 2014).

In 2015, Kubickova-Parsa-Nusair-Hu conducted a survey among Generation Y, which found that the millennial age group pays attention to green activities and is willing to pay more for the services of an environmentally friendly hotel (Kubickova et al. 2015).

Also in 2015, Deraman-Kassim-Ismail-Arifin-Zaini conducted a survey in Malaysia on how committed guests are to green activities. Results showed that there is a positive relationship between environmental awareness and acceptance of and participation in green activities, but hotels have a very high responsibility for education as well, which still lags behind (Deraman et al. 2015).

It is also clear from the short summary table of foreign research presented by the authors (*Table 1*) that geographical differences are less significant, rather the individual consumer behaviour of people is decisive in adopting green activities.

**Table 1: Summary of the results of foreign research**

<i>Researchers</i>	<i>Year of research</i>	<i>Topic of research</i>	<i>Short summary</i>
Tzschentke-Kirk-Lynch	2008	acceptance of green activities among guests	3 barriers of acceptance: loss of comfort, violation of the right to luxury, extra costs
Tsai-Tsai	2008	acceptance of green activities among guests	luxury and environmental awareness are mutually exclusive
Dolnicar-Leisch	2008	differences in home and hotel behavior	people behave in a more environmentally conscious way at home than in hotels
Ogbeide	2012	acceptance of green activities among guests	guests prefer green activity until they have to pay more for them
Baker-Davies-Weaver	2014	acceptance of green activities among guests	confirmation of the above 4 research
Londono-Hernandez-Maskivker	2016	relationship between green activities and consumer behaviour	environmentally conscious nations behave in an environmentally conscious manner in their travels
Kubickova-Parsa-Nusair-Hu	2015	consumer behaviour of generation Y	environmentally conscious and willing to pay more for it
Deraman-Kassim-Ismail-Arifin-Zaini	2015	acceptance of green activities among guests	positive correlation between environmental awareness and acceptance of green hotel activities, but the role of the hotel in education is huge

Source: Own editing.

After studying the above research, the authors have come to the conclusion that they should conduct an own research that does not focus on generally accepted green activities, but rather on those which may be detrimental to the customer experience.

### 3. RESEARCH METHODOLOGY

The aim of the research was to examine guests' environmentally consciousness through the "green" services of hotels. The research questions are the following:

- How "environmentally conscious" hotel guests are?
- What is the consumer profile in terms of environmental awareness?
- What "green" measures do guests consider important in a hotel, and how much these measures bother them.

In order to examine environmentally conscious behaviour, the questionnaire was compiled by the authors by excluding the types of green programs that guests do not notice and green services that do not affect the experience in either direction. Some of the studied areas (green plants, electric charging station, information disclosure) were surveyed using an importance scale. With other hotel activities (local products, digital devices, water consumption, selective waste collection, energy saving), the authors surveyed how disturbing these were for guests and how willing they would be to comply with the measures. Respondents could choose answers from values 1-6 for the questions. The guest profile based on environmental awareness was created using the Osgood scale. Consistent with previous research findings presented

in the previous chapter, the authors focused in their own research the plethora of green activities, which may reduce guests' comfort.

An additional aspect during the compilation of the questionnaire was the easy and quick completion. During the survey between September 2019 and January 2020, 204 evaluable questionnaires were created.

The sample elements were not selected in a random sampling procedure, so the sample is not representative. Thus, the results of the research can only be formulated for the respondents and it is not possible to generalise on the basis of the answers received. However, the results obtained can form the basis of further studies.

**Table 2: Distribution of respondents included in the study based on demographic variables**

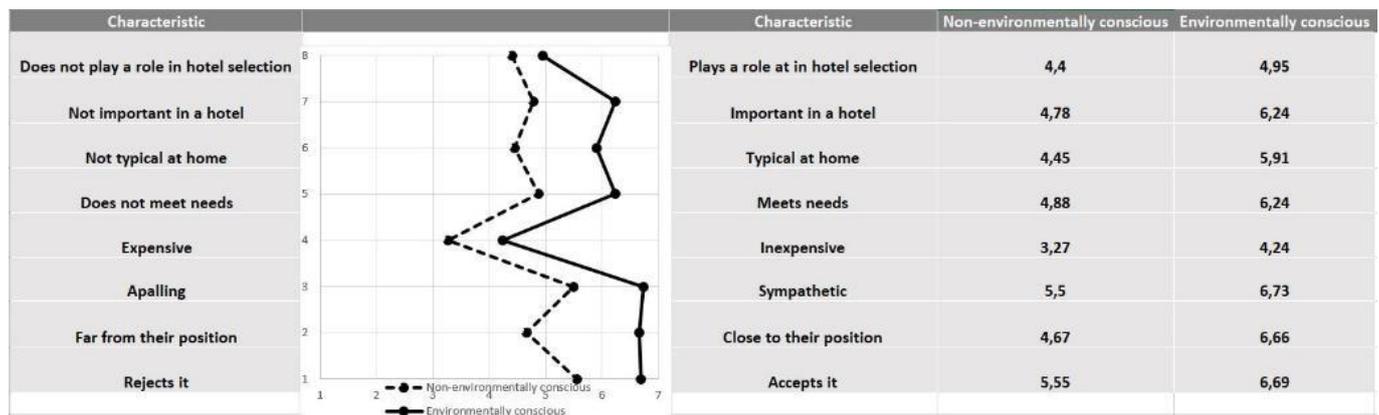
Background variable	Number	%
<b>Gender</b>		
Male	43	21,1%
Female	161	78,9%
<b>Age</b>		
18-34	64	31,4%
35-55	114	55,9%
56-	26	12,7%
<b>Total</b>	<b>204</b>	<b>100%</b>

Source: own editing based on research questionnaire.

In the sample, women are clearly overrepresented, and members of the 35-55 age group account for more than 50% of respondents (Table 2).

**4. RESULTS OF THE RESEARCH**

The aim was to create a guest profile in order to create two separate groups in terms of environmental awareness (the cluster analysis did not have appropriate results because the two groups cannot be significantly separated). The two groups were created based on responses to the semantic differential scale, which included attitudes about environmentally conscious measures. These are pairs of contrasts shown in Figure 1.



**Figure 1: Consumer profile on environmental awareness**

Source: own editing based on research questionnaire.

Consumer profiles created on the basis of the Osgood scale (Figure 1) show well-distinguishable characteristics based on environmental awareness. When applying the Osgood scale, the respondent should determine the extent to which the indicated pairs of opposites characterise the attitude object (Forgács 2017). There is a strong positive correlation between the values of the scale, so the movement of the answers to the questions allowed us to use it as a group-forming variable treated as a factor.

The “non-environmentally conscious” part of the arbitrarily created groups consisted of those who indicated lower values for scalar questions (1-5), while members of the “environmentally conscious” group were closer to green measures (value 6-7).

**Table 3: Distribution of groups divided on the basis of environmental awareness**

Variable	Capita	%
Non-environmentally conscious	60	29,4%
Environmentally conscious	144	70,6%

Source: own editing based on research questionnaire.

Table 3 shows that the majority of the sample agrees with environmentally conscious measures and for more than 70% of them, this behaviour also plays a decisive role in their home and accommodation choice.

Examining the two groups further, we also looked at the willingness to adhere to each environmentally conscious activity. The difference between the members of the two groups in terms of their willingness to give up certain comfort aspects during their trip in the spirit of environmental awareness was measured on the basis of responses to several compelling scales. This comparison was performed by discriminant analysis.

**Table 4: Distribution of mean values for the two groups**

<i>Variable / Determination</i>	<i>Non-environmentally conscious</i>	<i>Environmentally conscious</i>
Selective waste collection in the room	4,83	5,61
Multiple use of towels for multiple nights	4,83	5,54
Minimal use of air conditioning in heat	<b>3,30</b>	<b>4,11</b>
Use only the necessary lighting	4,62	5,29
Shower for minimum duration	<b>3,67</b>	<b>4,56</b>
Eating with minimal leftovers	4,92	5,59

Source: own editing based on research questionnaire.

The results show that members of the environmentally conscious group show a greater willingness to minimise the environmental impact during their stay at the hotel (Table 4). However, the use of air conditioning and the reduction of shower time are extremely low for both groups (the standard deviations do not provide more relevant information). Because the variables are not evenly distributed, we performed the Mann-Whitney test as a nonparametric test as well (Table 5), which shows that there is a significant difference between the two groups for each question.

**Table 5: Significance test result**

	<i>Willing [Selective waste collection in the room]</i>	<i>Willing [Multiple use of towels for multiple nights]</i>	<i>Willing [Minimal use of air conditioning in heat]</i>	<i>Willing [Use only the necessary lighting]</i>	<i>Willing [Shower for minimum duration]</i>	<i>Willing [Eat with minimal leftovers (eg. eat less for more turns at buffet)]</i>
Mann-Whitney U	3169,500	3245,500	3089,000	3192,000	2942,000	3438,500
Wilcoxon W	4999,500	5075,500	4919,000	5022,000	4772,000	5268,500
Z	-4,032	-3,608	-3,260	-3,304	-3,683	-3,089
Asymp. Sig. (2-tailed)	,000	,000	,001	,001	,000	,002

Note: a. Grouping Variable: Environmental awareness. Source: own editing based on research questionnaire.

No significant differences can be detected in the gender distribution of the individuals in the sample, so it can be said that the gender variable has no effect on environmental awareness.

In contrast, age proved to be a much more determining factor for eco-consciousness during a hotel stay. The data in the cross-tabulation (Table 6) show that 76.9% of the over-56 age group were in the non-environmentally conscious group, while this value decreases consistently with age.

**Table 6: Cross-tabulation of the age distribution of environmental awareness**

<i>Age</i>	<i>Non-environmentally conscious</i>	<i>Environmentally conscious</i>
18-34	<b>48,8%</b>	<b>51,6%</b>
35-55	<b>58,8%</b>	<b>41,2%</b>
56-	<b>76,9%</b>	<b>23,1%</b>

Source: own editing based on research questionnaire.

In order to find the reason for such a high proportion of the over-56 age group in the non-environmentally conscious group, we asked the respondents about the various eco-friendly measures they find disturbing during their stay at a hotel. The answers to the questions were examined one by one. As a result of the Kruskal Wallis test, we found a significant correlation for 3 aspects in the distribution of age groups (Table 7).

**Table 7: Significance test based on age group**

	<i>Selective waste collection</i>	<i>Tap water instead of mineral water</i>	<i>Domestic products</i>	<i>Water saving toilet tank</i>	<i>No printed guest information material</i>	<i>Only electronic invoice</i>	<i>Online registration form</i>	<i>More expensive non-genetically modified food</i>	<i>Hand towels and toilet paper made of recycled paper</i>
Chi-Square	,887	12,869	4,598	2,373	11,291	9,415	10,645	2,608	5,436
df	2	2	2	2	2	2	2	2	2
Asymp. Sig.	,642	,022	,100	,305	,004	,009	,005	,271	,066

Note: a. Kruskal Wallis Test, b. Grouping Variable: Age. Source: own editing based on research questionnaire.

As a result, the following environmentally conscious measures would be most disturbing for the over-56 age group:

- If there were no printed guest information material in the rooms
- If they would only received their invoice electronically
- If they had to fill out an online registration form before arrival

Based on the obtained results, we believe that it is not environmental awareness that plays a great role in the breakdown of age groups, but rather the fear of digitisation. The responses show that there is no significant difference in the alignment with environmentally conscious measures as long as they do not constitute e-administration outside the comfort zone of the respondents, and the perceived risk associated with it remains low.

It is also important to point out that regardless of age and the level of environmental awareness (i.e. for the whole sample), guests would be most disturbed by the group of eco-measures that come at an additional cost.

## 5. CONCLUSION

In our study, we focused on examining the attitudes of hotel guests towards the issue of green hotels. The results of foreign examples show a broadly uniform picture of consumer behaviour. The authors' questionnaire survey was a much shorter, more detail-focused research. Nevertheless, it can be concluded from the questionnaire as a whole that the environmental awareness of individuals also improved during the time between different research. The study also provides practical advice to hoteliers on how to pursue green activities. In the 21st century, this is almost a mandatory element for hotels, so the task should focus on which is the most effective way to implement the green solutions into the life of a hotel with the least harm to guests' sense of comfort.

Based on the research results, we believe that the responsibility of hotels has a huge impact on the green hotel issue. The guest will always be more environmentally conscious at home than in the hotel, but this can be changed consciously. With this in mind, the hotel is responsible for:

- searching for and finding guests who also follow environmentally conscious behaviour at the hotel
- informing guests about the hotel's green activities
- educating guests in an understandable and clear way on how to be more environmentally conscious
- communicating the sense of the term green hotel to prospective guests in a way that positively facilitates the booking decision
- phrasing green hotel activities in plain language
- using the term green hotel as a marketing tool only if there is specificity behind it
- introducing as many green activities as possible
- strategic thinking when introducing green activities

An eco-friendly attitude should be reflected in the strategy of the particular hotel, as these green activities involve increased costs on the part of the hotel.

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## COVID-19 AND GUESTS' PREFERENCES IN SHORT-TERM RENTALS: EVIDENCE FROM MADRID

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### ABSTRACT

This paper aims to test whether and how guests' preferences shifted towards social distancing attributes when they chose short-term rentals (Airbnb) in the first COVID-19 summer season. For our purpose, we make use of a semi-parametric hedonic modeling framework to check whether the implicit prices of what we identify as social distancing attributes changed between August 2019 and August 2020 in the city of Madrid. Our main variables of interest are accommodation size, the presence of a fully equipped kitchen, and room type (shared/private room vs entire apartment) as proxies of the capacity of the listing to allow social distancing. As for size, we expect that a reduction in the size of travel groups may lead to a shift in guests' preferences towards smaller listings. Besides, the availability of kitchen amenities may help to make for a more pleasant stay without the risk of eating out.

We find that guests preferred smaller, well-equipped listings to preserve social distancing during this time. Listings that have kitchen amenities had a premium price of around 20.4% in August 2020, up 15.2 percentage points compared with August 2019. Moreover, the implicit price for size-related variables decreased 2.7 percentage points, which indicates a preference for smaller accommodations. However, we do not have statistical evidence that guests are less willing to pay for shared and private rooms after COVID-19. Ultimately, we consider that Madrid is a suitable setting to study the effect of COVID-19 on the change of guests' preferences, since it is a major tourist destination that has been severely affected by the COVID-19 outbreak.

To answer our research question, we adopt a Generalized Additive Model (GAM) that allows controlling for non-linearities in both price determinants and spatial dependence of the error term. GAMs are suitable for detecting the non-linear relationship between prices and the urban environment, as the latter strongly influences accommodation prices. Our results are robust under different model specifications, including simple OLS. Additionally, we rule out the possibility that results depend on time and geography by performing several robustness checks. First, we reproduce our analysis on a different time frame, comparing August 2019 and August 2018, and we do not find any specific change in how social distancing attributes had been priced. Then, we show that results are similar if we choose a different case study by replicating the analysis for Barcelona, a city that, like Madrid, is of touristic interest and was an epicenter of the outbreak. To the best of our knowledge, this is the first contribution that provides evidence of a shift in guests' tastes for attributes that help preserve social distancing in the aftermath of the COVID-19 crisis. We argue that our findings are relevant well beyond the evolution of the ongoing pandemic, since we may reasonably expect long-lasting effects after a reorganization of travel patterns to better cope with future pandemics.

## THE EFFECTS OF SECTORAL SHUTDOWN ON THE WESTERN MEDITERRANEAN REGION ECONOMY OF TURKEY

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### ABSTRACT

Antalya, a province in the Western Mediterranean Region (TR61) in Turkey, has great importance in Turkey's tourism and agriculture industries in terms of production value and creating income. The output value of the tourism industry in the region approaches 40% of Turkey's tourism. Fisheries and agriculture are the other prominent industries in the regional economy, with shares of approximately 11% and 8% respectively in the regional GDP. In addition, the tourism industry triggers the demand in many service industries including accommodation and catering services, travel agencies, creative arts, performing arts and entertainment services, sports services and entertainment and leisure services, and air transport. Thus, it can be said that the importance of the tourism industry increases even more when its direct and indirect effects on income and employment are considered.

The negative effects of the Covid-19 pandemic started to be felt as of March 2020 and continued to intensify. The measures taken against the pandemic have been implemented as partial and/or complete shutdown, especially in the service industries. The shutdown indicates the emergence of a simultaneous contraction in both supply and demand sides in the economy.

From this perspective, this study focuses on the effects of the Covid-19 pandemic on TR61's economy and the reflection of the regional economic contraction on the Turkish economy.

The 2017 TR61 Regional 74-industry Input-Output matrix is used in the analyses. Demand-side scenarios are run to see the impacts of contraction in final demand components and the hypothetical extraction method is used to see impacts of the shutdown. The latter allowed observing the relative importance of each industry.

The contribution of the study is twofold. Firstly, the "real" value of the industries in the regional economy in terms of the total impact on other industries is derived by using the hypothetical extraction method. Secondly, the overall economic damage in the region and in the rest of Turkey that occurs through the tourism industry is revealed. Various multipliers and linkage coefficients derived from the I-O matrix are also used to further interpret the effects of the pandemic.

According to the findings, with a complete shutdown of the tourism sector, the production loss in the whole economy is 31.47%. The fisheries industry ranked first with a contraction of 48.81% among the others negatively affected by the tourism's shutdown. The fishing industry is followed by transportation and logistics with 22.26%, manufacturing of rubber and plastic products with 21.92%, and trade with 21.31%. The average contraction experienced in the industries corresponds to 16.37% with the complete shutdown of the tourism industry.

## **DETERMINANTS OF ATTENDEES' EXPENDITURE: AN ANALYSIS FROM A LOCAL ECONOMY POINT OF VIEW**

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### **ABSTRACT**

This study aims at investigating the determinants of expenditure participating in a number of well-known events staged in Madeira. In order to identify the most important variables we run a number traditional of econometric approaches, based on a database containing information on 3200 attendants to a portfolio of events. The results suggest that the benefits accruing to the local community will be enhanced by promoting in a synergistic way a number of initiatives and resources aiming at a specific market niches, namely the senior market. The events under analysis share to a certain extent a number of commonalities and similarities such as being rooted in the cultural traditions of the island and a similar average background in terms of visitors' profile. Events are expected to contribute to urban regeneration, commercial development, generation of income and creation of employment. Therefore, besides taking a prominent role in the overall tourism development strategy, events must also take a noticeable place the overall economic development strategy. Therefore, in this study we discuss in a tentatively manner a number of steps aiming at linking the tourism development strategy with initiatives aiming at developing the local economy.

## **Regular Session: RS18.1 - Resilience and Risk Management**

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/83379645511>**

**Chair Paolo di Caro**

## BIG REMOTELY SENSED DATA APPLICATION FOR FIRE SEVERITY AND POST-FIRE MONITORING

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### ABSTRACT

The importance of wildfires as a natural or a human-induced phenomenon has gained importance at regional and global levels in the last years. Improved remote sensing and computational capabilities enable the fast processing of large image datasets in real time. resulting in an increased need to evaluate fire impacts at a landscape scale, burn severity has become an important indicator of fire impact on the ecosystem. The main aim of this study is to propose a model to assess burn severity and post-fire recovery in the north of morocco. A sample of 50 fires that occurred in the morocco from 1997 until 2016 was selected, and then fire severity for each sample fire has been estimated using the pre- and post-fire landsat imagery on the Google Earth Engine (GEE) platform to estimate the degree of fire-induced ecological change. The rate of post fire regeneration has been estimated using the Normalized Regeneration Index (NRI).

## RISK ASSESSMENT OF GULLY EROSION BY MULTICRITERIA ANALYSIS (RHÉRAYA WATERSHED - WESTERN HIGH ATLAS)

Farid El Wahidi, Aïcha Fadil

UCA, Morocco

### ABSTRACT

The Moroccan territory is 93% dry and where land degradation is fundamentally an environmental risk. It happens particularly in the mountainous regions of the High Atlas which are on the fringes of development and economic growth. This could take on disproportionate magnitudes under the combined effect of natural and anthropogenic drivers; the consequences are often exacerbated by inadequate management and exploitation systems of available natural resources. Gully erosion is the most active and harmful to the soil and the population's assets in mountainous areas (e.g., Rhéraya watershed in Western High Atlas). Preventing this degradation dynamic and correcting its symptoms would help mitigate the vulnerability of the local population and strengthen the resilience of socio-ecological systems. Reducing the risk of soil gullying requires the use of decision support tools to make a complete diagnosis and identify priority action areas according to their severity level. The present study aims to systematically classify on an ordinal scale the risk of gullying in the Rhéraya watershed. Risk is estimated as a combination of hazard and vulnerability. These two components have been estimated using aggregative indicators using multi-criteria analysis (MCA) of various biophysical (precipitation, land cover, lithofacies, slopes, aspect) and social factors (human issues, infrastructure issues, economic issues) related to land degradation risk. The approach is inspired from the SCALES model (Spatialisation d'échelle fine de l'ALéa Erosion des Sols/large-scale assessment and mapping model of soil erosion hazard), the multi-criteria analysis AHP (Analytic Hierarchy Process) and spatial modeling techniques (GIS). The main results lead to a systematic classification of the territory with a focus on ravines as regards of the risk that they constitute for the environment and the local population assets. The developed model could be used as a spatially explicit information system and as a catalogue (Atlas) of dangerous ravines for sizing torrential correction thresholds and identifying their localization. It also serves as a tool to build defense and soil restoration strategies to protect the environmental goods and services and enhance the resilience of hydro-ecological system.

**MANAGEMENT OF RISK IN TOURISM****Zakaria Adidi**

Fsjes Souissi, Morocco

**ABSTRACT**

The tourism industry in Morocco is a fairly important economic sector; good year bad year he represents 8% to 10% of the country's GDP. The Moroccan state has always relied on tourism as a lever development producer of wealth and creators of jobs. In terms of tourism, Morocco has remarkable assets: its climate, its specific culture, its imperial cities and its geographic position. We should also underline the strong dependence of Moroccan tourism on five major European countries. Certainly, there seems to be some mitigation of the political risk associated with the Moroccan destination for French, English and Spanish tourists; tourists from Germany and Italy remain sensitive to this phenomenon. However, the Moroccan tourism sector remains highly vulnerable and dependent on demand foreign, mainly European. It is a sector at risk par excellence, because its evolution depends of the economic, political, security, climatic and health situation both at the national level internationally. The Effects of the Two Golf Wars, the "Arab Spring" and the Terrorist Attacks perpetrated in Europe or in the Maghreb countries are widely felt by Moroccan tourism. Added to this are the effects of climate change, which is hitting the territory hard. National; floods, floods, landslides, collapse of old buildings, more and more recurrent drought, without forgetting the seismic risks to which are exposed many regions of the country are all factors that can disrupt at any time, even deconstruct tourism which constitutes the main economic base of many Moroccan cities. However, the various economic development plans that Morocco had known since its Independence, as well as tourism sector strategies (Plan Azur for example) have not attached great importance to the tourist hazard which can occur at any time. Hence the need to adopt a new approach based on knowledge, forecasting, anticipating and managing tourism risk. It's Tourism Risk Management (or management of tourist risk). At a time of advanced regionalization, the Regions, each in relation to its natural and cultural specificities, its strengths and its structural weaknesses and through documents of territorial planning such as SRAT and PDR, but also tourism companies present in the territory are obliged to anticipate and prevent all kinds of risk: natural, technological, economic and financial, socio-political and security. Research objective: The objective of the thesis is to understand the management processes of the management planning of risks in a vulnerable economic sector such as tourism, their identification, their analysis, the planning responses to risks, as well as monitoring and controlling them as part of a territorial and regional development project. PROBLEM: The strong dependence of Moroccan tourism on the international market has made it a vulnerable sector subject to economic, financial, political, security and now economic fluctuations climate. The central problem that will guide this research will consist in answering the following question: What approach and what device to put in place in a tourist region in order to know, anticipate and manage risks?

**THE ROLE OF THE COHESION POLICY FOR SUSTAINING THE  
RESILIENCE OF EUROPEAN REGIONAL LABOUR MARKETS DURING  
DIFFERENT CRISES**

**Paolo Di Caro<sup>1</sup>, Ugo Fratesi<sup>2</sup>**

<sup>1</sup>Department of Law-University of Catania, Italy. <sup>2</sup>Politecnico di Milano, Italy

**ABSTRACT**

For this paper we assembled a novel panel-time series dataset to study the resilience of the European regional labour markets during the major economic shocks registered over the past three decades. Our analysis suggests that employment resistance varies across regions and economic crises. We also study the role of European cohesion policy for sustaining employment resilience during shocks in the European regions at Nuts2 level, by applying a heterogeneous coefficient modelling framework to new time series data on the EU funds. We find the presence of region- and crisis-specific patterns when looking at the impact of the cohesion policy in the short-run, even if there is a prevalence of cases with a positive impact of cohesion policy in crisis resistance. We finally discuss the policy implications of our study, which are of relevance for the current discussion on the recalibration of the cohesion policy after Covid-19 crisis.

## **Regular Session: RS10.2 - Regional development**

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/85836987366>**

**Chair Réka Horváth**

## REGIONAL INEQUALITIES AND DECENTRALIZATION IN THE CENTRAL AND EASTERN EUROPEAN COUNTRIES

Tomasz Kossowski, Pawel Motek

Adam Mickiewicz University, Poland

### ABSTRACT

The purpose of the study is to determine the relationship between decentralization and regional inequalities in the Central and Eastern European countries. Results of the research presented in many papers, mainly done since the beginning of the 21st century, do not lead to clear conclusions. Depending on the approaches used by researchers, the number of countries, the level of their socio-economic development, we can observe that decentralization leads to an increase in regional inequalities, as well as to their reduction in some situations. Studies also emphasized that this relationship may take the form of an inverted U. In the case of the Central and Eastern European countries, results of previous research are usually very general, ignoring diversity of these countries and treating them as one homogenous group. However, the political and socio-economic transformations in these countries followed different models. As a consequence of this fact, decentralization reforms were different among CEE countries, economic growth was different, and it resulted in various size of regional inequalities. In this research, we try to verify hypothesis that the relationship between decentralization and inequality will be best explained by the Kuznets curve in Central and Eastern European countries. To do this, we have created a panel database covering the countries of Central and Eastern Europe in the years 1990-2016. According to many previous studies, this database contains four groups of measures. The first of these groups has only one measure for assessing regional inequalities. It is calculated in a classic way based on regional GDP per capita. The second group of measures refers to fiscal decentralization and includes, for example, the share of regional authorities' expenditures in total state expenditure and, the measure of degree of tax decentralization. Political decentralization is measured by variables such as: the number of levels of regional authorities and the place of local government in state constitutional law. The measure of administrative decentralization is calculated as the degree of freedom in decision making at the regional level. We have run a model describing the impact of decentralization on the level of regional inequalities on this database. Due to the presence of spatial effects, the model has been estimated in several variants. For this purpose, classical and spatial econometrics methods were employed. The model approach was also used to verify the hypotheses about the change in inequality over time according to the Kuzniec curve and, the impact of economic growth on these changes.

## EUROPEAN METROPOLISES AND ITS DEMOGRAPHIC PROBLEMS: A SPATIAL APPROACH

Tomasz Kossowski, Justyna Wilk

Adam Mickiewicz University, Poland

### ABSTRACT

European metropolises are centers of life and socio-economic development of regions and countries. Despite of their privileged position in urban and economic system, they also try to overcome demographic challenges as other centers. Among them, the most important are aging processes that may strengthen or weaken metropolitan development. As a consequence, current activities in the field of the spatial planning and the spatial policy, as well as strategic plans, should take into account demographic processes taking place. The aim of the paper is to determine the demographic problems of European metropolises, such as disparities between the number of women and men, inadequate reproduction, shortage of people of working age, the growing share of older people, as well as to identify the spatial development of demographic processes and the role of metropolises in this respect. Another problem solved in the paper is classification of metropolises based on their population and age pyramids using symbolic data analysis methods and cluster analysis. It is a part of the larger study of demography in 1397 NUTS-3 units from 37 European countries in 2015., and these results will be also delivered as a background for the main problem of the study.

**THE UNINTENDED EFFECTS OF COHESION POLICY: THE WEALTHIEST REGIONS WILL FURTHER FLOURISH IN ROMANIA**

**Réka Horváth, Tünde Petra Szabó**

Babes-Bolyai University, Faculty of Economic Sciences and Business Administration, Romania

**ABSTRACT**

In this study, we explore a new research direction on the European Union (EU) cohesion policy. We identified a gap in the scientific literature and tested our assumption in Romania. According to our hypothesis, more economically advantaged regions attract more EU funds. We constructed several multiple regressions to determine whether GDP per capita and other economic variables can explain the total amount of structural and cohesion funds received by the different beneficiaries in certain regions. The results are mixed and support the hypothesis that wealthier regions attract more EU funds, which is not the intended purpose of the cohesion policy.

## **Regular Session: RS02.7 - Infrastructure, transportation and accessibility**

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/88538303825>**

**Chair Bert van Wee**

## IMPACTS OF THE BUILT ENVIRONMENT AND TRAVEL BEHAVIOUR ON ATTITUDES: THEORIES UNDERPINNING THE REVERSE CAUSALITY HYPOTHESIS

[Bert Wee](#)<sup>1</sup>, [Jonas de Vos](#)<sup>2</sup>, [Kees Maat](#)<sup>1</sup>

<sup>1</sup>Delft University of Technology, Netherlands. <sup>2</sup>Bartlett School of Planning, University College London, United Kingdom

### ABSTRACT

The importance of attitudes in the relationship between travel behaviour (TB) and the built environment (BE) has been the subject of debate in the literature for about two decades. In line with the Theory of Planned Behaviour, attitudes – which affect behaviour – are generally assumed to be constant. However, it is plausible that attitudes can change, both directly, and indirectly, through the impact of the built environment on travel behaviour, a process which is referred to as reverse causality (RC). Based on literature from social psychology, this paper provides a conceptual model for the explanation of attitude changes. It also reviews the literature in the area of BE and TB concluding that two explanations dominate: a change in attitudes due to new experiences which can be underpinned by learning theories, and a change in attitudes due to mismatches between attitudes and behaviour which can be explained by cognitive dissonance theories. The literature also suggests a few additional explanations, while we also suggest explanations not provided in travel behaviour literature. Finally, we present an agenda for future research.

## HIGH SPEED RAIL AND SPATIAL EQUITY IN DEVELOPING COUNTRIES: THE CASE OF TURKISH HIGH-SPEED RAILWAYS

[Ahmet Bas](#)<sup>1</sup>, [Marie Delaplace](#)<sup>2</sup>

<sup>1</sup>Abdullah Gul University, Turkey. <sup>2</sup>University Paris Est, Lab'Urba, France

### ABSTRACT

The twenty first century is characterized by the current and future extension of the high-speed rail (HSR) network in developing countries. According to the UIC (International Union of Railways) data there are 47,560 km of high-speed lines (HSL) in the world, 12,892 km were under construction as the date of 1st October 2019. More than 40,000 km were planned worldwide for completion by 2050. The twenty first century is characterized by the network extension in developing or emerging countries (China, Turkey, Morocco) and by projects in many others (India, Brasilia, Malaysia, Egypt, etc.). If lines are already in operation in China, Turkey, Morocco and others are built (Iran) and projects exist in numerous countries (Brasilia, Malaysia, Egypt, etc.) that is, in very different socio-economical contexts. High Speed Railway systems (HSRs) are an alternative way to the aviation sector and road transportations from the point of time reduce, cost and accessibility over distance of 250-1000 km. As it commonly known that HSR improves intra/inter-regional accessibility, enhance the mobility and can induce different travel purposes. When a new High-speed line (HSL) line is constructed, the cities which are located and have stations on the line are therefore gained advantages from these opportunities, because of accessibility improvements. However, can the issue of the potential increase in accessibility and in mobility be addressed in the same way in developing countries which are characterized by larger inequalities than in developed ones? The issue is to know for whom and for what use they are built. Has everybody access to high-speed rail in developing countries? Who can use HSR? Do low income and greater inequalities which characterize the developing countries influence the use of the transport infrastructure? The main issue is linked to the price policy, to the income level and also to the alternative mode of transportation. The aim of this communication is to analyze the link between high-speed line and spatial and social inequalities. After presenting the Turkish' case, we will analyze the HSR from the point of passengers' income, trip purpose and regional accessibility. We will show that the price policy in Turkey and the willingness to serve numerous cities all over the country makes High Speed rail a tool for a better equity.

## TRUCK PLATOONING TECHNOLOGY DIFFUSION: A MICRO-FOUNDED MACROECONOMIC MODEL WITH PROFITABILITY CONDITION AND CLUB EFFECT

[El Mehdi Aboukacem](#)

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### ABSTRACT

Truck platooning refers to the technology allowing Heavy Duty Vehicles (HDV) to travel in convoy formation using wireless communications and advanced driver assistance systems. Such convoys are called platoons. The lead truck is fully controlled by a human driver. In the followers, humans are still needed. However, in the “platoonable” sections of the roads, the followers react to the changes in the leader's movements automatically.

Platooning is expected to increase road safety and capacity, and to decrease fuel consumption and GHG emissions. However, despite the promises of profitability platooning suggests, the literature dealing with it lacks economic studies. Two important reasons may explain this situation. Firstly, the doubts concerning platooning technical functioning and its practical use are still numerous. Secondly, the literature dealing with the “engineering” aspects of platooning presents contrasting results concerning the benefits this technology can bring.

We explore here the mechanisms underlying the potential future spread of platooning. To the best of our knowledge, there are only two papers where the spread of a driverless technology dedicated to HDVs is addressed : Raj et al (2020) and Jesse (2019).

Despite they present very interesting insights, these papers can hardly be considered as falling within the scope of economics. In both, the adoption rates evolutions depend on time and on some other non economic criteria. Also, the two papers neglect an essential criterion for the commercial success of any driverless technology dedicated to HDVs: its profitability from the perspective of trucking companies. Yet, the individual decisions these companies make regarding these technologies is the cornerstone of their diffusion at a macroeconomic scale. To put it at its most basic, trucking companies' main objective is to make profit. Thus, they would adopt trucks equipped with new driverless technologies only if the profits generated thanks to them are higher than those generated by using the conventional trucks. As such, the issue of the “technological” trucks purchase and usage costs is central. However, to the best of our knowledge, this issue is never addressed in the literature.

Furthermore, when addressing platooning, it should be borne in mind that a truck equipped with this technology brings value only when it travels within platoons. Thus, from trucking companies' point of view, investing in such a truck can be profitable only if there are on the roads enough trucks with whom it is possible to form platoons. To the best of our knowledge, such a club effect has never been explored.

In the present paper, we build a micro-founded macroeconomic theoretical framework, dedicated to understanding some of the economic mechanisms underlying a potential diffusion of platooning. The model considers geography, expresses finely the costs of transport operations, and takes explicitly account of platooning costs. Furthermore, it formalizes mathematically the club effect inherent to the functioning and the commercial success of this technology. We simulate then many diffusion scenarios. In each one, we make different assumptions concerning the technology characteristics and the geographical environment. The calibration is conducted using different data sources.

## THE 'GOOD NIGHT' PROGRAM: AN INNOVATIVE MODEL FOR THE SOLUTION OF TRUCK CONGESTION IN ISRAEL

David Bentolila

Ruppin Academic Center, Israel

### ABSTRACT

Avoiding truck congestion and peaks in landside activity is one of the challenges to all transportation problems as well as container terminals. This paper presents an innovative model of economic incentives combined with state regulation that motivated 7.9% of the customers of Haifa sea port to shift to night hours for transportation to the port instead of peak hours during the day.

Efficient terminals seek a balance between ship-to-shore, yard and landside operations in order to create an integrated system without bottlenecks (Notteboom, 2006; Vernimmen et al., 2007, Bentolila et al 2016) and peaks in landside activity, particularly at the level of trucks arriving at the terminal to pick-up or drop containers.

We started analyzing the congestion problems in Haifa port a decade ago. The first step was to elaborate a pilot program called " Good Night" that overcame some of the night issues, by opening empty containers terminals during night. The program included a state resolution to pay monetary incentives to customers shifting to night hours. A deeper field study of the Good Night pilot project has been conducted in 2013, including 14,149 trucks, in order to face three critical issues of the program: what are the constraints of the customers during the night that we have to overcome in order to motivate them to shift to night hours, what is the level of the monetary incentive that is cost effective to pay for every truck or container and what are the effective hours to pay this incentive.

An economic transportation congestion model has been developed in order to define the market utility depending of different hours. The incentives hours of night went from 20:00 until 06:00 and the incentive payment varies from 80 to 100 IS (about \$28) for one full container arriving or leaving the port.

In Israel, as in many other countries, the problem of traffic congestion is becoming more and more crucial over the years. So, a further pilot program has been launched in 2019, in which the night incentives hours have been enlarged to 12 hours daily, starting at 18:00 until 06:00 and then reduced gradually again to eight hours daily.

The idea is to follow carefully the actual pilot and suggest further steps that will elevate the level of night transportation to 20% and even 25%.

Further research will be directed to the examination of the impact of night transportation on decongestion of traffic problems.

## **Special Session: SS12.1 - SMEs/Family Businesses and Regional Development**

**13:15 - 14:30 Tuesday, 25th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/88394645535>**

**Chair Stefano Amato**

**FAMILY FIRMS, REGIONAL COMPETITIVENESS AND PRODUCTIVITY: A MULTILEVEL APPROACH**

**Stefano Amato**

IMT School for Advanced Studies Lucca, Italy

**ABSTRACT**

In this paper we adopt multilevel design to investigate how much of the labour productivity of a sample of Spanish manufacturing is explained by firm-level versus regional characteristics. To account for differences across regions in terms of human capital, knowledge intensity, innovation, and physical endowment, we calculated by applying the principal component analysis (PCA) a synthetic indicator of regional competitiveness for the period 2002-2015. Our findings reveal as most of the variability of firms' productivity is attributed to firm-specific characteristics. However, the regional context matters with firm's performance that is strongly influenced by the overall quality of the regional environment in which are located. When firms are differentiated according to the family status, that is in family and non-family firms, cross-level interactions show as family firms are particularly sensitive to spatial advantages offered by location in well-endowed and prosperous regions. Theoretical implications at the crossroads between family business and regional studies together with policy implications are discussed.

## SMALL BUSINESS CLINIC: A DATA-DRIVEN DIAGNOSTIC AND ADVISORY TOOL FOR SMES IN LAGGING REGIONS

George Petrakos, George Anastasiou, Alexandra Sotiriou, Dimitris Kallioras

University of Thessaly, Department of Planning and Regional Development, Greece

### ABSTRACT

In Europe and in Greece, Small Business are a vital part of the economy and the challenges they encounter in their post crisis environment need to be addressed as a matter of urgency. Their size, in most cases, does not allow them to have real access to financial advice, guidance and support in planning, restructuring and developing their business, because of the lack of sufficient resources. In addition, such services are not always available outside large urban centers and the periphery. In contrast, larger firms typically receive these services from major consulting firms that are mainly based in the capital or large cities and have the expertise, access to big data and business analytics tools. Lack of access to advisory services is partly responsible for the high mortality rates of SMEs and especially the mortality of new businesses. Adapting to changes in a successful way requires addressing critical operation problems and improving effectiveness in decision-making.

This paper is based on research work conducted in the framework of a project aiming to create a web-based online 'big data hybrid business analytics advisory service model' for SMEs, that incorporates business analytics tools utilizing big data and supported by experts, called "Small Business Clinic" (SBC). Our approach combines economic and business information available with survey data depicting also the perceptions, attitudes and choices of the entrepreneurs. Databases of structured and unstructured information, alongside with input data from the surveyed enterprises, are linked, correlated and analyzed within an integrated business model in order to produce a set of indicators and algorithms. The tool delivers individualized diagnosis, benchmarking and advisory to small businesses in order to take advantage of "data-driven decision-making" and to achieve significant improvement in their productivity and profitability. Furthermore, the paper analyzes the adjustment and prospects of the productive system of SME's of Greece. The analysis focuses on the role of the internal and external environment, specialization, human resources and inter-firm relations, as well as their ability to compete in the post crisis demanding environment. The analysis is supported by a pilot survey conducted in the region of Thessaly, inquiring the patterns of decision making, the drivers of change, as well as the perceptions and attitudes of small firms in a number of critical domains. The results of the survey are used to control and fine-tune the indicators and algorithms used to produce the diagnostic and advisory services to SMEs irrespective of sector and location.

## SUSTAINABLE STRATEGIC DESIGN IN FURNITURE MSEs IN UBERLÂNDIA, BRAZIL

**[Fernando Moreira da Silva](#), [Juliana Cardoso Braga](#)**

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### ABSTRACT

In the city of Uberlândia, Brazil, there are 800 formal and informal SME's furniture companies. The majority of these companies are micro, between 6 and 12 workers, of familiar nature. The dispersion of SMEs in the sector over a very large territory and the small size of these productive structures have made it difficult to change the productive paradigm. The production of furniture in Brazil generates a large volume of wood residues and their by-products due to the cutting process itself and, mainly, by manufacturing waste. Each of these companies generates, on average, 300 tons of waste per month composed mainly of MDF chips and powder, i.e. about 7.2 tons per year, per company. Due to the environmental and legal restrictions to obtain solid wood, most of the manufactures use reconstituted wood panels, mainly of MDF produced from the reforestation wood. The manufacturing processes used by these furniture companies are therefore not sustainable, which configures approximately 22,000 m<sup>3</sup> of waste discarded per year on vacant lots in the city's peripheral areas. These residues are mainly composed of pieces of reconstituted wood (sawdust, chipboard and MDF scraps): most of the furniture industries still use waste in an irregular way. Residues resulting from the processing of reconstituted wood sheets may present some danger when they are not adequately disposed because of the presence of urea-formaldehyde in the composition and the high flammability of the material. The inspection and penalization actions have been ineffective, so it is necessary to rethink the problem involving the generation and disposal of waste from these companies. Most of these small organizations are too concerned with their livelihood, which is why they have not incorporated changes in their production that could lead to a general improvement in the processes, manufacturing methods and diversity of products. This paper presents a sustainable strategic design model for SMEs in Uberlândia which is part of the results of a research project, aiming not only to minimize the waste generated by these companies, but also to implement sustainability and design practices as strategies to incorporate added value to the developed products, which can generate visible economic gains for the companies and employment for the local community. The research was based on active research methodology to support project development, with a strong intervention component at the level of participatory design of the different stakeholders and the evaluation process using a focus group.

### KEYWORDS

Furniture products, Manufacturing Waste, Strategic Design, Sustainable Design.

### 1. INTRODUCTION

About 97% of the furniture companies in Brazil are made up of Small and Micro Companies (SMEs). The production is essentially made to order and made-to-measure furniture and employs semi-handcrafted manufacturing processes. The production processes are not sustainable, which means waste and a large volume of waste. Waste composed mainly of remains of reconstituted wood (mainly MDF) is often irregularly disposed of in public space, burned in the open or in bakery ovens. The irregular disposal of waste constitutes a threat to public health and the environment, degrades the image of the peripheries and accentuates social asymmetries. Inspection and penalization actions have been ineffective, which led to the present study, leading to a rethinking of the problem that, above all, involves the generation and disposal of waste from these companies. The "spraying" of SMEs in the sector over a very wide territory, as well as the small size of these productive structures, have made it difficult to raise awareness of a change in the productive paradigm, given that these companies are, for the most part, too concerned with their livelihood.

The present investigation aimed to identify and minimize waste and irregular waste disposal by furniture MSEs, reducing the environmental, economic and social impacts resulting from the production of personalized furniture through sustainable strategic design.

From the diagnosis carried out in five MSEs of personalized furniture in the city of Uberlândia, State of Minas Gerais, Brazil, a model was developed, the CACO model, which proposes the continuous improvement of products, services and production processes through a set of sustainable strategic design strategies, guidelines and tools that can be progressively implemented.

The model was evaluated by a panel of experts and an action plan was determined with a view to its implementation in a pilot company, a furniture SME. As a partial result of the investigation, it was found that as a result of the strategy of negotiation and articulation of public and private interests promoted by the Caco Project, 60 carpenters in the region started to dispose of waste in an environmentally correct way in a licensed industrial landfill.

The results showed that the model is a resource to reduce waste and the social, environmental and economic impacts of furniture MSEs, to encourage the correct disposal of waste, to reduce the degradation of public space, to generate savings for municipalities and to reduce the impacts for the community. society affected by irregular waste disposal.

## 2. FURNITURE INDUSTRY IN BRAZIL

The productive chain of the furniture industry in Brazil is historically specialized in the production of articles made with wood, because of the abundance of raw materials of forest origin (Galinari et al., 2013). However, due to environmental and legal restrictions for obtaining solid wood, the manufacture of wood panels produced with reforested pine and eucalyptus expanded in Brazil. According to information from the Brazilian Tree Industry (IBÁ), in 2016 the production of reconstituted wood panels (MDF, MDP, etc.) in Brazil was 7.3 million m<sup>3</sup>, of which 86% were destined for the domestic market. There are 18 panels producing factories in Brazil and the country occupies the 8th place in the world ranking of the largest producers of reconstituted wood panels (IBÁ, 2017). Effectively, there is a predominance use of MDF coated with laminate. Panel manufacturers offer products with a single dimension, which makes it difficult to use the boards, and consequently, results in greater material losses in joiners.

Due to the “pulverization” of companies across the national territory and the large number of informal micro-enterprises, in 2016 the Minas Gerais State estimates the existence of more than 17,500 furniture industries made up predominantly of micro and small companies with verticalized and unskilled production processes, many of which are joinery that execute customized furniture (Galinari et al., 2013; IEMI, 2016). These companies have gradually introduced high technology, but most of them still use outdated equipment and production systems. Large companies are basically serving the domestic market, in part, because of the high prices of wood panels in the national market (Leão, 2009); the low technology employed; and the lack of product differentiation due to low investment in design - with a predominance of product imitation (Castro & Cardoso, 2010; Crocco & Horácio, 2010; Galinari et al., 2013; IEL, 2018). One of the main obstacles to the development of Brazilian companies concerns the lack of insertion of design to support the conquest of new markets and the creation of Brazilian design (SEBRAE, 2002: 43). However, even with the drop in the number of personnel employed, the furniture sector is still relevant to the generation of jobs in the country. According to Galinari et al. (2013), the expressive participation of the furniture industry in employment levels and the dissemination of the furniture production chain throughout the national territory evidenced its importance for the Brazilian economy.

### 2.1 Triângulo Mineiro and Alto Paranaíba Region

A significant number of Micro and Small Companies (MPEs) in furniture is located in Minas Gerais State, in the mesoregion of Triângulo Mineiro and Alto Paranaíba. This mesoregion consists of sixty-six municipalities, seven of which are considered micro-regions, due to their differentiated production, distribution, exchange and consumption structures. Adding its 66 municipalities, the region has an estimated population of two million inhabitants, and has an area equivalent to 54 thousand km<sup>2</sup> (IBGE, 2015).

According to the Brazilian Institute of Geography and Statistics (IBGE), Uberlândia is the largest municipality in the region (683 thousand inhabitants - estimated population in 2018) and the second largest in the state of Minas Gerais, it has the third largest HDI (0.789) in the State and is the most influential city in the region (IBGE, 2018), mainly for its strategic geographical position in the regional and national context (SEPLAN, 2017), for its relevant economic and social performance in the national, state and regional scenario.

The Union of Woodworking and Furniture Industries of Vale do Paranaíba (Sindmob) established in the city of Uberlândia, Minas Gerais, Brazil, has 80 member companies and seeks to promote, mainly, lectures, exhibitions and trips for companies in the sector. In 2006 Sindmob in partnership with SENAI and SEBRAE carried out a diagnosis of the furniture industries in the region. According to the results, there are approximately 200 formal furniture MSEs. However, it is estimated that the number of furniture companies in the region is much higher, around 800 MSEs, due to the informality of most industries. Micro and Small Enterprises predominate in the region, 96% are Micro Enterprises (up to 19 employees) and 4% are Small Enterprises (from 20 to 99 employees) who have a small number of employees: an average of 6.2 employees per company. The production of companies in the region is essentially made-to-order and bespoke furniture, around 94% (SENAI, 2006).

The production process is semi-handcrafted, due in part to the local culture of handcrafted know-how and the appreciation of users for personalized products that suit defined functions and spaces. In most companies, furniture is made by woodworkers who have the knowledge and practice to make all the furniture. For this reason, production processes require qualified labor. The results are generally quality furniture and, consequently, have high cost, but which still compete with high-tech companies that produce modular furniture (Dal Piva, 2006).

It is important to consider that the production systems have a low degree of specialization, production with a low technological level and occur in a vertical manner, that is, different production processes are carried out by the same company. This process requires a series of steps: the analysis of the project, which is prepared by a professional (usually a designer or architect) or by the carpentry itself; cost calculations are performed; individual negotiation of each piece of furniture; visit at the client's home to survey measures; calculation and purchase of raw material; monitoring of all production until transportation and assembly, which is often completed at the customer's residence. Generally, this entire process is carried out by the joinery owner who participates in the entire production chain.

Generally, for the production of bespoke furniture, the basic raw materials used are panels derived from solid wood (plywood covered with natural wood veneer) and reconstituted wood panels (MDF, MDP, OSB and agglomerate). As

components, mainly used are wood veneers, edge strips, screws, dowels, glues, metallic hardware (handles, hinges, slides), among others. Solid wood is more used for the manufacture of pieces of small width and thickness. Most of the joineries in the region, 86%, produce residential furniture, being these products mainly destined for the local market, in a fierce competition based on prices (SENAI, 2006).

During the research implemented by SENAI, it was not evident how these companies employ design. However, what is observed as a common practice in the region is: (i) the development of personalized projects by the designers and later indication of the joinery services; (ii) joiners that outsource projects to serve customers who are directly looking for joinery; (iii) joiners who develop their own projects, through an intern with a degree in design; (iv) joineries that develop projects through a designer without training in design (SENAI, 2006).

## 2.2 Furniture waste: environmental, social and economic impacts

If, on the one hand, the furniture sector generates a large number of jobs, on the other hand, it is also considered a major consumer of raw materials and waste generator. The sector carries out the integrated use of materials, which, because of its distinct nature and the “lack of an adequate management plan, ends up hampering reuse, recycling and other modes of proper final disposal” (Kozak, et al., 2008: 205).

In addition to the diversity of materials, the production of customized furniture requires a series of production processes such as machining (cutting, drilling, milling,); sanding; assembly (fixing and gluing); transport; and cleanliness. All of these processes generate a large volume of various types of waste (sawdust, dust, panel scraps, edge tapes, packaging scraps, screws, glues and tow).

The estimated annual volume of residues from the furniture sector in Uberlândia in 2012 corresponded to 22 thousand m<sup>3</sup>, of which a significant part is composed of reconstituted wood residues (Nunes, 2013). The presence of additives urea-formaldehyde or phenol-formaldehyde used in the composition of reconstituted wood panels, requires special attention because this resin is part of the list of cancer products of the International Agency for Research on Cancer (IARC). For all these reasons, the joineries in the Triângulo Mineiro and Alto Paranaíba have an expressive environmental liability, mainly because of the irregular disposal of waste on land on the periphery of the cities in the region. This practice stems from factors such as: municipal policy, which is not very sensitive to environmental issues; the lack of municipal management aimed at the proper destination of this type of waste; the resignation of the needy populations, who live in the vicinity of these sewers; the low or no interest in assuming the share of environmental responsibility by the entrepreneurs of the MSEs in the region and the weak (social and environmental) awareness of the designers about the environmental impacts of their projects (Nunes, 2013). According to the diagnosis of SENAI (2006), 90.8% of the furniture manufacturers' SMEs in the region discard industrial waste, 3.7% sell it and 5.5% usually carry out recycling. Figure 1 presents the way in which, usually, the remains of production from a small joinery are collected, making provision for their disposal in the public space.



**Figure 1: Waste generated in five working days in a carpentry shop located in the city of Uberlândia. (Braga et al., 2017: 7)**

To dispose of the generated waste in an environmentally adequate way is insufficient to solve the problems dealt with. It is essential that there is a reduction in the consumption of resources, aiming, fundamentally, to minimize waste and, consequently, to reduce the impact on the environment (Pereira et al., 2010). PNRS recommends reducing the consumption source. According to Art. 9 of this Law, “in the management and management of solid waste, the following order of priority must be observed: non-generation, reduction, reuse, recycling, treatment of solid waste and environmentally appropriate final disposal of waste.” (Brazil, 2012: 15). The problem is the lack of recognition of the importance of these principles by all stakeholders and, consequently, and the innocuous change in behavior and practices.

According to Vicente (2012), the custom furniture sector has great potential to minimize its impacts, but for that it should deepen the knowledge about the life cycle involving its products and should be more open to contributions from other areas. In this context, the important role that design can play in generating value and minimizing impacts on the sector is highlighted. The problems caused by the abandonment of debris without any treatment and outside places previously prepared to receive it are not limited to its volume. The poor joinery waste management also causes social and economic impacts as described above. With regard to social impacts, it is important to add risks to public health from the toxicity of substances used in the production of reconstituted wooden boards. Formaldehyde, for example, is a carcinogenic solution used as an adhesive resin in the production process of this type of material (Pereira, 2013). Because of the use of resins containing formaldehyde, formaldehyde emission occurs both through the manufacturing environment and through the plates produced with these resins (Maloney, 1993).

### 3. STRATEGIES FOR THE DEVELOPMENT OF SUSTAINABLE PRODUCTS

The insertion of sustainable design strategies in local contexts and non-industrial production scales is very relevant for companies and indispensable to reduce the generation of solid waste, waste of materials, pollution and environmental damage caused by the production of personalized furniture. According to Fiksel (2009), sustainable design practices represent ethical behavior and good citizenship and, above all, a value strategy for companies' businesses. This principle of generating value and economic benefits for companies is known as eco-efficiency – i.e., doing more with less. This perspective is part of reducing the consumption of resources (energy, materials); reduce the environmental impact (reduce emissions, waste and the use of renewable resources); and creating value (providing better products, additional services, offering benefits to customers) (Bhamra, 2007).

Several corporations around the world already recognize sustainability as a strategy for business development, growth and survival and their ability to stimulate new business opportunities, improve competitiveness, increase customer confidence, and motivate employees, local communities, partners, etc. (Bhamra 2007; Fiksel 2009). Organizational changes for the insertion of eco-efficient design strategies also favor innovation and may offer a greater capacity to attract customers, as they improve the image of the organization and provide greater profitability through the reduction of environmental impacts, among other issues. All of these benefits obtained by adopting the principles of design and sustainability need to be integrated at a strategic level so that they can act effectively.

Strategies for the development of sustainable products are characterized by a systemic analysis of the product that also involves the search for alternative production technologies and strategies. Because sustainable design strategies are able to predict the desired result in all aspects of product development, determining the type of use, the market it will be used for, costs and possibilities of execution, generating flexible, durable, modular products or multifunctional, adaptable or recyclable (Barbero & Cozzo 2009).

Strategies aimed at a systemic approach involving all stages of product life should be considered when designing products. In this sense, whenever possible, designers should apply a set of eco-design strategies involving the entire product life cycle, that is, considering the stages of pre-production, production, distribution, use and disposal. They mainly involve: (a) the choice of low impact materials; (b) the reduction in the consumption of materials (raw materials and energy); (c) production optimization; (d) optimization of distribution; (e) optimization during use; (f) the extension of the product's useful life; (g) the optimization of the end-of-life of the product.

The establishment of efficient systems for the collection of materials, separation at the source and the environmentally appropriate final destination must encompass responsibilities shared by the products' life cycle. These initiatives require collective participation involving all generators - the community, manufacturers, importers, distributors, traders and the government - and the latter should stimulate the others, both through tax incentives, the valorization of recycled raw materials, educational campaigns, as well as through stricter legislation, inspection or even penalties. It becomes necessary to avoid disposal as much as possible, developing products that use less resources for production, that are durable, light, foldable, stackable, that use materials from renewable sources, that can be reconfigurable, adaptable, that can be standardized, demountable, upgradeable, refurbished, repaired, reused, which have greater efficiency in the consumption of energy, water and materials, which have more compact, reusable or biodegradable packaging. Most of the time it is impossible to adopt all these strategies for the same product, because these characteristics will be determined according to the performance and due to the context of use for which the object is intended.

#### 3.1 Innovation and sustainable design strategies

It is understood that sustainability strategies can be a key element for innovation, as they require prior understanding of the processes involving the entire product life cycle and also demand continuous improvements through the integration of environmental and social criteria in different stages of the product. process. According to Manzini and Vezzoli (2008: 22), sustainable design strategies should aim at creating “new scenarios that match sustainable lifestyles.” These authors also state that this scenario change can only emerge from the search for innovation through interpretation, environmental redesign, new product-services and the encouragement of new productive ideas that are intrinsically more sustainable for the environment, socially just and culturally attractive. So, sustainable design strategies have significant potential for generating social innovation.

Innovation is directly linked to sustainability, as both generally seek for a change, generally in the sense of improvement. With regard to sustainability, global environmental pressures and the urgent need to minimize environmental impacts with future generations in mind induces modifications and improvements in production processes, products and systems (Crul & Diehl, 2005) with the potential to reframe ways of life, while innovation (incremental or radical) allows the

introduction of novelty in products, processes and services, or allows its improvement, promoting differentiation and, consequently, the creation of value.

#### 4. DIAGNOSIS OF FURNITURE MPES OF THE MINAS GERAIS TRIANGLE

Different procedures and methods were used to collect qualitative data on the activities, operations and environment inherent to the production of personalized furniture and quantitative data on the general volume of waste produced. The diagnosis identified and analyzed the possible correlations between furniture production operations and the generation of tailings, that is, it identified the situations of waste, its causes and the opportunities for its reduction. Once the companies were defined, an active investigation led to the construction of knowledge about the investigated MSEs and to the identification of problems. Several data collection instruments contributed to the diagnosis of MSEs, namely: (i) semi-structured interviews; (ii) direct observation with mechanical support; (iii) documentary research; (iv) meetings with stakeholders; (v) bibliographic survey; (vi) quantitative survey on the volume of waste generated by joiners; (vii) and quantitative survey on the volume of waste sent for final destination. A toolkit was developed to support the diagnostic phase, which aimed to measure the amount of material (MDF) used in each project by joiners (material input and output). The toolkit was completed by the carpenters during the production process of the analyzed furniture. The completion of the toolkit is of low complexity and allowed: (i) to register and, later, to analyze the way in which the cutting of plates is usually planned; (ii) register and, subsequently, identify the quantity of MDF boards (new and reused) used in each project. The toolkit was made available to employees who also received guidance on how to use the tool (Braga, 2019). In addition, during the furniture production process, the waste materials were separated, identified, quantified (weighed and measured) in order to identify the percentage of material loss during the production process (waste output) (fig. 2).



**Figure 2: Process of separation and quantification of waste generated during the diagnosis. (Author, 2017)**

The data collected on the amount of MDF used for the production of the analyzed furniture were compiled using tables. The five joineries taking part in this research are scattered in different regions of Uberlândia. All SMEs are formal, family-owned and produce customized furniture, to order. The main products marketed by the companies are residential furniture (bedroom and kitchen furniture) aimed exclusively at the domestic market.

The main raw material used by carpenters is reconstituted wood panels (MDF). The finding is that there is a predominance in the use of laminated MDF panels (coated), and as components are used mainly, edge tapes, screws, adhesives, metallic hardware (handles, hinges, slides, aluminum profiles), among others.

In accordance with the statement by FIEMG (2002), it was found that companies have gradually been implementing technology. However, only one company investigated has a Computer Numeric Control (CNC) machine, which manufactures computer-controlled parts. The companies have a mix of semiautomatic equipment such as disconnect switches and edge glues and outdated equipment. The organizational structure of most MSEs is vertical (decision-making and supervision of people and tasks is centralized). The tasks to be performed are characterized by low horizontal specialization, as both owners and joiners are responsible for carrying out different activities (Wagner & Hollenbeck, 2012). The only exception is the finishing services that are usually outsourced. Each joiner is responsible for executing the complete furniture and the same activities are performed by several employees, which can cause communication failures.

#### 4.1 Productive process: description and identification of waste

The process of producing bespoke furniture, in general, involves a set of steps and operations that occur in a non-linear way. The production process by project, is adopted by all investigated carpenters, aiming to meet specific needs, with a fixed deadline to be completed. Once the project is completed, with the final assembly of the furniture, the joiner turns to a new project.

Although this type of production causes a low production volume, waste was detected throughout the process. According to Rampersad and Hubert (2007), waste is usually hidden because it is considered a normal symptom in the workplace. For waste is defined as any activity that does not add value to work or to the client and can be camouflaged in all operations. In this sense, the diagnosis analyzed the production process of personalized furniture and classified the main types of waste and its potential causes: waste of raw material; waste of time; fuel waste; waste of energy; waste of space (Slack, 2016).

It was found that there is an over-dimensioning in the calculation, mainly of MDF and edge tapes elaborated by the carpenters under the justification of avoiding probable interruptions in production caused by the lack of material. Therefore, the inaccuracy of the calculation of materials deserves due attention, as the abundance of materials generates uncontrolled and waste of raw materials on the part of carpenters. The cutting plan is carried out by the carpenters through manual annotations that describe the size of the parts to be sectioned. However, the annotations are only descriptive, referring only to the cutting dimensions, and do not constitute a plan for the optimization of the cutting of plates.

The diagnosis revealed that the lack of optimization of the cut has caused significant losses of material, because the joiners cut the MDF without planning the good use of the board. In these cases, it is valid to assume that: (i) the waste of raw materials is caused by the lack of planning and the large volume of waste generated; (ii) waste of energy is caused by the inefficiency in the use of the cutting machine (unnecessary cuts); (iii) space is wasted as a result of the accumulation of significant amounts of MDF leftovers.

The data triangulation of the three production stages (planning, production and distribution stage) makes it possible to conclude that all the processes characterized as generators of waste cause a certain type of socio-environmental and / or economic impact. However, some production processes have a higher level of correlation with waste (strong and moderate level) and, therefore, need to be prioritized during the development of sustainable strategies. They are: (i) planning stage: project design; verification of measures; analysis of the project and cutting plan; (ii) production stage: cutting; (iii) distribution stage: transport.

When considering the volume of raw material used and the amount of material insufficiently used by companies (24%), it was found that it is necessary to pay special attention to all processes that generate MDF waste. The quantitative analysis shows that a large part of the MDF leftovers made up of pieces (15%) is liable to be reused within the carpentry's own production process. The data reveals the importance of establishing strategies aimed at maximizing the use of MDF, its reuse and the environmentally correct destination. Therefore, we can conclude that sustainable strategic design proposals, as a result, can decrease: the consumption of natural resources (materials and energy); the generation of waste; the need to extract virgin raw materials; negative impacts on the environment; and reduce the production costs of MSEs.

The diagnosis showed that, on average, 24% of the wooden sheets are not sufficiently used. The significant loss of raw material is mainly due to the lack of planning to optimize the cutting of slabs, to design errors, production errors or due to excessive material acquisition. In 2017, the average amount of waste produced in Uberlândia by a universe of 50 furniture industries was 7.2 tons. per year, per company.

#### 5. CACO: SUSTAINABLE STRATEGIC DESIGN MODEL

The compilation of bibliographic and empirical data has allowed us to recognize six main sustainable design strategies, applicable to the joinery sector and which will contribute to the reduction of companies' socio-environmental and economic impacts (Braga, 2019): (a) select materials, equipment and resources with less impact; (b) minimize the consumption of materials and resources; (c) optimize production systems; (d) optimize transport systems; (e) extend the useful life of the furniture; (f) optimize the end of life of the furniture and make the correct disposal of waste. The preliminary model, in addition to the six selected sustainable design strategies, also presented a set of guidelines that aim to minimize the environmental, social and economic impacts of joiners.

CACO model development was based on: (i) preserve semi-handcrafted know-how; (ii) not compromising the furniture's durability characteristic; (iii) improving the work environment and preserving the health of workers; (iv) reduce the impacts on the population on the outskirts of the city caused by irregular waste disposal; and, simultaneously, (vi) promoting the sharing of a commitment of responsibility (social, environmental, cultural) by the stakeholders.

##### 5.1 Support instruments for the insertion of the Caco Model

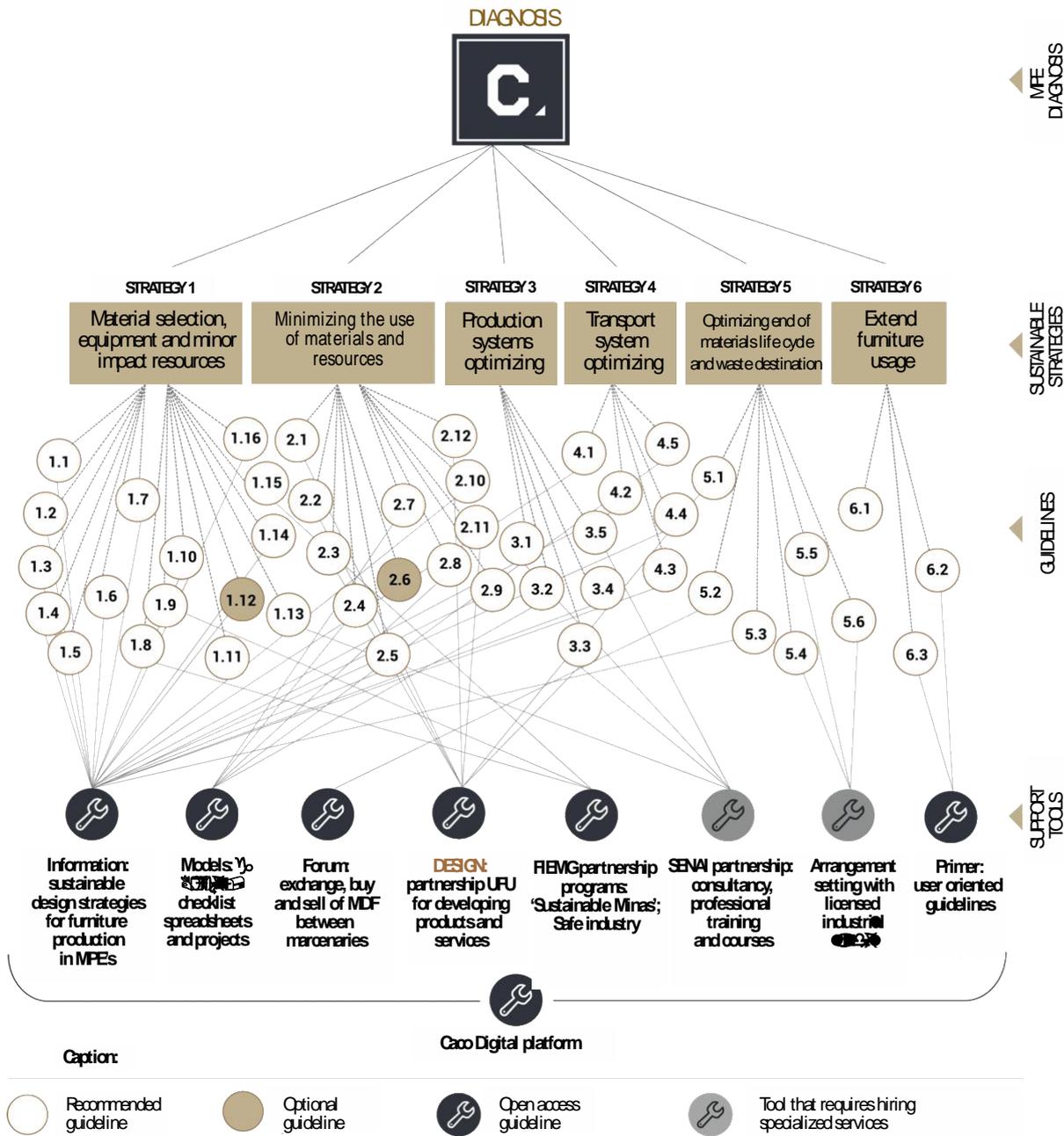
A set of support tools were also developed or negotiated by the Caco Project, targeting its model. These tools aim to disseminate knowledge about the sustainable strategic design model for custom furniture MSEs, assist in the insertion of the model and establish a direct communication process between the companies and the Caco Project.

All information about the sustainable strategic design model and the support tools are available to joiners free of charge through a digital platform, which is being developed by the Caco Project. The digital platform will consist of: (a) data on the furniture sector; (b) information on sustainable design strategies and guidelines applicable to the sector; (c) briefing

templates, spreadsheets, checklist, organization chart; (d) projects to optimize production systems; (e) forum for exchanging, buying and selling MDF between joiners; (f) information on the partnerships established by the Project with the UFU Design course, with FIEMG and SENAI to apply the model; (g) information on the agreement established with a licensed industrial landfill for the correct disposal of waste; (h) booklet aimed at furniture users on the correct maintenance of furniture and correct destination after use (Braga, 2019).

The final sustainable strategic design model proposes the continuous improvement of products, services and production processes of furniture MSEs through its progressive implementation. The insertion of the model is an important resource to reduce the environmental, social and economic impacts of the furniture industries, and to decrease the amount of waste sent to the final disposal.

The Caco Model consists of: (i) the company's diagnosis; (ii) a set of six strategies; (iii) 47 sustainable design guidelines; (iv) and nine support tools that aim to assist in the process of inserting strategies in MSEs. The model (fig. 3) aims to minimize waste, promote the management and correct disposal of waste and minimize the environmental, economic and social impacts of joiners (Braga, 2019).



Caption:

Caco Digital platform

- Recommended guideline
- Optional guideline
- ⚙️ Open access guideline
- ⚙️+ Tool that requires hiring specialized services

UFU – Federal University of Uberlândia | FIEMG – Federation of Industries of the Minas Gerais State | SENAI – National Industrial Apprenticeship Service

**Figure 3: CACO: sustainable strategic design model (Braga, 2019)**

A plan for inserting the strategies and guidelines was developed and the model was partially implemented in a pilot company selected from the furniture MSEs that participated in the diagnosis phase. In addition, as a partial result of the

Caco Project, 60 furniture MSEs from the Triângulo Mineiro region are already disposing their waste correctly in a licensed industrial landfill after the sectoral agreement articulated by the Caco Project.

## 5.2 Model evaluation by an experts focus group

Aiming at the qualitative approach, the preliminary strategic design model was evaluated by a group of experts according to the methodology presented by the authors Gatti (2012) and Morgan (1996). The selection criteria of the group considered the affinity and experience of the participants with the scope of the investigation (personalized furniture industry) and prioritized professionals recognized in the academic and professional environment as specialists in related areas such as sustainable strategic design, furniture and environmental management. The focus group made up of a total of 10 experts provided a valid judgment on the proposed sustainable strategic design proposal; collectively evaluated concepts, offered feedback on the model and contributed to the organization, selection and introduction of new guidelines.

The specialists considered that the diagnosis is a fundamental part of the sustainable strategic design model, as each company has a different reality and, therefore, the diagnosis is essential to understand the context and to guide the action plan aiming to implement the appropriate guidelines and strategies. The diagnosis allows to determine which strategies and guidelines should be prioritized during the implementation of the model in each company.

In general, the experts considered the sustainable strategic design model suitable for the context of furniture MSEs and to minimize waste, promote the correct disposal of waste and, consequently, minimize the socio-environmental and economic impacts of companies.

The focus group proposed the incorporation of some guidelines and tools in order to ameliorate the sustainable strategic design model. Based on the evaluation carried out by the focus group and the analysis of the contributions of several stakeholders (businessmen, carpenters, class representatives and technical consultants), the model of sustainable strategic design was revised and complemented. If the preliminary model contained 35 guidelines and seven support tools, its final version includes 47 sustainable design guidelines and nine support tools.

## 6. CONCLUSIONS

The achieved results allow us to prove that the environmental, social and economic impacts resulting from factory waste are of great importance, given the large volume of waste generated and the lack of proper waste management.

The theory that supports this study allowed to underline the importance of combining sustainable interrelated design strategies to achieve the target. Therefore, a set of strategies, guidelines and tools were selected and developed for the development of the sustainable strategic design model, already evaluated by a panel of experts - the CACO model. The insertion of strategies and guidelines on the part of furniture MSEs stimulates innovation, through the introduction of constant improvements in production processes, products and services through a model that bets on an environmentally correct, socially fair, culturally appropriate and economically viable system. From an environmental point of view, CACO is an important resource for furniture MSEs to reduce socio-environmental impacts related to the use of toxic and dangerous materials; reduce the consumption of virgin raw materials; minimize factory waste; reduce the volume of waste sent to final destination; reduce energy and fuel consumption; reduce emissions of particulate matter (dust and VOCs); contribute to increasing the useful life of the furniture; and to reduce the socio-environmental impacts related to the irregular destination of residues. The correct application of the model can contribute to the improvement of the living conditions of the population affected by irregular waste disposal, by burning waste in the open or in bakery ovens, as the model prioritizes the minimization of waste and promotes its proper management, in addition to benefiting the working environment, safety and health of workers in the furniture industries. The platform for waste exchange proposed by the model allows to stimulate the interaction between joiners and cooperation between companies in the sector. Culturally, the model favors the differentiation of furniture MSEs that produce furniture on non-industrial production scales and preserves the culture of semi-handcrafted know-how and local identity. From an economic point of view, the implementation of the model is an important strategy for positioning and differentiating itself from the competition, as the insertion of a set of strategies enhances the image of the company, which now offers an exclusive mix of socio-environmental values to customers. The positioning of the industry in the market for sustainable products and services generates new business prospects and advantages for companies, reducing competition based on price and making the imitation process more difficult. In addition, the implementation of strategies to reduce waste and improve production processes are important for the survival of furniture MSEs in times of crisis, allowing to reduce production and waste disposal costs, reduce energy consumption, reduce delivery time, increase production capacity and profitability.

As main result of the investigation, it was possible to verify that the five furniture MSEs participating in the investigation added to another 55 SMEs in the region started to correctly dispose of the waste in the licensed industrial landfill after the participatory negotiation strategy promoted by the CACO Project. The challenges inherent to the insertion of the CACO model must be overcome with the continuity in the active participation of stakeholders, with the strengthening of the relationship with the sector, with the collaborative work of specialists directly on the shop floor and with the dissemination of knowledge about the practices of sustainable strategic design applicable to the sector.

It was found, therefore, that the insertion of a sustainable strategic design model especially oriented to furniture MSEs, CACO model, encourages the correct disposal of waste, minimizes waste and environmental, economic and social impacts arising from the production of personalized furniture. The CACO model, supported by the strategies, guidelines and tools that characterize it, should continue to be constantly improved and tested, aiming its validation.

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## THE ROLE OF MEDIUM-SIZED FIRMS AND BUSINESS SIZE EVOLUTION IN REGIONAL RESILIENCE

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### ABSTRACT

Scholars have highlighted the role of regional features in the process of building resilience including the role of the dynamism in services sectors and innovation. However, the role of business size diversity and its dynamics in building resilient (and indeed resistant) economies has been largely overlooked in academic discourse. Moreover, economic development policy has focused on the two sides of business size spectrum, either on micro firms or on attracting larger projects through inward investments. In this context consideration of a 'missing middle' may exist in terms of policy development.

This paper focuses on the role of medium-sized firms in supporting regional resilience. Understanding connections between firm size distribution, business size growth dynamics and regional development provides insights for the regional resilience (and resistance) debate. This paper contributes by highlighting the importance of medium-sized firms as a consideration factor in determining the resistant or resilient nature of economies. We argue that locally-owned and highly productive medium-sized companies can offer a relative stability and facilitate the transformation of a regional developmental path, while a poorer performing sector can lead to regional resistance. The issue of medium-sized firms is organically related to business size evolution, the process of firms evolving from micro to small and medium-sized companies. We claim that a dynamic business population, with firms progressing relatively quickly from small to medium, contributes to the transformation and renewal of a regional economic growth path.

We examine these issues through the lens of the region of Wales. A framework linking regional economic resilience to firm size structure, evolution and heterogeneity is developed, before providing evidence of the significance of medium-sized companies in the Welsh economy and considering the implications for processes of regional resilience and resistance.

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## PLENARY SESSION II

14:45 - 15:45 Tuesday, 25th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/83563460045>

### Keynote Speech



*The Survival Of The City*

**Prof. Edward L. Glaeser**

Harvard University, United States

**Chair Carlos Azzoni**, University of Sao Paulo, Brazil

**Discussant Andrea Caragliu**, Politecnico di Milano, Italy

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# PARALLEL SESSIONS (4)

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## National Session: SS55.1 - Regional Science in Angola



**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/87320775891>**

**Chair Tomaz Dentinho**

## YOUTH PRECARIETY AND RESILIENCE IN ANGOLA'S SUB-URBAN SETTINGS

Jose Katito, Josefina Castellero

Universidade Óscar Ribas, Angola

### ABSTRACT

Based on literature, this text summarizes a research project on youth precarity and resilience in Angola's sub-urban settings, with a special attention on macro structural factors of poverty that underpin precarity. The research adopts a critical-normative stance and intends to produce use-inspired knowledge, targeting policy makers and civil society organizations.

Following Peter Hall with Michèle Lamont (2009) and Jon Schubert (2017), an institutional-cultural approach is utilized in order to understand the way in which institutional practices and cultural repertoires combine to produce young youth precarity. This implies looking, interrelatedly, at the ineffectiveness or lack of state policies and deep-rooted cultural practices that are detrimental to progress. Cultural practices include immediatism and the high symbolic value placed on generating children regardless of material conditions. By its side, the institutional-cultural approach transcends both institutional accounts, which focus exclusively on the public policy, and those that concentrate on the role of culture in development process.

Angola has made significant progress over the last two decades since the end of the civil war in 2002, which virtually destroyed the country since its outbreak in the aftermath of independence in 1975. Peace and security have been largely established and the country is becoming an important global player, while emerging as a regional power in Africa, thanks to a booming oil economy (Oliveira, 2015; Veins & Weimer, 2011; Carvalho et al., 2011; Rodríguez et al. 2013; Power & Alves, 2012; Chabal, 2007).

Moving from these premises, the research project seeks to understand the strategies that sub-urban youth in Angola implement in the search for better material and symbolic resources, the manner in which such strategies unintentionally end up perpetuating their precarity in a context of poor public policies and traditional cultures that basically lack an orientation toward progress for sub-urban life.

The historicity of these processes will also be stressed, by taking into account the impact of pre-colonial, colonial and post-colonial social order, as well as that of the civil war, on sub-urban youth precarity (Soares, 2015). This last point is important inasmuch it complements the focus on institutional-cultural factors, as most sub-urban youth were pushed from the war-affected countryside to sub-urban areas — the former being more secure — or were born in sub-urban areas from families who fled rural areas to seek safety. This means that the civil war marked most young people's lives. Furthermore, peace and political stability, along with scarce state investments in rural areas, have together stimulated youth exodus from rural to sub-urban settings over the last two decades. As a consequence, the living conditions of urban youth have worsened and their expectations for a prosperous sub-urban life frustrated, caught between their expectations with regard to the impact of economic growth and political stability, on the one hand, and the burdens stemming from a combination of institutional practices and cultural repertoires, on the other.

## TYOLOGIES OF AGRICULTURE AND THE DECISION TO INVEST IN FAMILY FARMS. A CHI-SQUARE ANALYSIS

Hélder Marcelino

Associação de Ciência Regional de Angola, Angola

### ABSTRACT

This research aims to analyze the possible connection between the types of agriculture and the decision of investing in family farms. Specifically, it is intended to estimate the significance level of the types of agriculture influence on investment decisions making on family farms in the commune of Lepi, municipality of Longonjo, province of Huambo, Angola, based on the typification that suggest the criteria of market linking, type of labor and sources of income. For this purpose, an economic analysis was carried out, based on an empirical data obtained through a survey on 361 households in the mentioned location, testing three hypothesis with application of Chi-square analysis, desiring to measure an eventual connection between the variables, assuming that the greater the value, the greater the chance of connection between them. However, the chi-square does not refer to the strength of such connection. If its value is zero, there is no association among the variables. The variables are presented in contingency tables and in graphs. The null hypothesis was tested with a significance level of 0,05. The results indicates that there is no significant connection between the types of agriculture and the decision to invest in family farms, regardless of the relationship they establish with the market, the used type of labor and sources of income.

## POOR PEOPLE ON THE OUTSKIRTS OF LUANDA CITY IN TIMES OF PANDEMIC: SOCIAL PRACTICES, HITS AND MISSES

Joaquim Calundungo

Universidade Agostinho Neto, Angola. Associação de Ciência Regional de Angola, Angola

### ABSTRACT

This paper focuses on the social practices of peripheral populations of the city of Luanda.

The aim of this paper is to discuss the practices of subaltern populations and its initiatives, actions, and effects in the context of the global pandemic of Covid-19. Also, address a set of government strategies and measures that have been used as a reference for many of the social practices and, at the same time questions several other practices.

Henceforth, based on the approaches made by other authors, particularly in the social sciences, immersed in the treatment of the subject of the global pandemic, it was carried out a preliminary analysis of social practices and, qualitative approach, using various research techniques, such as observation, semi-structured interviews, observation, and focused interviews, as well as documentary analysis.

During the critical situation of the global pandemic, many governments, including the Angolan government started to integrate external models and references to deal with pandemic of Covid-19. At the national level, the efforts undertaken have mainly aimed to the population compliance with the guidelines and initiatives that advocate the defence of life and the minimization of the number of victims of covid-19.

The empirical studies have suggested that a set of practices related to the context of the pandemic of Covid-19 and the need for protection of its subjects and communities sometimes they align with (government) guidelines, some distance themselves or even ignore the guideline measures that can potentially protect the population of Angola.

It is concluded that, despite the fulfilment of some institutional measures by the population, there have also been a number of problematic effects that directly affect subaltern populations. It is also concluded that impoverished populations have shown immense difficulties in following and understanding many of the government guidelines and strategies, which has raised important aspects of the dialogue between leaders and governed and public policies in general.

## CULTURAL TOURISM IN ANGOLA AND LOCAL DEVELOPMENT: A REALITY OR STILL A CHALLENGE?

Ziva Domingos

School of Hospitality Management and Tourism of Agostinho Neto University, Angola

### ABSTRACT

The socio-economic and cultural changes and the challenges of globalization that are taking place today, across the world, accentuated by the pandemic crisis of Covid-19, call on the public authorities, agents of change and civil society to rethink development models, looking for placing "man" at the centre of their policies and strategies and rationally exploiting all resources in order to contribute to the improvement of the quality of life of local communities, through the eradication of poverty, which is one of the main objectives of sustainable development.

Angola is recognized as a country, not only with a rich economic potential, but also with a rich diversity of its tangible and intangible cultural heritage, constituting the true "substance" for the promotion of cultural tourism at the local and international level, and consequently, one of the means to achieve sustainable development in Angola, aiming at social justice, through the elimination of asymmetries and the promotion of equal opportunities, especially for the most vulnerable populations.

In the Angolan context, the real questioning of the "Tourism and Development" relationship lies in knowing what the impact of tourism has been, in this case, cultural tourism on local development; how cultural tourism has contributed to development aimed at local communities, at this time that Angola is taking on the challenge of deconcentration and decentralization of public power and governance and, at the same time, facing the global health crisis of Covid-19? Considering the current local realities and specificities and moments of crisis, could this binomial "Tourism and Development" in Angola, be already a fact or is it still a challenge? Such is the problem to which we intend to respond. If, on the one hand, the promotion of cultural tourism in Angola starts to take shape, even timidly, its impact on local development seems to be still negligible.

## National Session: SS56.1 - The Colombian Economy and its Regional Structural Challenges



ASOCIACIÓN COLOMBIANA  
DE ESTUDIOS REGIONALES  
Y URBANOS

**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84686769452>**

**Chair Jaime Bonet**

## ELASTICITIES OF REGIONAL TOTAL FACTOR PRODUCTIVITY IN THE COLOMBIAN ECONOMY

[Carlos Espinel](#)<sup>1</sup>, [Eduardo Haddad](#)<sup>2</sup>

<sup>1</sup>Federal University of São Carlos, Brazil. <sup>2</sup>University of Sao Paulo, Brazil

### ABSTRACT

The principal aim of this paper is to evaluate the implicit total factor productivity (TFP) elasticity of each sector in the model by taking into consideration the Colombian regional structure with regard to national and regional output growth, in the long run. In order to reach this goal, a computable general equilibrium model (CGE) was specified: B-MCOL. The database that enables the use of the CGE model is the interregional input-output system for 2015 in Colombia estimated by The University of São Paulo Regional and Urban Economics Lab (NEREUS). The model is formed by productive sector, investors, household, federal government and regional government. There are 54 sectors responsible for production of goods in the 33 departments of Colombia. This simulation can be understood as the calculation of impacts on output growth given an increase in productivity in each of the sectors of the Colombian economy and this exercise will allow to identify from a new perspective the strengths and weaknesses of the Colombian economy that could be used to promote economic policies or restructure ongoing economic policies that no longer have significant effects. Empirical evidence over the years has strengthened the idea that differences in the stock of physical and human capital alone are not capable of explaining most of the differences in income among countries. In this case, the total factor productivity is a crucial element in explaining economic growth. The main objective of this research is to calculate the impacts of increased productivity in Colombia (by taking into consideration the Colombian regional structure) on output growth by estimating the set of implicit TFP elasticities in the context of the model, defining 1% shocks in TFP in each sector in each Colombian department. The sector that most affect national Gross Domestic Product (GDP) is the other services sector, followed by the industry sector. Bogotá is the region where increased productivity has the greatest impact on national GDP. Also, it has the greatest impact in the other regions as well. Almost 50% of the total growth after an increase in productivity is concentrated in three areas. The results of total factor productivity shocks showed that Colombia has a very concentrated economy, both regionally (Bogotá, as capital of the country and city that concentrates the largest portion of the national population, plays a starring role) as sectorally (other services and industry sectors with a significant share of the gross domestic product).

## REVISITING THE STRUCTURAL INTERDEPENDENCE: A COMPARATIVE ANALYSIS FOR BRAZIL, COLOMBIA, AND MEXICO

[Fernando Perobelli](#)<sup>1</sup>, [Geoffrey Hewings](#)<sup>2</sup>

<sup>1</sup>Federal University of Juiz de Fora, Brazil. <sup>2</sup>University of Illinois at Urbana Champaign, USA

### ABSTRACT

The regional interdependence can be measured by different indicators. At this chapter we will address this issue analyzing the interdependence from the intermediate inputs side and from final demand side among Brazilian, Colombian, and Mexican regions using input-output database from 2013-2015. Which is the relevance in this kind of analysis? The analysis of the structure of regional interdependence plays an important role contributing to a better design of regional policy. According to Williamson (1965) regional inequality is an issue related to development. For the author, the inequalities are generated at the early stage of development and as far as an economy became mature there will be a process of regional convergence or at least, a decrease on it. To reach this aim we will use the final demand decomposition and the hypothetical extraction. We depart from the ideas of growth poles and central places (Perroux, 1955 and Christaller, 1933) to implement the regional hypothetical extraction and observe the impact of those regions upon the regional economies. On the other hand, this exercise enables us to measure the relative importance of the most important regions in each country upon the rest of the economies.

## REGIONAL DIFFERENCES IN THE ECONOMIC IMPACT OF LOCKDOWN MEASURES TO PREVENT THE SPREAD OF COVID-19

Jaime Bonet<sup>1</sup>, [Diana Ricciulli](#)<sup>1</sup>, Javier Pérez<sup>1</sup>, Eduardo Haddad<sup>2</sup>, Inacio Araujo<sup>2</sup>, Fernando Perobelli<sup>3</sup>

<sup>1</sup>Banco de la República, Colombia. <sup>2</sup>Sao Paulo University, Brazil. <sup>3</sup>Universidade Federal de Juiz de Fora, Brazil

### ABSTRACT

This paper analyzes the regional economic differences in the impact of lockdown measures ordered by Colombia's national government to prevent the spread of COVID-19. Using an input-output model, we estimate the regional economic losses of extracting a group of formal and informal workers from different sectors of the economy. Results show regional differences in the impact of lockdown measures on labor markets, local economies, and their productive sectors. We also find that peripheral regions concentrate a higher number of informal workers in isolation than the inner regions. Regarding the economic impact, regional losses range between 5,4% of GDP (Amazonia) and 6,3% (Coffee Area and Antioquia). Finally, we compare the Colombian case with other developing economies, articulating what the Colombian case can tell us that informs about other countries' experiences in fighting the COVID-19 pandemic.

## **Regular Session: RS15.1 - Theoretical and empirical urban economics**

**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/88466279359>**

**Chair Janet Kohlase**

## SMART CITIES AND THE URBAN DIGITAL DIVIDE

[Andrea Caragliu](#)<sup>1</sup>, [Chiara Del Bo](#)<sup>2</sup>

<sup>1</sup>Politecnico di Milano, Italy. <sup>2</sup>Università degli Studi di Milano, Italy

### ABSTRACT

The debate on urban smartness as an instrument for planning and managing more efficient cities has been recently positing that smart cities could be raising inequalities. Several theoretical arguments have been presented in support of this claim, most revolving around the idea that the smart city movement would be driven by MNCs, which would persuade city managers of the need of investing in their devices, at the expense of segments of the population not ready to reap their benefits (Vanolo, 2014; Shelton et al., 2013). Following up on our own research carried out on the impacts of urban smartness (Caragliu et al., 2011; Caragliu and Del Bo, 2012) and Smart City policies (Caragliu and Del Bo, 2018 and 2019a), in Caragliu and Del Bo (2019b) we found that a negative relationship exists between urban smartness and the intensity of urban income inequalities, suggesting that Smart City features, if anything, help reduce income inequalities. In this work we instead empirically verify whether smart urban characteristics are associated to an increase in urban inequalities along the digital divide dimension among urban dwellers. In order to provide an empirical test of this hypothesis we exploit a large data base of 309 European cities, with data on smart urban characteristics, along with the measures of digital divide obtained with the use of survey data carried out at the EU level.

## A POLITICAL-ECONOMY PERSPECTIVE ON MAYORAL ELECTIONS AND URBAN CRIME<sup>27</sup>

**[Amitrajeet A. Batabyal](#)<sup>1</sup>, [Hamid Beladi](#)<sup>2</sup>**

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### ABSTRACT

We provide a political-economy analysis of crime prevention in an arbitrary city in the United States. City residents (voters) elect mayors (politicians) and elected mayors determine the resources to be allocated to crime prevention. Between the two time periods, there is an election. Politicians are either honest or dishonest. The marginal cost of public monies  $\psi$  measures how efficiently an elected mayor converts tax receipts into crime prevention. Voters have identical per period utility functions. We ascertain the equilibrium outcome and per period voter well-being. Second, we show that an increase in  $\psi$  reduces the equilibrium allocation of resources to crime prevention and voter well-being. Third, a dishonest politician can delay the revelation of his dishonesty. A critical value of  $\psi$ ,  $\psi^*$ , exists such that a dishonest incumbent separates and loses the election if and only if  $\psi > \psi^*$  and he pools and is re-elected otherwise. Finally, we note that an increase in  $\psi$  can raise voter well-being when politicians are more likely to be dishonest.

### KEYWORDS

City Resident, Crime Prevention, Election, Mayor, Voting

### JEL CLASSIFICATION

R11, R50, D72

### 1. INTRODUCTION

#### 1.1. Preliminaries

The work of researchers such as Witte (1996) tells us that urban crime is a major issue for Americans. Complementing this point, Rainwater (2019) reminds us that in 2019, “public safety” was one of the top ten worries of mayors in cities throughout the United States (US). Because urban crime is a serious public policy problem, we can now find a large empirical and case-study based literature on this subject. Criminologists in particular and social scientists more generally have examined the ways in which a lack of economic opportunities, social disorganization, poverty, and the presence of unsupervised youth contribute to the presence and prevalence of urban crime.<sup>28</sup>

Politics and politicians in the form of mayors clearly affect the ways in which the problem of city crime is understood and dealt with (Dunn, 2020). This notwithstanding, Marion and Oliver (2013) rightly point out that it simply does not make sense to only blame mayors for the prevalence of urban crime. What actually matters for crime prevention, says Asher (2020), are the policies adopted by a mayor and not his or her party affiliation. Given the clear connection between politics, politicians, i.e., mayors, and the efficacy of alternate crime prevention policies, it is pertinent to ask what economists and regional scientists have written about the nexuses between the behavior of city residents who vote to select their mayor and the urban crime fighting policies that are put in place by the elected mayor. Therefore, we now briefly discuss this literature and then proceed to the main questions that we study in our paper.

#### 1.2. Literature review

Sharp (2006) examines the reasons for the disparity in the size of contemporary police forces in large cities in the US. Her detailed empirical analysis shows that the size differences in question can be explained by the legacy of the racial unrest during 1960-1970, racial disorders in the 1980s and 1990s, and by the prevalence of racial minorities in the current population. Does a mayor’s party affiliation influence urban crime rates? Using regression discontinuity design analysis, Ferreira and Gyourko (2009) demonstrate that whether a mayor is a Democrat or a Republican has no bearing on either crime rates or on the allocation of local public spending in large US cities.

Does a mayor’s gender have an impact on crime rates in a city? In their study of this question, Ferreira and Gyourko (2014) first point out that women’s participation in mayoral elections in the US increased from negligible numbers in 1970 to approximately one-third in the 2000s. Then, employing a regression discontinuity design, they point out that a

<sup>27</sup> Batabyal acknowledges financial support from the Gosnell endowment at RIT. The usual disclaimer applies.

<sup>28</sup> See Ward (1976), Lynch (1981), Kohfeld and Sprague (1988), Hale (1996), White (1996), Gibbons (2004), Kourtit (2019), Lehmann (2019), and the many references cited in these sources for more on this and related issues.

mayor's gender has no bearing on city crime rates. Interestingly, this negative result holds in the short and in the long run. Thompson (2017) analyzes how two different fiscal stress labeling systems for municipal governments affect their functioning in Ohio. His econometric analysis shows that the actual label used to delineate a municipality has a minimal impact on both crime rates and on the employment of police.

Heberlig *et al.* (2017) utilize data for 104 cities during 1992 to 2012 and show that a reduction in the crime rate increases the likelihood that an incumbent mayor will seek another term in office. In addition and in contrast with the other mayoral accomplishments they study, a reduction in the crime rate seems to help mayors win re-election. Wiig (2018) describes how a citywide, multi-instrument surveillance network was used to complement the technologically mediated community policing in Camden, New Jersey. He points out that even though the success of this surveillance-driven community policing strategy in reducing crime was mixed, the strategy did succeed in providing Camden with a positive "ready for business" image.

Concentrating on Brazil, Ingram and da Costa (2019) study how the party identification of mayors, the partisan alignment of mayors and governors, electoral competition, and voter participation affect homicide rates. Geographically weighted regression analysis shows that the above four explanatory variables have dissimilar impacts on homicide rates across Brazil's 5562 municipalities. Finally, Batabyal *et al.* (2020) study the centralized versus decentralized provision of a controversial crime-fighting technology such as facial recognition software to the police in American cities. They show that there are circumstances in which the technology is provided with majority voting in a city even though it is inefficient to do so and that it is efficient to provide the technology in a city but majority voting will lead to this technology not being provided.

Our review of the literature leads to the following noteworthy conclusion. To the best of our knowledge, there are *no theoretical political-economy* studies that have analyzed the connections between the voting behavior of the residents of a particular city, the election of a mayor in this city, and the prevalence of crime in this same city.

### 1.3. Objectives

Given this lacuna in the literature, we adapt the analysis in Batabyal and Beladi (2020) and provide the *first* formal, political-economy analysis of urban crime that arises from the interaction between city residents (voters) and mayors (politicians) who promise to devote resources to the prevention of crime. The remainder of this paper is organized as follows.

Section 2 describes the two-period, political-economy model of crime prevention in an arbitrary city in the United States. In this model, city residents or voters elect mayors or politicians to office in each time period and elected mayors decide the extent of the resources to devote to crime prevention. Between the two time periods, there is an election. Politicians are either *honest* which means that they are genuinely interested and hence efficient in disbursing resources to fight crime or *dishonest* which means that they are less interested and thus inefficient in disbursing resources to combat crime. The marginal cost of public monies  $\psi \geq 1$  measures how *efficiently* elected mayors convert tax receipts into crime prevention. All voters have identical per period utility functions. Section 3 computes the equilibrium outcome and per period voter well-being. Section 4 demonstrates that an increase in  $\psi$  reduces the equilibrium prevention of crime and voter well-being. Section 5 permits a dishonest politician to borrow money and thereby delay the revelation of his inefficiency. In this setting, a dishonest politician may seem to be honest and this influences his chance of getting elected mayor. This section solves for the equilibrium outcome and then demonstrates that there exists a critical value of  $\psi$ ,  $\psi^*$ , with the property that the dishonest incumbent separates and loses the election if and only if  $\psi > \psi^*$  and that he pools and is re-elected mayor otherwise. Section 6 points out that an increase in  $\psi$  can raise voter well-being when politicians are more likely to be dishonest. Section 7 concludes and then suggests two ways in which the research described in this paper might be extended.

## 2. THE THEORETICAL FRAMEWORK

Consider the interaction between residents and politicians seeking to be the mayor of an arbitrary city in the United States. There are two time periods in our model. Between the first and the second time period, there is an election to determine which politician will be elected mayor in the second period. Politicians differ in terms of how *honest* they are in genuinely wanting to reduce crime in the city under study. These politicians also differ in terms of the *efficiency* with which they are able to convert tax revenues into actual crime prevention. Voters are uncertain about the honesty of the politicians seeking to be elected mayor. Put differently, they are uncertain about how efficient politicians are in reducing crime in the city under study.

We suppose that politicians are honest with probability  $p > 0$  and that they are dishonest with complementary probability  $(1 - p) > 0$ . We assume that an honest politician is also efficient in disbursing resources to fight crime and that a dishonest politician is relatively inefficient in disbursing resources to combat crime in the city under consideration.<sup>29</sup> We model this efficiency aspect of the story by supposing that an honest or efficient politician disburses resources to fight and thereby reduce crime at *low* cost. Similarly, a dishonest or inefficient politician distributes resources to combat and therefore lower crime at *high* cost. In symbols, an honest politician disburses resources for

<sup>29</sup> Following Sharp (2006) and for concreteness, we shall think of "disbursing resources" as being akin to contributing to the size of the city police force. So, in this way of looking at the issue, increasing (decreasing) the disbursement of resources is equivalent to raising (lowering) the size of the city police force. It is understood that all else being equal, a larger police force is likely to reduce crime by more than a smaller police force.

crime reduction at unit cost  $\delta_L > 0$ , a dishonest politician distributes resources for lowering crime at unit cost  $\delta_H$ , and we have  $\delta_H > \delta_L$ .

All residents (voters) of the city under study have an identical per period quasi-linear utility function and this function is given by

$$U(R, T) = H(R) - \psi T, \tag{1}$$

where the function  $H(\cdot)$  is differentiable, increasing, and concave,  $R$  denotes a crime index,  $T$  denotes taxes, and  $\psi \geq 1$  represents the marginal cost of public monies. The reader should think of  $R$  as a crime index such as the NeighborhoodScout's crime index which ranks crime on a 0-100 scale and where 0 (100) is the least (most) safe that a city can be. The specific point to grasp here is that an increase (decrease) in  $R$  raises (lowers) a city resident's utility and is therefore desirable (undesirable).<sup>30</sup> Because the parameter  $\psi$  can be thought of as a measure of the scarcity of public resources in our city, an increase in  $\psi$  means that it is now *more* difficult for politicians to raise tax revenues to increase the size of the police force in our city. Without loss of generality and to keep the subsequent mathematical analysis transparent, we suppose that there is no discounting between the two time periods. Finally,  $G > 0$  denotes the private gain to politicians from being elected mayor in the city under study.

With this description of the theoretical model out of the way, we are now in a position to solve for the equilibrium result that arises from the interaction between residents (voters) on the one hand and politicians on the other in our city and to then determine the per period well-being of the voters.

### 3. THE EQUILIBRIUM RESULT AND VOTER WELL-BEING

Let  $i$  denote the type of the incumbent mayor in office in our city in time period 1. Then, the value of the crime index that arises in this time period is given by the solution to the maximization problem

$$\max_{\{R\}} H(R) - \psi \delta_i R. \tag{2}$$

The first-order necessary condition for an interior solution to the above problem is given by the equation

$$H'(R^*) = \psi \delta_i, \tag{3}$$

where  $R^*$  is the optimal value of the crime index.<sup>31</sup> We know that the  $H(R)$  function is increasing and concave. From this it follows that the derivative  $H'(R)$  is positive and decreasing in  $R$ . Using this last point, we deduce that

$$R_L^* \equiv R^*(\delta_L) > R^*(\delta_H) \equiv R_H^*. \tag{4}$$

The inequality in (4) tells us that the value of the crime index when the honest or low cost incumbent fights crime by raising the size of the city police force is *greater* than the value when a dishonest or high cost incumbent combats crime by increasing the size of the city police force. Our city voters observe the value of the crime index that emerges in the first time period and then they re-elect the honest incumbent and get rid of the dishonest incumbent in which case a new incumbent is elected to replace the dishonest incumbent as mayor.

If a dishonest politician is removed from office then the new incumbent will be honest and efficient with probability  $p > 0$  and dishonest and inefficient with probability  $(1 - p) > 0$ . As such, suppose that in the first time period, the incumbent mayor in office is honest. Then, after observing the value of the crime index in our city, residents will re-elect this incumbent. In this case, an arbitrary city voter's per period well-being is

$$U = H(R_L^*) - \psi \delta_L R_L^*, \tag{5}$$

and therefore this person's total well-being is simply the sum of the two per period expressions given in equation (5) or  $2U$ .

On the other hand, if the incumbent mayor in the first time period is dishonest and inefficient then this incumbent will be removed from office. In this case, an arbitrary city voter's well-being in the first time period is

$$U_1 = H(R_H^*) - \psi \delta_H R_H^*. \tag{6}$$

This same voter's well-being in the second time period depends on whether the elected mayor turns out to be honest (this happens with probability  $p$ ) or dishonest (this happens with probability  $(1 - p)$ ). Consequently, this arbitrary city voter's second period well-being can be expressed as a weighted sum and that sum is

$$U_2 = p\{H(R_L^*) - \psi \delta_L R_L^*\} + (1 - p)\{H(R_H^*) - \psi \delta_H R_H^*\}. \tag{7}$$

Hence, in this second case, an arbitrary city voter's total well-being is given by the sum of the two expressions given in equations (6) and (7) or  $U_1 + U_2$ . We now proceed to show that a rise in the marginal cost of public monies or  $\psi$  reduces both the equilibrium value of the crime index and the well-being of voters in the city under study.

### 4. A RISE IN THE MARGINAL COST OF PUBLIC MONIES

Let us begin by totally differentiating the first-order necessary condition for an optimum given in equation (3). This gives us

$$H''(R^*)dR^* = \delta_i d\psi. \tag{8}$$

We now use the concavity of the  $H(\cdot)$  function, which means that the second derivative of this function is negative, to obtain an expression that can be signed. That expression is

$$\frac{dR^*}{d\psi} = \frac{\delta_i}{H''(R^*)} < 0. \tag{9}$$

30 Go to <https://help.neighborhoodscout.com/support/solutions/articles/25000001997-what-is-the-crime-index-> for additional details about this index. Accessed on 3 December 2020.

31 Note that because the  $H(\cdot)$  function is concave, the second-order sufficiency condition  $H''(\cdot) \leq 0$  is satisfied.

Equation (9) shows that when the marginal cost of public monies or  $\psi$  increases, the equilibrium value of the crime index *falls*. This result arises because an increase in  $\psi$  means that it is now *more* difficult to raise the tax revenues that will be used to increase the size of the city police force and thereby reduce crime.

To demonstrate the validity of a similar claim for the well-being of voters in the city under study, we use a well-known result in microeconomic theory, namely, the envelope theorem.<sup>32</sup> Now, recalling equation (1) and then using the envelope theorem, we get

$$\frac{dU(R_i^*)}{d\psi} = \frac{\partial U(R_i^*)}{\partial \psi} = -\delta_i R_i^* < 0. \tag{10}$$

The right-hand-side (RHS) of equation (10) clearly tells us that an increase in the marginal cost of public monies or  $\psi$  *lowers* the well-being of voters in our city in *both* time periods and for *both* possible types of incumbent politicians (honest or dishonest). This negative finding strengthens the previous finding in equation (9) that an increase in  $\psi$  lowers the equilibrium value of the crime index  $R^*$ . Specifically, since the RHS of equation (10) depends on  $R^*$  which is lower, it follows that the well-being of voters in our city is also lower. We now proceed to analyze the case in which a dishonest politician is able to hide the fact that he is dishonest by borrowing monies and thereby delaying the revelation of his inefficiency to our city voters.

### 5. A DISHONEST POLITICIAN SEEMING TO BE HONEST

The modeling framework now is basically the same as the framework described in section 2 but there is one salient difference. Specifically, a dishonest incumbent can *delay* the revelation of his dishonesty and inefficiency by borrowing money denoted by  $M > 0$ . This borrowing is observable to our city voters only after the election at the end of the first time period. In addition, this borrowing by a dishonest incumbent permits him to appear honest because he can act as if the unit cost of raising the crime index or lowering crime is low when it is, in fact, high. The reader should note that this course of action also results in the creation of a budget deficit in an election year.

In the first time period, the incumbent mayor observes the unit cost  $\delta \in \{\delta_L, \delta_H\}$ . He then selects the value of the crime index or the amount by which crime is to be reduced  $R$  and the amount of money  $M$  that he would like to borrow. These two actions lead to a total tax bill given by  $T = \delta R - M$ . Next, our city voters observe the choices of  $R$  and  $T$  before the election. On the basis of these two observations, voters draw a conclusion about the incumbent mayor's type. The incumbent is re-elected if he is at least as likely to be honest as a rival who is honest with prior probability  $p > 0$  and dishonest with prior probability  $(1 - p) > 0$ . In the second time period, the politician then in office again selects  $R$  given  $\delta$  and he repays the money  $M$  he borrowed in the first time period. These two actions give rise to a tax bill denoted by  $T = \delta R_\delta + M$ . No additional elections take place in our model.

There are now two tasks to complete. First, we would like to compute the equilibrium outcome that arises in the interaction between our city voters and politicians. Second, we want to establish that there exists a critical value of  $\psi, \psi^*$ , with the property that the dishonest incumbent *separates* and loses the election if and only if  $\psi > \psi^*$  and that he *pools* and is re-elected otherwise.<sup>33</sup>

We begin by pointing out that voters do *not* observe either the incumbent's type  $\delta$  or the money  $M$  that he has borrowed before the election. Therefore, in a pooling equilibrium, the following equality

$$\delta_H R_L^* - M = \delta_L R_L^* \tag{11}$$

must hold. An implication of equation (11) is that in order to bewilder voters into thinking that he is honest, a dishonest incumbent mayor will borrow

$$M = (\delta_H - \delta_L) R_L^* \tag{12}$$

in the first time period. Since this borrowed money must be paid back in the second time period, a dishonest incumbent will choose to pool and be re-elected mayor if and only if the borrowed quantity  $M$  is no larger than  $2G$  which is his private gain from being mayor for two time periods. In symbols, the inequality that must hold is

$$2G \geq (\delta_H - \delta_L) R_L^*. \tag{13}$$

Now, supposing that the expression in (13) holds as an equality, we get

$$R_L^*(\psi^*) = \frac{2G}{\delta_H - \delta_L}. \tag{14}$$

Using equation (3), we can simplify the expression in equation (14) and, simultaneously, infer the critical value of  $\psi, \psi^*$  that we are looking for. We get

$$\psi^* = \frac{1}{\delta_L} H' \left( \frac{2G}{\delta_H - \delta_L} \right). \tag{15}$$

We have already demonstrated in section 4 that the optimal value of the crime index  $R_L^*$  is a *decreasing* function of the marginal cost of public monies  $\psi$ . This last result tells us that when  $\psi$  increases, the left-hand-side (LHS) of (13) decreases. This allows us to conclude that for all  $\psi > \psi^*$ , (13) holds as a strict inequality and hence we get a separating equilibrium. In this equilibrium, a dishonest incumbent mayor will choose to separate and lose the election at the end of

32 See Varian (1992, pp. 490-492) for a textbook description of the envelope theorem.

33 The game we are analyzing here is a "signaling game" which is one kind of dynamic game of incomplete information. Standard equilibria to analyze in signaling games are the "pooling" and "separating" equilibria. Now, as in our present analysis, consider a signaling game with two kinds of players, i.e., politicians and voters. In a pooling equilibrium, all *types* (honest or dishonest) of a specific kind of player (in our case politicians) send the *same* message or signal to the other kind of player (in our case voters). This interaction between politicians and voters leads to a pooling equilibrium. In contrast, when the different types of politicians (honest or dishonest) send *different* messages or signals to the voters, the ensuing interaction between politicians and voters leads to a separating equilibrium. For more on these ideas, the reader ought to consult a standard game theory text such as Fudenberg and Tirole (1991).

the first time period. In contrast, when  $\psi \leq \psi^*$ , this incumbent mayor will effectively pool and be re-elected mayor in the second time period.

Before continuing further, let us stress three points about our analysis thus far. First, an inefficient incumbent politician's ability to borrow money  $M$  does not ensure that he will be re-elected mayor in the election after the first time period. The purpose of borrowing  $M$  is to bewilder voters into thinking that an inefficient mayor is efficient. If voters believe this attempt to bewilder them then this makes re-election more likely but not certain for the inefficient incumbent mayor. Second, the  $2G$  term on the LHS of (13) makes sense because the per period private gain from being elected mayor is the constant  $G$  and we are accounting for this private gain over two time periods in (13). Finally, in general, there is nothing necessarily untoward about an elected politician borrowing money, promising to pay it back in an ensuing time period, and thereby creating a budget deficit. This happens and hence we now have a literature on the "political budget cycle."<sup>34</sup> That said, our final task in this paper is to demonstrate that a rise in  $\psi$  can increase voter well-being when politicians are more likely to be dishonest.

## 6. A SECOND RISE IN THE MARGINAL COST OF PUBLIC MONIES

Upon reflection, it is easy to confirm that in the pooling equilibrium that we have been discussing, the well-being of voters differs only in the second time period. Hence, before the resolution of uncertainty about  $\delta$  and  $M$ , voter welfare in the two time periods under study is given by

$$U_1 = H(R_L^*) - \psi \delta_L R_L^* \tag{16}$$

and

$$E[U_2] = p\{H(R_L^*) - \psi \delta_L R_L^*\} + (1-p)\{H(R_H^*) - \psi(\delta_H R_H^* + M)\}, \tag{17}$$

where  $E[\cdot]$  is the expectation operator.

To figure out the effect of the marginal cost of public monies  $\psi$  on voter well-being over the two time periods in our city, we differentiate the sum  $U_1 + E[U_2]$  with respect to  $\psi$ . This gives us

$$\frac{d(U_1 + E[U_2])}{d\psi} = -(1+p)\delta_L \delta R_L^* - (1-p)(\delta_H R_H^* + M) - (1-p)\psi \frac{dM}{d\psi}. \tag{18}$$

In order to sign the expression on the RHS of equation (18), we need to first sign the derivative  $dM/d\psi$ . To do so, we differentiate equation (12), keeping in mind the dependence of  $R_L^*$  on  $\psi$ . This gives us

$$\frac{dM}{d\psi} = (\delta_H - \delta_L) \frac{dR_L^*}{d\psi} < 0 \tag{19}$$

and the sign of the expression on the RHS of equation (19) follows from the fact that  $R_L^*$  is a decreasing function of  $\psi$ .

Let us now use the result in equation (19) to ascertain the sign of the derivative in equation (18). After several algebraic steps, we infer that the well-being of voters in our city *might* increase with a rise in  $\psi$  as long as the inequality below

$$-\psi \frac{dM}{d\psi} > \frac{1+p}{1-p} \delta_L R_L^* + \delta_H R_H^* + M \tag{20}$$

holds. A careful review shows that the RHS of the inequality in (20) is *increasing* in the probability  $p$ . Therefore, the likelihood that the condition in (20) will hold is higher when  $p$  is *small*. In turn, this last inference suggests that the condition in (20) will hold more often than not when  $(1-p)$  is large and this means that the politician under consideration is more likely to be dishonest.

Why does this counterintuitive result hold? To answer this question, observe that in comparison with dishonest politicians, we generally expect honest politicians to make our city safer by raising the crime index to a higher value. All else being equal, this increased value of the crime index makes the residents of our city better off. However, in order to fund the increase in the size of the city police force that makes the city safer and hence voters better off, politicians need to raise tax revenues and this taxation influences the well-being of voters negatively.

Now remember that the marginal cost of public monies or  $\psi$  measures how hard it is for politicians to raise tax revenues. In our setting, when we allow dishonest politicians to appear honest, there is a range of values for  $\psi$  ( $\psi \leq \psi^*$ ) where dishonest politicians effectively appear to be honest. The interaction of this "range of values for  $\psi$ " with the magnitude of the probability  $p$  gives rise to scenarios in which the activities of dishonest politicians *may* raise the well-being of voters in our city. This completes our political-economy perspective on mayoral elections and urban crime.

## 7. CONCLUSIONS

In this paper, we provided a political-economy analysis of crime prevention in an arbitrary city in the United States. City residents (voters) elected mayors (politicians) and elected mayors determined the resources to be allocated to crime prevention. Between the two time periods, there was an election. Politicians were either honest or dishonest. The marginal cost of public monies  $\psi$  measured how efficiently an elected mayor converted tax receipts into crime prevention. Voters had identical per period utility functions. We ascertained the equilibrium outcome and the per period well-being of the voters. Second, we showed that an increase in  $\psi$  reduced the equilibrium allocation of resources to crime prevention and voter well-being. Third, a dishonest politician could delay the revelation of his dishonesty. We showed that a critical value of  $\psi$ ,  $\psi^*$ , existed such that the dishonest incumbent separated and lost the election if and only if  $\psi > \psi^*$  and that he pooled and was re-elected otherwise. Finally, we noted that an increase in  $\psi$  could raise voter well-being when politicians were more likely to be dishonest.

The analysis in this paper can be extended in a number of different directions. Here are two potential extensions. First, it would be useful to distinguish between *different kinds* of criminal activity in a city and to then see what impact different

<sup>34</sup> See Waknis (2014), Bohn (2019), Ferris and Dash (2019), and the references cited in these papers for additional details about this literature.

kinds of crime reducing activities undertaken by the police in one time period have on the electability of mayors and on the well-being of residents in subsequent time periods. Second, it would also be helpful to study criminal activity in a set of cities where the actions of a “tough-on-crime” mayor in one city drives criminals to other cities and hence gives rise to crime related *spatial spillovers*. Studies of crime prevention in cities that incorporate these aspects of the problem into the analysis will provide further insights into how the interactions between politicians (mayors) and voters (residents) can lead to lower crime and hence to higher well-being for all involved parties.

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## THE SILVER ECONOMY IN EUROPEAN CITIES

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### ABSTRACT

In 2018, 101.1 million of EU citizens were over 65, nearly 20% of the total population that will become 28.5% in 2050. The ageing population poses challenges not only for welfare systems sustainability, but also in terms of suitability of goods and services, that should be adapted to the needs of older people, the so-called Silver Economy. This paper concerns the opportunities of the Silver Economy in European cities, investigating their readiness to host an increasing number of senior citizens with their needs, and the vast range of challenges and opportunities that the ageing population represents for European policy makers.

Using representative microdata coming from a recent “Perception Survey on the Quality of Life (QoL) in European Cities, 2019” by the Directorate-General for Regional and Urban Policy for 83 European cities, we assess their suitability for the elderly and which of the factors identified by mainstream literature contribute more to it. To achieve this aim, on the subset of over 65, we correlate to a dichotomous dependent variable identifying if a city is (or is not) a good place to live for elderly people a set of covariates falling into the following macro areas: i) development of an age-friendly built environment; ii) knowledge for an active and healthy lifestyle; iii) integrated care services and improved connectivity; iv) olderpreneurship. Finally, we assess the relative contribution of each regressor to the explained variance.

Our results have various policy implications. First, ranking cities according to their suitability to old people we can identify relevant patterns in Europe. Second, the recognition of the relative importance of each regressor, together with its significance and sign, provides a powerful tool to assess the relevance of each macro area, and of each component, allowing to identify the most appropriate policy interventions and the place to intervene.

## **Regular Session: RS14.1 - The spatial dimension of sustainable development**

**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room Marrakech**

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## DOES PRIOR PERFORMANCE ACROSS SDGS RELATE TO THE SUCCESS AGAINST COVID-19? A COUNTRY-LEVEL ANALYSIS

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### ABSTRACT

The COVID-19 captured the whole world dragging into a crisis with major health, economic, and social dimensions since it is officially characterized as a pandemic by the World Health Organization. Not only do the countries of all suffer from COVID-19 related infections and deaths, but also they face a severe economic slowdown, unemployment, job losses, and food insecurity, among many other devastating effects of the pandemic. Besides, there is a great amount of uncertainty that makes the decision-making even harder for governments despite living with pandemic for more than a year. The 2020 sustainable development report by the United Nations points to the uneven effects of the COVID-19 for countries on achieving the sustainable development goals (SDGs) for 2030. Developing countries have already suffered severely from the pandemic, which is more unlikely for them to achieve sustainable development goals, and this may even worsen their positions across many individual SDGs. However, some developed countries with strong economies and high sustainability indices also do not appear to control the pandemics more effectively than others. Other characteristics such as the demographical structure, policy approaches, and the regional and contextual factors are likely to play a role in the battle towards the pandemic. Thus, we explore how the country's prior sustainability index might mitigate or facilitate its COVID-19 performance. We choose the members of G-20 due to their wide spatial distribution across all continents of the earth, the large share of the world population, and high representation of the overall GDP. We analyze the two-way relations between the sustainability index and various metrics of COVID-19 in four different quadrants. When countries with high sustainability index put high efforts towards combatting COVID-19, some get better outputs, such as lower deaths related to COVID-19 while others do not. Our initial analyses result in clusters of G-20 countries that differ by their sustainability levels and various performance and effort measures of COVID-19. The interpretation of the clusters of countries will shed light on the regional, demographic, and country-specific characteristics that make their battle against the pandemic a success or failure. Moreover, the real test with a pandemic reveals the susceptibility of the existing sustainable development goals, resulting in more unmet SDGs for 2030 than expected. Policymakers, governments, international and local organizations, and other stakeholders can benefit from this study in revising and building policies in sustainable development.

### KEYWORDS

COVID-19, G-20 countries, regional factors, sustainability index, sustainable development goals (SDGs)

### 1. INTRODUCTION

The emergence of COVID-19 has resulted in millions of lost lives with severe economic and social damage. The human race has shown enormous effort in the battle with the pandemic since its emergence, already with several vaccines developed and used worldwide. Despite the scientific and technological success, the COVID-19 pandemic demonstrated how vulnerable the economic and social systems we built and the resources we rely on. We have seen many wealthy countries suffered in a great deal in terms of lost lives and the inability to provide the proper medical treatment to the COVID-19 patients. At the same time, some countries have handled the pandemic much better, managing to control the spread of the disease by developing timely strategies and policies. The great variability amongst the countries makes us question their sustainability. Is it because they have built more sustainable and resilient systems? Or how does the prior progress across sustainable development goals relate to the performance in dealing with such a rapidly spreading pandemic?

The latest report on sustainable development goals by the United Nations (Sachs et al., 2020) points out how the impacts of COVID-19 have increased the inequality between countries. Many developing countries were already facing difficulties in achieving the 2030 targets for the SDGs before the outbreak of the COVID-19. On the other hand, countries with high SDGs were expected to manage this process better since they have better health infrastructure and well-established institutions. Although there are indications of these, some countries do not fully conform to this classification. The difference in managing performance of COVID-19 could also be attributed to the different policies such as closing schools, restricting transportation, and directing businesses to work from home that they implement.

All these issues point out that sustainable development goals should be examined and re-evaluated in the light of changing circumstances with the effects of the COVID-19. Besides, it should be taken into account that each country handles this pandemic in different ways and reacts with different policies to prevent it. We perform country-level descriptive analyses to explore the nexus between performance across sustainable development goals and the COVID-19

measures. We choose G-20 countries for their broad representation in terms of both the world economy and population. In order to simplify the analyses and to be able to see the effects of different variables at the same time, we classify the countries into four quadrants using a two-way matrix. The quadrants are formed according to two factors: sustainability index showing the country's progress across seventeen SDGs and total tests per one thousand population.

Our analyses reveal different characteristics of the countries in different quadrants. Not all countries were affected to the same degree. The cumulative cases and deaths appear to be higher for countries in quadrants with higher sustainability indices. Such countries are also inclined to perform more tests than the overall median number of tests conducted in our sample. There are also exceptions, such as Canada and Germany deviating from their peers in the same quadrant with fewer deaths and cases. Among the countries in quadrants with relatively low sustainability indices, Mexico has much higher death rates than its peers in the same quadrant. Regarding the effects of the policies that countries adopt during the pandemic, a higher stringency index does not appear to affect the country's response measures such as cumulative deaths and cases nor the effort measured in the total number of tests.

The remainder of this study is organized as follows. Section 2 discusses the relationship between COVID-19 and sustainable development goals in a comprehensive manner. We explain the data and methodology in section 3. Finally, Section 4 provides conclusions and discussions for possible future research directions.

## 2. THE NEXUS BETWEEN COVID-19 AND SUSTAINABLE DEVELOPMENT GOALS

### 2.1. Confronting the COVID-19 pandemic while tackling 2030 Agenda for SDGs

When the United Nations (UN) declared the 2030 Agenda for Sustainable Development in 2015, they described the challenges to sustainable development that our world faces at that time. According to the declaration, there are huge disparities within and among the countries in terms of power, opportunities, wealth, and gender (United Nations, 2015). Besides, there are other major problems such as gender inequality, unemployment, depletion of natural resources, global health threats, and natural disasters. The 2030 Agenda acknowledges the risk associated with the immense issues and the opportunities that arise with them as follows, *"The survival of many societies, and of the biological support systems of the planet, is at risk. It is also, however, a time of immense opportunity. Significant progress has been made in meeting many development challenges."*

The latest report for the Sustainable Development Goals by the UN before the outbreak of the pandemic was released in 2019, revealing the progress against the targets of the 2030 Agenda. While the progress in critical areas was valuable, it is not sufficient to achieve the 2030 Agenda since poverty, hunger, and disease continue to be a problem for low and middle-income countries (United Nations, 2019). The progress towards the 2030 goals has been limited, which turned upside down with the pandemic outbreak. World Health Organization (WHO) declared the COVID-19 as a pandemic on March 11, 2020, which had resulted in more than 118,000 cases and 4,291 lost lives in 114 countries within a few months of its appearance (WHO, 2020). After a year, total cases have exceeded 125 million, with more than 2.5 million deaths (Worldmeter, 2021) along with devastating effects in the world economies, health systems, and social lives. Vaccinations that have started in the mid of December 2020 have been the hope to exit the tunnel for going back to normal; however, only 4% of the world population were vaccinated one year after the outbreak (Worldmeter, 2021).

The COVID-19 pandemic's effects have already been substantial in all aspects of individual lives all over the world. Evaluating sustainable development goals will be pointless without considering the impact of the ongoing outbreak of COVID. Naidoo and Fisher (2020) identify sustainable economic growth and globalization as the two conditions required for the success of SDGs where the pandemic COVID-19 has broken up both resulting in greater uncertainties for the future. The 2020 Sustainable Development Report by the United Nations draws attention to the pandemic's uneven effects on countries with vulnerable population groups, low-quality public health systems, or poor leadership (Sachs et al., 2020). While developing and underdeveloped countries are more likely to suffer more from the pandemic's negative impact, the number of cases and deaths due to the COVID-19 has surpassed others among many wealthy nations.

### 2.3. Is COVID a Threat for SDGs?

Due to its scope and economic impact, Filho et al. (2020) consider COVID-19 a major threat to achieving the UN sustainable development goals. The authors anticipate the most obvious effects to occur in SDGs 1 (No poverty), 2 (Zero hunger), 3 (Good health and well-being), 4 (Quality education), 5 (Gender equality), 8 (Decent work and economic growth), 10 (Reduced inequalities), and 16 (Peace, justice and strong institutions). Within a short time frame since the pandemic outbreak, several other studies highlight similar issues that are likely to be major obstacles to achieving sustainable development worldwide. Sumner et al. (2020) estimate the increase in poverty to be more than 80 million for the US \$ 1.9/day critical line relative to the 2018 numbers assuming a 5% contraction in per capita incomes. This number would be 180 million and 420 million if the contraction in per capita incomes is assumed to be 10% and 20%, respectively.

Mukarram (2020) anticipates the effects of COVID-19 on sustainable development goals to be two-folded. First, the prior achievements on some of the SDGs will be lost due to the direct effects of COVID-19 on these goals. Secondly, countries face the necessity to shift the priorities among SDGs, affecting the progress of the goals that are shifted down in the priority lists. Considering these effects on SDGs, Mukarram (2020) suggests reformulating sustainable development strategies during and after the post-pandemic period, focusing on SDG 17 (Partnerships to achieve the goals).

On the other hand, there are opinions anticipating the COVID-19 might indeed stimulate the efforts to realize the UN's 2030 goals working as a catalyst (Ottersen & Engbretsen, 2020). While the pandemic delayed the working progress for

all countries, there are many other ways to mitigate the adverse effects on sustainable development goals, such as developing and practicing digital sustainability (Pan & Zhang, 2020).

### 3. METHODOLOGY AND EMPIRICAL ANALYSES

#### 3.1. Data and Variables

In understanding how prior performance across SDGs relate to the success against COVID-19, we have conducted descriptive analyses of the COVID-19 related variables and the Sustainability Index (SI) for the sample of countries that we consider. We have chosen three different variables to associate with the COVID-19 pandemic: total cases, total deaths, and total tests. Because of the different population sizes of the countries in our sample, we used the normalized versions of these variables to get a more accurate depiction of the comparison among these countries. While total cases and total deaths are scaled by one million, the total tests are normalized by one thousand as calculated and revealed by the data generated at ourworldindata.org (Ritchie et al., 2021). Total cases represent the cumulative number of confirmed cases whose infection status has been verified by the laboratory tests. The number of confirmed cases comes out of another source of data which is the total tests. The number of tests allows us to see countries' performance, which acts as a critical indicator of how much effort countries are making in handling the pandemic process.

In addition to the three variables, we also used the country's stringency index, which is an indicator of how strict the policies implemented by the government during the pandemic. This index, a composite measure of nine response metrics (school closures, workplace closures, cancellation of public events, restrictions on public gatherings, closures of public transport, stay-at-home requirements, public information campaigns, restrictions on internal movements, and international travel controls), is developed by the Oxford Coronavirus Government Response Tracker (OxCGRT) project. The data on Covid-19 variables, which are utilized in the descriptive analyses, have been obtained from the website of ourworldindata.org (Ritchie et al., 2021).

To reflect on the sustainability performance of countries, we have used the sustainability index developed by the United Nations. The sustainability index monitors the countries' progress and assesses their relative positions in achieving the 2030 targets in which all 17 goals are equally weighed (Sachs et al., 2020). The 17 goals and descriptions of them are presented in Table 1. We have used the most recent scores of countries calculated via SI in 2019 in our analyses.

**Table 1. Sustainability Development Goals (SDG) and descriptions\***

SDG	Description
Goal 1.	End poverty in all its forms everywhere
Goal 2.	End hunger, achieve food security and improved nutrition, and promote sustainable agriculture
Goal 3.	Ensure healthy lives and promote well-being for all at all ages
Goal 4.	Ensure inclusive and equitable quality education and promote lifelong learning opportunities for all
Goal 5.	Achieve gender equality and empower all women and girls
Goal 6.	Ensure availability and sustainable management of water and sanitation for all
Goal 7.	Ensure access to affordable, reliable, sustainable, and modern energy for all
Goal 8.	Promote sustained, inclusive, and sustainable economic growth, full and productive employment, and decent work for all
Goal 9.	Build resilient infrastructure, promote inclusive and sustainable industrialization, and foster innovation
Goal 10.	Reduce inequality within and among countries
Goal 11.	Make cities and human settlements inclusive, safe, resilient, and sustainable
Goal 12.	Ensure sustainable consumption and production patterns
Goal 13.	Take urgent action to combat climate change and its impacts
Goal 14.	Conserve and sustainably use the oceans, seas and marine resources for sustainable development
Goal 15.	Protect, restore and promote sustainable use of terrestrial ecosystems, sustainably manage forests, combat desertification, and halt and reverse land degradation and halt biodiversity loss
Goal 16.	Promote peaceful and inclusive societies for sustainable development, provide access to justice for all and build effective, accountable and inclusive institutions at all levels
Goal 17.	Strengthen the means of implementation and revitalize the Global Partnership for Sustainable Development

\*Source: <https://sdgs.un.org/goals>

In this study, we have chosen G20 countries to form the sample of countries for our analyses. G20 countries include *Argentina, Austria, Brazil, Canada, China, France, Germany, India, Indonesia, Italy, Japan, Mexico, Russia, Saudi Arabia, South Africa, South Korea, Turkey, UK, the USA, and the European Union*. The reason we choose these countries is that they account for two-thirds of the world's population, 85% of global gross domestic product, more than 75% of global trade, and about 80% of global energy-related carbon dioxide emissions. While 19 members of G20 are individual countries, the European Union represents the 27 countries that could not be analyzed as a whole due to the design of our study. Because the efforts countries make towards handling the pandemic vary greatly, the assessment needs to be made at the country level. Besides, the sustainability index is a country-based measure that simply cannot be accumulated over a region. Thus, we have included the European Union countries as separate countries in our sample. However, in order not to overcrowd the sample, we have included the member countries within the EU with a total population of over ten million. Overall, nine countries were added to the sample, which account for approximately 80% of the European Union population.

### 3.2. Quadrant Analyses of the Sample Countries

To analyze the two constructs together (i.e., COVID-19 and sustainability), we have created a matrix of one designated variable for COVID-19 and another one for the performance of sustainable development goals. The variable *total tests* was chosen as the designated variable for COVID-19 since it represents the country's efforts to deal with the pandemic. The other variable in the matrix is the sustainability index we use to evaluate the progress towards achieving the SDGs. Considering the matrix of the two variables, we come up with four quadrants, as shown in Figure 1. Each of the countries in our sample is positioned in a quadrant according to the values it assumes for the two variables relative to the overall median values for all countries. The circumstances of the countries in these quadrants can be explained as follows:

- **Quadrant 1 (Q1):** Countries with a high sustainability index and carrying out a high number of tests
- **Quadrant 2 (Q2):** Countries with a low sustainability index and carrying out a high number of tests
- **Quadrant 3 (Q3):** Countries with a low sustainability index and carrying out a low number of tests
- **Quadrant 4 (Q4):** Countries with a high sustainability index and carrying out a low number of tests

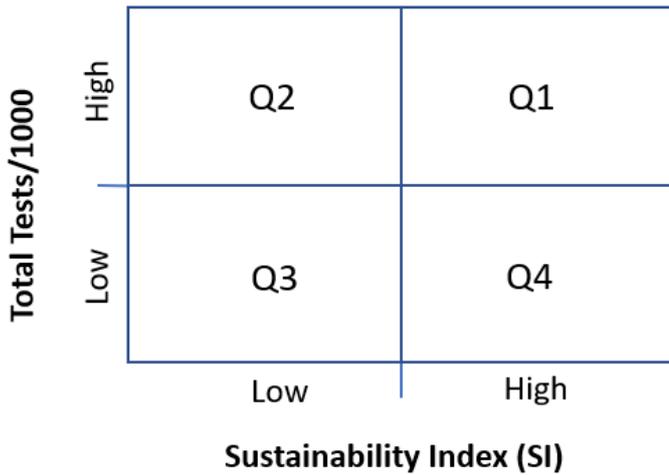


Figure 1. Matrix representation for the two variables: *Total tests/1000 & Sustainability index*

The quadrant depiction of Figure 1 allows us to classify the countries in our sample, as shown in Figure 2. Most countries are classified either in Q1 or Q3, where there are ten countries in each quadrant. The countries in Q2 have SI levels lower than the overall median; however, they conduct more tests than the overall median. There are four countries placed in this quadrant: Italy, the USA, Greece, and Russia. Similarly, there happen to be four countries in Q4 that are Poland, Netherlands, Japan, and South Korea. While these countries have high SI levels, they conduct fewer tests relative to the overall median of all countries.

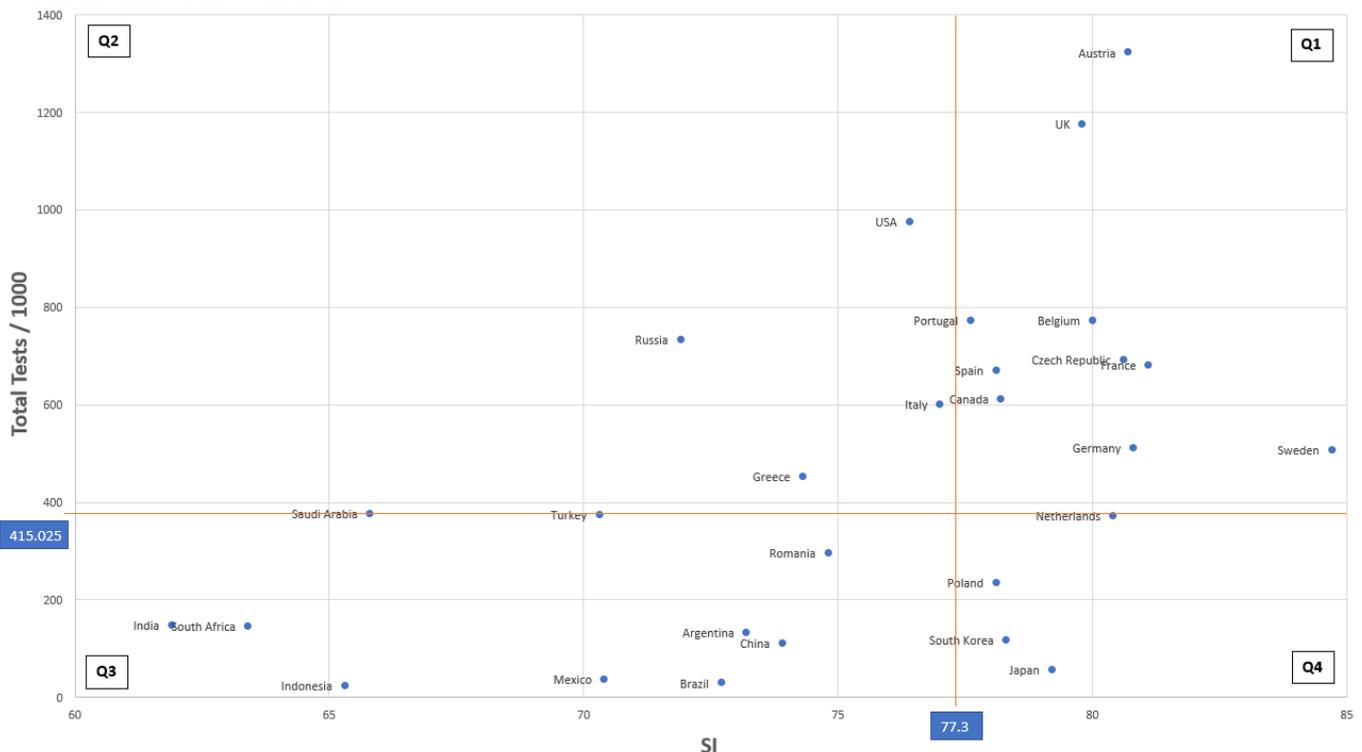


Figure 2. The distribution of countries across the four quadrants

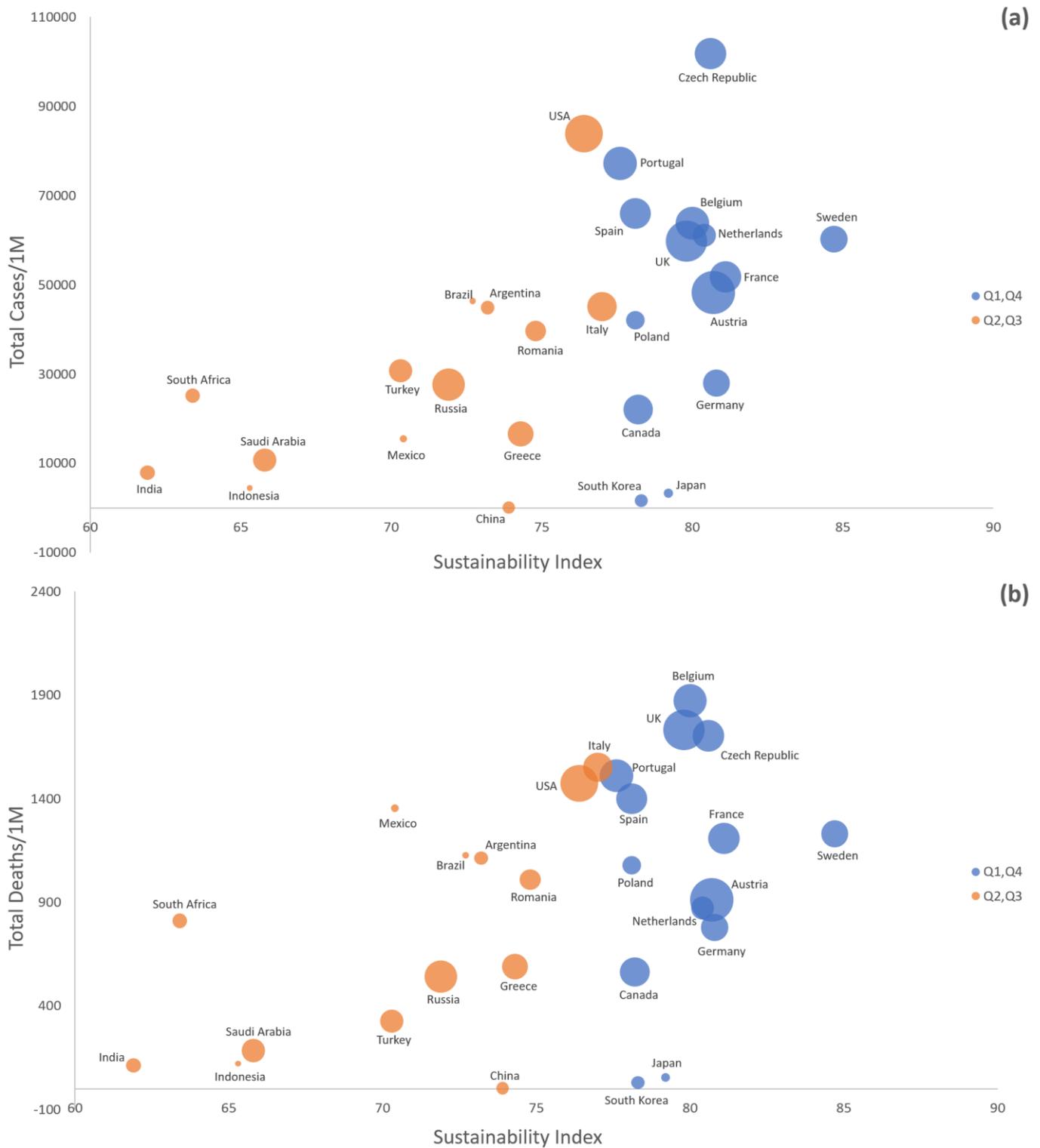
Combining the two constructs into one in the form of quadrants allows us to analyze how countries in these quadrants differ in two other major indicators of COVID-19 performance: total cases and total deaths. We develop a cross table where we classify the countries in four quadrants according to their status in total cases and total deaths relative to the overall median for both variables. In Table 2, each quadrant is divided into four sub-categories subject to the number of cases and deaths in the countries. Considering the variables total cases and total deaths as proxies for the success of COVID-19, the rows in Table 2 allow us to analyze the performance of countries within each quadrant. We make three different analyses using the quadrant scheme as the basis.

**Table 2. Classification of countries in quadrants subject to the number of cases and deaths**

	High Cases & High Deaths	High Cases & Low Deaths	Low Cases & High Deaths	Low Cases & Low Deaths
High SI & High Tests Q1	Belgium, Czech Republic, UK, France, Spain, Portugal, Sweden	Austria		Canada, Germany
Low SI & High Tests Q2	Italy, USA			Greece, Russia
Low SI & Low Tests Q3	Argentina, Brazil		Mexico, Romania	China, India, Indonesia, Saudi Arabia, South Africa, Turkey
High SI & Low Tests Q4	Poland	Netherlands		Japan, South Korea

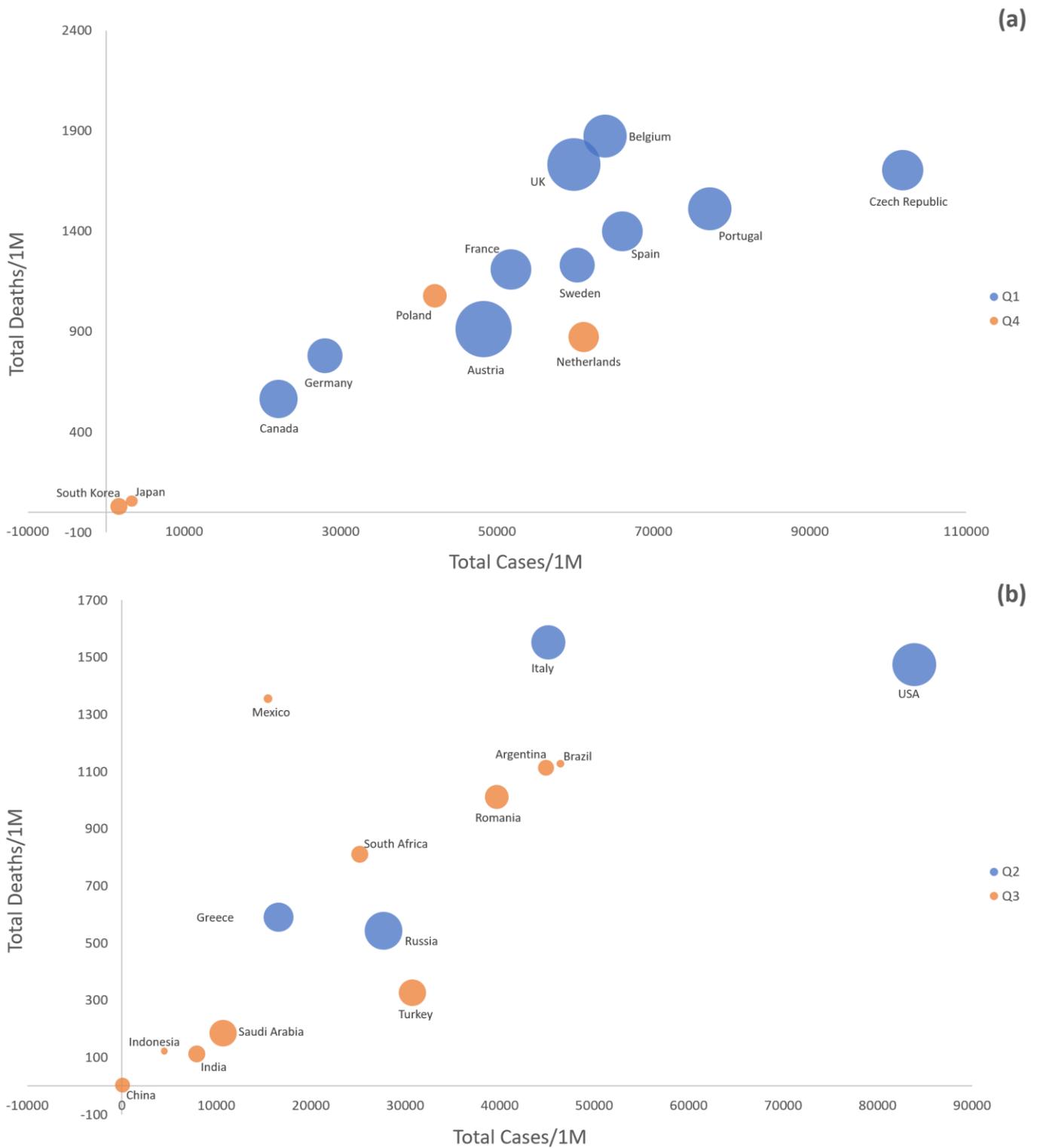
**3.2.1. How do Countries in Different Quadrants Differ in Total Cases and Total Deaths?**

Considering all four quadrants together, we first investigate how total cases and total deaths change with the country’s sustainability index. We have two plots to illustrate this. Figure 3a (3b) shows total cases (total deaths) relative to the sustainability index. In both plots, to differentiate the high SI countries (Q1 and Q4) from low SI ones (Q2 and Q3), we have used different colors for these pairs. Moreover, we depict the number of tests with the bubble sizes in these graphs. We can make several insights based on the analyses of Figure 3. We observe that total cases and total deaths in general increase with the sustainability index of the countries. High SI countries characterized by blue color (in quadrants Q1 and Q4) tend to have higher cases and higher deaths except for a few countries: Canada, Germany, Japan, and South Korea. Besides, most of these countries conduct a high number of tests relative to the overall median of all countries, as shown by the large bubble sizes. On the other hand, low SI countries shown in orange tend to have lower cases and deaths. The bubble sizes are in general smaller, highlighting that these countries conduct fewer tests than the others. However, some countries are deviating from the general trend here. Amongst the low SI countries, the USA, Italy, Argentina, and Brazil have relatively higher cases and higher deaths. Moreover, Mexico and Romania have higher deaths despite the low cases.



**Figure 3. (a) Total cases, (b) Total deaths per one million versus Sustainability index for all quadrant pairs. Bubble sizes represent total tests per 1000 population**

While we can observe the connection between outcome measures of COVID-19 (i.e., total cases and total deaths) and the sustainability index via figures 3a and 3b, we further explore the relations between total cases and total deaths in more detail. We plot total deaths versus total cases separately for high SI countries (Q1 and Q4) and low SI countries (Q2 and Q3) in figures 4a and 4b, respectively. Additionally, we show the total tests scaled by thousand population via bubbles. In both plots of Figure 4, we observe total deaths increase with total cases.



**Figure 4. Total deaths per one million versus Total cases per one million for countries with (a) high SI, (b) low SI. Bubble sizes represent total tests per 1000 population**

Figure 4a shows the countries that have high SI scores relative to the overall median. Among these, the countries in Q1 (i.e., represented with blue bubbles) conduct a relatively high number of tests, whereas those in Q4 (i.e., represented with orange bubbles) conduct fewer tests compared to the median. Most of the high SI countries also conduct a large number of tests residing in Q1. Besides, the countries in Q1 happen to be on the right side of the plot having higher total deaths and total cases per million. Nevertheless, some countries do not fit this general pattern. South Korea and Japan have very low death and case rates. Canada and Germany also deviate significantly from their peers in the same quadrant (i.e., Q1), managing fewer deaths and cases.

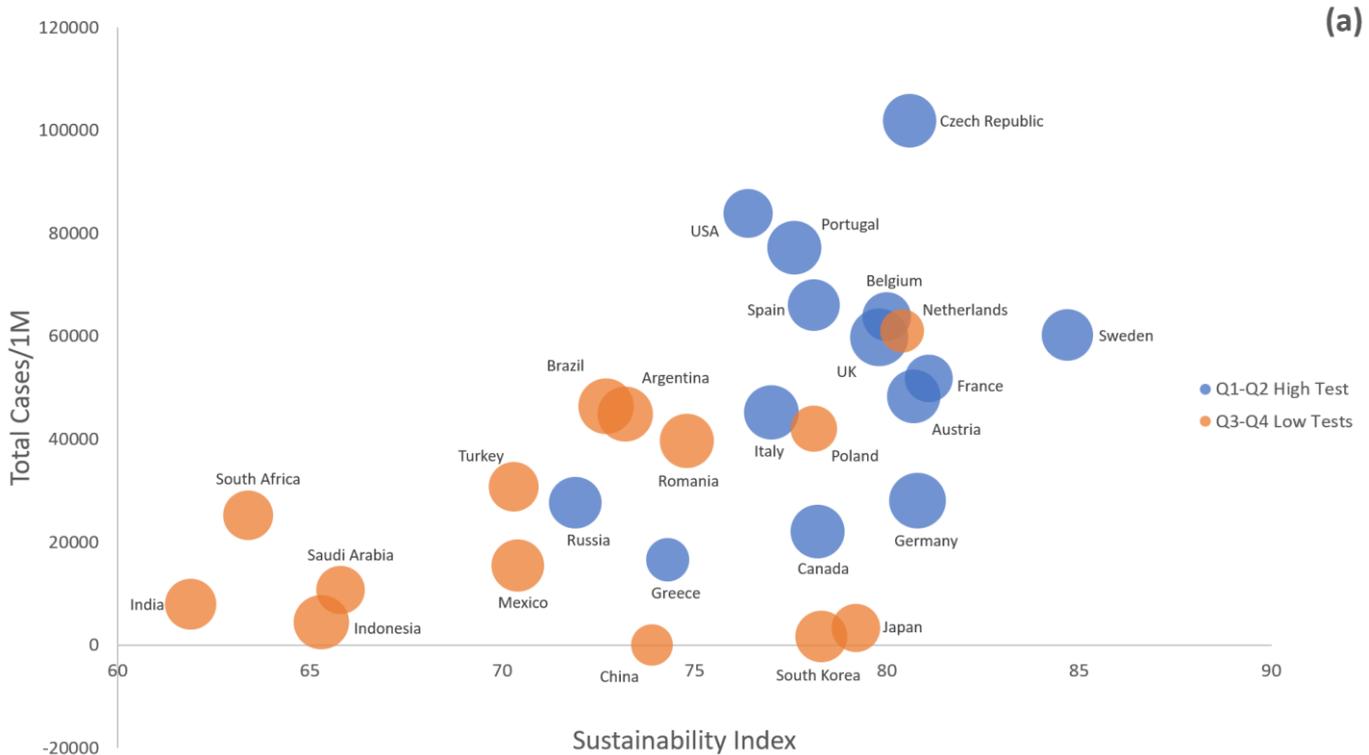
The relationship between total deaths and total cases (each measured per one million) for countries with low SI scores is shown in Figure 4b. In this plot, the countries in Q2 (Q3) conduct a high (low) number of tests relative to the overall median number of tests for all countries. Compared to Figure 4a, we observe that most of the low SI countries, which is more than 70% of all, conduct fewer tests. Besides, these countries tend to have lower total deaths and total cases—

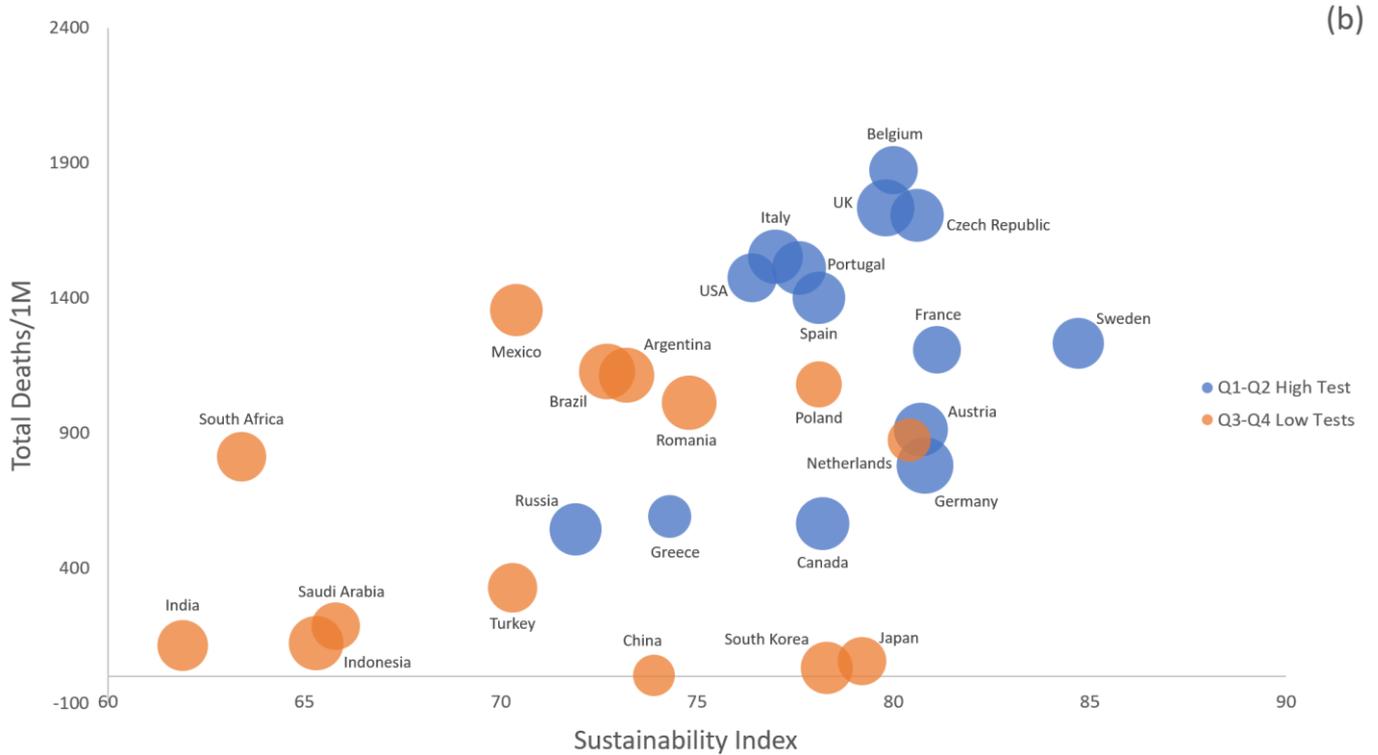
however, a few countries deviate from the general pattern. Firstly, Italy and the USA have relatively high case and death rates in this group. In comparing the two, we observe that the USA has much more cases than Italy for approximately the same death rates in both countries. Secondly, Mexico has much higher death rates than its peers in Q2 and the total cases of own.

**3.2.2. How do the Policies Associate with Total Cases and Total Deaths for Countries in Different Quadrants?**

In exploring the relationship between the prominent COVID-19 related factors (i.e., total tests, total cases, and total deaths) and the sustainability index of countries, we attempt to evaluate the third factor in association with the other two. The newly incorporated factor is the stringency index of the country, showing the strictness of the policies implemented during the pandemic. Figure 5 allows us to observe all three factors in the same plots. In Figure 5a (5b), we draw total cases (deaths) per one million versus the sustainability index for all countries in our sample. We take into account the stringency index as bubbles in this graph. We also differentiate between two quadrant pairs. The high SI quadrants (Q1 and Q4) and the low SI quadrants (Q2 and Q3) are shown in different colors.

A higher stringency index does not seem to change the country’s position concerning the effort (i.e., number of tests) or the response (i.e., death and case rates) measures. The stringency index is composed of several different response metrics such as school and workplace closures, stay-at-home requirements, and restrictions on travels or public gatherings. While separate analyses of individual measures might reveal different effects, the composite measure does not seem to show a pattern in association with COVID-19 related factors or the sustainability index of the countries.





**Figure 5. (a) Total cases, (b) Total deaths per one million versus Sustainability index for the high test (Q1 & Q2) and low test (Q3 & Q4) quadrant pairs. Bubbles represent the Stringency Index of the countries**

#### 4. CONCLUDING REMARKS

In the battle with COVID-19, countries with high sustainability index were expected to have lower number of cases and deaths. However, our descriptive analyses revealed that the general pattern had been precisely the opposite of what was expected. Although countries with a high sustainability index, in general, have higher overall performance across individual goals, such as SDG 3 (Good health and well-being), they were observed to have difficulties in overcoming the pandemic as many as or even more than the other countries. In this context, sustainable development goals need to be reevaluated considering their widespread effects by the UN. It would also be beneficial to consider this evaluation with a more holistic view. While the individual success of countries is vital in ending the pandemic, we cannot neglect the fact that all countries are part of one whole where there are bottlenecks linked to each other. *Leaving no one behind* needs a more holistic approach in terms of partnerships, which needs a strong emphasis on setting the targets for sustainable development goals.

The general trend for our classification of the countries in the form of quadrants also reveals some exceptions. Among the two types of countries (i.e., high and low sustainability indices), some appear to deviate significantly from the general trend of the group that they belong to, which might imply the role of some other characteristics. Canada and Germany have fewer deaths and cases than their peers in the same quadrant formulated based on the cumulative tests and sustainability indices. Similarly, Mexico, characterized as a country with a low sustainability index and a low number of tests, is found to have higher death rates than the overall median of countries in the same quadrant. While the country's overall stringency index does not seem to correlate with the COVID-19 response measures or the cumulative tests performed, detailed analyses focusing on the country-level characteristics are needed to explore this issue further.

In our analyses, we have considered sustainable development goals as a whole. The abundance of missing data for some individual SDGs and the short time frame to conduct the analyses have been the limitations of our study. For future research, more comprehensive analyses can be made in which sustainable development goals are addressed one by one, which allows each goal to be evaluated within itself. Thus, more effective solutions can be proposed by identifying the specific weaknesses of countries.

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## SMALL AREA ESTIMATION OF MULTIDIMENSIONAL POVERTY: THE CASE OF CAMBODIA

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### ABSTRACT

Many public policies in developing countries are spatially blind. Among the drivers of this blindness is the lack of up-to-date geographical breakdown of data which limits the ability of policymakers to develop and assess impact of policies to tackle poverty at a granulated subnational scale. In this context, this study aims to contribute to the estimation and mapping at a granulated spatial scale of multidimensional poverty in light of the global MPI (g-MPI) measure. The methodological framework encompasses techniques from Small Area Estimation (SAE). Specifically, this study uses Bayesian spatial hierarchical models which allow us to combine information provided by surveys and additional sources of data to estimate poverty indicators that are not formerly targeted by national surveys.

The case of study was Cambodia. We estimated spatial and spatio-temporal predictive models for the years 2000, 2005, 2010 and 2014. The inputs of the models come from two types of information. Type 1 encompasses spatial points of misaligned clusters of household locations, for which the source is the Demographic and Health Surveys (DHS). The DHS provided the main information to measure the g-MPI. The second type of data are the auxiliary predictors, including multiple gridded and polygon information which inform variability of poverty risk across space. Among this group we use corrected nightlight data, accessibility to cities, build-up areas, rice land per family, number of rainy days and population. Additionally, this research compares our geostatistical models with the most commonly used method for poverty mapping as proposed by Elbers, Lanjouw, and Lanjouw (2003). The reason for this comparison is that although ELL has served as a valuable and applicable instrument, it mainly relies on timely census data, which are not periodically available in developing contexts.

This study concludes that the incorporation of survey design could be critical to generate more accurate predictions. Moreover, it finds that more complex spatio-temporal models do not necessarily yield better estimations, specifically in larger time spans. We hypothesize that this is the case because of the natural smoothness effect implicit in these models. We also found that the relatively recent strand of research on the field of geostatistics such as the main models used in this research offer promising tools to overcome data limitations (e.g. census availability). For instance, the rough comparison between the ELL and geostatistics leads to similar predictions of poverty.

### 1. INTRODUCTION

Development is a spatial phenomenon. There is evidence that location is a major determinant of poverty (Bedi et al., 2007). In spite of continuous efforts from the developing world to generate reliable information on living conditions and poverty, it is still an issue the scarcity of information at sub-national scale and its evolvement over time. Such measures are critical to generate appropriate public policies to confront the persistent spatial inequality, particularly relevant in developing contexts. It is paradoxical that amid the so-called big data era many developing countries are still facing such challenges, a ubiquitous characteristic. An illustration of this situation is Angola, which collected census information for the last time in 2014, 44 years after its previous census in 1970s (Blumenstock, 2016). In this context, a rising demand for accurate and timing development indicators, a needed request for poverty indicators at scale, and a fast pace changing population have facilitated the development of novel branches of research that aims the generation of economic performance and development indicators using non-standard methods and/or data.<sup>35</sup>

Small area estimations (SAE) have become valuable techniques to understand the subnational distribution of wealth and poverty across time. The concentration of this research is on the subgroup of SAE techniques that uses geostatistical models, which, to best of our knowledge, has not been applied to poverty (as understood in development economics). This study also adds to the literature a comparison between methods, providing estimations of the so-called World Bank method (ELL). Furthermore, it sets out to incorporate spatio-temporal models. This research also aims to contribute to the incorporation of different sources of data into geostatistical models, which has not been found in the surveyed research. Lastly, despite the popularization of indicators such as the Multidimensional Poverty, its estimation has not been explored in the set of techniques of SAE. More specifically, the measure of poverty used envisioned a multidimensional approach in light of (Alkire & Foster, 2011). Therefore, the work presented here provides one of the first investigations into the SAE of multidimensional poverty index, as proposed by Alkire and Foster (2011). In short, this study seeks to contribute to this growing area of research by exploring and extend alternative techniques to the estimation of development indicators at small scales.

<sup>35</sup> The United States of America has started the SAIPE program which aims to estimate poverty for USA's districts.

In order to accomplish the goals, this research uses primarily a Bayesian hierarchical model, which enable predictive inference about the spatially continuous and incomplete observed phenomena of multidimensional poverty. It takes advantage of multiple sources of data currently available, such as georeferenced Demographic Health Survey, satellite data and administrative data records to generate estimations of poverty at county level when data is not widely available. The case used for this application is Cambodia, for which such poverty measure is generated for the years 2000, 2005, 2010 and 2014.

Cambodia can be a relevant case of study for the understanding of spatial changes of poverty at small scale for a wide range of reasons. Its recent history and economy have experienced a significant structural transformation, which has caused, in turn, important changes of its development indicators (Clark, 2020). The drop of poverty rate over the last years has exceeded the country's Millennium Development Goal expectations, with a reduction of 31.7pp, from 52 in 2004 to 20.5 in 2011 (World Bank, 2013). Likewise, its Gini coefficient has shown an important reduction within the same period. Such reduction is more salient between 2007 and 2012, dropping from 40.4 to 29 (Harbo & Gjonbalaj, 2019). This paper has been divided into seven parts. The second part introduces a background of research related to the study of small area estimation applied to the case of poverty. It is followed by a description of the main poverty indicator used in this study as well as the methods used. The fourth section describes the sources of data used. The fifth and sixth section present the results and its limitations. It will then go on to the main conclusions drawn from the results.

## 2. PRECEDING METHODS ON SMALL AREA ESTIMATION (SAE) OF POVERTY

SAE is concerned with the estimation of disaggregated domains when information collected is not representative for these domains. Most surveys are representative at national scale or by state. However, it is common the case that some estimates are necessary at finer scales such as districts or counties.

To better understand poverty mapping, we can draw a distinction between two mainstreams of research. The first group of studies includes unit-level models that rely on a combination of classical statistical techniques. They mostly combine census and survey data using hedonic regression models. This stream has been led primarily by the method developed by Elbers, Lanjouw, and Lanjouw -ELL- (2003). Supplementary extensions such as Empirical Bayes strategies have been grounding on ELL ((Molina & Rao, 2010); (Molina & Rao, 2010); (van der Weide, 2014)). Several applicable cases are encountered in this group in Vietnam (Lanjouw et al., 2017; Minot, 2000), Cambodia (Elbers et al., 2007; Fujii, 2007), Ecuador (Araujo et al., 2006; Elbers et al., 2004), among others. Most of this work is applied to monetary poverty.

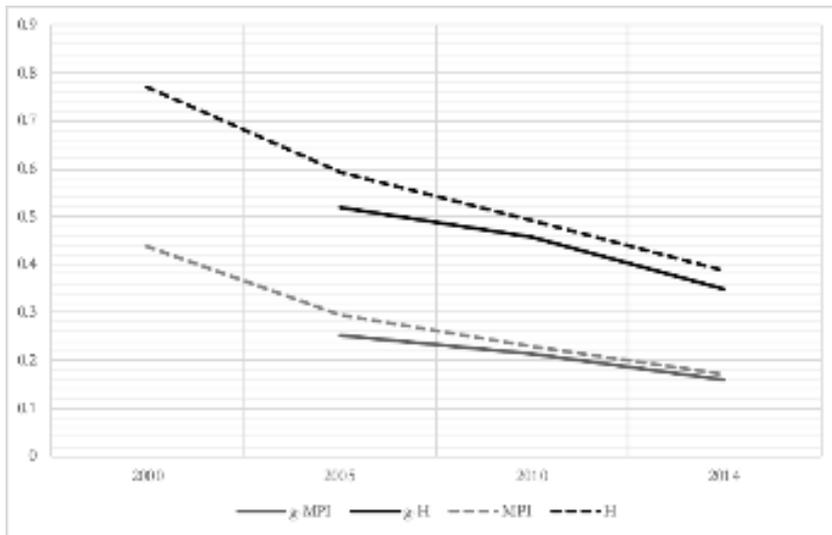
On the other hand, the second and later class of studies has forayed into a different direction, where the units of analysis are spatial (polygons or points). It bundles geostatistical models and machine learning algorithms and we call this group space-type models as it focuses on spatial predictions, in contrast to individuals' imputation as it is the case for the ELL and comparable methods. Major improvements in the accessibility to satellite data such as nightlight information has been critical to estimate proxies of areal human development, given that such signals are closely associated to economic performance (Noor et al., 2008; Pinkovskiy & Sala-i-Martin, 2014; Wang & Ma, 2017). In this same line of research are studies that draw estimations from satellite imagery but are not limited to nightlight data. In addition, they include multiple sources of information, such as vegetation indexes, imagery building information, types of roofs, forest cover, precipitation, and roads, among others (Blumenstock, 2016; Jean et al., 2016). A last wave of investigations has made attempts to include phone call records and social media data to proxy socioeconomic conditions (Fatehikia et al., 2020; Hernandez et al., 2017; Njuguna & McSharry, 2017; Soto et al., n.d.; Steele et al., 2017). This strain of research that links SAE and poverty are mostly concentrated on computer science and do not offer precise definitions of poverty, as understood in the development economic literature. Instead, most of them have used wealth indexes as constructed by popularized households' surveys.

This study does not use machine learning techniques, but it has been classified in this sub-group of research given that they intersect on two fronts. First, the unit of analysis are spatial, instead of individuals. Second, the auxiliary predictor come from non-standard sources of data. They differ in the strategy used for estimations. Although each method has advantages and disadvantages, one of the value-added of the geostatistical models is that they allow the interpretation of the influence of covariates on the desired outcome, given the relative simplicity of their specifications.

## 3. MULTIDIMENSIONAL POVERTY MEASURE AND SAE ESTIMATION

### 3.1 Estimation of multidimensional poverty

There are multiple measures of poverty. The two larger types of poverty measures are the monetary poverty and the multidimensional poverty. Most of the research on Small Area Estimations of poverty is centered on monetary poverty. Purposely, the global multidimensional poverty index (g-MPI) is the targeted variable of this study. The main reason is the lack of understanding of the changes at a small scale of multidimensional poverty in a shorter frequency than every census in developing countries. The global MPI has the advantage that uses a standard set of indicators and data (DHS) to produce poverty estimates, which can be comparable across time and between countries. A full description of the g-MPI can be found in the publications of Oxford Poverty & Human Development Initiative -OPHI- (Alkire et al., 2018, 2019). Overall, our estimates reflect a generally larger multidimensional poverty in Cambodia with similar trends, when compared to the published g-MPI (Figure 1).



**Figure 1. Adjusted headcount ratios (MPI) and headcount ratios estimated versus OPHI**

Source: own estimates (dotted lines) and OPHI (n.d.) (smooth lines).

### 3.2 Predictive model

We propose a hierarchical Bayesian framework to model the probability of being poor from a multidimensional perspective. Consider a binary outcome and let be the number of individuals with the characteristic of interest (multidimensional poverty condition) in cluster  $c$  be  $Y_c$ , and total population size  $n_c$ . Then, we use a sampling adjusted spatial model defined by a beta-binomial model which yields the following marginals:

$$P(Y_c|p_c,d) \sim \text{Beta-Binomial}(n_c, p_c, d) \tag{1}$$

Where  $p_c$  describes the probability of being poor in a spatial point  $c$  and  $d$  attempts to measure the overdispersion of the data. Furthermore, the probability of poverty is given by a spatial model of the form:

$$p_c = p(s_c) = \text{expit}(\alpha + z_c \beta + d(x)^T \beta + S(s_c) + \epsilon_c) \tag{2}$$

This specification accounts for strata fixed effect of the surveys. To enhance the precision of granulated scale, a set of spatial covariates  $d(x)^T$  for each location is included. It is worth mentioning that the enhance of the model given is subject to the quality of covariates included and their explanatory power. Finally,  $S(s_c)$  describes a spatial random effect at cluster with location  $c$ . For the estimation of the spatial model, it was used the standard Matérn covariance as follows:

$$\text{cor}_{\text{Matern}}(s_i, s_j) = \frac{2^{1-\nu}}{\Gamma(\nu)} \chi(\kappa \|s_i - s_j\|)^\nu K_\nu(\kappa \|s_i - s_j\|) \tag{3}$$

$s_i$  and  $s_j$  represent the location of two spatial points. Thus,  $\|s_i - s_j\|$  represents the Euclidean distance between two clusters.  $K_\nu$  defines the Bessel function,  $\Gamma$  defines the gamma function, and  $\kappa$  is a standard parameter. As in a standard spatial correlation, Matérn assign higher correlations to closer points in space (Zuur et al., 2017).

Alternatively, we tested a spatio-temporal model. The amplified version of (2) is given by:

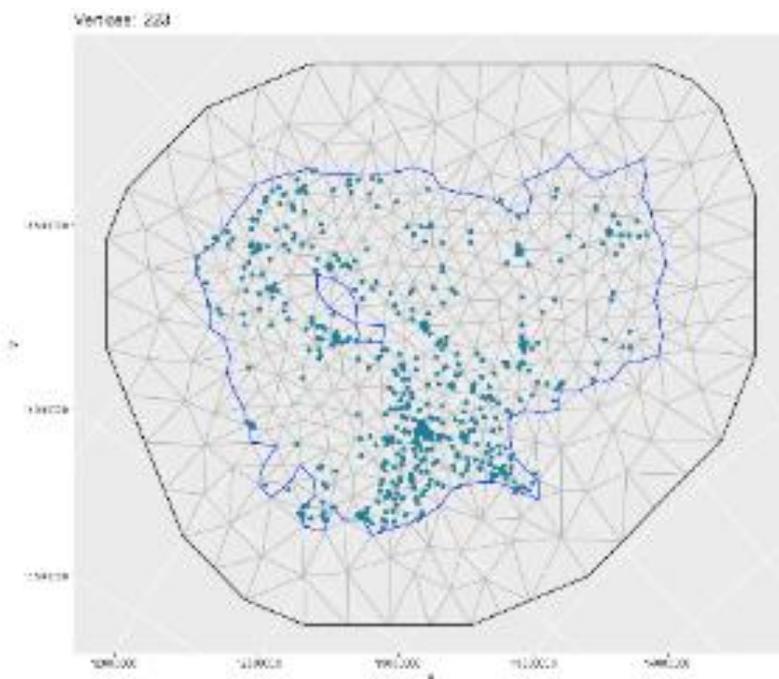
$$\log(p_{ct}) = \log(p(s_{ct})) = \alpha + z_{ct} \beta + d(x_{ct})^T \beta + S(s_c) + v_c + \partial_t + \gamma_t + \epsilon(s_c, t) \tag{4}$$

Where  $\epsilon(s_c, t) = a\epsilon(s_c, t-1) + \vartheta(s_c, t)$

Compared to (2), (4) includes a space time random effect given by  $\epsilon_{ct}$ , which follows autoregressive process AR1. Moreover,  $\vartheta(s_c, t)$  represents a Gaussian distribution with space dependency and time independent at each defined  $t$ .

The most well-known ways to estimate Bayesian models is through MCMC methods. In last years, the introduction of R-INLA has significantly changed the application of Bayesian models, as the method involved speeded time estimations for spatial or spatio-temporal models. The Integrated Nested Laplace Approximation (INLA), method behind R-INLA, approximates outcomes through numerical integration (Rue et al., 2009). This study uses the package R-INLA due to the granularity of estimates which requires large computational scales.<sup>36</sup> Particularly relevant in the applications of R-INLA to spatial point processes estimation is the discretization of the continuous space targeted, the level 0 of Cambodia in this case. It is performed through the triangulation of the space. The constrained refined Delaunay triangulation for R-INLA for year 2014 estimations is shown in Figure 2. Although there is still a developing area of research, the discretization of space is important in the final outcomes of the models, as they define the neighbors of the data.

<sup>36</sup> More about the R-INLA project can be found at <https://www.r-inla.org/>



**Figure 2. Constrained refined Delaunay triangulation**

After prediction at different resolutions were obtained, the data was aggregated at different scales. The method of aggregation is described by equation (5):

$$P_l = \frac{\int p_{(s)} l_{(s)} \partial s}{\int l_{(s)} \partial s} \quad (5)$$

Where  $P_l$  is the polygon estimate,  $p_{(s)}$  defines the estimated poverty rate for a continuous space  $S$  and  $l_{(s)}$  describes population.

#### 4. DATA

We classified the data sources into two groups: type 1 data and type 2 data, as follows: **Type 1:** spatial points of misaligned clusters of household locations. The source of this information is the Demographic and Health Surveys (DHS) collected every five/four years is available from 2000 until 2014 in the case of Cambodia. The jittered points where the data is collected is displayed in Figure 3. The DHS data is the source for the response variable. **Type 2:** auxiliary predictors, including multiple gridded information which inform variability of poverty risk across space.

##### 4.1 Type one: *The Demographic and Health Survey*

The main source of information, which includes the variables used to estimate the multidimensional poverty index, is the Demographic and Health Survey of Cambodia collected in 2000, 2005, 2010 and 2014. The strategy used by the CDHS was a stratified sampling in two stages. This implies that the sample was chosen separately from each stratum. In the first stage, a set of Enumeration Areas (EAs) from the Census is randomly selected, and their probability of selection is based on each unit size (number of households in each EA). Moreover, only a random segment of EAs with more than 200 households were selected (largest EAs).<sup>37</sup> In the second stage of randomization a fixed number of urban (24) and rural (28) households are selected for each EAs through an equal probability systematic sampling. For the years 2005, 2010 and 2014 the total number of sampling stratum are 38, which corresponds to 19 domains for rural-urban areas. The year 2000 collected information on 34 stratum (17 domains and rural-urban areas). The total number of clusters selected, also called primary sampling units (PSU), each year are: 471 in 2000, 557 in 2005, 611 in 2010, and 611 in 2014. Figure 3 displays the spatial distribution of individual surveyed clusters by year. As expected, and based on the sampling strategy used, a larger proportion of clusters are concentrated in the most populated areas of Cambodia. The DHS also follows a geo-masked strategy of the population. It is, for the purposes of respondents' confidentiality, clusters coordinates are displaced within a 2 Km radius in urban areas and within a radius of 10 Km for rural clusters (Burgert et al., n.d.; Perez-Heydrich et al., 2013).

<sup>37</sup> A comprehensive description of the sample design and assessment of sampling weights is described in the surveys' reports: National Institute of Statistics-Cambodia (2006, 2011, 2015).

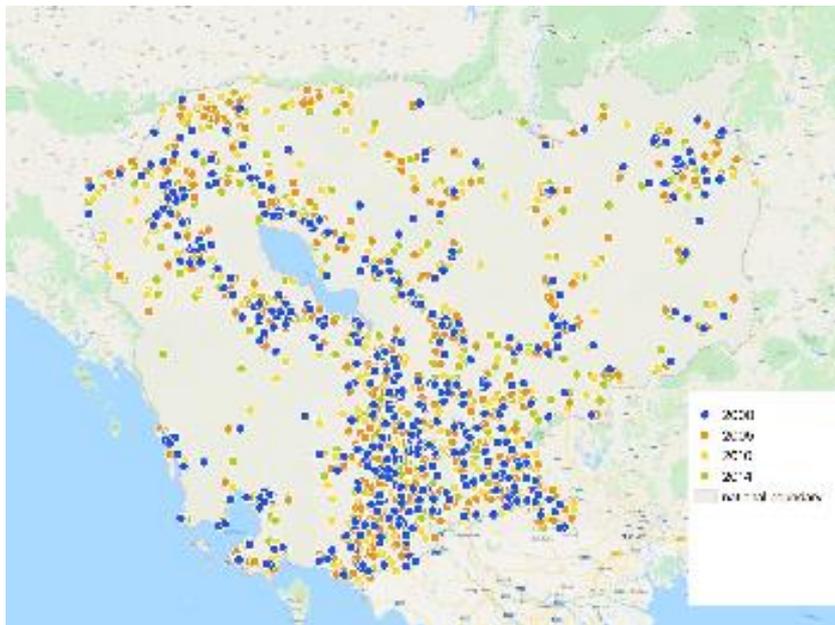


Figure 3. Survey data: geo-masked clusters in Cambodia.

#### 4.2 Type 2 data

Even though we explored multiple sources of variables, and multiple models were tested, the final set of information used was restricted by the WAIC criteria used for models' comparisons. Moreover, as described before, the cluster are randomly jittered around a specific radio for urban and rural areas. To reduce the noise that it could produce, the extraction of the covariates considers the mean within the defined buffer for each cluster location, 5km for urban and 10km for rural points. In the case of the dichotomous variable (urbanicity), it was used the mode of data within a buffer.

**Nightlight information.** This study uses estimates of the project Shining (new) light on Regional Inequality, Convergence and Development, which produces corrected nightlight data, assuming a Pareto property of the truncated information (Bluhm and Krause, 2020).<sup>38</sup> The corrected estimates are produced for the same period and the same spatial resolution as the NOAA original data set. For some years, there are two types of data available, based on the auxiliary flights' information used for the correction. The selected years and respective flights used in our estimates are 2000-F15, 2005-F15, 2010-F18 and 2013-F18.

**Accessibility to cities:** we have used an open available global map on estimated travel time to cities, made available by (Weiss et al., 2018).<sup>39</sup> It includes information for 2015 and is available at a resolution of one by one kilometers. Thus, we have used the same source of information for all years. This strongly assumes that the connectivity did not significantly change over the years. The inclusion of time variability was not possible due to data restriction.

**Urbanicity:** the main source of information to feed the predictive model is the GHS Urban Centre Database (GHS-UCDB)-UCDB R2019A.<sup>40</sup> This data characterizes degrees of urbanization for global grids at one by one kilometers (Dijkstra & Poelman, 2014).

**Wet days:** we use wet days data provided by Climatic Research Unit (CRU) Time Series (TS) v. 4.01 release by CEDA Archive (Harris et al., 2014). The data produces monthly gridded information from January 1901 to December 2016 at a global scale with a resolution of 0.5 x 0.5 degree. In this regard, we have estimated average gridded values for the years/months matching the survey collection timing.<sup>41</sup>

**Rice field:** we included information on number of families with less than one hectare of rice land from the Commune database of Cambodia (2011).<sup>42</sup> The information is available at the second administrative level, Commune, and only for 2011. As the approach followed before, we strongly assume that the map of rice distribution by family has not changed and, so it was linked to all years analyzed.

**Population:** The source of information is the population density produced by the project WorldPop (<https://www.worldpop.org/>). The dataset is available a resolution of approximately 1 km at the equator (30 arc-second).

##### 4.2.1 Census data

For the purpose of contrasting, we estimated the alternative frequentist techniques as proposed by ELL. One critical difference between geostatistical models and the ELL method is that the latter's main input is Census data. We used the

38 The information can be downloaded from <https://lightinequality.com/>

39 The information was accessed at <https://malariaatlas.org/research-project/accessibility-to-cities/>

40 Data available at: <https://ghsl.jrc.ec.europa.eu/download.php>

41 Information retrieved from [https://crudata.uea.ac.uk/cru/data/hrg/cru\\_ts\\_4.01/](https://crudata.uea.ac.uk/cru/data/hrg/cru_ts_4.01/)

42 Retrieved from <https://data.opendevlopmentmekong.net/dataset/commune-database-of-cambodia-commune-level-2011/resource/e64b6bf1-2610-419d-844a-d15ba6dff167>

2008 Census and it was obtained from the IPUMS-International database (Minnesota Population Center, 2020). The distribution of responses in the Census 2008 and DHS 2010, although different years were close.

**Table 2. Summary of variables in Census 2008 and DHS 2010**

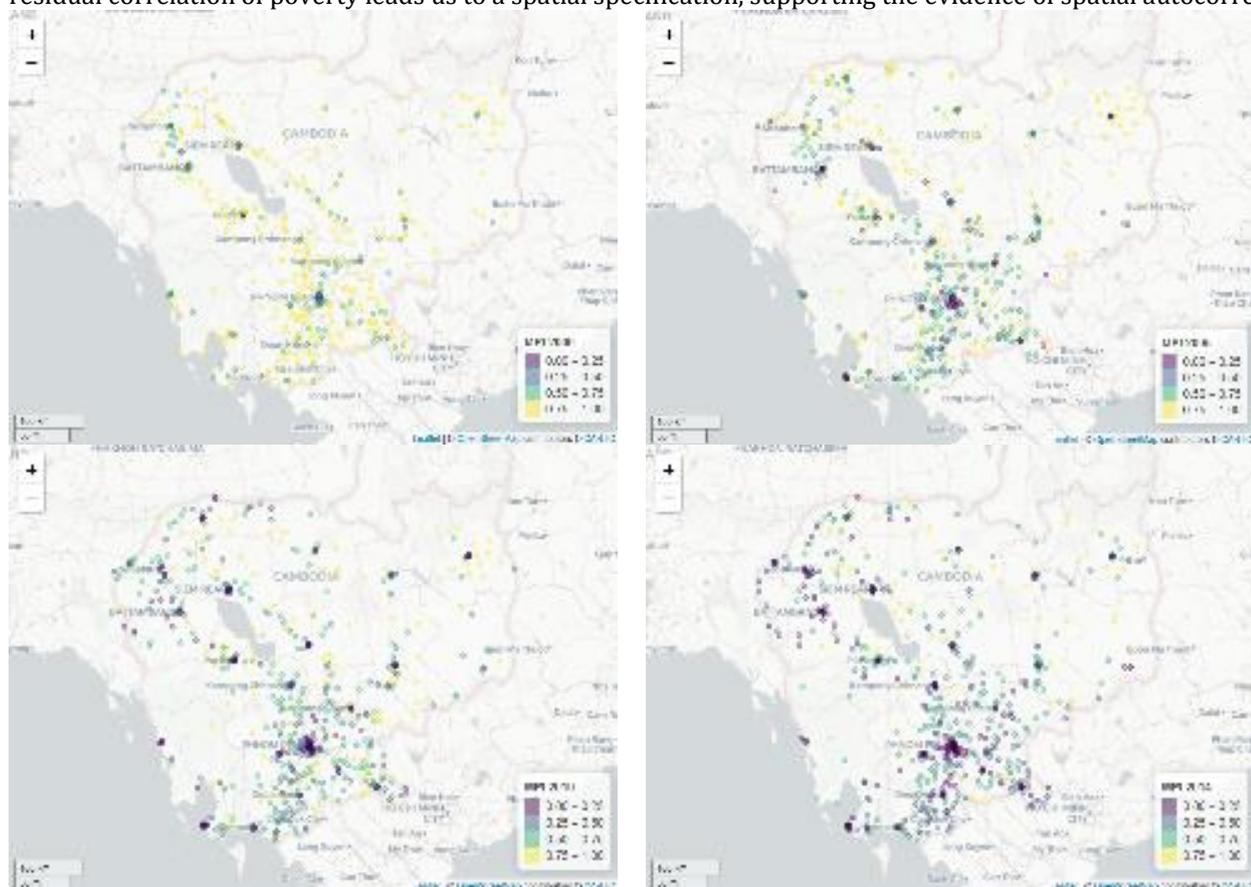
Variable	Census 2008	SD	DHS 2010	SD
Household head age	43.563	14.399	46.200	13.298
Household head (male)	0.744	0.437	0.766	0.423
Household head education	4.612	3.732	4.543	3.671
Urban	0.192	0.394	0.178	0.383
Fuel (gas)	0.888	0.316	0.880	0.324
Piped water	0.136	0.343	0.073	0.259
Rooms	1.543	1.273	1.446	0.891
Radio	0.398	0.490	0.448	0.497
TV	0.595	0.491	0.648	0.477
Electricity	0.259	0.438	0.326	0.469
No. children under 5	0.378	0.623	0.764	0.855
No. children (5-18)	1.645	1.482	2.011	1.497

Source: own estimations based on (Minnesota Population Center, 2020) and DHS 2010.

**5. RESULTS**

**5.1 Evidence of spatial correlation of poverty**

The distribution of headcount poverty at the cluster level is displayed in Figure 4, where some areas, especially those close to the capital of Cambodia Phnom Penh, exhibit significant changes between 2000 and 2014. It can be concluded that the distribution of multidimensional poverty in Cambodia has not been random across space. Even though this scenario suggests that geostatistical models are not spurious, we follow a standard exploratory test to formally identify whether a spatial process would be relevant for our models. Specifically, we conduct a residual spatial analysis of generalized linear mixed model (GLMM) with a binomial link function, using an empirical variogram. The tests for spatial residual correlation of poverty leads us to a spatial specification, supporting the evidence of spatial autocorrelation.



**Figure 4. Cluster-level multidimensional poverty of Cambodia 2000-2014**

5.2 Results of selected models<sup>43</sup>

The noteworthy changes of cluster poverty over space (Figure 4) is evident in the estimated gridded maps. A comparison between 2000 and 2014 maps visibly shows such change. In 2000 most of the area has a large proportion of people living in multidimensional poverty -above 80%- (Figure 5). The high monetary and multidimensional poverty rates observed in early maps in Cambodia reflect the aftermath of historical civil conflicts during 1970s. Such conflicts have had long lasting effects on the well-being of Cambodians, ranging from reductions on educational attainment, earning, fertility and health of its population (Islam et al., 2014); all of them associated with the risk of poverty. As a word of caution, notice that areas where non or fewer cluster information is gathered display higher standard deviations of the posterior (lighter colors in Figure 6). In spite of potential large variability of the estimates the results, especially in early years where there are less clusters, results are robust to different comparisons from differences sources that are not provided due to space limitations.

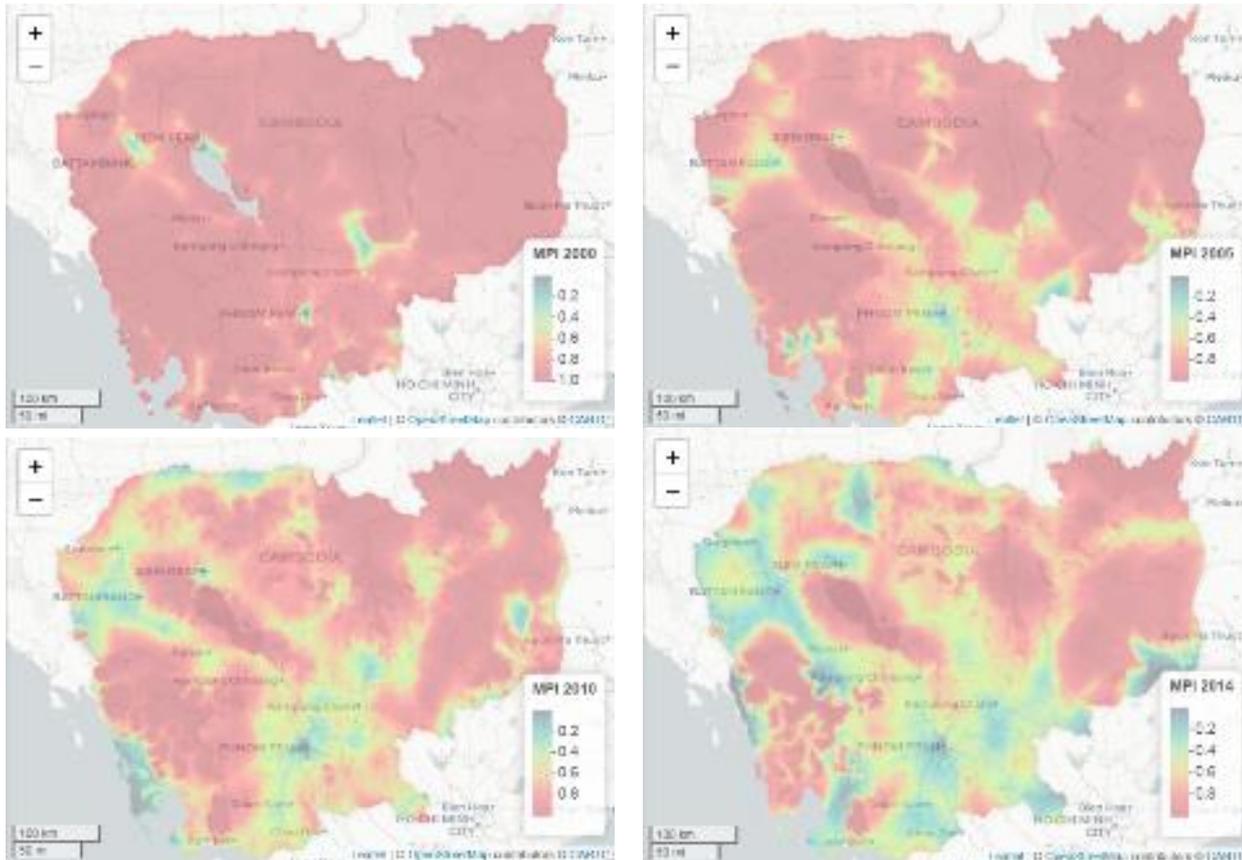
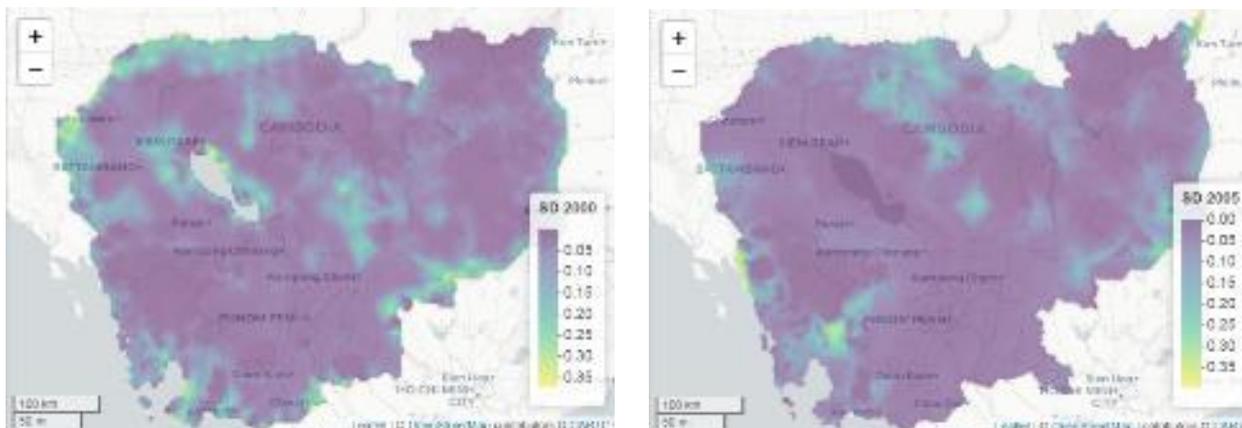


Figure 5. Geostatistical models estimate of headcount MPI 2000, 2005, 2010, 2014



43 The discussions of the results will be limited to the spatial models instead of the spatio-temporal models, because we encountered that spatio-temporal models might generate over smoothing effects, such that it generates poorer predictions than the spatial models within the time span considered. Results of those models are presented in Appendix 5.

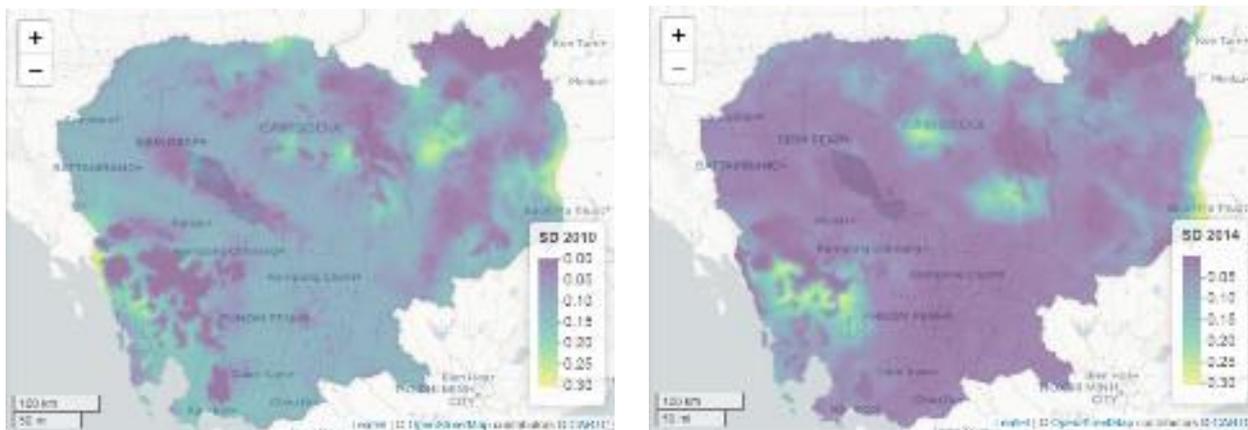


Figure 8. Geostatistical models standard deviations

### 5.3 ELL versus Geostatistical models

The results at district level from the ELL model and Geostatistical models for 2010 are plotted in Figure 9. The overall pattern of poverty distribution for both estimates are similar. In order to build the model for ELL predictions it was followed the suggested procedure of a stepwise selection (Zhao & Lanjouw, 2006). The final set of variables used for the beta model are listed on the data description section. The adjusted R squared produced by the selected model was 0.5264, which is similar to the R squared encountered in similar applications where it ranges from 0.41 to 0.53 (Demombynes et al., 2008). Both models indicate that districts located in Eastern Cambodia have the largest incidence of multidimensional poverty, with a visible larger variability observed in the Geostatistical predictions. The correlation of measures of these two methods is 0.8.

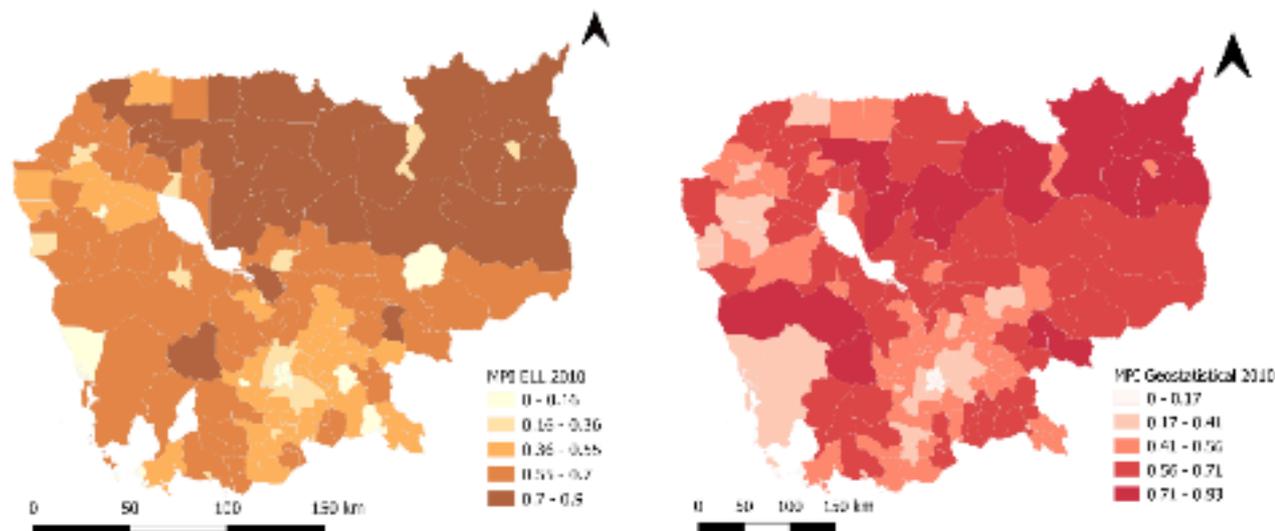


Figure 9. District estimates of poverty using ELL and Geostatistical models 2010

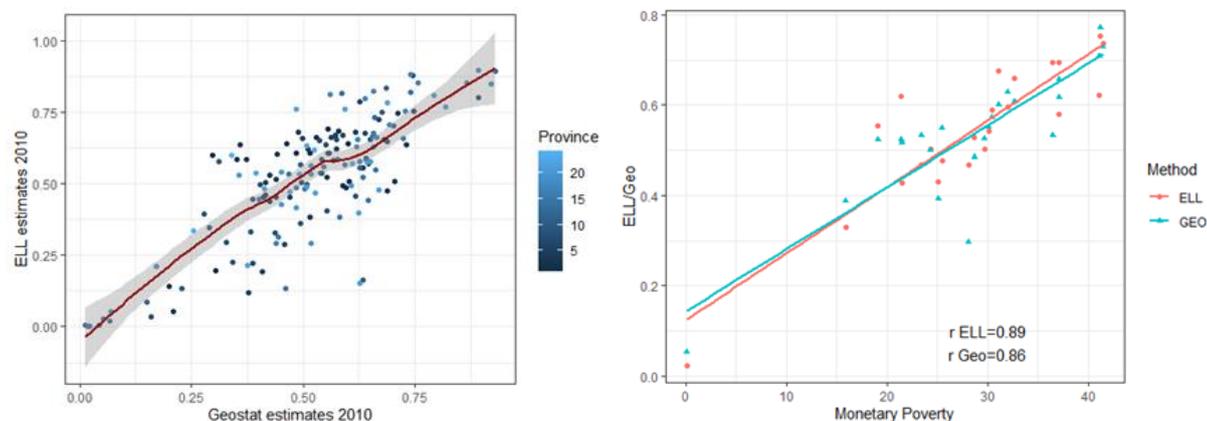


Figure 10. District estimates ELL 2010 versus Geostatistical models 2010

Moreover, results were further aggregated at the province scale. They show that the correlation between the estimates proposed in this study and the ELL method are higher than districts, it was 0.89. Likewise, the strong association between

both sets of estimates and the monetary poverty confirm previous results. The correlation between ELL and geostatistical estimates and the monetary poverty for 2010 are close (0.89 and 0.86, respectively), while the ELL is slightly higher than the geostatistical.

This study does not aim to defend one method over the other, each technique has advantages and flaws. But provided that the ELL can accommodate full census information and can be further combined with survey information and local information, it can be an appropriate method if the data is available. On the other hand, geostatistical models are also subject to error and do not count with the rich set of a census. Yet as exposed in the results, the predictors of these two techniques are very close. The major benefit of the geostatistical models is that they do not rely on census data and can incorporate information from multiple scales, which are increasingly available.

## 6. CONCLUSIONS

Since its first publication around two decades ago, the ELL method has become and remain as a leading method for the estimation of poverty at subnational scale. Although ELL has served as a valuable and applicable instrument, it still has some limitations that are not effortlessly circumvented in developing settings. Namely, it mainly relies on timely census data, which are not periodically available in developing contexts. Moreover, most of these applications are limited to monetary poverty and, thus, this paper offers a contribution about its applicability for multidimensional poverty. Specifically, for the g-MPI.

The relatively recent strand of research on the field of geostatistics such as the main models used in this research offer promising tools to overcome such common limitation. For instance, the rough comparison between the ELL and geostatistics encountered leads to similar predictions of poverty. Nevertheless, this is a growing research strand that can be improved with access to more data, as recent trends show, as well as more efficient computational tools, like R-INLA. This study shows that within geostatistical models the incorporation of survey design could be critical to generate more accurate predictions. Moreover, more complex time-space interaction models do not necessarily would yield better estimations, specifically in larger time spans. Moreover, this research also offers alternatives to similar studies on machine learning that use less parsimonious models, the predictive power of both strategies seems to be comparable based on the surveyed machine learning publications.

This study also roughly contributes to the discussion about the compatibility between monetary poverty and multidimensional poverty measures. The predictors of the models at a lower scale show a strong correlation, in the case of Cambodia, between both forms of poverty for different years. Such associations are even closer among the tails of poverty distribution, where poorer (top) areas in a multidimensional scale also occupied first (last) positions in the monetary rank. Lastly, although surveys collections, innovative techniques and computational power improvements can allow us to identify and have granulated pictures of poverty more often, it is worth highlighting that they are by no means substitutes of census data, but rather alternative to generate intermediate portraits of the spatial phenomena of poverty (and other indicators). As beautifully synthesized by McElreath (2015, p. 2):

*“Rather than idealize angels of reason, scientific models are powerful clay robots without intent of their own, stumbling along according to the myopic instructions they embody. Like with Rabbi Judah’s golem<sup>44</sup>, the golems of science [models] are wisely regarded with both awe and apprehension. We absolutely have to use them, but doing so always entails some risks”.*

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<sup>44</sup> Golem is defined by (McElreath, 2015) as a clay robot from Jewish Folklore. The context of the example can be found on page 1.

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## **Regular Session: RS06.1 - Methods in Regional Science and Urban Economics**

**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/85836987366>**

**Chair Geoffrey Hewings**

**A NOTE ON THE EMPIRICAL IDENTIFICATION OF SUB CENTRALITIES  
WITHIN CITIES**

**Carlos Azzoni, Rodger Antunes**

University of Sao Paulo, Brazil

**ABSTRACT**

Although the traditional Central Business District (CBD) still has the largest single concentration of jobs in most cities, employment has sprawled over space, creating subcenters (SDB). Theoretical models have dealt with this phenomenon, highlighting its effects on wages, land prices, etc. Researchers have proposed empirical procedures to identify the SDB within cities, but no one has become standard in this empirical field. In this paper, we propose a new methodological procedure, based on nonparametric estimators. Our approach does not rely on previous knowledge of the employment distribution and does not use arbitrary threshold values and band sizes. For each cell, we calculate spatial employment averages using kernel functions and distance bands defined by the AIC optimization criteria. We use the quantiles of the distribution of the estimated spatial averages as cutoff values. As a means of validation, we identify SDB for the São Paulo metropolitan area (Brazil) using our method and the method proposed by McMillen and Smith (2003). Our model is more conservative in identifying areas pertaining to SDBs, and presents lower error terms and standard errors relative to those estimated by their methodology.

## IMPLICATIONS OF GENERAL RELATIVITY THEORY FOR REGIONAL SPATIAL INTERACTION MODELING

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### ABSTRACT

In the last few years, there have been profound leaps in our understanding of the complexity and spatial dynamics in the cosmos. Several recent discoveries have radically shifted our theoretical and empirical views on the inner workings of the Universe. Perhaps most profoundly, the detection of gravitational waves, along with the first photo of a black hole, have finally confirmed Einstein's theory of general relativity. Accordingly, Newtonian gravity has been rendered passe in certain key regards. In particular, Newtonian gravity does not apply for phenomena in the Universe when there is: 1) extreme mass-energy density, 2) strongly curved dynamic space-time, and 3) mass- energy dynamics with  $v \sim c$ , where  $v$  is velocity and  $c$  is the speed of light. In such cases, gravitational dynamics are governed by the principles of General Relativity Theory (GRT) rather than Newton's Law of Gravitation. Using suitable analogies, we explore the extent to which similar properties and dynamics apply to spatial socio-economic phenomena on Earth, with a primary focus on spatial interaction in cities and regions. We hypothesize that the above three cases might pertain to megacities or megaprojects; metropolitan areas containing excessive flux in patterns of spatial interaction and travel times; and, regional systems where volume is at capacity. To test this and other possible analogies, we will consider conducting a meta-analysis of calibrated gravity models in the relevant literature, assessing how the performance of models correlate with these and other pertinent factors. We will also discuss how tests of general relativity used in cosmology might be adapted to assess when a standard Newtonian gravity model is not appropriate for characterizing urban and regional spatial interaction. Lastly, several analytical and computational solutions for GRT, along with a variety of so-called modified gravity models to account for the assumptions behind GRT, have been proposed in the literature. We will explore their relevance for spatial interaction modeling in regional science.

**ENHANCING OUR UNDERSTANDING OF A REGIONAL ECONOMY: THE  
COMPLEMENTARITY OF CGE AND EIO MODELS.**

**Andrew Crawley<sup>1</sup>, [Geoffrey J.D. Hewings<sup>2</sup>](#)**

<sup>1</sup>University of Maine, Orono, USA. <sup>2</sup>REAL and University of Illinois, USA

**ABSTRACT**

Economic impact models are powerful tools for the assessment of policy changes in regional economies. Computable General Equilibrium (CGE) models have grown in popularity, becoming the dominant choice of practitioners and academics in this field. This popularity has been at the expense of an older class of model, the Econometric Input Output (EIO). The present paper demonstrates how both models, using the same input data, may yield different outcomes. However, the paper suggests that EIO has been underutilized but even though it provides a strong complementary tool accompany that enhance analyses using a CGE approach. This paper urges regional economists to rediscover the EIO model, especially two variants that are described in the paper, and bring them to the forefront of their research agenda.

**CROSS-SECTIONAL DEPENDENCE IN GIBRAT'S LAW**[Xieer Dai](#)

The Hebrew University of Jerusalem, Israel

**ABSTRACT**

One of the most conspicuous empirical findings in the social sciences is Gibrat's law or the law of proportionate effect. The idea was developed by (Gibrat, 1931) for French manufacturing firms and concluded that firm growth is a random effect, independent of firm's size. This law is also widely found in cities' growth, income, and wealth. Since Gabaix (1999) and Eeckhout (2004), it has become popular to test Gibrat's law in cities. In general, there are both static and dynamic ways to test Gibrat's law for city's size empirically.

The static approach is to test the distribution of city's size. Distribution of city size is a controversial issue with two common contenders: the Pareto and the log-normal. The law of proportionate growth gives rise to a log-normal distribution. When the process is normalized, and a lower bound is set, the distribution leads to a power law in the upper tail.

This paper provides additional evidence on whether Gibrat's law holds for the growth of broadly defined 'cities' such as MSAs and NUTS regions. This paper extends the random growth model to incorporate both strong (common factor) and weak cross-sectional dependence (spatial dependence). A regional population random growth model with global and individual technological shocks is formulated. Common factors and spatial dependence are derived as a result of interregional migration.

It is shown that if the growth processes of regions obey Gibrat's Law with cross-sectional dependence and when the spatial weight matrix is non-stochastic, the unit root process can still lead to Power Law distribution in the tail.

In the empirical section, I test both static and dynamic hypotheses of the random growth model using three regional datasets of European NUTS 2 regions across 30 years and U.S. counties and MSAs across 50 years. The regional population distributions for these three datasets are characterized as lognormal distributions in the body with a power-law distribution in the tails.

A panel unit root test in the presence of spatial autoregressive error (SFIPS) is proposed. The critical values are tabulated using Monte Carlo simulations. The SFIPS tests and CIPS tests confirm Gibrat's law with strong and weak cross-sectional dependence for NUTS 2 regions and the U.S. MSAs.

## **Regular Session: RS09.1 - Regional and urban policy**

**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/88538303825>**

**ACCESSIBILITY AND SOCIAL NETWORKS IN FAMILY ADHESION TO  
SOCIAL HOUSING: EVIDENCE FROM A BRAZILIAN HOUSING LOTTERY  
CASE**

**Patrick Nasser, Eduardo Haddad**

University of São Paulo, Brazil

**ABSTRACT**

We investigate how accessibility, measured by the difference of job market Hansen indexes, and social networks, measured by the geographical approximation across different age-bands densities, are related to the final decision of accepting the benefit by the poorest participants of Brazilian housing program “Programa Minha Casa Minha Vida” (PMCMV) in the city of São José do Rio Preto (São Paulo state), where potential beneficiaries were randomly drawn for the year of 2013. From the lists of municipal draws, identified Cadastro Único (Brazilian national register for federal social programs), identified RAIS (Brazilian national register for formal labor activity) and beneficiaries’ information disclosed by state bank Caixa Econômica Federal, we estimate different specifications of Probit models using the difference of job market Hansen indexes between PMCMV households and origin family addresses. Also, we use the 2000’s and 2010’s National Census at the census tract level to create IV-Probit models using the first Census local age densities-bands as instruments for our social networks model. Our results indicate that worse accessibility prospects are related to non-compliance decisions, and we do not reject the null hypothesis for the effect of age-based social networks on compliance besides showing that neighborhoods might affect different age-compositions households differently. From the public policy perspective, these results show that the program might not reach an important part of low-income families’ locational preferences.

## **Special Session: SS12.2 - SMEs/Family Businesses and Regional Development**

**16:00 - 17:15 Tuesday, 25th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/88394645535>**

**Chair Lech Suwala**

## RETHINKING CULTURAL POLICY: THE ROLE OF THE CULTURAL INDUSTRY AND SMALL MANUFACTURING COMPANIES

Salma Mhamed Hichri

University of Sfax- LAREQUAD, Tunisia

### ABSTRACT

The use of cultural policy as part of economic development and urban regeneration strategies is increasingly an uncontested issue. However, this consensus masks serious dilemmas regarding strategic choices and their implementation in economic and cultural development. Indeed, policy-makers have always considered the cultural economy either as an appendix to the knowledge or creative economy or as a means of improving consumption (Evans, 2009) which implies that art and culture objects are consumer goods that enhance the attractiveness and image of the city. This has led to an increasing polarization and bifurcation of cities culturally and economically around knowledge industries. These focus on high-skilled workers (Allmendinger, 2002; Cullingworth and Caves, 2014) leaving traditional craft skills and the self-employed to the margins (Girard, 2006). This has led to a kind of opposition between the knowledge economy and the material economy (Hudson, 2012).

Moreover, while these policies, too focused on knowledge-based industries, seek to rid cities of the manufacturing heritage and land use, there is a real revival of interest in custom manufacturing, artisanal production, and additive manufacturing (Jakob, 2012; Thomas et al., 2013; Luckman, 2013; 2015; Anderson, 2012 ). This renewed interest is further supported by an awareness of the vulnerability of consumer-oriented development and the questioning of its sustainability.

In response, we consider that reorienting cultural policy by focusing on the promotion of cultural production is an important opportunity that can reconcile the city with its industrial heritage. This allows cultural policy to reinvent itself and to overcome the limits of a cultural development based on consumption. Thus we are interested in the articulation between the cultural economy and the cultural industry. We show that cities can develop more equitably and sustainably if they consider and recognize their industrial and cultural heritage in their cultural and urban policy. Such a heritage can only flourish in perfect symbiosis with place (Scott, 2004). Indeed, new research supports the growing importance of small firms and small, flexible manufacturers and specific at the place (Mistry & Byron, 2011, Bryson & Ronayne, 2014). From this perspective and based on the analysis of small manufacturing firms in Tunisia, we show that they offer important possibilities for rethinking cultural policy.

**RADICAL ENTREPRENEURSHIP: CHALLENGING CASTE-BASED DISCRIMINATION AND SOCIO-STRUCTURAL CONSTRAINTS TO INCLUSION IN RURAL BANGLADESH**

[Grace Mueller](#)

University of Edinburgh, United Kingdom. Cambridge Institute of Sustainability Leadership, United Kingdom. University of Texas at Austin, USA

**ABSTRACT**

The rise of entrepreneurship as a strategy for development in the Global South is a reflection of growing geopolitical interest in the liberalization of economies and decentralizing state power as a means to maximize global social welfare. While it has been made clear that top-down approaches to ‘empowerment’ through ‘financialization’ often result in failed development attempts and stagnant markets, few studies have sought to understand entrepreneurship as it naturally evolves in its social and cultural contexts. In rural Bangladesh, characteristics of the non-institutionalized entrepreneur merge Western and South Asian market principles, creating a form of relational entrepreneurship that may open new pathways to mobility through dignified personhood creation, gender equality advancements, and economic opportunity not available to previous generations through other forms of labor.

In this paper I show how entrepreneurship among a rural Dalit community plays a significant role in the ability for poor families to change their circumstances. Through the observation of six entrepreneurs over six weeks, I found that entrepreneurs utilize certain behaviors to navigate three primary poles of inequality: economic stagnation and opportunity, social exclusion and inclusion and interdependence and context-specific agency. New freedoms gained through entrepreneurship enable marginalized men, and doubly marginalized women, to challenge the status-quo and negotiate power at a local level, opening new pathways for the study of ‘radical’ entrepreneurship as an avenue for the pursuit of upward mobility amongst marginalized groups in South Asia and elsewhere. This study is relevant to research which explores the role of self employment and small enterprises in creating structural change at a local level, particularly in contexts of extreme marginalization.

**FAMILY FIRMS AND ECONOMIC SPACES - BUILDING BRIDGES  
BETWEEN FAMILY BUSINESS AND REGIONAL STUDIES /SCIENCE**

**Lech Suwala<sup>1</sup>, Rodrigo Basco<sup>2</sup>**

<sup>1</sup>Technische Universität Berlin, Germany. <sup>2</sup>American University of Sharjah, UAE

**ABSTRACT**

This paper is a review that searches for common fertile ground between the previously unconnected disciplines of family business and regional studies /science that have experienced delicate approximations in the past five years. Most existing studies linking both disciplines, however, are fragmented, dispersed and scattered not allowing for a systematic assessment of these approximations. Based on their relations to peculiar spatial entities – hereby we mean a superordinate term for spatial factors / structures, spatial process, spatial contexts, spatial scales, spatial settings, spatial policies, and spatial concepts – we are taking stock and attempting to group those studies along an extensive literature analysis. Moreover, we present two systematic attempts model (spatial family model, regional familiness model) already incorporating some of those entities within a single theoretical framework. We conclude that research streams in both disciplines have partly a high degree of overlaps. Therefore, we call for more interdisciplinary work to commonly address research gaps and exchange insights on theoretical, empirical and practical grounds around ideas of ‘Spatial Familiness’ and/or ‘Family Spatialities’.

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# PARALLEL SESSIONS (5)

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## National Session: SS56.2 - The Colombian Economy and its Regional Structural Challenges



ASOCIACIÓN COLOMBIANA  
DE ESTUDIOS REGIONALES  
Y URBANOS

**17:30 - 18:45 Tuesday, 25th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/87320775891>**

**Chair Jaime Bonet**

## BOILING HOT! ECONOMY-WIDE IMPACTS OF CLIMATE CHANGE ON COLOMBIAN COFFEE YIELDS

Pedro Levy Sayon

University of São Paulo, Brazil

### ABSTRACT

Colombian coffee is renowned worldwide for its quality and delicious taste. It is one of the major crops of the country, being the world's third largest exporter. Although coffee growing is not relevant in terms of GDP, it plays an important role when it comes to employment, with over half a million families benefiting directly from it, potentially more indirectly. Given the importance of this commodity in the economy, global warming has sparked the discussion about how to overcome the coming hindrances imposed by new climate conditions. Using the forecasts of (Sierra, 2019), the present chapter tries to quantify said hardships in an interregional computable general equilibrium framework.

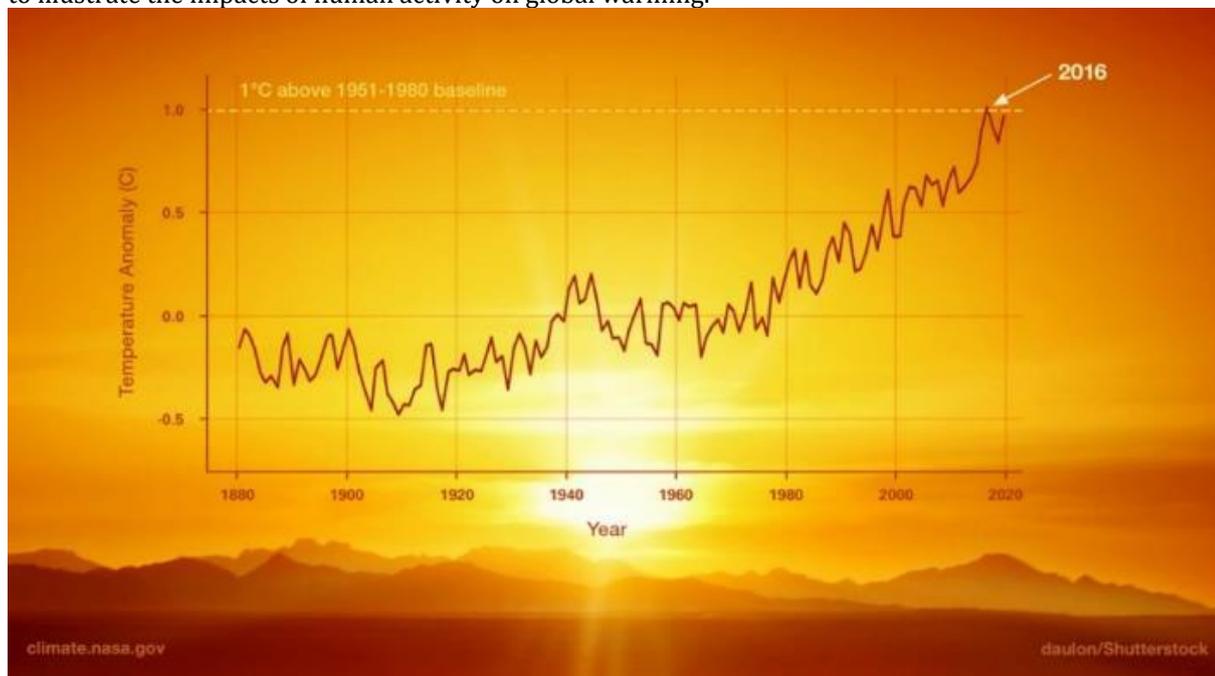
### KEYWORDS

Climate change, coffee productivity, general equilibrium, Colombia.

### 1. CLIMATE CHANGE & GLOBAL WARMING

The term climate change refers to a physical phenomenon in which there are globally long-lasting shifts in temperature, precipitation, cloudiness, amongst other atmospheric conditions, in regard to their historical averages. Contrary to popular belief, it distinguishes itself from global warming in the sense that the latter only encompasses the first of the aforementioned climate characteristics: temperature. Such variations may be caused by many different reasons, such as internal Earth processes, external forces (e.g., solar activity), or, more recently, because of human intervention.

The Goddard Institute for Space Studies (GISS) is a laboratory in the Earth Sciences Division of the Goddard Space Flight Center from the North American Space Agency (NASA) affiliated with the Columbia University Earth Institute. One of the key objectives of the institute's research is the study of climate change in the 21<sup>st</sup> century and the prediction of long-term change in the average weather patterns resulting from said phenomenon. Bellow, follows a figure prepared by the GISS to illustrate the impacts of human activity on global warming.

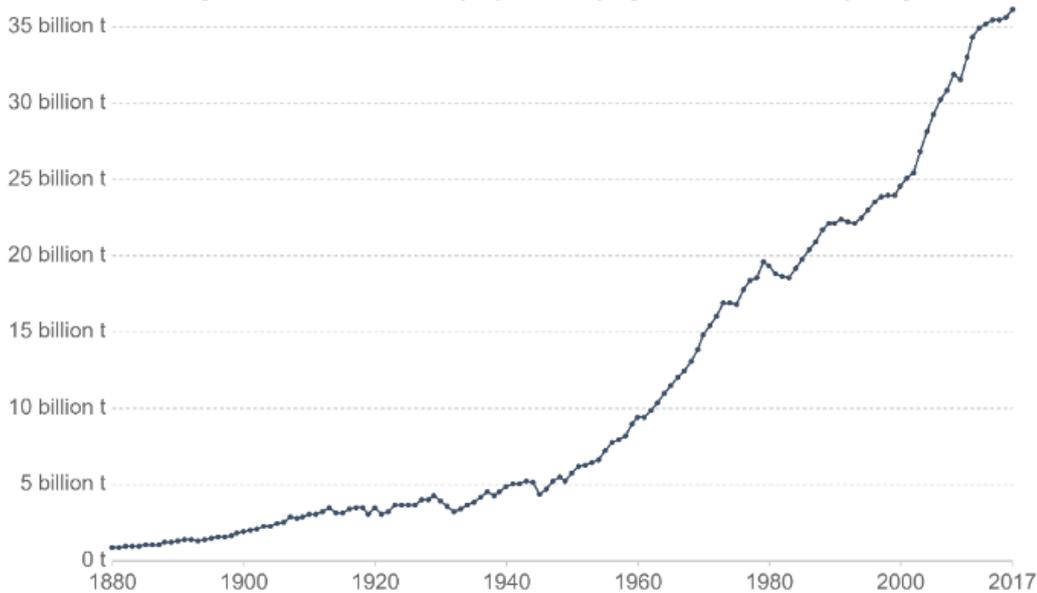


**Figure 1.1 - Change in Global Surface Temperature Relative to 1951-1980 Averages**

Source: NASA's Goddard Institute for Space Studies.

Changes observed in Earth's climate since the early-20<sup>th</sup> century are primarily driven by human activities, particularly fossil fuel burning, which increases heat-trapping greenhouse gas levels in the atmosphere, raising the planet's average surface temperature. As seen above, there is a sharp detachment of temperatures from the baseline average starting just

before 1980, marking the beginning of human induced global warming. Not coincidentally, greenhouse gases emulate almost the same pattern, starting a couple of decades prior, because there is a strong lagged component correlating emissions and temperature. The following figure is a graphic demonstrating the previous statement.



**Figure 1.2 – World Annual CO<sub>2</sub> Emissions**

Source: Global Carbon Project, Carbon Dioxide Information Analysis Centre (CDIAC).

Albeit carbon dioxide (CO<sub>2</sub>) is not the only greenhouse gas, it accounts for over than 80% out of the total, making it an excellent proxy for measuring emissions. Prior to the Industrial Revolution, the concentration of pollutants was insignificant. The amount of CO<sub>2</sub> released annually remained relatively low prior to the mid-20th century. In 1950, the world emitted just over 5 billion tonnes of this gas – about the same as the US, or half of China’s annual emissions today. By 1990, this had more than quadrupled, with 22 billion tonnes. Since then, they have continued to grow rapidly, totaling now over 36 billion tonnes each year. Growth has slowed over the last few years, nevertheless total emissions have yet to reach their peak.

In this sense, it is relevant to inquire the magnitude of the impact of human activity on climate as well as, reciprocally, the consequences of such new weather conditions on the economy. There is a plethora of studies correlating global warming and productivity, particularly in industries involved in extraction of raw materials, such as farming, logging, hunting, fishing and mining. Furthermore, many developing countries have strongly primary based economies, meaning that those sectors tend to make up larger portions of the country’s gross domestic product (GDP). Amongst such cases, a few examples in Latin America come to mind: Chilean copper, Paraguayan soy beans, and – the particular case of interest for this book’s chapter – Colombian coffee.

## 2. COLOMBIAN COFFEE INDUSTRY HISTORY

### 2.1 Formerly

First of all, it should be noted that this subsection, which entails an analysis of Colombian economic history, follows thoroughly the work of (Ocampo, 2015). The most popular story about the origins of coffee in America indicates that the French first brought the seeds to their colonies in Guyana and in the Antilles in the late-17<sup>th</sup> century. From this starting point, coffee growing spread throughout the continent in the first half of the 18<sup>th</sup> century. It finally reached Colombia around the middle of this era when the Jesuit Order introduced the crop in its farms at the Eastern Plains (Orinoquía), at the Cauca’s Valley and in other smaller regions.

Coffee growing remained, nonetheless, a minor activity for over a century, not only in Colombia, but also around the world. In European countries, its consumption was restricted in the 18<sup>th</sup> century to a few sectors of aristocracy, who could bear the high costs of an exotic drink. In 1790, for example, the total world trade in beans was 1.2 million 60kg bags of unripe coffee, a tiny fraction of what it is today. Only in the late-19<sup>th</sup> century, in the wake of the Industrial Revolution with slow popularization of its consumption in Europe and the United States, began the real history of the coffee industry. In Colombia, its first commercial experience came out as a subproduct of the pinnacle of coffee growing in the Venezuelan Andes after its independence. In fact, the first crops of relevant scale were produced in the Cúcuta region in the 1830s. From there, coffee growing spread first to Pamplona and Ocaña, in Norte de Santander, and later to Santander, Cundinamarca and western Colombia.

During the first years, it is difficult to know the real magnitude of Colombian exports, since much of what was registered as such in Cúcuta customs were actually re-exports of Venezuelan coffee. Although there are higher estimates, it would not seem an exaggeration to affirm that the total production of coffee in Colombia in 1860 was between 30,000 and

40,000 bags. By then, registered exports, including Venezuelan coffee, had reached 55,000 bags. Yet, coffee was still a marginal item within Colombian foreign trade as a whole, since it represented only 4% of total exports. From then, the grain's production experienced three different booms in the 19<sup>th</sup> century, which generated a significant displacement of the coffee frontier to the interior of the country. The first of these expansions took place in the 1860s. During this period, exports rose to around 100,000 bags but production remained concentrated in Norte de Santander. When the Office of Statistics made the first attempt in 1874 to reliably estimate the country's coffee production, it amounted to about 110,000 bags, out of which 95,000 came from that region.

The second boom took place during the 1870s. This expansion made it possible to increase exports of the grain from 100,000 to 22,000 bags approximately and to turn coffee into one of the important products of Colombian foreign trade: by the end of that decade, it already represented more than 20% of the country's external sales. This growth generated yet another and more significant shift in the production frontier. Albeit Norte de Santander continued to increase its harvests until it yielded 120,000 bags in these years, most of the new production was concentrated in Santander and Cundinamarca, which by the middle of the following decade were producing 60,000 and 40,000 bags, respectively. In the first case, expansion began at the beginning of the decade around Bucaramanga, hence consolidating its economic dominance over this region of the country at the expense of the historic centers to the south of this department. In Cundinamarca, on the other hand, the extension of plantations began a little later. In both regions it was interrupted by the fall in international prices that took place in the early 1880s and the civil war that followed.

Shortly after political order was restored during the Regeneration, the third and most important coffee boom of the 19<sup>th</sup> century began. The country's production expanded considerably in the 1890s, reaching around 600,000 bags when the Thousand Days' War broke out. By then, it already represented about half of Colombian exports. This expansion coincided with the best international grain prices of the second half of this era. In fact, in the early 1890s, real coffee prices were 40% higher than in the 1870s and almost three times higher than in the mid-19<sup>th</sup> century.

Other factors undoubtedly played a role in this process. As a reflection of the general crisis that Colombia's foreign trade experienced in the early 1880s, the depreciation of silver in the international market and the subsequent introduction of paper money, the peso experienced a substantial real devaluation. During the initial stage of this process, coffee production costs tended to fall in terms of gold (the international monetary unit), thus promoting plantings. No less important was the landowners' access to credit granted by foreign business houses in conditions that were attractive for that time: 6% annual interest (with 1.5 or 2 additional percentage points of commissions), two years of term and subsequent payment in coffee.

In regional terms, the expansion of the 1890s was the most diversified of the 19<sup>th</sup> century. The axis of expansion was the west of Cundinamarca (and the surrounding areas of Tolima), which increased its yields from 40,000 to 230,000 bags during these years. Outside this region, production began to expand on an appreciable scale in Antioquia, which by the end of this era was amounting about 90,000 bags. Santander doubled its harvests, until it reached around 120,000 bags. Norte de Santander and Cauca's Valley also participated, albeit on a more modest scale in the peak.

In western Cundinamarca, the expansion followed three different lines. The first of them followed the route from Bogotá to Honda; the second, the province of Tequendama, accompanied by Bogotá River on its descent to the Magdalena River; and the third, the Sumapaz region, followed by the downslope route towards Girardot. Coffee development apparently began in the first of these lines during the 1870s, from where it headed for Tequendama and, to a lesser extent, towards Sumapaz in the late-19<sup>th</sup> century. In Antioquia, coffee had begun to develop also in the 1870s in the vicinity of Medellín. The expansion of the end of this era, however, was concentrated in southeast Antioquia, especially in Fredonia district. In Cauca's Valley, on the other hand, most of the development then had its epicenter in a geographic depression, in the vicinity of Cali and Palmira.

The first decade of the 20<sup>th</sup> century did not seem particularly likely to result in a large coffee expansion. Despite the enormous efforts made by the Government of São Paulo in Brazil to restrict planting and defend grain prices, these remained at extremely low levels since 1899. Coffee farms were unproductive and still affected by the greatest civil conflict in Colombian history, and hence were incapable of yielding development. Only the iron discipline imposed by General Rafael Reyes and his attempts to promote new economic enterprises were positive elements for a new export boom.

In spite of the unfavorable elements, the coffee industry took on an unexpected positive turn in the national economy during this period. By the late 1920s, production had more than quintupled, surpassing over 3 million bags. Not only did the crop become Colombia's main export commodity, but also the country itself became one of the world's largest producer (second only to Brazil), the first in soft coffees. In the early-20<sup>th</sup> century, 3,5% of all coffee in the world was being harvested in Colombian territory. At the end of the decade, this share had risen to 10% and it would continue to grow in the coming years.

This sudden growth implied in a radical change in the agricultural frontier and in the means of production. In fact, increased production concentrated in Antioquia colonization areas in Old Caldas, south of this department and to the north of Tolima and Cauca's Valley. This region had been populated since the early years of independence and by the beginning of the 20<sup>th</sup> century it had acquired an important volume of dwellers. The settlers initially developed a slash-and-burn agriculture similar to that practiced in other regions of the country, but with some additional commercial activities (pigs fattening, saddlery, etc.). Coffee did not play an important part of this process, even in the late settlement regions (Quindío), since its long gestation period did not adapt to the requirements of the colonization process. Nonetheless, in the early-20<sup>th</sup> century, the crop expanded rapidly in small and medium-sized properties that had developed in the region thanks to a long process of struggle for land from the settlers against the owners of unproductive

farms, who had the support of the commercial elites of Medellín and later Manizales. Still, this diffusion process of the peasant units did not prevent them from maintaining an appreciable concentration of property in the colonization areas. According to estimates, around 20% of land awards in Antioquia and Caldas between 1823 and 1931 (about 250,000 hectares) favored settlers or small and medium-sized owners (less than 50 hectares).

The advance of coffee in this region during the first three decades of the 20<sup>th</sup> century was incredible. Antioquia and Caldas went from producing 90,000 bags in 1900 (around 15% of national yields) to 384,000 in 1913 (36%) and 1,622,000 in 1932 (47%). Production from Tolima and Cauca's Valley was about 110,000 bags in 1913 (10% of total), but it was represented mainly by harvests from farms located in the west side of the first and at the south of the latter. In 1932, outputs from those departments were 802,000 bags (around 23% of national yields) and were concentrated in the central mountain range. Besides, the coffee industry started to spread to new regions of the country, especially Cauca, Nariño, Huila, Boyacá and Magdalena. The traditional producing zones in Norte de Santander, Santander and Cundinamarca concentrated 82% of national production at the turn of the century (500,000 bags), yet in 1932 those yields reduced themselves to sole 24% (820,000 bags).

The great bonanza that the coffee economy experienced before the crisis of 1929 was not abruptly interrupted. On the contrary, it kept growing in later decades. In the early 1960s, harvests amounted to a total of 7.8 million 60kg bags of unripe coffee, about three times of what it was in the second half of the 1920s, although it became less dynamic. In fact, production as well as exports experienced a sharp increase throughout the first decades of the 20<sup>th</sup> century (between 6% and 8% annually), only for harvests to stabilize in smaller 5% growth rates in the 1930s. This started to slow even further, however, in the 1940s, until it reached less than 2% in both the 1950s and the 1960s.

Previous trends were reflected in national portion in world grain production and trade. In the early 1930s, the country concentrated 10% of all exportable yields and 12,4% of coffee foreign sales. Those shares would keep on growing until they had reached their peak at 20% during the Second World War. With loss of dynamism, so did those values start to decline in the postwar period, only to stabilize in the 1960s between 13% and 12%. Noteworthy, even half a century later, not much has changed production-wise, neither in terms of Colombia's placement in the coffee market. Notwithstanding the clear connection between the country's macroeconomic policy and the crop's business cycle, especially in the second half of the 20<sup>th</sup> century with further development and integration of world financial markets, this will not be covered here<sup>45</sup>. This brief history of Colombian coffee industry served its purpose in demonstrating how the regional distribution of production became what it is and also in foretelling the national role in this commodity's world trade, which will be further detailed the next subsection.

## 2.2 Currently

Today, Colombian coffee consumption has become a worldwide phenomenon, whose drink is widely renowned for its quality and delicious taste. It is the major crop of the country, who is also a major player in foreign trade of this commodity. Despite coffee growing not making up a relevant portion of the nation's GDP (less than 1%), it plays an important role when it comes to employment, with over half a million families benefiting directly from it, potentially more indirectly when considering interindustry linkages and income induced effects. Because of this product's popularity and importance to the economy, many researchers and enthusiasts started to wonder what may happen to its production in a climate changing setting.

In regard to the general structure of production presented in Chapter 8 (*Chaining Juan Valdez: Linkages in the Colombian Coffee Industry*) of this book, the first relevant characteristic of this product's supply chain is its division between two industries: coffee growing and coffee processing – given the sectorization of the economy in the interregional input-output system (IIOS) for Colombia in 2015. Although the eighth chapter gives a more detailed picture of those two, it is important not only to remember that they are strongly interlinked with one another, but also to investigate what other sectors are connected to them as well as which primary factors they are demanding.

Considering the first of those, coffee growing, its intermediate demands are dominated by basic chemical substances (e.g., fertilizers), agriculture (e.g., coffee seeds), electrical equipment, land transportation (e.g., tractors and trucks), and financial activities, respectively. Those five sectors concentrate almost 90% of total input necessary for coffee growing and are almost entirely provided domestically, with the exception of the chemicals, where around half is imported. This intermediate consumption, however, corresponds to only a third of total expenditure from the industry, whereas the other two thirds are split almost equally between labor and capital, and thus coffee harvesting is in neither way intensive. Finally, it should be pointed out that none of this sector's output are exported, which means that all of its production is absorbed by the local market, a large share by coffee processing, which will be further detailed in the next paragraph.

This next industry, coffee processing, on the other hand, has over 80% of its intermediate demands coming from the previous. The others, in order of relevance, are: coffee processing itself, wholesale and retail trade, financial activities and plastic products (e.g., packaging). When adding the four latter to the former, it accounts for over 95% of the total input necessary. With the exception of financial activities, where almost three quarters are imported (likely foreign banks investing in the crop's production), most of the inputs are provided domestically once more. Differently from growing, intermediate demand here concentrates more than 90% of total expenditure from the industry, followed by capital with 7% and lastly labor with no more than 1%, which makes processed coffee a capital-intensive product. Finally, one more important distinction in this case is that not all the production is destined to the local market. Quite the opposite, it is a very important export for the country, whose relevance will be illustrated shortly.

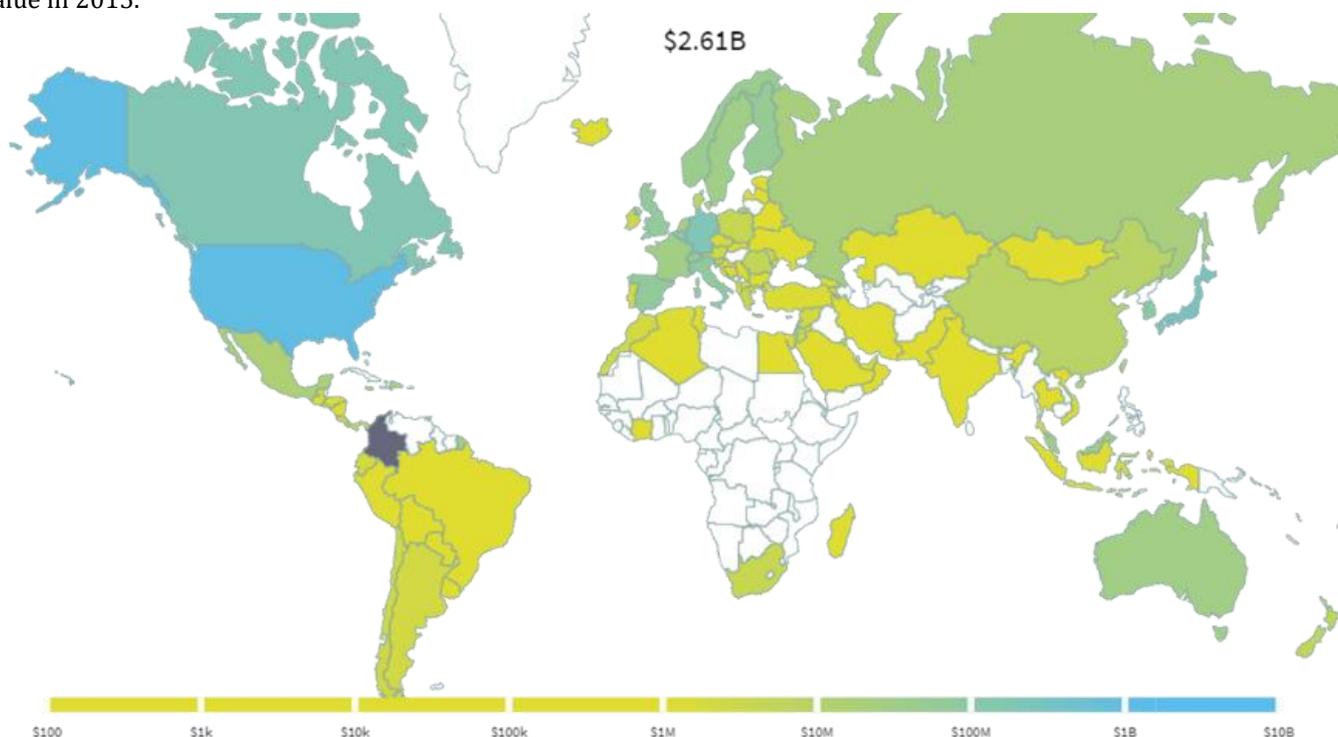
<sup>45</sup> For more information on this subject, see (Ocampo, 2015).

**Table 2.2.1 – Total Colombian Exports in 2015 (COP Billions)**

#	Commodity	Code	COP Billions	Share
1	Extracción de petróleo crudo y gas natural y actividades de apoyo para actividades de explotación	S7	\$37,598.00	32%
2	Extracción de carbón de piedra y lignito	S6	\$11,712.72	10%
3	Fabricación de sustancias químicas básicas	S24	\$ 8,678.10	7%
4	Fabricación de productos metalúrgicos básicos	S27	\$ 8,341.61	7%
<b>5</b>	<b>Elaboración de productos de café</b>	<b>S14</b>	<b>\$ 6,725.24</b>	<b>6%</b>
6	Agricultura y actividades de servicios conexas	S1	\$ 6,574.54	6%
7	Coquización, fabricación de productos de la refinación del petróleo y actividades de mezcla de combustibles	S23	\$ 5,769.66	5%
8	Alojamiento y servicios de comida	S45	\$ 4,850.11	4%
9	Transporte aéreo	S42	\$ 4,146.46	3%
10	Preparación, hilatura, tejeduría y acabado de productos textiles	S19	\$ 2,187.16	2%
11	Actividades profesionales, científicas y técnicas; Actividades de servicios administrativos y de apoyo	S49	\$ 2,172.02	2%
12	Fabricación de productos de caucho y de plástico	S25	\$ 1,778.92	1%
13	Fabricación de aparatos y equipo eléctrico; fabricación de productos informáticos, electrónicos y ópticos	S28	\$ 1,732.52	1%
14	Fabricación de vehículos automotores, remolques y semirremolques	S30	\$ 1,492.23	1%
15	Fabricación de papel, cartón y productos de papel y de cartón; actividades de impresión	S22	\$ 1,462.61	1%
16	Información y comunicaciones	S46	\$ 1,352.06	1%
17	Fabricación de otros productos minerales no metálicos	S26	\$ 1,162.33	1%
18	Fabricación de maquinaria y equipo n.c.p.	S29	\$ 1,071.57	1%
19	Elaboración de azúcar y elaboración de panela	S15	\$ 1,027.38	1%
20	Elaboración de aceites y grasas de origen vegetal y animal	S11	\$ 962.36	1%

Source: IIOS Colombia 2015.

When looking at the previous table, it is possible to note that the top five most exported commodities from Colombia in 2015 are, in order: petroleum, coal, chemical substances, basic metallurgical products and coffee. Albeit the latter is only the fifth in terms of total value, it is the first amongst agricultural products and accounts for over 700,000 tonnes of exported grains. The Atlas of Economic Complexity is a data visualization tool built at the Harvard Kennedy School of Government and powered by Harvard Growth's Lab that allows users to explore global trade flows across markets and track these dynamics over time. The next two figures were produced using this platform and will display, respectively, the destination countries of that commodity and the relative importance of Colombian coffee in terms of total exported value in 2015.



**Figure 2.2.1 – Absolute Destination of Colombian Coffee in 2015 (USD)**

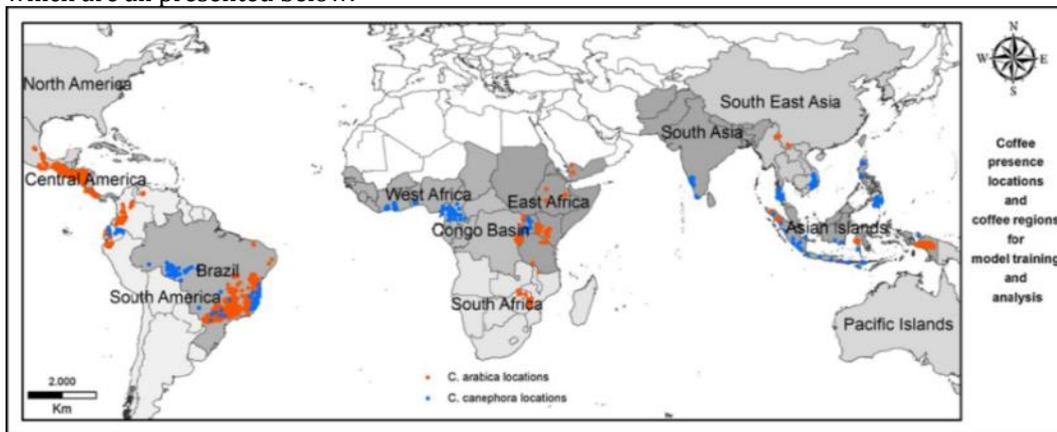
Source: The Atlas of Economic Complexity.



produced yet another report in order to disclose the findings from the authors of this paper. There, they describe in more detail the channels with which climate change affects coffee yields. First, the rising temperature damage the beans. Also, the more frequent droughts lower the crop's growth. And lastly, the advancing pests, particularly the coffee borer beetle (*Hypothenemus hampei*), stress the plant, reducing productivity.

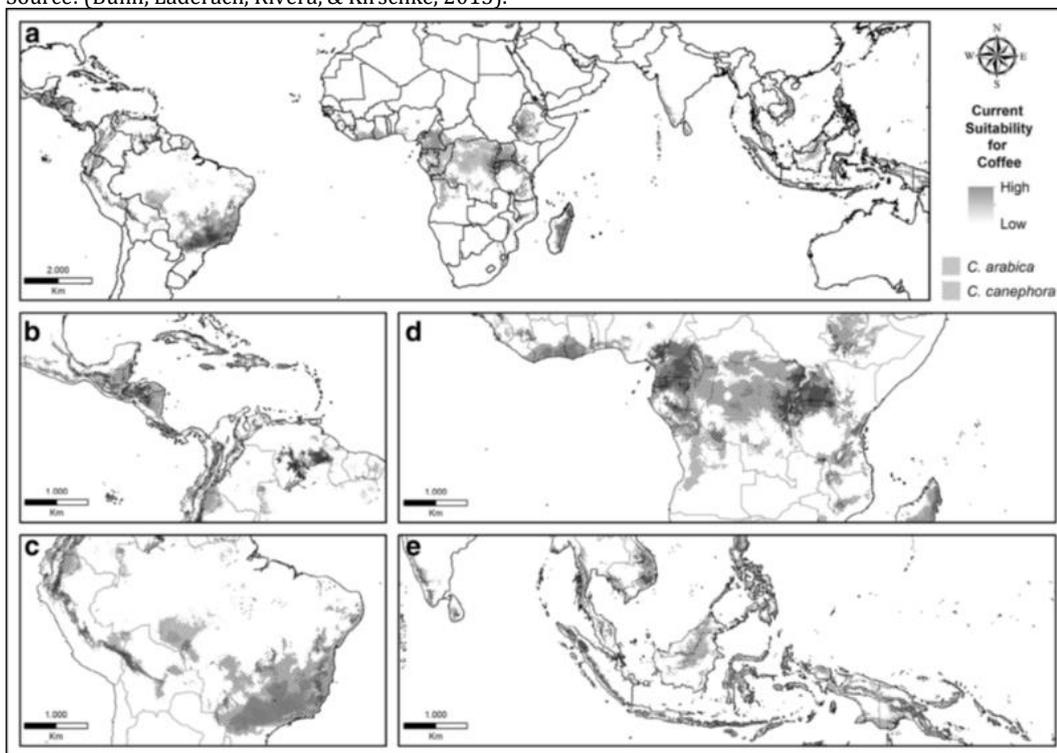
Moreover, the authors also simulate the reduction of coffee farming land for arabica beans by 2050. They create three different scenarios: one in which there are no changes to the current baseline, another in which there are gradual cuts in emissions, and yet a third one with dramatic cuts. Respectively, those scenarios yield 58%, 49% and 43% of loss each, meaning that even in such a case where emissions are diminished drastically, inertial effects of climate change will still imply in depletion of over than 40% of terrain suitable for this crop. The authors generated the future climate data by downscaling a general circulation model (GCM), which is a type of climate model that employs a mathematical algorithm of the general circulation of the planetary atmosphere or ocean.

Afterwards, they operated this model for the representative concentration pathways (RCP) 2.6, 6.0 and 8.5, which are greenhouse gas concentration (not emissions) trajectories adopted by the Intergovernmental Panel on Climate Change (IPCC), namely those three distinct scenarios described in the above paragraph. Finally, they analyzed impacts for latitude, altitude, regions and land-use classes to hypothesize future impact scenarios on global coffee production. With those results in hand, the article displays a series of maps illustrating coffee suitability and how it will change by 2050, which are all presented below.



**Figure 3.1 – Coffee Presence Locations**

Source: (Bunn, Läderach, Rivera, & Kirschke, 2015).



**Figure 3.2 – Current Coffee Suitability**

Source: (Bunn, Läderach, Rivera, & Kirschke, 2015).

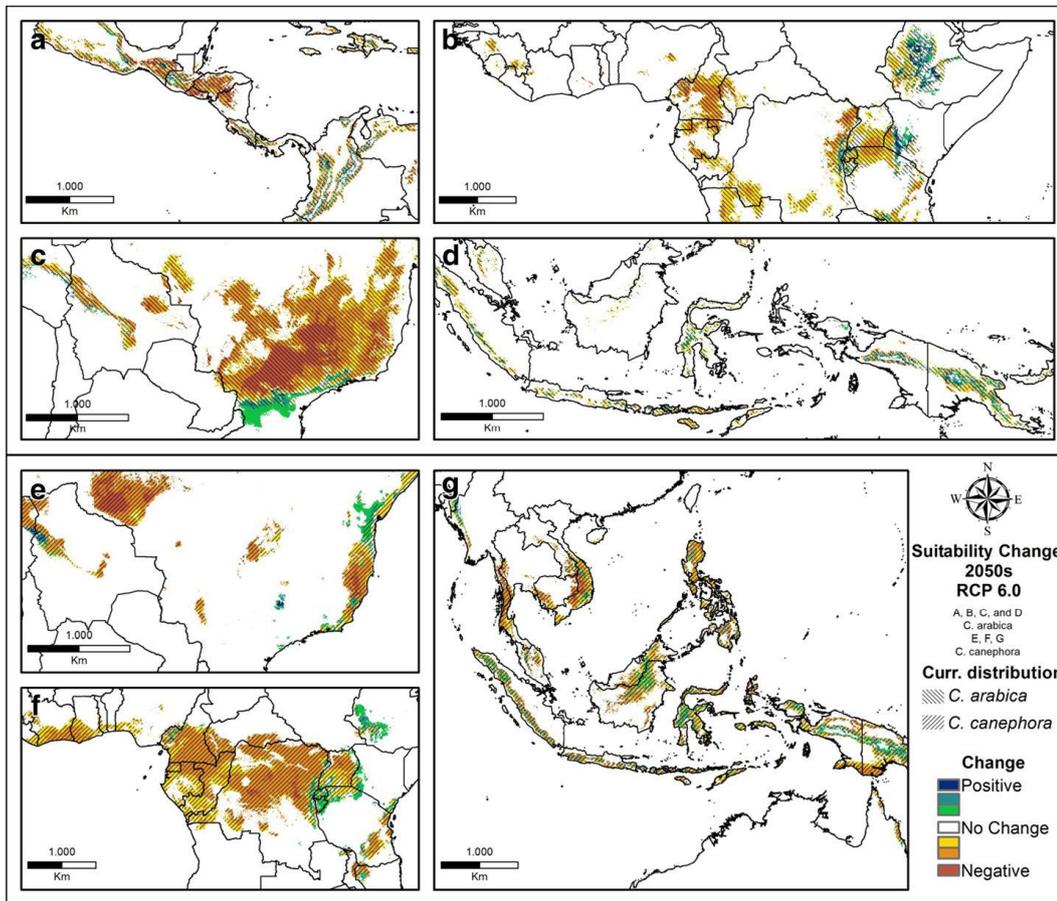


Figure 3.3 – Suitability Change by 2050 (RCP 6.0)

Source: (Bunn, Läderach, Rivera, & Kirschke, 2015).

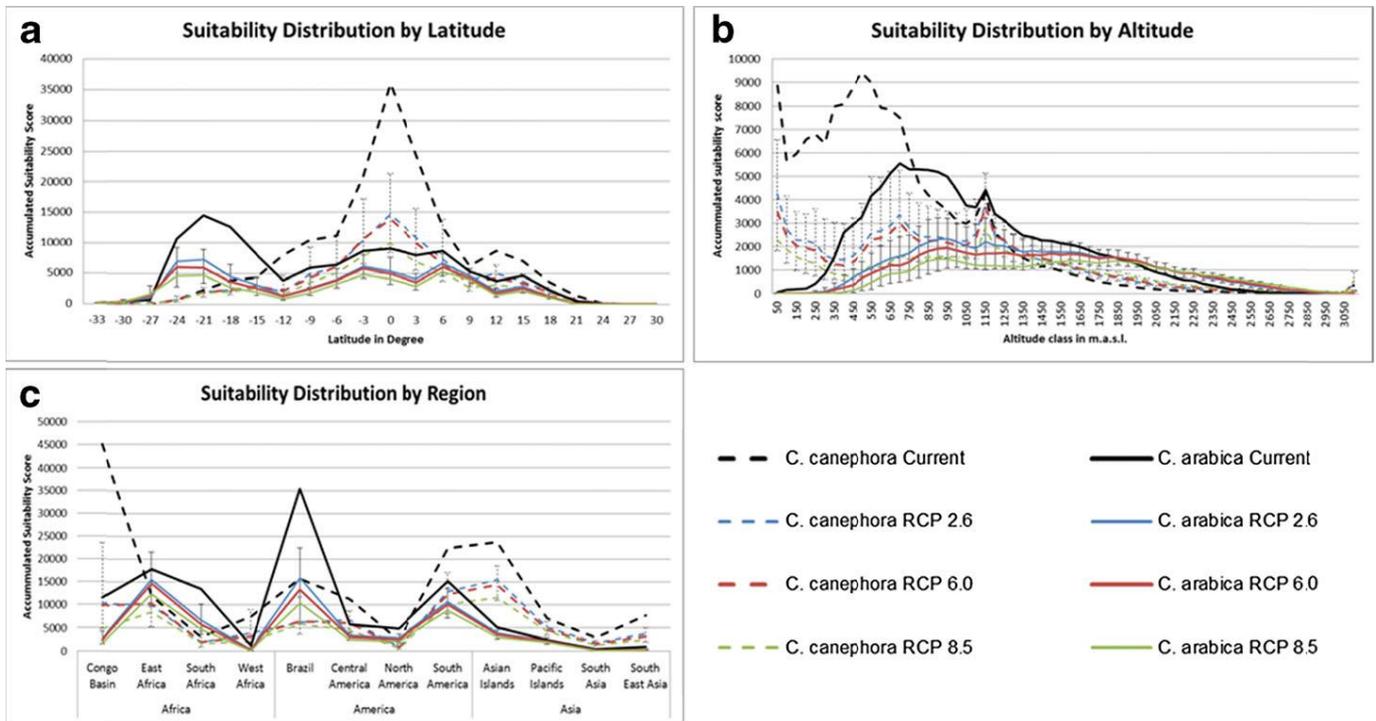


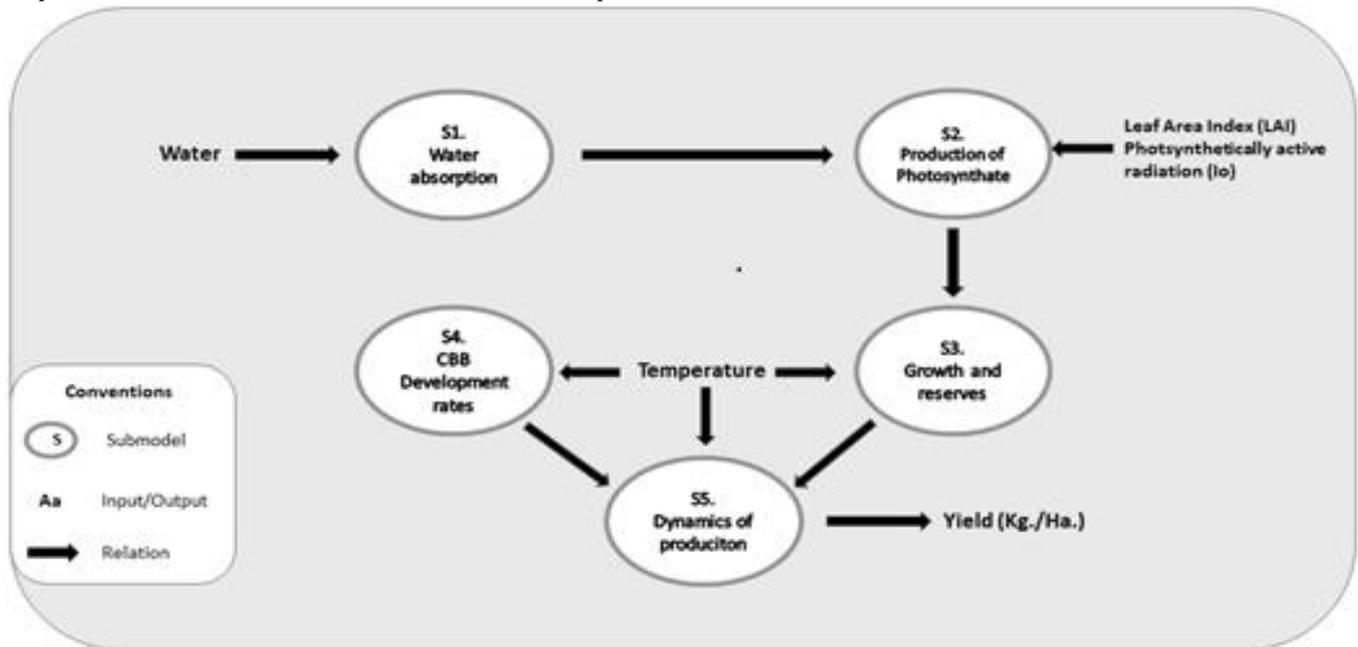
Figure 3.3 – Suitability Distribution by Latitude, Altitude and Region

Source: (Bunn, Läderach, Rivera, & Kirschke, 2015).

As can be seen in the images above, Colombian coffee is composed mainly by arabica beans. It was also previously mentioned that, regardless of scenario, this species will likely experience a great reduction of farmable area. The paper, nonetheless, does not place its focus on Colombia, whose coffee suitability is shown to undergo positive changes overall

in figure 3.2. Ergo, comes the previously posted question: what may happen to the country's popular crop in different RCP alternatives? The co-author of this book's chapter tries to answer that question in (Sierra, 2019) by providing a multi-step model to forecast total coffee yields in each of the nation's 1,123 municipalities.

The simulation uses two different inputs: precipitation and temperature. Water comes in the first step of the model, in which its absorption by the plant is calculated. After that, the output of the previous step determines the production of photosynthate using a measurement called Leaf Area Index (LAI). This, in turn, is what causes the coffee to flourish. Then, temperature comes in to influence growth, as well as the dynamics of production and the life cycle of the coffee borer beetle. When all five sub-models have been completely integrated, they yield coffee productivity, measured in kilograms by hectare. The author provides a schematic to enhance the understanding of his model, as well as how each of those steps communicate with one another and with its inputs.



**Figure 3.4 – Proposed Model for Coffee Yields**

Source: (Sierra, 2019).

Previous forecasts have estimated an increase between 4% and 24% in coffee yields on a national level. However, with over 500 municipalities producing this crop, this model predicts the expected outputs with a high degree of heterogeneity. Not only latitude plays a major role in coffee suitability, but also altitude, as was shown in the pictures of this section. Colombia is a vast country, but more so when it comes to topology, having peaks as high as the Andean mountain range and valleys as low as sea level. This only makes it all the more interesting to imagine the possible outcomes of global warming in such a diverse region. Especially when, contrary to logical expectations, a changing climate in this specific case brings benefits to a particular crop.

Lastly, it is important to note, nevertheless, that what matters for the coming simulation is not the total coffee yields as outputted by the forecasting model, but instead percentage changes. Therefore, for the exercise performed here, first there is an aggregation of the outputs provided by the co-author in order to observe them on a departmental level. After that, they are transformed into a variation of productivity relative to a baseline scenario, which is observed by the IIOS for Colombia in 2015. These are, then, inputted in an already calibrated general equilibrium model using the same database. The shock itself, as well as its results and interpretations will be further detailed in the coming section.

**4. CLIMATE SHOCK, RESULTS & ANALYSIS**

After all the previously described steps have been completed, there is now a fully implementable computable general equilibrium (CGE) productivity shock. Out of the 32 departments and the capital district in Colombia, only 18 of them are affected. It varies from a decrease of almost 23% to an increase of a little over 21%, and affects only the coffee harvesting industry (remembering, from the second section, that there are two sectors involved in coffee in Colombia – growing and processing). This happens because due to the aforementioned mechanisms through which global warming and humidity affect the crop's output, it only makes sense for a primary-based industry to be influenced. Moreover, it should be noted that the computations are all simulated with a long-term closure, given that climate change is, by itself, a perennial phenomenon. The following two figures illustrate the inputs of the model discriminated by region and the role of topology in its composition, respectively.

Table 4.1 – Productivity Shock by Department

#	Department	Shock
R1	Antioquia	-7.98
R5	Boyacá	15.28
R6	Caldas	-0.94
R7	Caquetá	-0.03
R8	Cauca	-5.70
R9	Cesar	4.36
R11	Cundinamarca	-10.37
R12	Chocó	0.29
R13	Huila	-21.38
R16	Meta	4.27
R17	Nariño	-5.92
R18	Norte de Santander	15.86
R19	Quindío	-1.91
R20	Risaralda	-0.54
R21	Santander	22.73
R23	Tolima	-16.28
R24	Valle del Cauca	6.16
R26	Casanare	0.83

Source: Own elaboration.

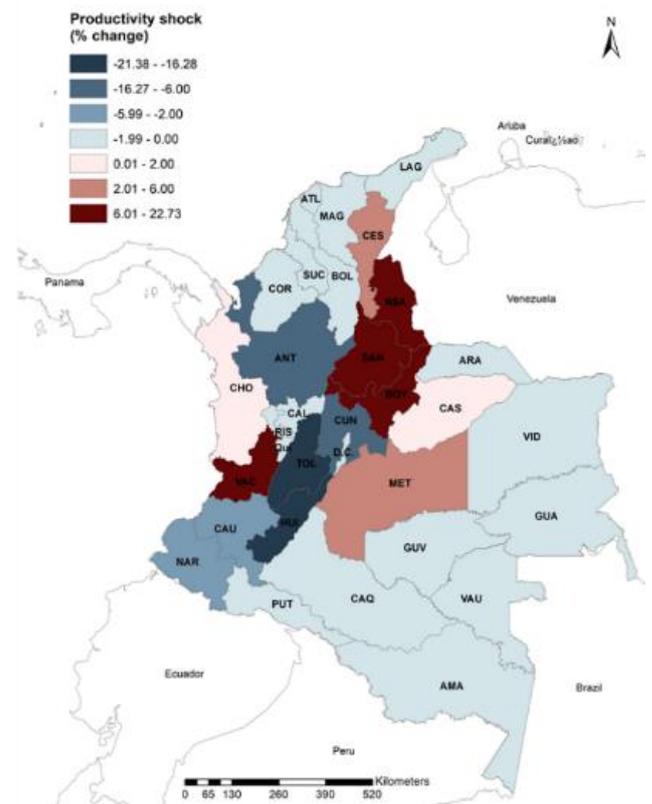


Figure 4.1 – Topology and Productivity Shock

Source: World Atlas.

As it is possible to notice in the two previous images, there is a clear overlay between the country’s altitude and the climate shock. This happens because due to Colombia’s unique topology, higher regions tend to have colder temperatures, even when close to the Equator. In other words, departments whose heights are closer to the sea level are already suitable for coffee and will experience a drop in productivity, whereas the Andean mountain range will see its lands become farmable for coffee.

Another detail that leaps into the eyes of an attentive reader is the fact that in both pictures the productivity shock is presented in shades of blue for negative values and shades of red for positive ones, which is at least strange given standard data coloring conventions. Actually, this is on purpose: due to the computable general equilibrium model's structure, negative values should be interpreted as an increase in productivity, and vice-versa. For instance, as the simulation will take place in all input augmenting technical change, a positive value observed for the shock in table 4.1 means that coffee growing will require more inputs to produce the same level of output. Again, the reverse logic applies to negative values.

Additionally, this was already mentioned, but it is essential to underline that the only industry affected by the initial productivity change is coffee growing. Hence, all other effects captured by the model are indirect or induced by the optimization of each agent's objective functions given the new set of restrictions – those equations are all specified in the methodological chapters of this book. Finally, the results of the CGE simulation will be presented in the coming paragraphs. First, there are the macroeconomic effects, more specifically in GDP and its components. After that, there is the regional distribution of this impact and how it relates to the national results. And lastly, there are the sectorial results which evaluate how each industry is affected by a change in coffee productivity.

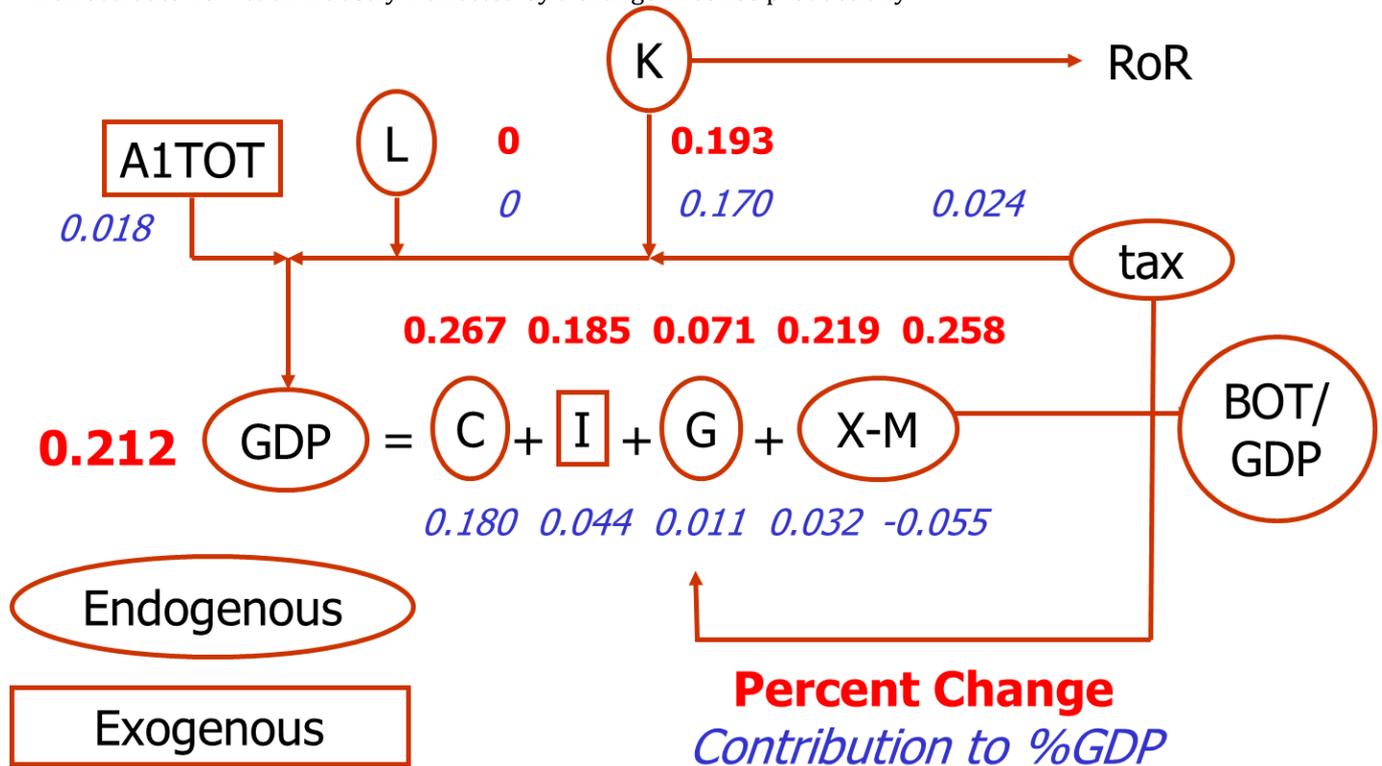
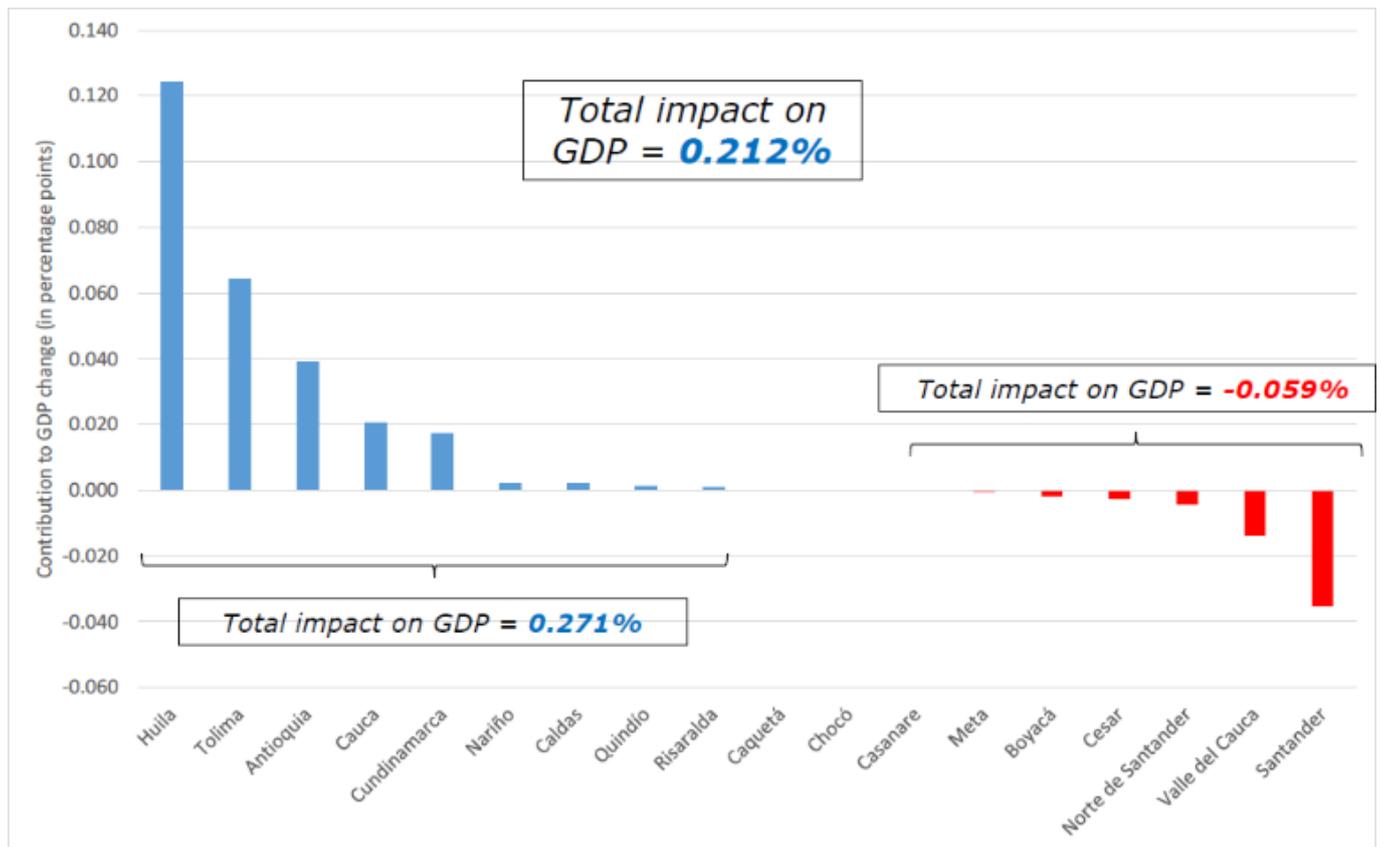


Figure 4.2 – Macroeconomic Results

Source: Own elaboration.

The schematic above provides a clear view of how each macroeconomic variable influence product in the new equilibrium. It provides both variations relative to themselves in the baseline scenario and how much they contribute, in absolute, to total percentage change in GDP. Also, the top line represents the income approach computations, whilst the bottom one covers expenditure. The first relevant information here is that this shock induces an 0.212% increase in national income. Interestingly, though, less than 10% of this variation is due to the shock in all input augmenting technical change. More than 80% comes from capital and around 11% comes from taxes on the income side. On the other hand, almost 85% of total growth in GDP is captured by an increase of 0.267% in household consumption when looking at expenditure. The rest comes from investment (21%), exports (15%), government spending (5%), and imports influence this change negatively (-26%) as it also rises in absolute terms.



**Figure 4.3 – Contribution to GDP Change by Origin of Shock**

Source: Own elaboration.

The previous graphic illustrates the decomposition of total impact on product amongst the different departments affected by the initial input of the model. It should be easy to realize that this is a very different number from that observed in the productivity shock in table 4.1. As was mentioned just previously, the latter makes up only a small portion of the GDP's change. Therefore, what is being shown above is actually the aggregate effect in each of those regions after the algorithm finishes iterating and the economy reaches convergence once again. In other words, each of those values account for not only the change in coffee growing yields in its respective department, but also the difference in labor and capital from the income side, or, alternatively, variations in household consumption, investments, government spending, exports and imports from the expenditure's approach.

The most relevant region in terms of impact is Huila, whose contribution alone accounts for almost 45% of total increase in GDP. Looking only at departments which influence the product's variation positively, it is followed by Tolima, Antioquia, Cauca, Cundinamarca, Nariño, Caldas, Quindío, and Risaralda. Together, those nine yield a change of 0.271% in national income. On the decrease side, Santander is the most significant of them all, with around two thirds of total impact on GDP. Analogously, it is followed by Valle del Cauca, Norte de Santander, Cesar, Boyacá, and Meta. These six accumulate a negative variation of 0.059%. When subtracting the latter from the former, the already mentioned total impact on product is obtained. Albeit other regions generate no relevant effect on GDP, that does not mean that they do not experience changes in the distributions of their gross regional product (GRP), but this will be demonstrated shortly.

Top 5		
#	Department	GRP ( $\Delta\%$ )
R13	Huila	3.295
R23	Tolima	1.286
R11	Cundinamarca	0.320
R33	Vichada	0.311
R22	Sucre	0.291

Bottom 5		
#	Department	GRP ( $\Delta\%$ )
R9	Cesar	-0.119
R18	Norte de Santander	-0.193
R19	Quindío	-0.232
R6	Caldas	-0.281
R21	Santander	-0.305

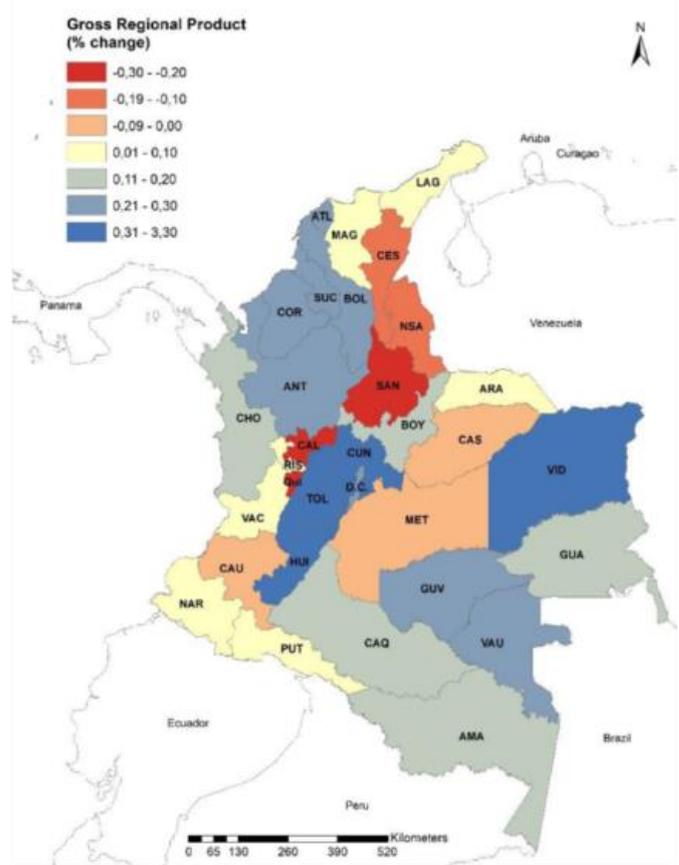
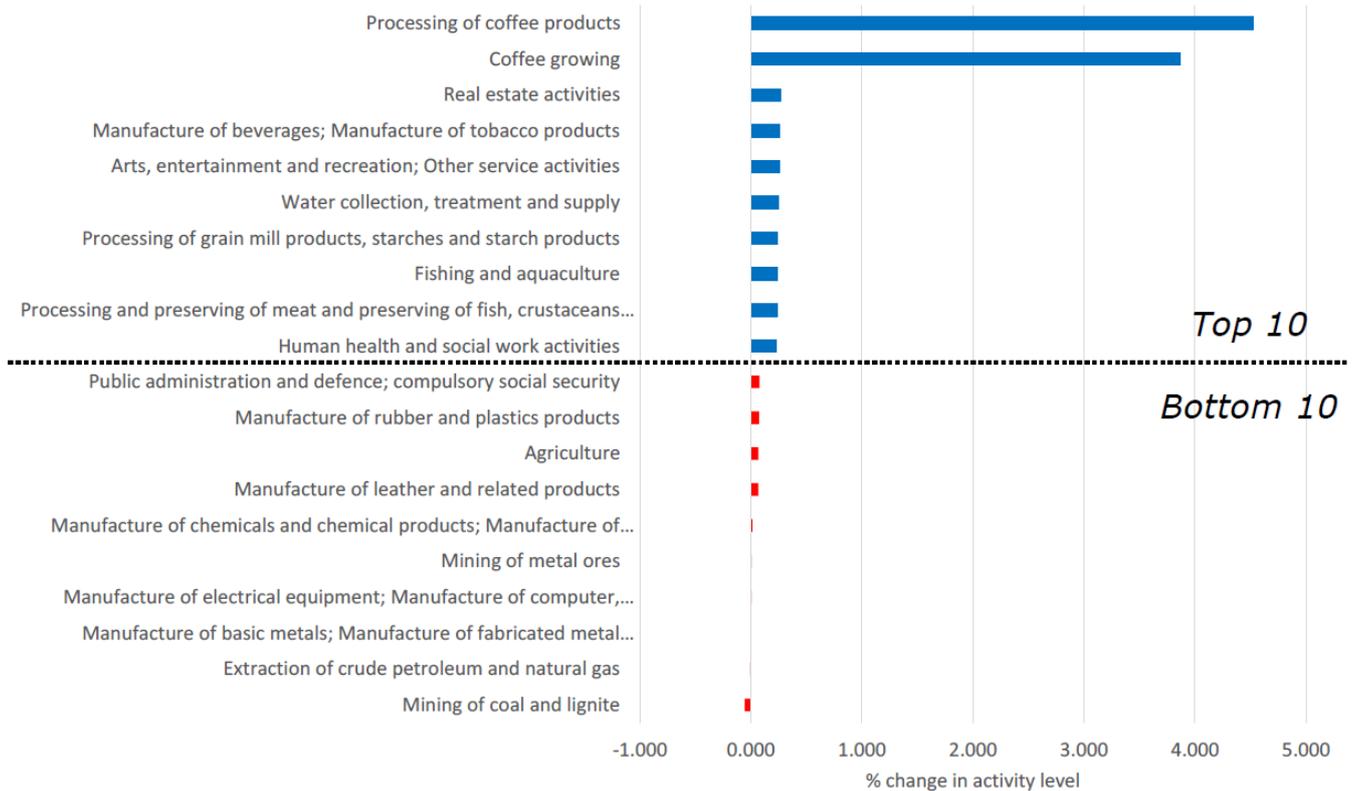


Figure 4.4 – Gross Regional Product Percentage Change

Source: Own elaboration.

Similar to the contribution to GDP, Huila and Tolima are the departments whose GRP has increased the most, which also emulates the largest productivity gains with the initial shock. They are followed by Cundinamarca, a region whose contribution to national income in the simulation, counterintuitively, is second to Antioquia and Cauca (besides the already mentioned previous two). This happens, nevertheless, due to the share of those departments' product in the economy. In other words, even though Cundinamarca's growth relative to itself was higher than Antioquia and Cauca, the latter two's share in the country's GDP is larger, which means that a smaller percentual variation still yields higher absolute effects in Colombia. To further enforce this argument, fourth and fifth biggest GRP percentage changes are Vichada and Sucre, respectively, which do not even appear in figure 4.4 given the small contribution they pose to income in this scenario.

On the reduction side, Santander occupies the bottom of the list, also replicating the pattern observed in figure 4.3 and in table 4.1. It is followed by Caldas, Quindío, Norte de Santander and Cesar, out of which only the latter two play a relevant role in reducing Colombia's GDP. The others do not amount to a significant impact in the national income for the same reason described previously: their economies are relatively small when compared to other departments. Another detail that is worth mentioning is the fact that, with the exception of the top two, no other region displayed a percentage change in GRP greater than one in module. This means that even with spatial heterogeneity amongst product growth and shrinking, overall results tend to be small, which is consistent with the CGE model's structure, as the shock takes place only in coffee farming. Finally, it should be noted that the geographical results also overlap the country's topology as shown in figure 4.1. Now, this section will place its focus on sectoral results, exploring interindustry linkages in the Colombian economy.



**Figure 4.5 – Impact on Activity Level by Sector**

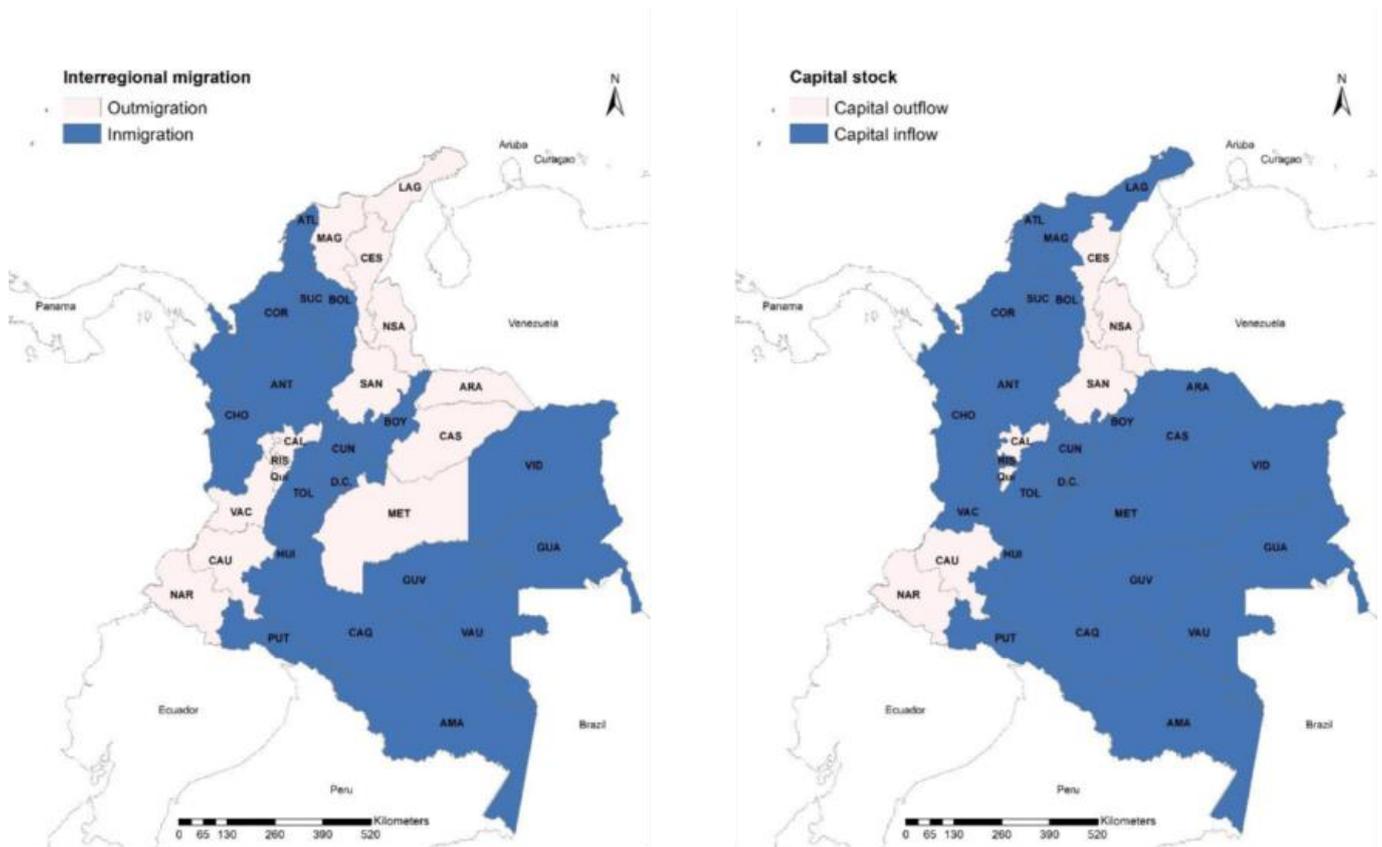
Source: Own elaboration.

Evidently, the most impacted sectors are coffee related, namely growing and processing. What comes as a surprise, though, is the fact that in spite of the initial productivity shock happening only in the first of these industries, the latter presented higher percentage change in activity level in the new equilibrium. It reached around 4.5% growth rate, whereas the farming branch stayed a little below 4%. This happens because of the crop’s supply chain in Colombia and the strong connection between those activities.

As was stated by the end of the second section of this book’s chapter, most of all output from coffee growing goes to processing, meaning that it does not benefit from increased productivity in other sectors and hence from increased demands for unripe beans. Whilst the other industry provides its products to different consumers and is more integrated in the national economy. Furthermore, about one third of total harvesting expenses are destined to labor, which means that a smaller necessity of inputs in this particular activity induces income effects in the form of salaries to the families. Ironically, this result does not affect the sector that originated it in the first place as only a minority share of its sales comes from final demand, which is not true for coffee processing.

After the top two, the most affected industries are: real estate, beverages and tobacco, entertainment, water supply, mill products, fishing, processing and preserving of meat, and human health and social work activities. Interestingly, all those eight displayed an increased activity level no higher than 0.5% each. In other words, after coffee related sectors benefit from the shock, the impact is relatively homogenous amongst many other activities, and it is likely explained by the same mechanisms responsible for growth in the previous two: increased demands for their products and cheaper inputs now available.

Another curious observation here is that even in the ten least affected industries, five of them still yielded positive results, with only four showing no relevant signs of increased or decreased activity level and one lone sector presenting itself in a shrunk state relative to the initial equilibrium – mining of coal and lignite. Ergo, when comparing sectoral and regional results, there is a clear difference: the former is much more heterogenous, not only in magnitude, but also in direction as many departments showed a decrease in GRP.



**Figure 4.6 – Impacts of Primary Factor Mobility**

Source: Own elaboration.

Finally, the last analysis presented in this section regards primary factors mobility, as can be seen above. Labor's behavior, portrayed on the figure's left side, also reflects Colombian topology, as if workers are migrating from lower departments to mountainous regions in search of new jobs now provided by a physically rising coffee growing industry. Capital stock, as shown in the image's right side, also contemplates this phenomenon, but more departments are receiving investment, particularly those in the Amazonian Colombia.

## 5. CONCLUSIONS & POSSIBLE NEXT STEPS

Colombian coffee has an interesting history, as it was brought to America by the French, but its first commercial experience in the country came out half a century later almost accidentally as a result from one neighbor's successful enterprise. From then, the industry experienced a series of transformations in the coming couple of centuries as the nation was molding itself politically and economically into what it is known today as contemporary Colombia. At the same time, the second half of the 20<sup>th</sup> century along with the last couple of decades have seen the emergence of a worldwide debate regarding the contribution of human activity to a natural phenomenon called climate change. Throughout these years, the scientific community has established a clear causation relationship between those two and started posing incommodious questions to leaders and policy-makers around the world, whose answers would define actions that could prevent some of the coming hindrances imposed by such new weather conditions, thus diminishing the loss of mankind's life quality on Earth. This chapter tried to answer a few of those inquiries, in particular those regarding the prospects of the crop responsible for one of the world's most popular drinks: Colombian coffee.

As expected from a chapter in this book, the chosen methodology is a CGE model whose parameters were calibrated using the national IIOS from 2015. The inputs for the climate shock were provided by (Sierra, 2019), in which the long run scenario was simulated using a multi-step model encompassing the many stages of development from the plant. Intriguingly, even with heterogeneity amongst different regions, the productivity variation in coffee growing is overall positive in Colombian territory, which is due to the country's particular topology. The results from this exercise were presented in the previous section, though it is safe to express that this last characteristic, height, played a major role: as the temperatures become warmer, lower regions will become unsuitable for harvesting, whereas the Andean mountain range will potentially experience a sharp increase in yields. It is also important to note that despite macroeconomic results being relatively small – which is consistent with the given inputs – they are heterogenous amongst different departments, replicating the pattern from the previous statement. The sectoral results were more homogenous and coffee related industries (growing and processing) were most positively affected by the shock, which is expected given the production structure of this commodity.

Finally, this work is not free of limitations. While reading this chapter, it may be reasonable to assume that climate change portrays, contrary to popular belief, a positive scenario for Colombia. Nevertheless, this is not the scope of the analysis.

Even if working in a general equilibrium framework, i.e., accounting all markets' equilibria simultaneously and not only the coffee industry, the inputs of the model reflect a situation in which the latter is the only effectively affected by future climate characteristics, whilst everything else will remain unaltered, which is a very strong assumption. While this does not necessarily invalidate the results encountered, it certainly raises questions in a sense of what would happen to other sectors in this setting, not only as an indirect result through coffee productivity increase, but also as a direct consequence of those new weather patterns, thus rendering this exercise as a milestone for future analysis of the same nature.

As for next steps *per se*, this work could also be subject to development itself through the accomplishment of a few additional exercises. Amongst such cases, the first example that comes to mind is the introduction of a more detailed analysis regarding the difference between production quantity and quality. In the entirety of this research as well as in the simulation that powers the climate shock, various scenarios are only comparing difference in total crop yields, but they do not take into account that these outputs are not automatically the same. For instance, even if coffee farming moves up the hill towards the Andean mountain range, those newly planted beans do not necessarily reflect the same quality as those harvested closer to the sea level, which may result in a very strong difference in the drink's flavor. This effect will reflect on the commodity's price, which is also a measurement for productivity that could be used in the CGE's structure. Moreover, the model does not take into account any uncertainty, ergo rendering the shock a deterministic exercise. By integrating a stochastic module into the simulation, given by the standard deviations of the multi-step prediction process, results come out not as one single outcome anymore, but as a wide set of different possible scenarios, with various probabilities of occurrence for each of them, which makes them all the more credible as, in reality, randomness occupies an important place. Lastly, this CGE framework also makes room for inputting land as primary factor, enriching the already carried out analysis, although this last suggestion strongly relies on data availability for calibration.

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**REGIONAL ECONOMIC DISPARITIES IN COLOMBIA**

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**ABSTRACT**

This paper studies changes in income inequality in Colombia over the 2010-2019 period from a regional perspective. It focuses on how labor and non-labor (pensions, transfers, among others) income contributed to the reduction of income inequality, measured through the Gini coefficient, within most of the main cities of the country. Although, the current Covid health and economic crisis are acting as a severe negative shock, significantly affecting economic performance and social indicators, this paper highlights what worked in the previous decade in the path to achieve social cohesion and regional development, that can be replicated after the current events.

We follow Bourguignon and Ferreira (2004) to model the main decisions of the household that determine their income in a system of equations that we estimate sequentially for each of the cities of interest. Our results show that inequality was reduced within all the largest 13 cities of Colombia except one, in which non-labor income played a significant role in increasing inequality. The determinants of this reduction vary by cities, given that in some cities the main driving force were changes in non-labor income, while in others it was due to changes in the factors that determine labor income.

## URBAN TRAVELERS GO TO THE BEACH: REGIONAL EFFECTS OF DOMESTIC TOURISM IN COLOMBIA

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### ABSTRACT

The aim of this document is to address the role played by domestic tourism as a mechanism of interregional transfers of income. In Colombia, domestic tourism flows follow a pattern of origin in the central regions to destinations in the periphery. One of the main tourist destinations is the Caribbean Coast, which exhibits the worst socioeconomic indicators in the country. It is expected that the injection of resources, through tourists' expenditures, will contribute to systemic effects in the destination regions. There is little empirical evidence of such regional impacts of tourism in Colombia, with most of the existing studies adopting qualitative methods. Those that use quantitative techniques do not consider a systemic approach to calculate regional impacts. In this sense, the aim of this paper is to analyze the regional impacts of the consumption patterns of expenditures by Colombian tourists, focusing on the Caribbean region, using an interregional input-output model, together with data from the Encuesta de Gasto en Turismo Interno (EGIT) 2014-2015. The empirical evidence found in this work contributes towards the study of the domestic tourism to inclusive economic growth in terms of socioeconomic characteristics of jobs and income generation, both direct and indirectly. This is important to provide insights for the formulation of tourism-related regional policies. The results suggest that domestic tourism can be considered as an important channel to produce a more efficient allocation of resources to improve income distribution in Colombia. We conclude that regional policy strategies aimed at the tourism sector may be relevant to the local development of the Colombian Caribbean.

## National Session: SS45 - Selected regional science topics in Mexico



17:30 - 18:45 Tuesday, 25th May, 2021

Room NEREUS

<https://us02web.zoom.us/j/84686769452>

Chair Serena Serrano Oswald

## THE REGIONAL SOCIO-ECONOMIC OUTLOOK OF MEXICO: INEQUALITIES DURING THE PANDEMIC LOCKDOWN, 2020

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### ABSTRACT

This work intended to provide, particularly to scholars from abroad, a general outlook of Mexico's economy and regional socio-economic inequalities throughout this country. Once being understood these, it is expected to understand why is it that the high numbers of contagious cases cannot still be lowered, and Mexico is today one of the nations among the worst numbers of Covid-19 contagious and deaths in the world.

The COVID-19 Pandemic has hit social life and economic activities worldwide. However, the impacts caused in the LDCs have probably been harder than in the more developed nations. This paper proposes that backward states' institutions like Mexico, governing a territory and people with many shortages in infrastructure of several types and with enormous gaps between rich and poor people, then, have faced the Pandemic and measures adopted with many problems in their implementation to combat and control it.

In this paper, we propose that Covid-19 has hit harder in those agglomeration urban centres and mostly within the peripheral urban settlements in them due to problems such as poverty overcrowding housing, scarce basic infrastructure, and services there, and their need to commuting every day. The delays in trying to lower the contagious tendency became even harder due to people's ignorance and discredit for their governments and politicians, and negative reactions upon the State's measures to avoid further contagious.

Once all this outlook has been understood, this paper will look at the South-Eastern part of Mexico as one focus to alleviate inequalities and purposes for better integration of backward regions to the whole country's recovery.

## ECONOMIC CRISIS AND RESPONSES OF THE MEXICAN STATES UNDER THE COVID-19 PANDEMIC

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### ABSTRACT

Due to the extraordinary measures that the Federal Government undertook in Mexico to mitigate the spread of infections caused by the COVID-19 pandemic, productive and social activities considered non-essential were suspended, which had an impact on the contraction of economic activity. Although estimates have been prepared that offer an idea of the decline of the economy at the national level, based on aggregate indicators, there is no perspective that accounts for the magnitude of the impact in the different regions of the country. In this work, a methodological proposal is applied to understand the economic performance of the gross domestic product (GDP) of the states of Mexico and their productive sectors during the period of greatest restrictions imposed by the health emergency COVID-19 during 2020.

The main purpose of this paper is to estimate the degrees of impact on the economic activities of the states of Mexico during the stage of greater social confinement and productive inactivity in 2020. It is not a projection, but an exercise of ex ante measurement that allows explaining the levels reached by the regional economic contraction. Although some of the sectors and businesses have been able to reactivate one year after the pandemic began, a period of greater inactivity was recorded during the second quarter of 2020, a period in which the government's confinement provisions were accentuated, social distancing and regulation of non-essential activities. Likewise, the measures implemented by the state governments in order to cushion the adverse effects caused by this situation are analyzed.

The results show heterogeneous impacts on the performance of the economic activity of the Mexican states level associated with their productive structure and the proportion of their branches subject to greater government regulations. For their part, the actions of the state governments were mainly oriented towards temporary and reactive measures to favor affected social and economic sectors, but also those that present conditions of high vulnerability. Public policies in subnational government scale show that were mainly aimed at poor population, the unemployed, as well as small businesses.

## REGIONAL ECONOMIC IMPACTS IN MEXICO CAUSED BY FLOODS ON AGRICULTURE: AN INTEGRATED APPROACH VIA SPATIAL AND CGE MODELING

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### ABSTRACT

The economic impacts of natural disasters are broader than direct physical destruction. Disregarding the indirect and macroeconomic effects can seriously underestimate the total consequence over the society. This paper aims to address global and regional economic impacts in Mexico caused by productivity reductions on agricultural sector as consequence of floods occurred in 2020 in the Mexican States of Chiapas and Tabasco. Instead focused on direct economic losses, our study tackles the assessment of indirect and economic repercussions by productivity reduction on agriculture. We present a methodology in two integrated steps. In the first part, we developed a spatial analysis to measure the direct impacts of floods on the cropland areas based on open and freely available datasets provided by GADAS-USDA, LandScan and Copernicus. In the second stage, we access the indirect effects by translating the cropland losses in falling productivity of the primary factors used in the agricultural sector, through a Mexican interregional Computable General Equilibrium (CGE) model – BMMX. Our results show, between others, a contraction of 0.002044% in the national GDP, equivalent to 26 million dollars (USD, 2013) and -190 employed people. As expected, the greater losses in terms of production, employment, income and consumption were concentrated in Chiapas and Tabasco but they also propagated to other southern States of Mexico. In addition, positive economic effects were observed in the States of northern Mexican showing economic gains from substitution. Our results show in detail the spillover effects that agriculture losses, caused by natural disasters, a flood event in our case, can have into both the regional economies and the national economy of Mexico. A quantification of these impacts can contribute to design holistic strategies for risk management and the adoption of better public policies at both regional and national level. Finally our works expose the utility that nowadays have the spatial CGE modelling, which working together with engineering and GIS models, are being positioned as a key tool to measure the indirect impacts of disasters.

### KEYWORDS

Mexican agriculture, CGE modelling, economic losses, floods, spatial analysis.

### 1. INTRODUCTION

Intense hydrometeorological phenomena represent an important threat regarding to social and economic losses worldwide, having caused most of the climate-related disasters in recent decades, especially floods, hurricanes and storms events (Aguilar and López, 2020; CRED, 2015, CEPAL, 2014). In addition, climatic change, caused by human activity, can increase the vulnerability of the population of several countries to those phenomena (Bresch, 2009). In Mexico, hydrometeorological disasters have been recurrent and are the biggest cause of economic losses. Estimates suggest that 31 million of people and over 41% of its territory are exposed to hydro meteorological phenomena, which includes not only the main urban centers but also rural areas, especially in the winter, when hurricanes and convective storms or cold fronts bring intense rainfalls to these regions (Bonasia, 2019). Considering the period between 2000 and 2015, according to data from Mexican government, 93% of economic losses were associated with hydrometeorological phenomena, including chemical, geological and other phenomena.

In the last twenty years, the Mexican states of Veracruz, Tabasco and Chiapas has presented the greatest economic losses due to hydrometeorological disasters as tropical cyclones and intense rains and floods. In addition, those states present remarkable socioeconomic vulnerabilities, such as low income and lack of community mitigation actions. (Novelo-Casanova and Rodríguez-Vangort 2016; Aparicio et al, 2009). In 2020, Tabasco and Chiapas suffered from the floods after heavy rains caused by the hurricane Eta, which was estimated to be the one of the worst in the last fifty years<sup>46</sup>.

<sup>46</sup> To more information, see: <https://mexiconewsdaily.com/news/overflowing-rivers-create-worst-flooding-in-50-years/>; <https://atalayar.com/en/content/floods-and-landslides-affect-mexican-states-tabasco-and-chiapas>, and

Agricultural sector of Mexico is exposed to various hydrometeorological perils, which can cause considerable economic impacts both at regional and national level, in the producers and in the family economy. Damages in agricultural sector can interrupt the production cycle in other industries as food, services and livestock products, reducing production, profits and generating unemployment, among other effects. The occurrence of floods, especially in rural regions tends to cause a slowdown or paralysis of agricultural activity by damaging crops, cattle and other animal's meat production, destruction of machinery and land, and not allowing workers to carry out their activities. In particular, floods have been the cause of significant losses of agricultural land and pasture in recent years in the states of Tabasco and Chiapas, according to data from the General Directorate of Risk Analysis of Mexico.

Thus, we paid special attention on the damage that floods can cause in the agricultural sector and in the economic repercussions of this damage. The economic impacts of natural disasters are broader than direct physical destruction and, disregarding the indirect and macroeconomic effects, can underestimate the total impact of disasters to society. Our paper proposes a methodology to estimate the high-order economic effects that productivity reduction on agricultural sector, caused by a flood event, can have over the whole economy and how this shock can propagate to other industries, sectors and geographic regions. We particularly applied our methodology to the case of 2020 floods occurred in Chiapas and Tabasco, in Mexico.

Our methodological approach consists of two stages. In the first stage, we use a spatial analysis to measure the direct impacts of floods on the cropland areas (the percentage of cropland areas lost by floods) by using geo-located datasets provided by GADAS-USDA, LandScan and Copernicus. In the second stage, we access the indirect effects of this occurrence by using the BMMX model, a full interregional general equilibrium model developed for Mexico (Haddad et al., 2019). We couple the spatial analysis with the BMMX model by translating the percentage of losses in agricultural areas into technological shocks on productivity of primary factors (capital and labor) of the regions affected by the flood event, in our hand-on case, Chiapas and Tabasco. Finally, BMMX model allows us to see the economic channels through which shocks propagate within Mexican economy and quantify the size of the indirect consequences. Now a day, CGE modeling is settle as one of the best frameworks to estimate indirect impacts of natural disasters (Jonkman et al., 2008; Haddad and Teixeira, 2013; Jonkhoff, 2009; Pauw, K. et al., 2011; Carrera et al, 2015; Leon et al., 2021) and we believe their use are becoming a standard for indirect impacts modeling.

We have found a contraction of 0.002044% in the Mexican GDP, equivalent to 26 million dollars (USD, 2013) as consequence of productivity reduction on agricultural sector caused by 2020 Floods in Tabasco and Chiapas. The greater losses in terms of production, employment, income and consumption were concentrated in Chiapas and Tabasco but they also propagated to. Positive economic effects were also observed specially in the States of northern Mexican.

The paper unfolds as follows. Section 2 reviews Mexican flood background focused on the State of Tabasco and Chiapas; Section 3 presents the in detail the methodology to integrated spatial analysis with CGE modeling to estimate indirect impact of productivity reduction in agricultural caused by a flood event ; Section 4 presents and discusses the results and finally Section 5 exposes the conclusions of the paper.

## 2. FLOODS IN TABASCO AND CHIAPAS

Mexico is a country greatly affected by natural disaster, especially earthquakes and floods which cause, according to the UNDRR (2015) – United Nations Office for Disaster Risk Reduction, an annual average loss of 1,350 and 870 million dollars respectively. From 2000 to 2021, the Mexican government issued 2,350 emergency declarations, 92% related to hydrometeorological disasters. In the case of the Mexican States of Tabasco and Chiapas, 90% and 65% of those declarations correspond to flood and rain events. As seen in Figure 1, Chiapas and Tabasco are located in the southern part of Mexico, being overall characterized by a humid tropical climate, with rainfall that can average more than 3,000 mm per year.

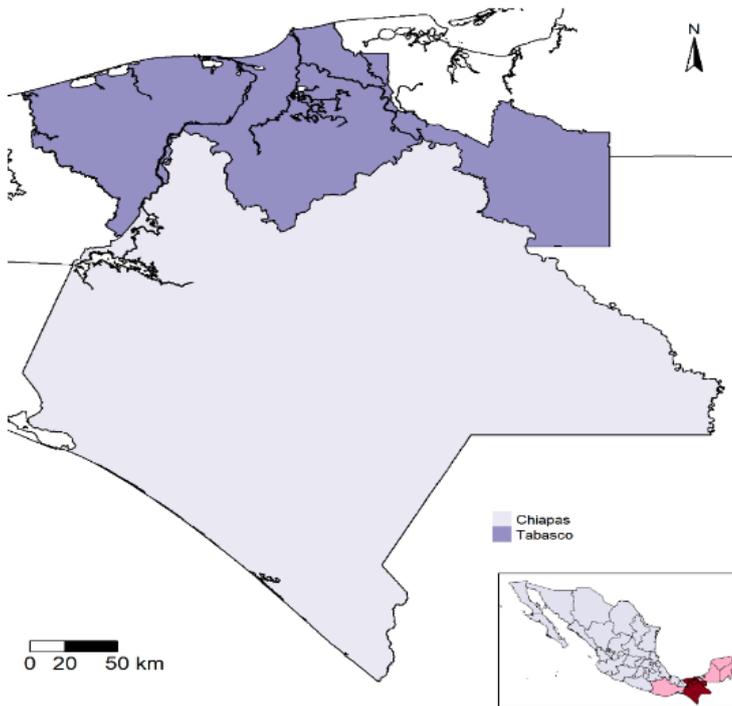
According to data from the Direction of Analysis and Risk Assessment of Mexico in the period 2000 to 2015, the greatest economic damage in the states of Chiapas and Tabasco was due to hydrometeorological phenomena, mainly due to tropical cyclones, extreme rains and floods. Figure 2 shows the flood hazard index for Mexico provided by CENAPRED, which exposes to Tabasco and the northeast of Chiapas with a very high flood index.

In 2007, a major flood event hit Tabasco and Chiapas States causing economic losses estimated on 2,918 million dollars according to CENAPRED (2018), being one the most expensive disaster in the last 40 year in Mexico. Furthermore, in 2011 and 2013, floods events caused in Tabasco losses estimated on 740 and 31 million dollars respectively.

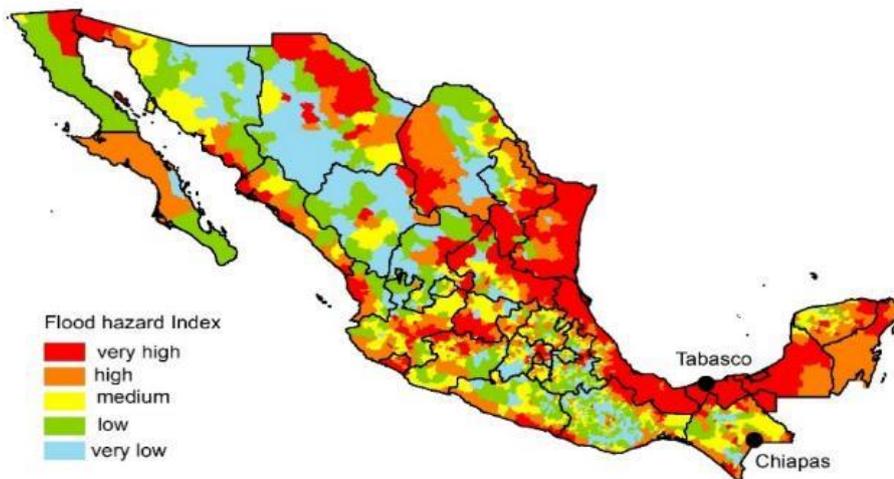
In 2020 took place the most recent flood event that has hit Tabasco and Chiapas regions, causing very important losses which has not still been well defined and studied in the literature. Part of those losses are addressed in this paper, specifically those regarding to indirect losses caused by productivity reduction in agriculture of the region affected.

Tabasco has an average annual rainfall that range from 2,000 to 4,500 mm, being the Mexican State with the highest level of precipitation. In addition, its topographic and hydrographic characteristic contribute to floods since the Tabasco plain presents scarce slopes and is located in the confluence and deltas of several rivers like Grijalva, Mezcalapa, Carrizal, Samaria among other. On the other hand, the destruction of the ecosystem is another cause of floods in Tabasco given that deforestation, caused by livestock and crop activities, affects water runoff in the basins, vegetation does not consume water, it goes down the river and quickly increase the flows. In the case of Chiapas, the northeast region of the state

presents rains throughout the year and in the remaining state, abundant rains in the summer season. Depending on the state's region, the average annual rainfall ranges from 1,200 mm to 4,000 mm (INEGI, 2021).



**Figure 1 – Selected States – Chiapas and Tabasco, Mexican Southeast Region.**



**Figure 2 – Flood hazard index for Mexico.**

Source: CENAPRED 2016

Other natural factors that aggravate floods consequences are the evolution of river beds, as they become sedimented, the elevation of sea level, the untreated effluent flows from metropolitan areas, etc. Cumulative effects are also possible due to total non-recovery from previous floods. This effects had a clear example on the 2007 and 2008 floods in Mexico, particularly affecting road structures, cropland, pasture areas and agricultural production (Zapata et al., 2011).

### 3. METHODOLOGY

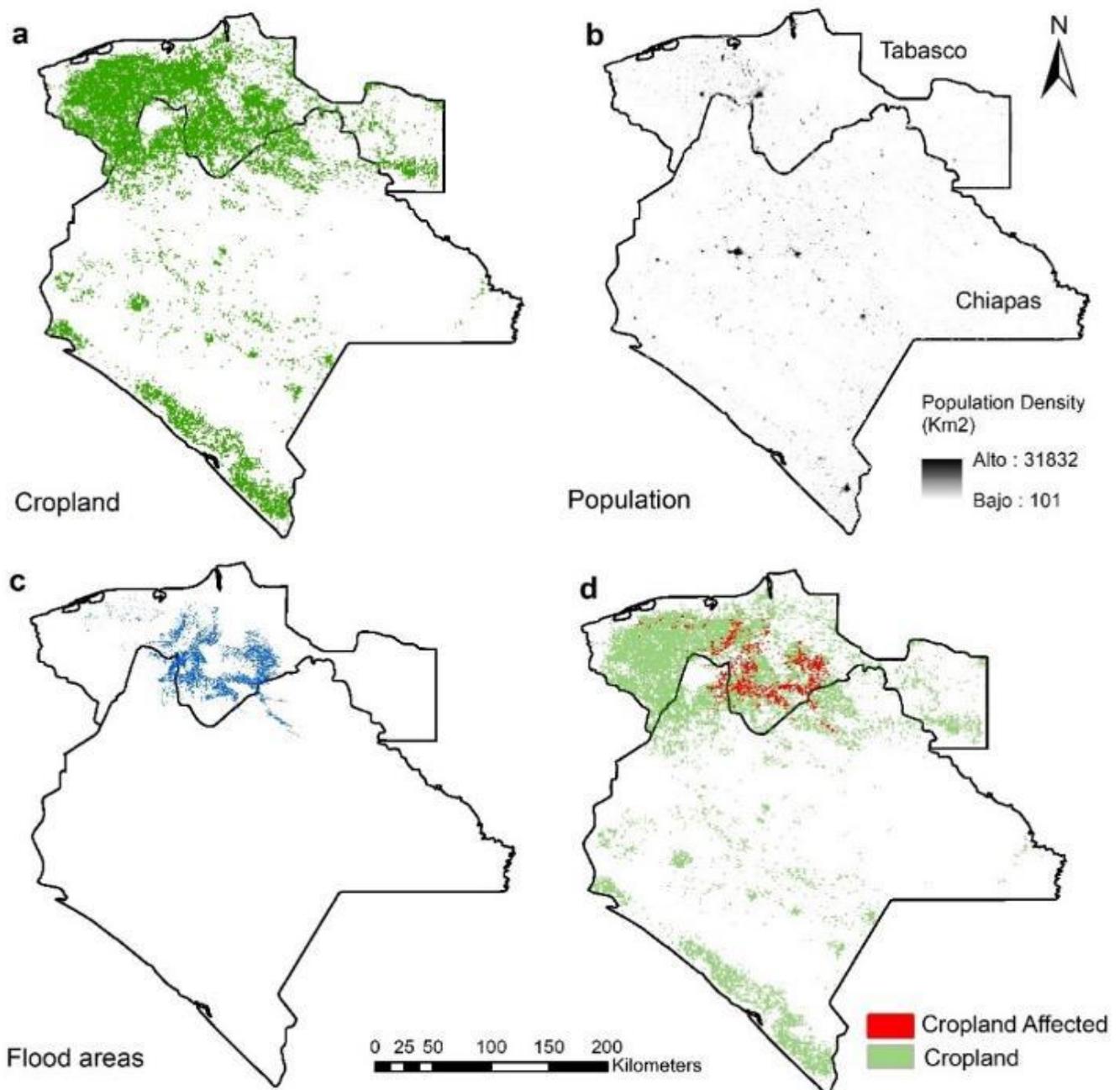
This section is divided into three parts. The first part presents the spatial analysis and the database used to measure the direct impact of the 2020 floods in Chiapas and Tabasco, Mexico, on the agricultural production of these States. The second part presents and discusses the BMMX model, which is used to assess the indirect impacts of this disaster. Finally, the third part shows the integration procedure between the spatial analysis and the BMMX model, in order to estimate the indirect economic consequences a flood event.

#### 3.1 Direct impacts of floods – a spatial analysis

To estimate the direct impacts on the agricultural sector of an economy caused by a major flood event, we propose a spatial analysis that harnesses free spatial datasets available worldwide, in order to estimate the cropland areas affected

by the event. In addition, although a flood event can damage several assets as buildings, machinery. etc., of the agricultural sector, impacts on the land component can lead a large productivity reduction given its majority importance in this sector. Therefore, our assumption at this point is that the reduction of the croplands extension will be directly proportional to the decrease in the productivity of primary factors within the agricultural sector, as shown in equation 1 (section 3.3). Bellow, we describe the spatial analysis carried out over the Mexican regions of Tabasco and Chiapas affected by a major event occurred in 2020 around the months of October and November.

The spatial analysis begins by estimating a croplands grid of the area under study using the data provided by the Global Agricultural and Disaster Assessment System – United States Department of Agriculture (GADAS/USDA). The panel **a** of Figure 3 shows the croplands extension estimated for Tabasco and Chiapas with a resolution of 500 meters. Once extracted croplands, we use LandScan data to apply a population density filter that removes the cropland cells that intersect with population densities higher than 100 inhabitants per square kilometer. Landscan (Panel **b**) provide a geo-located population density dataset with a 30 arc second resolution ( $\approx 1 \text{ Km}^2$ ). Our assumption is that cells with a population density higher than 100 have a low probability to be a cropland. The next step is to intersect the cropland grid previously filtered by LandScan with the flood extension map provided by Copernicus (Panel **c**) to obtain the cropland cells affected by the flood event (Panel **d**).



**Figure 3 – Spatial analysis of croplands affected in Tabasco and Chiapas by a major flood in 2020**

Panel **a** shows the estimated croplands based on data obtained from GADAS – USDA with a resolution of 500m. Panel **b** shows a 30 arc second grid ( $\approx 1 \text{ Km}^2$ ) with the population density provided by LandScan. Panel **c** shows the mapping of the flooded areas carried out by Copernicus through its Emergency Management Service (EMS). Panel **d** shows the estimation of croplands affected by the major flood event of 2020 that hits Tabasco and Chiapas.

In our analysis, we are interested in estimating the percentage of the total croplands affected by the flood event so that we compute this value as the ratio between the number of cropland cells affected and the total number of cropland cells (after being filtered by LandScan). We found an allocation of 13% and 3% of croplands affectation respectively for Tabasco and Chiapas.

## 3.2 Data sources of spatial analysis

The GADAS is a web-based Geographic Information System (GIS) which integrates a vast collection of data, including precipitation data, vegetation index, crop masks, land cover data, irrigation and water, elevation and infrastructure, political data, and others. The USDA, through its Foreign Agricultural Service (FAS), provide the information available on GADAS based on the use of satellite imagery and remote sensing data. FAS, through GADAS, delivers monthly estimates of area, yield and production for 17 distinct commodities in over 160 countries around the world. In our case, we used the cropland 500m mask.

LandScan is a dataset that provides the global population distribution with a resolution of approximately 1 km (30" X 30"). Using updated demographic and geographic data together with remote sensing imageries, LandScan uses multivariate dasymetric modeling techniques to disaggregate census counts within different levels of administrative boundaries.

Copernicus is a European Union initiative with the support of the European Space Agency (ESA) and the European Environment Agency (EEA) orientated to developing information services based on satellite Earth Observation and in situ (non-spatial) data. Copernicus provides information on natural disasters such as forest fire or floods, and monitors the environment on land, sea and in the atmosphere. The Copernicus Emergency Management Service (EMS) Mapping addresses emergencies worldwide resulting from natural or man-made disasters.

## 3.3 The indirect impacts - the BMMX model

The BMMX model, an interregional computable general equilibrium model (CGE) for Mexico (Haddad et al, 2019), is a fully operation spatial CGE model developed under a theoretical structure similar to Haddad (1999) and Haddad and Hewings (2005).

The BMMX was built from an Interregional Input-Output Table for Mexico (Haddad et al, 2019), with base year in 2013. The estimation of the Interregional Input-Output Matrix for Mexico (IIOM-MX) is based on the Interregional Input-Output Adjustment System (IIOAS) method. The IIOAS method was developed to estimate interregional input-output systems under conditions of limited information (Haddad, 2017). For the particular case of Mexico, the authors used data from national and regional accounts provided by the Instituto Nacional de Estadística y Geografía (INEGI) for the years 2013 and 2014. The data consist mainly of the Supply and Use Tables (SUT) at the national level, and regional data on sectoral Gross Regional Product (GRP) and macro regional aggregates.

The BMMX model recognizes the economies of 32 Mexican States from a bottom-up approach - where national results are obtained from the aggregation of regional results. The BMMX identifies 37 sectors in each Mexican State, one representative household for each State, regional governments and one federal government, and a single foreign area that trades with each Mexican States. The model has local primary factors used in the production process, according to regional endowments (capital and labor). The regional and sectoral classification are shown in the Annex.

The behavioral structure of economic agents in the BMMX model is given by microeconomic assumptions, which can be subdivided into producers, households, government, investment and external demand, following Haddad and Araújo (2020).

It is assumed that, in each State, there is a representative optimizer producer operating for each sector of the model through optimizing behavior (minimizing costs), being able to produce multiple products (commodities). The production function is modeled by a nested structure, which, at the top, is coordinated by a Leontief function making the separability between intermediate inputs and primary products (capital and labor), in other words, there is not exchange between these two types of inputs. However, there is a possibility of substitution within these inputs, for example between the capital and labor factors, which is determined by a Constant Elasticity of Substitution (CES) function.

Household consumption is allocated across different sectors (both external and domestic) according to linear expenditure system (LES) demand functions, derived from the maximization of a Stone-Geary utility function. Similarly, the hypothesis of the existence of a representative optimizing consumer in each region of the model is used. The substitution between domestic and imported consumption is given by differences between domestic and foreign price levels, this also occurs with the demand among the Mexican States (interregional).

In each region of the model, it is assumed that there are two distinct agents that characterize government consumption, the federal government and the regional government. The model also contains equations that determine the level of investment in each sector for each region. However, the investment is considered fixed in the short-term analysis used in this work. For exports, the model distinguishes between traditional and non-traditional export sectors.

BMMX is used in our approach to propagate the damage in flooded agricultural areas, in our case caused by the 2020 floods in Tabasco and Chiapas, through the entire Mexican economy, and for being able to measure their regional and national consequences. The main channels of propagation of the general equilibrium effects involve changes in the prices of primary factors, affecting the firms' competitiveness (sectoral production), the demand for these factors (employment level) and thus, the household consumption and income (Haddad et al., 2013).

Following, let's see how we introduce the direct impacts caused by the flood in the cropland areas into the BMMX model as shocks of reduction in the technological productivity of the primary factors. In other words, how we integrate the spatial analysis with our CGE model.

### 3.4 Integration of the spatial analysis and BMMX model

In the first stage, the spatial model was used to project the direct impacts of floods through the percentage of cropland areas affected by them, as observed in Tabasco and Chiapas, in October/November of 2020. Now, in a second stage, we translate this percentage of decrease in the agricultural areas into technological productivity shocks of primary factors in the CGE modelling.

The integration procedure between the spatial analysis of cropland affectation and the CGE model, BMMX is based on the next argument. Since that the agricultural production depends highly on the land factor, when this factor is prevented from being used, the use of other factors (capital and labor) is also interrupted in this production. Then, we can assume that the size of the shock observed in the land component is very similar to the level of the total shock in the primary production factors. This assumption simplifies the integration of models given that, for this particular case, we don't require information of labor and capital stock affectation.

Thus, we propose to compute the total productivity shock caused to primary factors of agricultural sector with the next expression, which is in accordance to Carrera et al. (2015):

$$\% \text{ Losses in productivity of primary factors} = \frac{\text{flooded ares in cropland}}{\text{total cropland areas}} \times \frac{\text{estimated affected days}}{365} \quad (1)$$

The spatial analysis gives us the percentage of agricultural areas affected by the 2020 floods in the Mexican States of Chiapas and Tabasco, which were -13% and -3%, respectively as shown in section 3.1. In addition, given that floods in 2020 may have affected production equivalent to the period of a harvest in these States, as suggested by Carrera et al., (2015), we assumed that effect of floods over the crops could be felt for an average period of 6 months (approximately 182 days). Based on these estimates, the shocks of the productivity drop of the primary factors in Tabasco and Chiapas agricultural sectors are 6.5% and 1.5%, in that order. In the model structure, the increase in productivity is given in negative values, which implies the need for less work to produce a certain quantity of product. In a similar way, we can interpret the positive values as an increase in the quantity of product that the same number of workers will be able to produce.

In order to estimate the short-term consequences of flood effects, the simulations were carried out under a standard short-term closure, where the capital stock, labor supply, population, investment, government spending, technology and agent preferences are fixed. In this closure, regional employment is driven by variations in wage rates among the Mexican States, which indirectly determine regional unemployment rates and, therefore, impact regional income. Household consumption follows household disposable income, circulating the income flows.

Although we are focused on a short-run analysis, the directions of results of our comparative static analysis will be similar in long-term, of course with the differences due to magnification effects of losses at long-run if no mitigation actions are taken.

Next section presents and discusses the results obtained mainly in terms of the variation of activities at national, regional and sectoral levels.

## 4. RESULTS

According to our simulations, the reduction in national GDP (-0.002%) and in employment (-0.0004%) in Mexico caused by productivity reduction on agricultural sector as consequence of floods in 2020 in Tabasco and Chiapas were estimated on -0.002% and 0.0004%, which, in absolute values mean 26 million dollars (USD, 2013) and -190 employed people, respectively.

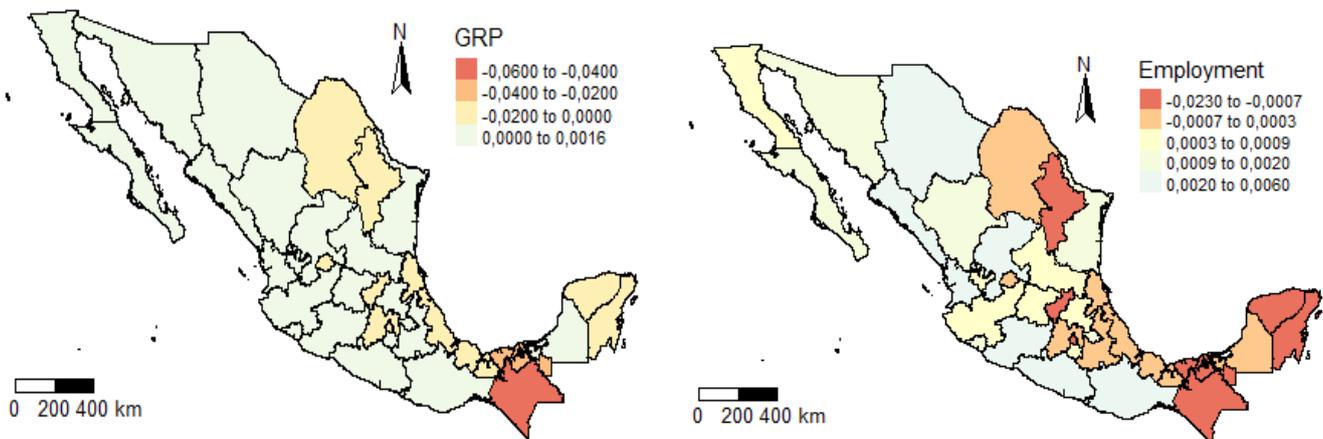
The losses observed imply a reduction in the trade balance, with a decrease of -0.002134% in exports and an increase of (0.004117% in Mexican imports. Regarding the welfare of national residents, there is a decrease, with a reduction in real household consumption (-0.000514%) and a raise in the consumer price index (0.000846%). Table 1 summarizes the macroeconomic effects of the fall in agricultural productivity in Chiapas and Tabasco, resulting from the floods.

Figure 4 shows the regional impacts on the GRP, aggregate employment, nominal consumption and in the families' income. It is possible to observe that the greatest negative impacts on the GRP occurs in Chiapas (-0.060502%) and Tabasco (-0.029775%), regions directly affected by the floods, however, other Mexican States located in the south are indirectly affected as Yucatan and Quintana Roo with a GRP contraction of -0.000879% and -0.000342%. On the other hand, GRP increases in other States mainly in the northern Mexico, such as the case of Sinaloa (0.001649%), the main Mexican agricultural producer.

**Table 1 - Macroeconomic Impacts of floods (in percentage change)**

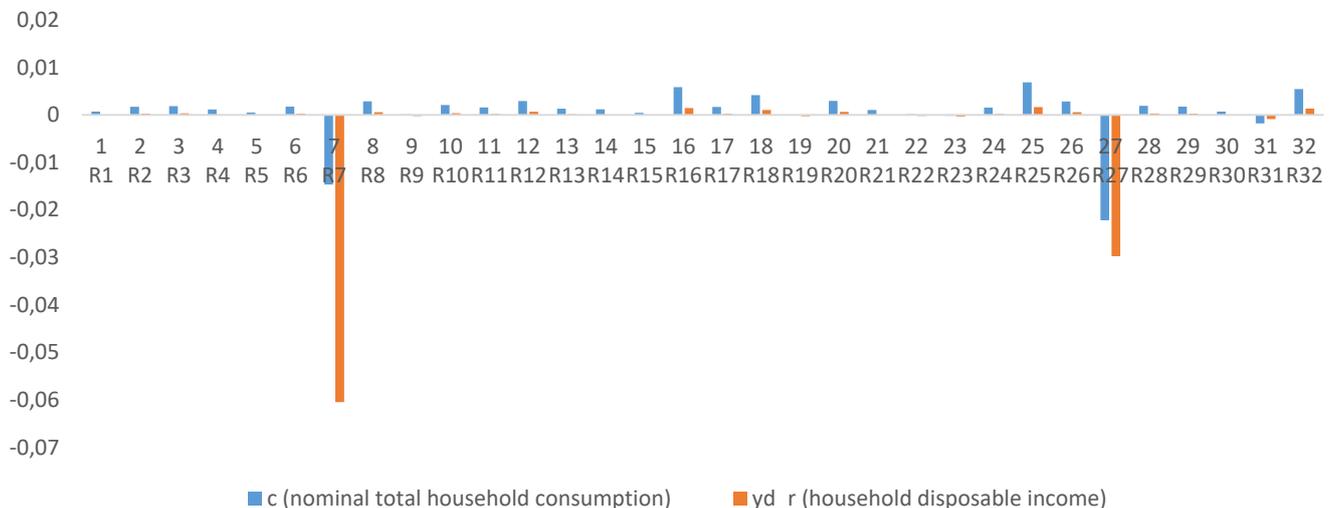
Real GDP	-0.002044
Real household consumption	-0.000514
Real government consumption - Regional	0.001793
Real government consumption - Federal	0.001084
Export volume	-0.002134
Import volume	0.004117
National employment	-0.000407
Consumer price index	0.000846
Investment price index	0.000436
Regional government demand price index	0.000569
Federal government demand price index	0.000569

The same pattern of regional impacts is verified for employment, consumption and income, as shown in Figure 4, where the biggest reductions are in Tabasco, Chiapas, Yucatan and Quintana Roo while the States with the greatest gains are: Sinaloa, Michoacan de Ocampo and Zacatecas.



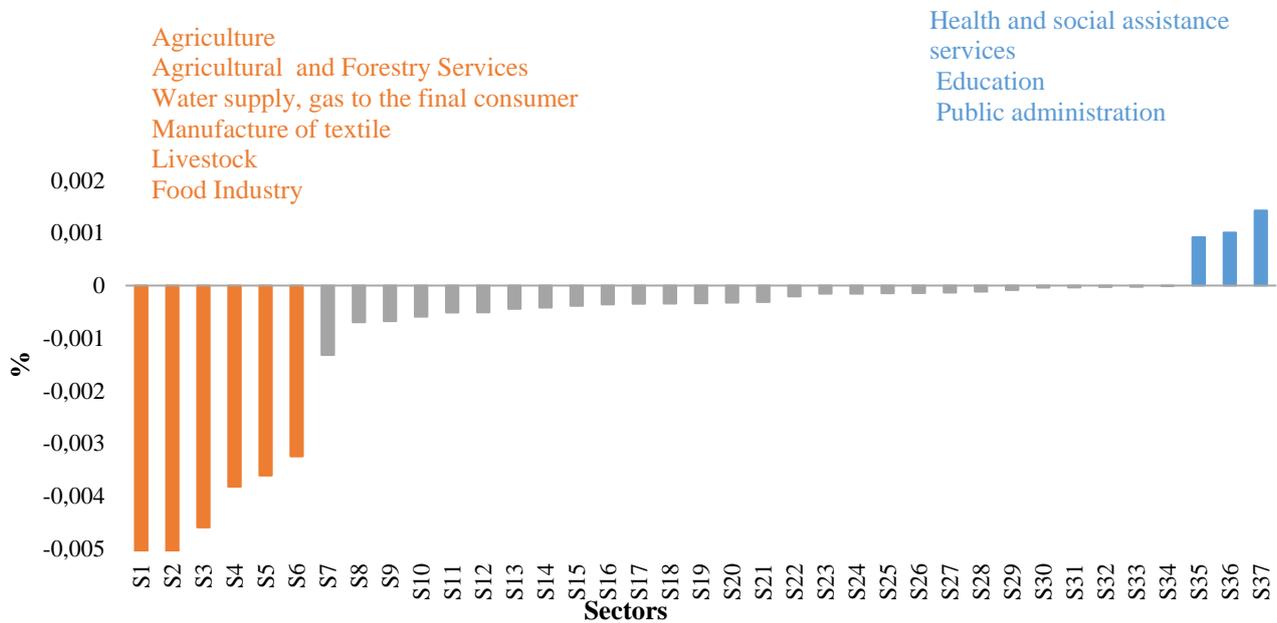
**Figure 4 – Gross Regional Product (GRP) and employment**

In relation to nominal consumption and income of households, losses are also concentrated in the States of Chiapas (R7) and Tabasco (27), and in their neighboring States like Yucatan (R31) and Quintana Roo (R23), as can be seen in Figure 5. The other Mexican States, mainly those located in the North, show an increase in consumption and income of households, which can be explained by the competitiveness gains indirectly achieved by these States from the decrease in agricultural productivity in Chiapas and Tabasco.



**Figure 5- Variations in household consumption and income**

From the sectorial point of view, and given the economic links among the regions and sectors, as shown in Figure 6, the reduction in agricultural production in Tabasco and Chiapas as consequence of floods propagates throughout the economy producing negative impacts not only on the agricultural sector but also on the production of other sectors strictly related to agricultural activity, such as forestry services (-0.105039%), water supply, gas to the final consumer (-0.004596%), manufacture of textile (-0.003821%), livestock products (-0.003611%), food industry (-0.003246%). Only three sectors registered positive variation: health and social assistance services (0.00092%), education (0.00101%), public administration (0.001427%).



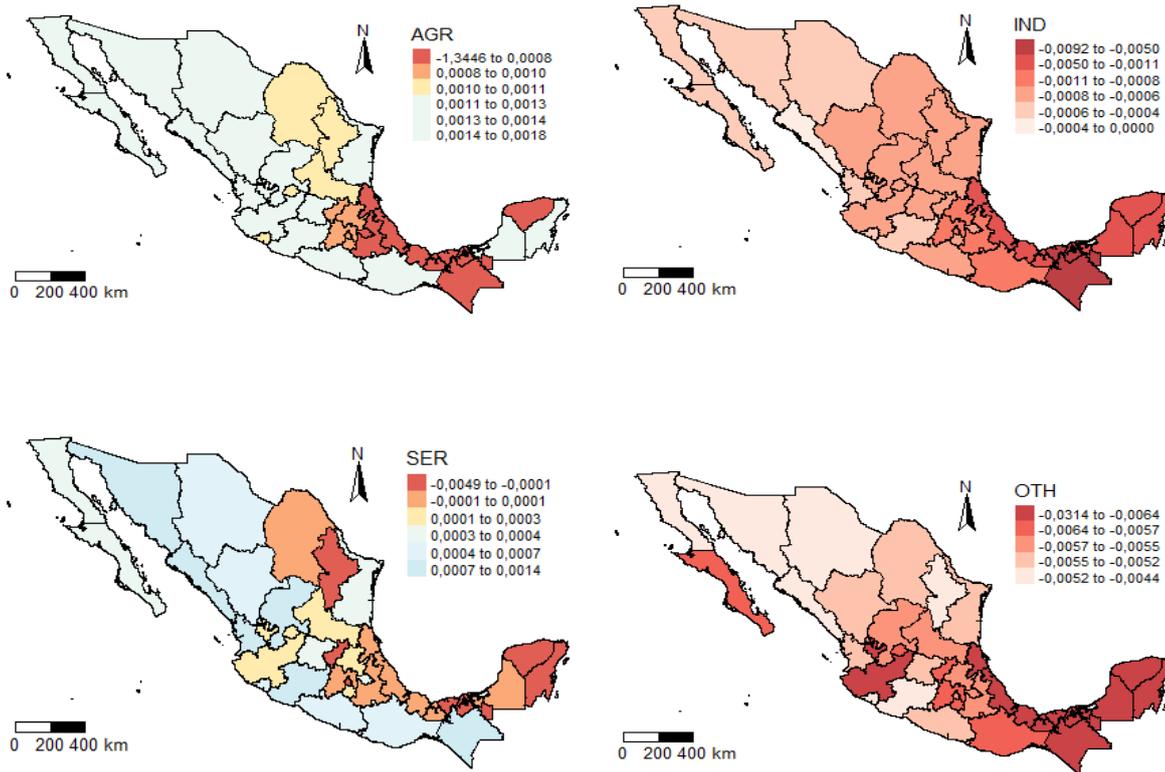
**Figure 6- Activity level in the Mexican economy by sectors**

Sectorial variations differ among Mexican States, as can be seen in Figure 7, in which the average variations of the sectoral production are presented using four groups: agricultural and livestock activities (AGR), industries (IND), services (SERV) and other activities (OTH).

It is observed that the activity level of the agricultural sectors decreases in Chiapas and Tabasco as a direct consequence of the shock. Another State in southern Mexico that also showed a reduction in the agricultural and livestock activities (AGR) was Yucatan (-0.00083%). The other States showed an increase in AGR, these increases being greater in those located in the North of Mexico compared to the South, as is the case of Sinaloa (0.008965%) – the State with the largest increase in AGR. We obtained that the agricultural sector<sup>47</sup> (S1) of Chiapas and Tabasco, suffered a fall in production of -6.54% and -1.56% respectively, values which are very similar to the magnitude of shocks applied to primary factors as consequence of floods. We believe that those results are reasonable and for one side, are in concordance with the real behavior of the economy and for the other one, verify our assumption of modeling regarding to the high and direct relation between the reduction of land crop and the agricultural production level.

In relation to the performance of the industrial sector (IND), we noted losses in the activity level of all Mexican States, being greater in the region where the Tabasco and Chiapas Flood took place, it is, in the southern of Mexico. The variations in the level of activity in the sector services (SERV) also follows the regional pattern, with increases in production in States in northern Mexico and declines in the States of Chiapas, Tabasco, and in other southern States. Services reductions occur due to links between some segments of services and agricultural and livestock activities, such as trade services (S23 and S24), transportation (S25), financial and insurance (S27). In relation to other activities (OTH), impacts distribution are most negative in the southern States as shown in Figure 7.

<sup>47</sup> According the regional and sectoral classification present in Annex.



**Figure 7 - Average performance of all sectors: agricultural and livestock activities (AGR), industries (IND), services (SERV) and other activities (OTH)**

## 5. CONCLUSION

In this paper we have presented a useful methodology to quantify the indirect economic impacts caused by a major flood event, focusing our attention on how the floods can affect the agriculture and how these losses can propagate through other economic sector and regions of a country. We applied this methodology to study the recent 2020 floods that hits the states of Tabasco and Chiapas, in Mexico.

We have successfully integrated a spatial analysis of direct damage with a CGE model, the interregional general equilibrium model of Mexico (BMMX), to estimate the economic channels through which direct losses in agricultural sector can cascade within the Mexican economy. To evaluate the direct effect, specifically the cropland affectation, we carried out a spatial analysis based on the exploitation and combination of free available GIS datasets from GADAS-USDA, LandScan and Copernicus, obtaining an affectation of 13% and 3% of agricultural areas in Tabasco and Chiapas respectively. Cropland affectation was integrated to the interregional CGE model BMMX based on the assumption that reductions of croplands extension are directly proportional to the productivity decrease of primary factors within the agricultural sector. This assumption simplified the integration of models without a significant reduction in accuracy as shown in the results section. In addition, as proposed by Carrera et al. (2015), the productivity shock on agricultural sector was calculated considering a time period of six months, resulting in productivity shocks of 6.5% and 1.5% in Tabasco and Chiapas.

Although agricultural activity is not the main activity performed in Tabasco and Chiapas, we have shown how a shock in agricultural productivity, resulting from the 2020 floods, has an impact in Mexican economy, estimating a GDP contraction of 23 million dollars, around 190 loss jobs, and losses in production, and other economic variables, not only in the States affected by the flooding, but also in other States, especially in the southern region of the country as Yucatan and Quintana Roo. We also provide quantitative results of negative and positive impacts related to prices, exports, consumption, income, and production, at regional and sectoral levels, which can be useful for a better understanding of regional and national economic implications.

The evaluation of indirect impact and losses, resulting from recurring events, can contribute to the adoption of public policies for a better and holistic disaster risk management in the counties by addressing, in addition to physical destruction of assets, the indirect effects that catastrophic events can trigger. The reality of climate change, aggravating existing natural conditions, places a major burden of adaptation on the agricultural sector, which repercussions, as shown in this paper, can be felt through an entire economy. Nowadays, there are multiple plans and actions designed to increase the resilience of the countries to direct consequence of disasters, however, plans and programs to increase resilience for the indirect losses, if they exist, lag far behind. Methodological developments to contribute to a better understanding of

indirect consequences of disaster are the kick-off to include those aspects within a holistic resilience facing natural disaster.

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ANNEX– REGIONAL AND SECTORAL CLASSIFICATION OF THE BMMX MODEL

Regions		Sectors				
		Agricultural and livestock activities (AGR),	Industries (IND)	Services (SERV)		
R1	Aguascalientes					
R2	Baja California	S1 Agricultura	S14 Fabricación de prendas de vestir; Curtido y acabado de cuero y piel, y fabricación de productos de cuero, piel y materiales sucedáneos	S28 Servicios inmobiliarios y de alquiler de bienes muebles e intangibles		
R3	Baja California Sur	S2 Cria y explotación de animales	S15 Industria de la madera	S29 Servicios profesionales, científicos y técnicos		
R4	Campeche	S3 Aprovechamiento forestal	S16 Industria del papel; Impresión e industrias conexas	S30 Corporativos		
R5	Coahuila de Zaragoza	S4 Pesca, caza y captura	S17 Fabricación de productos derivados del petróleo y del carbón; Industria química; Industria del plástico y del hule	S31 Servicios de apoyo a los negocios y manejo de residuos y desechos, y servicios de remediación		
R6	Colima	S5 Servicios relacionados con las actividades agropecuarias y forestales	S18 Fabricación de productos a base de minerales no metálicos	S32 Servicios educativos		
R7	Chiapas	<b>Other activities (OTH)</b>	S19 Industrias metálicas básicas; Fabricación de productos metálicos	S33 Servicios de salud y de asistencia social		
R8	Chihuahua	S6 Minería petrolera	S20 Fabricación de maquinaria y equipo; Fabricación de equipo de computación, comunicación, medición y de otros equipos, componentes y accesorios electrónicos; Fabricación de accesorios, aparatos eléctricos y equipo de generación de energía eléctrica; Fabricación de equipo de transporte	S34 Servicios de esparcimiento culturales y deportivos, y otros servicios recreativos		
R9	Ciudad de México	S7 Minería no petrolera	S21 Fabricación de muebles, colchones y persianas	S35 Servicios de alojamiento temporal y de preparación de alimentos y bebidas		
R10	Durango	S8 Generación, transmisión y distribución de energía eléctrica	S22 Otras industrias manufactureras	S36 Otros servicios excepto actividades gubernamentales		
R11	Guanajuato	S9 Suministro de agua y de gas por ductos al consumidor final	<b>Services (SERV)</b>	S37 Actividades legislativas, gubernamentales, de impartición de justicia y de organismos internacionales y extraterritoriales		
R12	Guerrero	S10 Construcción	S23 Comercio al por mayor			
R13	Hidalgo	<b>Industries (IND)</b>	S24 Comercio al por menor			
R14	Jalisco	S11 Industria alimentaria	S25 Transportes, correos y almacenamiento			
R15	México	S12 Industria de las bebidas y del tabaco	S26 Información en medios masivos			
R16	Michoacan de Ocampo	S13 Fabricación de insumos textiles y acabado de textiles; Fabricación de productos textiles, excepto prendas de vestir	S27 Servicios financieros y de seguros			

## THE LITHIUM ISSUE: WHAT HAPPENED - WHAT HAPPENS - WHAT SHALL HAPPEN?

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### ABSTRACT

#### Initial Remark

These three aspects about time establish the three parts of the present paper. The stress is placed on time, not on space. Yet not because we exclude space but only to have it subordinated to time aspects, which means they will only be considered in so far as time dilucidation shall require some pointing to underlined a territorial trait or set of traits therein involved.

Let us recognize since the beginning that -as a matter of fact- quite a number of steps are almost everywhere underway in Latin America, yet we will focus on those impacting upon our Latinamerican regions, mostly: (A) some of Mexico, and then (B) some other countries, particularly upon Bolivia, Argentina and Chile –even when some potential is actually present in some others which will just eventually be referred to.

#### FIRST PART: WHAT HAS HAPPENED

##### A. In Mexico.

There exists a bordering region between Sonora and Chihuahua states, in the extreme North of Mexico, which it is called Bacadéhuachi. It became known because it started to be referred as having a high lithium potential. Indeed for some people, one amongst the highest at world level. Yet as we will see later, the the initially amount assumed of 243 million tons has been seen as a blunt exaggeration. Of course, the main characteritic traits will be dealt with along the paper itself.

##### B. In Latin America.

The most important lithium area in the rest of Latin America is settled in a place called ‘Salar de Uyuni’. It is shared among the following three countries: Bolivia, Argentina and Chile. This has been subjected to a much more systematic and careful exploration. It has reported a detailed established amount of 24million tons. The paper will give some of its key specificities.

#### SECOND PART: WHAT NOW HAPPENS

In general terms, it should be said that, partly due to Covid-19, and partly to putting off the initial somehow imaginative enthusiasm; now it seems clear that the lithium potential in the whole of Latin America is not one of the highest global levels, but rather a much more modest and below among the general levels at world scale. Yet not much more has been contributed sofar. As a matter of fact, we witness a stagnant situation Covid intevening.

#### THIRD PART: WHAT SHALL HAPPEN?

This is obviously the toughest (?) question. However some broad trends should be made explicit: (a) the urgency of a gradual and progressive general move towards cleaner sources of renwable energies, (b) the increasing techological developments related to the production of clean or hibrid vehicles for transportation as well as industry machinery; (c) the awareness that a post-covid be epoch will be sooner or later approaching, which in some aspects will pushing forward an ever higher interest in extra terrestrial positive and/or more risky facts and threats.

## **Regular Session: RS02.2 - Infrastructure, transportation and accessibility**

**17:30 - 18:45 Tuesday, 25th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/88466279359>**

**Chair Júlio Vicente Cateia**

## INFRASTRUCTURE INVESTMENT, FUNDING SCHEMES, AND POVERTY REDUCTION: EVIDENCE FOR GUINEA-BISSAU

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### ABSTRACT

Guinea-Bissau is a poor country with agricultural-base economy. The government has elaborated development policies aimed at improving the country's comparative advantage and poverty reduction. These policies resulted in US \$1 billion infrastructure investment program in 2015. This study aims to analyze the socioeconomic impacts of this program using a dynamic micro-simulated computable general equilibrium model. Our results show positive impact of infrastructure investments on the level of economic activity, productivity, and sectoral spillovers. The funding schemes determine these outcomes as they contribute to increase wealth accumulation as well as to mitigate in the long-term the urban and rural households' poverty.

### KEYWORDS

Infrastructure investment. Poverty. CGE modeling. Guinea-Bissau.

### 1. INTRODUCTION

The economists have placed infrastructure as a primary determinant of macroeconomic performance and individual wellbeing (Rosentein-Rodan, 1943; Aschauer, 1989; De la Fuente and Estache, 2004). For instance, the roads availability may allow production to be expanded, because roads can be used to the goods transportation purpose between the urban center and the field. This may create job opportunities in both rural and urban environment. As employment grows with the poor households' participation, the poverty incidence rate may decrease. Thus, the vulnerability of the poor to income shock must be reduce by investing in physical infrastructure (Jalan and Ravallion, 2002; World Bank, 2002; Ali and Pernia, 2003).

This study focuses on Guinea-Bissau economy. Guinea-Bissau is a least developing country in West Africa characterized by low macroeconomic performance and high level of poverty. Its gross domestic product (GDP) per capita and the Human Development Index are US\$ 600 and 0.424, respectively, placing it in the low human development category worldwide, ranking 177th out of 189 countries. The life expectancy at the birth is 46 years and more than 69 percent of the population live in absolute poverty - less than two dollars a day. The low infrastructure services may explain these results: from a total of 2,755 km of existing highways, only 22 percent is asphalted, 80 and 66 percent of the population does not have access to basic sanitation facilities and electricity, respectively (World Bank Development Indicators, 2017).

Back in 2015, however, the Guinean government, together with its development partners, tackled the development challenges by increasing infrastructure investment. It elaborated an ambitious investment program in new infrastructure to encourage the transformation of this poor economy into a competitive one, with food self-sufficiency and less poverty and social inequality (GUINEA-BISSAU, 2015). The government aims to (i) mitigate the existing bottlenecks through the construction of the new port, urban-rural roads, priority land routes and inland waterway shipping, and (ii) accomplish urban development by building economic poles in order to establish them as epicenters of economic activity.

The purpose of this study is to provide macro-micro level evidence of infrastructure public investment in a developing country with the agriculture-based economy. Our study fits in the context of the growing economics literature that infrastructure impact economic outcomes (Van de Walle, 1998; Songco, 2002). According to this literature, infrastructure creates production facilities and stimulates economic growth (BARRO, 1991; Prud'Homme, 2004).

Infrastructure impacts economic results both directly and indirectly. Directly, infrastructure availability increases the factor productivity and aggregate product, as well as household income and consumption (Romp and de Haan, 2005; Warner, 2014). These direct effects are widespread and intense in developing countries where the technology of production is not still convex.

Indirectly, infrastructure can have several effects on socioeconomic variables. For instance, the individuals can use income from increased productivity to invest in the education of their children. The construction of a new infrastructure (transport and the road condition) may influence the school attendance rate, learning environment and students' outcomes (Earthman, 2004; Miguel and Kremer, 2004).

Although these positive effects of infrastructure, the empirical evidence of public infrastructure investment on economics outcomes goes back to the studies of Aschauer (1989a, 1989b), Munnell (1990a), which first show public infrastructure

investment to have positive effects in different context. Munnell (1990b), Nadiri and Mamuneas (1994), and Wolff (1996) confirm these results.

However, subsequently some studies (e.g., Garcia-Mila and McGuire, 1992; Holtz-Eakin, 1994; Morrison and Schwartz, 1996; Garcia-Milà, McGuire and Porter, 1996) have reported insignificant impact of infrastructure public investment on economic activity, which generated a mix of findings. Therefore, while Devarajan, Swaroop, and Zou (1996) point out that, holding global government spending constant, increasing government expenditures tends to lower the economy long run growth rate, Canning and Pedroni (2004) show for pairs of countries that infrastructure stimulates long run growth. Calderon and Serven (2010) also findings a positive correlation of 0.35 between GDP growth and infrastructure quantity index in African countries.

The public infrastructure investment has positive effect on the level of economic activity because it complements the private investment (Aschauer, 1989; Erden and Holcombe, 2005), instead of decreasing it as advocates the crowding out hypothesis (e.g., see Cavallo and Daude, 2011; Everhart and Sumlinski, 2001).

By analyzing the long-term trends in the development of South Africa's economic infrastructure and its relationship with the country's long-term economic growth, Perkins, Fedderke, and Luiz (2005) reported positive relationship between the two variables, that is, infrastructure is important to support economic activity in a growing economy. Ndulu (2006), in its turn, places the infrastructure as a potential mechanism that can help foster stronger economic growth in Africa.

The recent empirical findings from infrastructure public investment have to do with the refinement given to the method that best reports the results, ranging from the choice of the functional form to the details of relevant empirical methods. Some authors, such as GU and Macdonald (2009), resort to a dual approach to estimating the effects of public capital on production, since earlier studies by Aschauer (1989) used primal approach, which allowed only to estimate the production function as to deduce the contribution of public capital in terms of output in the economy (JOANIS, 2017).

This study aims to analyze the macroeconomic, sectoral, and household level implications of the public infrastructure investment in Guinea-Bissau. Our study builds specially on those applying computable general equilibrium (CGE) framework to evaluated impact of policies on economic outcomes in poor countries (Sangare and Maisonnave 2018; Go et al, 2016; Chitiga 2016).

We contribute to the existing literature in several directions. First, we contribute by developing the BISSAU-DYN model, a dynamic recursive micro-simulated CGE model, which is the first CGE model applied for this economy. The choice of this version is justified by three reasons: (i) the effects of building a new infrastructure may be lagged and thus take some time to manifest in the economy. With this model, we will be able to understand the behavior of relevant economic variables over time and its structural effects, such that it is possible to provide evidence for socioeconomic policies; (ii) Guinea-Bissau is a typical example of a small open economy that accompanies exogenous shocks. Such an economy is unstable and this instability stems from several reasons including, but is not limited to the, domestic institutions fragility that affects economy performance either at starting point or overt time, and the recursive dynamic model may best represent the structure of this economy; and (iii) as for a long period the potential policy effects could not be analyzed due to lack of adequate data, the application of the CGE framework will also fill this empirical gap. Moreover, the CGE model has the advantage of allowing to analyze interconnections between sectors and to investigate both the direct and indirect impacts of the infrastructure investment policies.

Second, although governments have been practicing economic policy with the aim of promoting the development of the productive forces important to fight against structural poverty, few policies are focused on the sectors to which the households find its source of income. By concentrating on both rural and urban sectors, we will be able to provide instructive micro level evidence for the elaboration of public policies consistent with the reality of each households.

Finally, our study analyzes the economic implications of new infrastructure investments and the different funding mechanisms. This gives us an additional advantage because we can understand how a government in a poor country like Guinea-Bissau may rationalize its scarcity resources to boost productive investments. In addition, the agricultural production, whose share in the GDP is about 60%, is the main source of the household's income in Guinea-Bissau. The present investment program is expected to contribute to poverty alleviation since it deals with transportation infrastructure, which is essential for the flow of agricultural production. Thus, by identifying sectoral returns of infrastructure investments, we will provide evidence to assist in orienting incentives for the development of sectors with higher productivity or whose employment of the population reduces the existing poverty rate.

The remaining of this study is structured as follows: In section 2 we present the CGE model used for simulation, the calibration procedures, closure, and the database. Section 3 reports and discusses the results and Section 4 concludes the discussion.

## 2. METHODOLOGY

We analyze the impact of new infrastructure investment on socioeconomic outcomes by using the CGE framework as proposed by Savard and Adjovi (1998) and Savard (2010), who first introduce the positive externalities associated to the public investment in infrastructure into national-bilateral CGEs models. The foundations of this model stems from neoclassical assumptions in the tradition of Dervis, De Melo and Robinson (1982). These authors appropriated from an analytical framework developed almost a century ago by Leon Walras (Shoven and Whalley, 1973; De Melo, 1988; Decaluwe, Martens, and Savard, 2001).

We will use a dynamic recursive CGE model as in Boccanfuso *et al.* (2014). However, our model has its own specificities since it is based on country with different socioeconomic characteristics. As in Savard (2010), the key assumptions of this model concern infrastructure spending, externalities of public infrastructure, and the budget

constraint faced by government to funding this infrastructure construction. For the first assumption we seek to understand how infrastructure investment occurs and how we can model it. The second one is drawing from the set of non-exhaustive following questions: Are there public infrastructure investments externalities? How do they propagate in the model? These questions are answered by choosing and appropriate externalities functional form.

The budget constrained assumption represents the idea that the resources for infrastructure investments are not a gift for government. They are supposed to come from government revenue. If they do not come from this source and if the government decides to pursue its policy initiatives, it must find ideal funding source either through fiscal instruments or transfers from other agents. We present these assumptions below.

We assume that the government funds its investments program through its revenues ( $Yg_t$ ) that come from several sources, such as direct taxes on household ( $Tdh_t$ ) and firms' incomes ( $Tdf_t$ ), indirect taxes on industry production ( $Tip_{j,t}$ ), taxes on commodity ( $Tic_{i,t}$ ), and imports duties on commodity ( $Tim_{i,t}$ ). Therefore, Equation (1) says that an amount spent on a new building is supposed to depend on the government's ability to collect taxes. To what extent taxes scale impacts the economic activity is a subject matter under investigation in some simulation scenarios. In addition, there are receipts as remuneration of public capital ( $Ypkt$ ) and transfers from other agents ( $Tri_t$ ), typically households ( $Trgov,h,t$ ), firms ( $Trgov,f,t$ ), and the rest of the world ( $Trgov,row,t$ ).

$$Yg_t = Tdh_t + Tdf_t + Tip_{j,t} + Tic_{i,t} + Tim_{i,t} + Ypkt + \sum_i Tr_{i,t} \tag{1}$$

where  $\sum_i Tr_{i,t} = Tr_{gov,h,t} + Tr_{gov,f,t} + Tr_{gov,row,t}$

Income taxes are described in Equations 2 and 3 as linear function of total incomes of households ( $Yh_{h,t}$ ) and firms ( $Yf_{f,t}$ ), respectively. Note that the marginal rate ( $ttdh1_{h,t}$ ) are different from the average rate of taxation for any non-zero intercepts ( $ttdh0_{h,t}$ ) that are fully index to changes in the consumer price index ( $Cpi_t$ ).

$$Tdh_{h,t} = Cpi_t^n \cdot ttdh0_{h,t} + ttdh1_{h,t} \cdot Yh_{h,t} \tag{2}$$

$$Tdf_{f,t} = Cpi_t^n \cdot ttdf0_{f,t} + ttdf1_{f,t} \cdot Yf_{f,t} \tag{3}$$

Government also may funding its policy through a tax applied to the value of each industry production (Equation 4). Taxes on production therefore are industry  $j$  unit cost ( $Pp_{j,t}$ ), excluding taxes directly related to the use of capital and labor, but including other taxes on total aggregate output of industry  $j$  ( $XST_{j,t}$ ).

$$Tip_{j,t} = ttip_{j,t} \cdot Pp_{j,t} \cdot XST_{j,t} \tag{4}$$

where, at time  $t$ ,  $ttip_{j,t}$  is tax rate on the production of industry  $j$ .

Finally, the government can implement two types of taxes on products or commodities. Taxes applied on the sales value at domestic market include margins (trade and transport margins) and custom duties (Equation 5). In a static version of the model, the production and sales taxes may be emerged and modeled accordingly, restricting the government's ability to carry out double taxation at the stage of production and at the final consumption. However, as the goal is also to check each funding source and its effect on model variables over time, we separate production from sales taxes in the dynamic version of the model.

$$Tic_{i,t} = ttic_{i,t} \left[ \left( (Pl_{i,t} + \sum_{ij} Pc_{ij,t} \cdot tmrg_{ij,i}) Dd_{i,t} + ((1 + ttim_{i,t}) Pwm_{i,t} e_t + \sum_{ij} Pc_{ij,t} \cdot tmrg_{ij,i}) IM_{i,t} \right) \right] \tag{5}$$

where, at time  $t$ ,  $Pl_{i,t}$  is the price of local product (excluding all taxes on products);  $Pc_{ij,t}$  is the purchaser price of composite commodity (including all taxes and margins);  $Pwm_{i,t}$  is the world price of imported product (expressed in foreign currency);  $Dd_{i,t}$  is the domestic demand for commodity  $i$  produced locally;  $e_t$  is the exchange rate; price of foreign currency in terms of local currency; and  $IM_{i,t}$  is the quantity of the product imported.  $ttic_{i,t}$  is a tax rate on commodity;  $tmrg_{ij,t}$  is the rate of margin  $i$  applied to commodity  $i$ ; and  $ttim_{i,t}$  is the rate of taxes and duties on imports of commodity

In our model, part of the government revenue that comes from transfers is obtained without any counterpart since it is not explicitly related to a specific form of agent behavior. So, the sign of these transfers between government and non-governmental institutions depend on the economic characteristic of Guinea-Bissau and may be positive or negative depending of national data characteristics contained in social accounting matrix (SAM) that may have positive or negative values. The households and firms' transfers to government are defined as a proportion of their disposable incomes. Like income taxes, these transfers are supposed to represent contribution of the social program and, for modeling purposes, they are treated in the same way (Equation 6 and 7).

Government transfers from rest-of-the-world (ROW) are addressed differently because they can be derived from the other nature regardless of its income. All forms of aid (or interest-bearing external loans) to Guinea-Bissau are the ROW transfers to the country. Technically, these transfers are initially set equal to their SAM values ( $Tr^0_{gov,row}$ ) and grow each period at the same population growth rate ( $pop_t$ ), being indexed fully to the consumer price index (Equation 8).

$$Tr_{gov,h,t} = Cpi_t^n \cdot tr^0_{h,t} + tr^1_{h,t} Yh_{h,t} \tag{6}$$

$$Tr_{gov,f,t} = \gamma^{TR}_{gov,f} \cdot Yf_{f,t} \tag{7}$$

$$Tr_{gov,row,t} = Cpi_t^n \cdot Tr^0_{gov,row} \cdot pop_t \tag{8}$$

where, at time  $t$ ,  $tr^0_{h,t}$  represents transfers by type  $h$  households to government (an intercept);  $tr^1_{h,t}$  is the marginal rate of transfers by type  $h$  households to government; and  $\gamma_t^{TR}$  is the share parameter (or transfer functions).

Current government budget or deficit (positive or negative savings -  $Sg_t$ ) constraint equation (Equation 9) show deficit used entirely for public investment as difference between revenue and its expenditures, which consist of transfers to non-governmental agents ( $Tr_{gov,agn,t}$ ) and current expenditures on goods and services ( $G_t$ ).

$$Sg_t = Yg_t - Tr_{gov,agn,t} - G_t \tag{9}$$

There are now important elements to look at the model default closure, in order to define the behavior over time of the model variables that adjust to meet the current policy. We assume that public expenditure is exogenous and grows over time as population growth rate. The amount of public investment in infrastructure (ITgt) will be allowed to change when it is changed the closure as to take into account the fiscal instruments. From the above relationships, the government can adjust the current budget or deficit as funding mechanism. Equation (10) considers the two funding sources.

$$ITg_t = Sg_t + Deficit \tag{10}$$

As in Boccanfuso *et al.* (2014), we assumed that if infrastructure construction is fully funded only with public savings, the government will not change its debt stock and will not incur in deficit from one period to another. However, if government resorts to debt stock, it should not only get a deficit, but the amount of debt should increase from one period to another depending on the interest rate charged on the initial loan.

We will return in the next section with the discussion of scenarios of simulation and model closure. What is most interesting to emphasize now is the statement that public investment can have externalities, which is the cornerstone of this study. The externality assumption was brought up by Savard (2010), and subsequently adopted by Estache, Perrault and Savard (2012) and Boccanfuso *et al.* (2014) and set as follows:

$$\theta_{i,t} = \left( \frac{Kg_t}{Kg_{t-1}} \right)^{\varepsilon_i} \tag{11}$$

where, at time  $t$ ,  $\theta_{i,t}$  is the externality (or sectoral productivity effect) set as a function of the ratio of current stock of public capital ( $Kg_t$ ) over public capital of the previous period ( $Kg_{t-1}$ ), and  $\varepsilon_i$  is a sector-specific elasticity. The values of these parameters will come from Harchaoui and Tarkhani (2003) study who estimated externalities by sector for Canadian economy. This choice is justified, mainly, because there is no data at the sectoral level that allow such estimation for the Guinean economy. However, since the literature recurrently reveals decreasing returns in the public infrastructure investment and the present study is about a developing economy where returns are still increasing, the use of elasticities estimated for developed country can be considered as conservative (Estache, Perrault, and Savard, 2012, p.5).

The current stock of public capital is the sum of stock of public capital of the previous period, which grows at a rate of the level of investment required to maintain the capital stock ( $g_{kg}$ ), and public investment in new capital of the previous period ( $ITg_{t-1}$ ), both terms associated with a discount factor, which is the depreciation rate of public capital ( $\delta_g$ ) - Eq.12:

$$Kg_t = Kg_{t-1}(1 + g_{kg})^t(1 - \delta_g)^t + ITg_{t-1}(1 - \delta_g)^{t-1} \tag{12}$$

The motivation to use the externalities function (as in Eq.11) is due to its role in increasing the total factor productivity. The causality can be described as follows: a new investment program in the infrastructure carried out by the official government, that is, increase in  $ITg$ , will increase the public capital stock through the time and generate a positive production externality (captured by parameter  $\theta_i$ ). This force appears in the value-added ( $Va_{i,t}$ ) equation (Eq.13) through this theta parameter, so that:

$$Va_{i,t} = \theta_{i,t} A_i L d_{i,t}^{\alpha_i} K d_{i,t}^{1-\alpha_i} \tag{13}$$

where  $A_i$  is the scale parameter;  $L(d_{i,t})^{\alpha_i}$  and  $K(d_{i,t})^{1-\alpha_i}$  the labor and capital demand by industry  $i$ , respectively; and  $\alpha_i$  the Cobb-Douglas parameter. Hence, like in Boccanfuso *et al.* (2014), an increase in  $\theta_i$  represents a Hicks neutral productivity improvement.

This formulation is also commonly used in the empirical literature estimating externalities parameters of infrastructure public investment on the total factor productivity (see Lynde and Richmond, 1993b; Bajo-Rubio and Sosvilla-Rivero, 1993; Gramlich, 1994; Herrera, 1997 among others). Estache, Perrault and Savard (2012) argue that adopting this formulation in the CGE framework implies that investment in infrastructure can act as a source of comparative advantage since the function is sector specific. This is important for the development policies to maximize the capacity of the sectors and to exploit the resulting gains even at household level.

It is worth noting that externalities from past public capital stock are calibrated in the  $A_i$  parameter of the  $Va_{i,t}$  function, non in  $\theta_{i,t}$  function, since the externality measured by  $\theta_i$  represents the portion associated with the new investments of 100 million per year for 25 years, the investment time-calendar. In other words, every \$ 1 spent on infrastructure construction will have effects on total factor productivity through the  $\theta_i$ , affording the scale of production  $A_i$ . The externalities arising from the same amount of new public investment are again added to the value of  $A_i$ , which already carries the effects of past investment, and impact for the economy must be greater than the previous period. In the dynamic environment, however, it is expected that the effects of  $\theta_i$  will be smoothed due to adjustment in the factor market, since  $\theta_{i,t}$  is exogenous in  $Va_{i,t}$ .

The specification is completed by introducing the dynamics in the model. If the government uses the surplus of its revenue resulting from a year of good growth as a public investment, the current GDP should increase. In this case, a standard static model would count for modeling the externalities of public investments. However, with the evidence that public investments do not have an explicit correlation with contemporary GDP, this scenario is unlikely to occur, first because governments have announced investments in public works to boost their economies during the reception and do not have time to wait for golden periods to start such investments and, second, because the majority of public investments are operational only several years after expenditures have occurred. For example, after announcing the

package of new public investments in infrastructure construction, a road may take 7 years to be completed; an airport may take more time, and so on for other investment categories. This delay makes the impact of public investments to be no instantaneous. An appropriate theoretical framework should be called. Therefore, it is the existence of important lags of several years between expenditures on public investment and completion of the capital stock the main motivation behind the choice of the dynamic CGE model.

The introduction of the dynamic implies that the model considers the dynamics of investment and endogenous accumulation of capital, as well as the savings dynamics and the accumulation of wealth over time. As labor force as well as technological progress are time-indexed, the model is no longer concerned with comparative static analysis, but with the cumulative effects on the economy of current policy.

The evolution of capital stock is modeled through the investment demand functions (Eq. 14) as in Decaluwé *et al.* (2012), where the volume of new type of capital allocated to business-sector industry is proportional to the existing stock of capital ( $Ind_{k,i,t}$ ). The proportion varies according to the ratio of the rental rate ( $R_{k,i,t}$ ) and the user cost of that capital ( $U_{k,i,t}$ - Tobin's q), which depends on the price of new capital (or replacement cost of capital -  $PK_t^{new}$ ), the rate of interest ( $IR_{k,t}$ ), and the rate of depreciation (Eq.15).

$$Ind_{k,j,t} = \phi_{k,i} \left[ \frac{R_{k,j,t}}{K_{k,j,t}} \right]^{\sigma_{k,j}^{INV}} Kd_{k,j,t} \tag{14}$$

$$U_{k,j,t} = PK_t^{new} (\delta_{k,j} + IR_{k,t}) \tag{15}$$

where, at time t,  $\phi_{k,j,t}$  is the scale parameter (allocation of investment to industries) and  $\sigma_{k,j}^{INV}$  is the he elasticity of private investment demand relative to Tobin's q.

The level of investment demand at time t is used in the capital accumulation rule equation (Eq. 16), which states that stock of capital in industry i in period t + 1 is equal to the stock in t, minus depreciation of capital ( $\delta_{k,j}$ ), plus the volume of new capital investment in the t.

$$Kd_{k,j,t+1} = Kd_{k,j,t}(1 - \delta_{k,j})Ind_{k,j,t} \tag{16}$$

$$Lcs_{t+1} = Lcs(1 + n) \tag{17}$$

The dynamic specification is completed through another set of update variables that grow at a constant rate per period, governed by official population growth rates over time which enters the model as a free parameter n. We use this parameter to introduce the labor force growth ( $Lcs_{t+1}$ ) in the usual way as in Equation 17.

### 2.1 Data base and model closure

We use data from two sources: International Food Policy Research Institute (IFPRI) and World Bank. With the support of the IFPRI, the SAM of Guinea-Bissau to be used in this study was built by Cabral (2015), from the African Growth and Development Policy Modeling Consortium (AGRODEP), and it provides a comprehensive information on the country's economy in the 2007<sup>48</sup>. It has 22 sectors, 9 production factors and 85 accounts, classified into the following six accounts: factor, institutions, activity, domestically sold commodity, export commodity, and accumulation. Each account represents the agent's relationships determining the dynamics of the economy in the period in question.

The factors of production are offered in the market and their effective use for production represents costs in terms of wages and rent; they are remunerated conventionally, that is, paid based on their marginal costs; the revenues are transferred to households in the form of factor income. The households' income, already in the accounts of the institutions, comes from two sources: wages and transfers from the government.

After the receipts, the income is used by the households in several ways: one part is destined for the payment of taxes, another for the consumption of domestically offered commodities and another for savings. In addition to normal operations, firms receive subsidies and pay taxes to the government, which they also receive from households and the ROW. Through redistributive policies, the government transfers can go as income to households, subsidies to companies, and accumulates international reserves that can be used for a variety of purposes, mainly for offsets between residents and non-residents or the ROW. The government consumes and saves part of its revenues. International capital entering the country can be used to buy domestic production (exports) or to fund domestic consumption (investment). The accumulation accounts and their interconnections with the other matrix vectors complete the interconnection of the flows.

For the micro-simulation purpose, we use the 2014 official minimum wage to disaggregate households in six urban and six rural types (Table 1) and then emerge the resulting shares with every rows and columns in the SAM as to obtain a new level of consumption and income for every household, generating an updated SAM for the current minimum wage base year.

**Table 1 - Household disaggregation by minimum wage**

Household 1	H1	≤ 1 minimum wage	50,000*	0.018
Household 2	H2	≤ 2 minimal wages	100,000	0.036
Household 3	H3	≤ 4 minimal wages	200,000	0.072
Household 4	H4	≤ 6 minimal wages	600,000	0.218
Household 5	H5	≤ 8 minimal wages	800,000	0.290
Household 6	H6	≤ 10 minimal wages	1,000,000	0.363

Source: Authors elaboration. \*:50,000 is the current official minimum wage in 2014.

48 The Social Accounting Matrix of Guinea-Bissau is obtained by request. Interested parties can access: <http://www.agrodep.org/dataset/2007-social-accounting-matrix-sam-guinea-bissau>.

The main general observation for households is that we respect the initial classification that there are two types of workers (skilled and unskilled) and two types of households (urban and rural). Therefore, in terms of the treatment of the labor market, all urban households offer skilled labor, while their rural counterparts offer unskilled labor. The reason for disaggregating workers in several types is that it allows to visualize which sector demands more the labor offered by poor households, for example. We could observe that, for a given total supply of factors, the agricultural sectors demand more unskilled labor from the rural environment, while the industrial and service sectors demand more skilled labor. The public infrastructure investment program is evaluated by considering different scenarios. The base year is 2014, and the program covers the period from 2015 to 2025, with investments already applied between 2015 and 2017. It is worth to emphasize that it is the effects of public investments aimed at building new construction infrastructures that are widespread in the models and that those investments for rehabilitation or maintenance are not considered. As an effect, the model can carry the cumulative effects of the infrastructures being built as well as their impacts at the end of the program. The projection for 2030 is carried out as to consider the lag and dissemination of public investments after the program is completed. Table 10 summarizes the main infrastructure scenarios to be simulated in the model.

**Table 2– scenarios of infrastructure investment simulations**

<b>Simulation 1: reference Scenario</b>	
Business as Usual	Growth of 2 % per year of the 2015–2030 period (from t to t + 16)
<b>Simulations 2, 3, and 4: Scaling up new public investment</b>	
Scenario 1	10% increase in public investment program from 2015 to 2030
Scenario 2	3.3 % increase in public investment program from 2015 to 2030
Scenario 3	6.7 % increase in public investment program from 2015 to 2030
<b>Simulation 5, 6, 7,8,9 and 10: funding schemes</b>	
Scenario 4	\$1 billion investment program of 16 years funded 100% by debt
Scenario 5	\$1 billion investment program of 16 years funded 50% by debt and 50 by sale taxes
Scenario 6	\$1 billion investment program of 16 years funded 50% by debt and 50% by transfers from abroad
Scenario 7	\$ 1 billion investment program of 16 years funded 50% by debt and 50% from firm tax
Scenario 8	\$1 billion investment program of 16 years funded 50% by debt and 50% from income tax
Scenario 9	\$1 billion investment program of 16 years funded 50% by debt and 50% from production tax

Source: Authors elaboration.

**Simulations: 2, 3, and 4:** An amount of 1 billion announced for 10 years corresponds to a 100 million investments per year. In this case, new public investments are made based on a 10 per cent increase in public spending per year from 2015 to 2030 (*Scenario 1*). In order to consider separately the effects of the investments already made and those planned, the time-calendar of this program is divided in two periods, from 2015 to 2018 and from 2019 to 2025. In the first 3 years the government invested 33 million and should invest the remainder 67 million in the upcoming years. The shock size of 3.3 per cent corresponds to the proportion of money spent on public investments over the program budget in the first period (*Scenario 2*), and 6.7 per cent is the proportion of the remainder spending over this budget in the second period (*Scenario 3*).

**Simulations 5, 6,7, 8, 9, and 10:** That public investments may raise indebtedness is what underlies the present scenarios. The goal is to conduct a comparative analysis of various funding schemes for implementing the government program in 2015. By comparison, we assume that the official government can use different fiscal instruments and external resources to fund its investment package, as well as its current deficit. We also assume that the government has access to domestic private funding and other external resources. It is not the level of the current deficit that the government will use for its policy purposes, but rather the proportion of public debt to household, firms and to the rest of the world. Of course, if these shares increase then the current public debt should increase and in the next period the government must either cease investing or will incur in high deficits. The extent to which private funding can increase the public deficit will depend on the interest rate. If it is unsustainable, that is, if the interest rate of the economy grows faster than the resources the government can earn as a benefit of the program, an increasing budget imbalance is expected as the government continues its investment initiatives. Otherwise, there will be a level of public revenue compatible with the current deficit and the public investment program is sustained.

Scenario 4 considers the case where the government uses the 100% of debt to fund its program for 16 years. In scenario 5 the government uses half the debt and half comes from indirect sales taxes as the funding mechanisms. In the next scenario the government mixes the debt and external resources, the half coming from each source. In scenarios 7 and 8 there is the possibility of taxing firms and households, respectively, at a margin corresponding to 50% of their incomes as resources needed for investments. To complete the required resources, the government must still increase its debt by 50%. In the last scenario 9, half of the resources available for funding comes from the public debt and the other half from production taxes.

The simulations of the scenarios 1,2 and 3 are performed by considering the follow model closure. As the shock is done directly on the ITg, the new investment in infrastructure and consequently savings is kept fixed. Therefore, if initial ITg is 100 and the government decides to increase by 10 per cent that amount without changing its deficit, the savings should increase by 10 per cent. Keeping public expenditures as well as transfers as constant, according to (3), government revenue should increase by the same proportion. Meanwhile, for simulations from 5 to 10 (scenarios 4 to 9), we let ITg

to adjust to balance government current accounts and then scaling taxes and debt. That involves uncovering optimal levels of taxes and loans that would match a 10 percent increase in ITg.

### 3. RESULTS

A policy can have different effects for the sectors and for the main macroeconomic aggregates. Thus, after the presentation of the simulated macro results, the results at the sector level are reported subsequently. We start the discussion with the results of scenarios 1, 2, and 3, which represent a government decision to scale up new infrastructure investments for the comparative advantages promotion and poverty reduction purpose. These scenarios represent an increase in public investment by 10%, 3.3%, and 6.7%, respectively.

Next, we turn to the funding mechanisms, which are resources the government obtains to the infrastructure investment accomplishment purpose. In scenario 4 government uses the 100% of debt to attend its investment objectives, while in the scenario 5 he mixed debt and indirect sales taxes half from each funding source. In the scenario 6 the government mixes the debt and external resources, the half also coming from each source. In scenarios 7 and 8 the policy authorities use taxes from firm and household incomes, while in the scenario 9 funds comes from the public debt and production taxes.

#### 3.1 Scaling up new public infrastructure investment

##### 3.1.1 Macroeconomic results

The Table 3 shows that the effects of new investment on standard macroeconomic aggregates depend on the shock size and the period the government decides to increase the new public investment. *Ceteris paribus*, an increase in public investment will raise the production by the construction sector and produce externalities in subsequent periods in the model.

In the second year of the policy execution, the growth generated by the construction of the new infrastructure is high with an increase in GDP of 0.454, 0.154 and 0.309%, respectively for scenario 1, 2 and 3, compared to the BAU scenario. This is followed by positive growth generated by externalities of the investment program from the third year, which continues even after the program has been completed. However, as we move further in time the externalities effects are decreased given that there is public capital depreciation.

We that the amount required for investment purpose may not completely comes from public deficit, given that growth will increase government income and hence funding needs are below the amount announced for the investment program. We can see from Table 4 that government real income increases during greater economic growth periods and faster afterward to a maximum of 1.142, 0.369, and 0.759%, respectively for scenarios 1, 2, and 3 at the end of the simulation in 2030.

The increase in income is directly influenced by the stronger GDP growth, which is also positively impacted by higher factors productivity and aggregate employment (Table 5). The deficit has increased as a result of these policies. However, current deficit starts to decrease even if funding needs are still present at the end of program in 2025, since GDP has shown a good performance through the program period, which provides enough additional government revenues to fund its investments (Table 6).

In terms of the infrastructure investment funding mechanisms, the first important observation in this analysis is that funding sources produce similar effects for most macroeconomic and sectoral variables. The most obvious cases are the GDP (see Table 4). Productivity plays a crucial role in the behavior of macro and sectoral outcomes. We observe that increase in GDP is supported by the positive aggregate productivity and less by the additional employment, as in the case of scenarios 5, 7 and 8. In these scenarios, the percentage changes in composite employment in the last year of simulation are negative. Government revenue as an additional funding source declined in the first three years of the policy, but from 2019 to 2030 we observe a positive and persisted percentage change in government revenue.

**Table 3 - Gap compared to BAU scenario for real GDP (GDP\_Real)**

Year	2015	2016	2017	2018	2019	2020	2021	2022
Scenario1	0.454	0.401	0.366	0.344	0.333	0.329	0.330	0.335
Scenario2	0.154	0.135	0.123	0.115	0.112	0.110	0.111	0.112
Scenario3	0.309	0.272	0.247	0.233	0.225	0.222	0.223	0.226

Year	2023	2024	2025	2026	2027	2028	2029	2030
Scenario1	0.341	0.349	0.358	0.366	0.374	0.382	0.390	0.397
Scenario2	0.115	0.117	0.120	0.123	0.126	0.129	0.131	0.134
Scenario3	0.231	0.236	0.242	0.247	0.253	0.259	0.264	0.269

Source: Authors elaboration. Model results.

**Table 4 - Gap compared to BAU scenario for government real income (G Real)**

Year	2015	2016	2017	2018	2019	2020	2021	2022
Scenario1	-2.123	-1.278	-0.632	-0.148	0.21	0.472	0.661	0.798
Scenario2	-0.776	-0.468	-0.238	-0.068	0.055	0.144	0.208	0.254
Scenario3	-1.495	-0.901	-0.452	-0.118	0.127	0.305	0.433	0.526

Year	2023	2024	2025	2026	2027	2028	2029	2030
Scenario1	0.897	0.968	1.02	1.058	1.087	1.109	1.127	1.142
Scenario2	0.287	0.311	0.328	0.341	0.351	0.358	0.364	0.369
Scenario3	0.592	0.64	0.675	0.701	0.72	0.735	0.747	0.757

Source: Authors elaboration. Model results.

**Table 5 - Gap compared to BAU scenario for aggregate employment (LDC) and Factors aggregate productivity (FACT)**

Factors and Employment	Scenario 1	Scenario2	Scenario3
<b>Year</b>	<b>2030</b>	<b>2030</b>	<b>2030</b>
Aggregate employment	4.703	1.515	3.115
Aggregate productivity	0.134	0.046	0.091

Source: Authors elaboration. Model results.

**Table 6 - Gap compared to BAU scenario for public debt (DEF)**

Year	2015	2016	2017	2018	2019	2020	2021	2022
Scenario1	58.406	46.396	36.032	27.589	21.006	16.038	12.375	9.713
Scenario2	20.554	16.127	12.424	9.472	7.205	5.510	4.269	3.371
Scenario3	40.365	31.877	24.662	18.844	14.341	10.959	8.473	6.670

Year	2023	2024	2025	2026	2027	2028	2029	2030
Scenario1	7.794	6.412	5.409	4.673	4.122	3.698	3.363	3.089
Scenario2	2.726	2.261	1.923	1.675	1.489	1.346	1.232	1.139
Scenario3	5.372	4.437	3.759	3.261	2.888	2.600	2.373	2.186

Source: Authors elaboration. Model results.

### 3.1.2 Sectoral Results

We analyzed the sectoral results in terms of value added (VA), factor returns, and exports performances, verified after each shock. Two things are evident in these results. First, we found that the construction and transportation sectors absorbed more from the shocks of new investments at the end of the simulation, whether in terms of VA or factor returns. This implies that part of the public investment is retained and reinvested in the construction sector, which was the focus of current policy.

The values of the transport sector are due to the direct link between construction and transport sectors. The structure of our model, with a consistent macro closure, public investments in construction is expected to act on economics in the same way as public investments in the transport sector. This is justified because many construction services depend on transport logistics to be effective. Therefore, as production in the construction sector grows, production in the transportation sector should grow accordingly, to a lesser or greater extent. The values of the electricity-water sector are not surprising, since water and electricity are intermediate inputs in construction. An increase in investment in construction sector will increase the demand for these inputs, leading to an increase in its sectoral production.

**Table 7 - Gap compared to BAU scenario for sector results at the end of simulation**

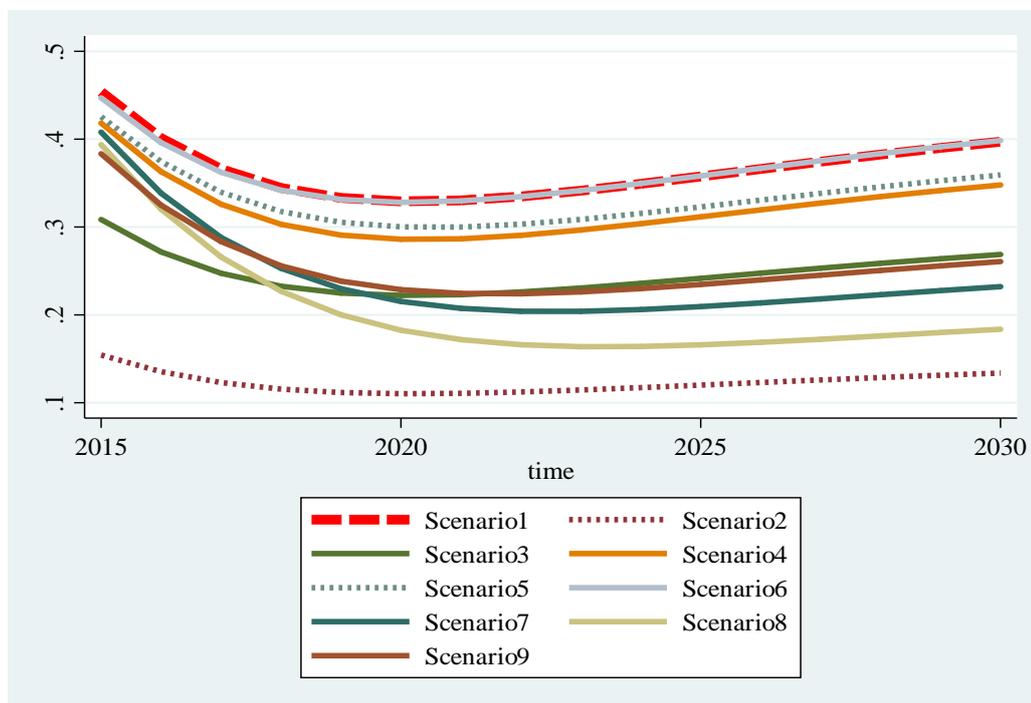
Variable	Value added (VA)			Factor return (FAC)			Exports (EX)		
	1	2	3	1	2	3	1	2	3
Scenario									
Millet	0.105	0.030	0.106	0.945	0.008	0.049	0.053	0.691	0.389
Sorghum	-0.062	-0,026	-0.047	2.409	0.785	1.604	-0.416	-0.138	-0.279
Maize	-0.153	-0,057	-0.109	2.423	0.79	1.614	-0.492	-0.164	-0.331
Rice	0.169	0,052	0.109	2.442	0.796	1.626	-0.220	-0.072	-0.147
Fonio	-0.069	-0,028	-0.051	2.405	0.784	1.602	-0.424	-0.140	-0.284
Cotton	0.112	0,032	0.071	2.519	0.822	1.678	-0.255	-0.084	-0.171
Other agriculture	0.238	0,074	0.155	2.474	0.806	1.648	-0.150	-0.049	-0.100
Cashew nut	-0.362	-0,112	-0.235	1.612	0.527	1.075	-0.336	-0.104	-0.219
Breeding-hunting	-0.022	-0,011	-0.019	2.350	0.766	1.565			
Forestry	0.108	0,033	0.070	2.349	0.766	1.565	-0.254	-0.082	-0.168
Fishery products	-0.071	-0,030	-0.054	2.396	0.78	1.594			
Mining	-0.010	-0,003	-0.006	2.023	0.660	1.348			
Food and beverages	0.284	0,089	0.186	2.847	0.932	1.900	0.172	0.058	0.116
Other industries	-0.083	-0,030	-0.059	2.621	0.861	1.752	-0.360	-0.119	-0.242
Electricity-water	0.822	0,281	0.560	3.241	1.072	2.174			
Construction	2.116	0,702	1.421	3.049	1.004	2.040			
Trading and repair	0.040	0,013	0.027	2.543	0.833	1.698			
Hotels-restaurants	-0.207	-0,067	-0.137	2.090	0.682	1.393			
Transport	0.463	0,156	0.313	2.814	0.924	1.881			
Financial services	0.325	0,110	0.221	2.703	0.888	1.807			
Services to firms	-0.142	-0,043	-0.091	2.073	0.678	1.383			
Public administration	0.027	0,067	0.22	0.290	0.070	0.085			

Source: Authors elaboration. Model results.

The second general observation is that current policy increased sectoral factor returns and created structural changes in the economy in the long run, as it caused a significant increase in the production of non-traditional sectors, such as the food and beverage sector. Consequently, we observed an important change in the composition of the country's export grid. That's because, Guinea-Bissau, like many West African countries, is a net food importer, which means that the domestic food supply is historically lower than the population's demand. Current policy would reverse this situation. The country will produce food in quantities above what is necessary for domestic consumption, that is, the country is a net exporter of food.

### 3.2 Scaling up new public infrastructure investment and funding schemes

In this section, we analyze the results of scenarios 1 to 3 and those of scenarios 4 to 9 from the comparative perspective of economic activities, income, cost of living and the externalities that carry the potential of public investments for the production side. Both the increase in investment policies and the funding schemes adopted had a positive impact on the level of economic activity, with scenarios 1 and 6 showing greater effects that persisted over time (Figure 1). After an initial period of positive impacts on the level of economic activity, the effects of scenarios 4 and 5 reduced from 2015 to 2017 period and then recovered until 2020 where they remained stable until 5 years after the program is completed. Scenario 8, in turn, lost its initial impact on the aggregate product more sharply, but is scenario 2 which had the least positive effects on economic activities.



**Figure 1 - Gap compared to BAU scenario for real GDP (GDP\_Real)**

Source: Authors elaboration. Model results.

We start to look at externalities at the end of the simulation, in the same sense that the effects of new public investments are spread in the model after the program is completed in 2030. It is possible to observe that all scenarios produce positive productivity externalities for sectoral variables (Table 8). However, we can also note that each sector responds differently to the shock performed and that the size of the shock is not sector invariant. In the Column 2 representing *scenario 1*, externalities are most absorbed by all agricultural sectors, especially Millet and Rice (0.385), Cotton (0.240), Other agriculture (0.490), Breeding-hunting (0.394) and Cashew nuts (0.296). Percentage changes relative to the BAU scenario of the industrial and service sectors are not negligible, but they are lower than those of the agricultural sectors. Externalities are lower for real estate and services to firms and public administration, both with a percentage variation of 0.017 five years after the policy in question.

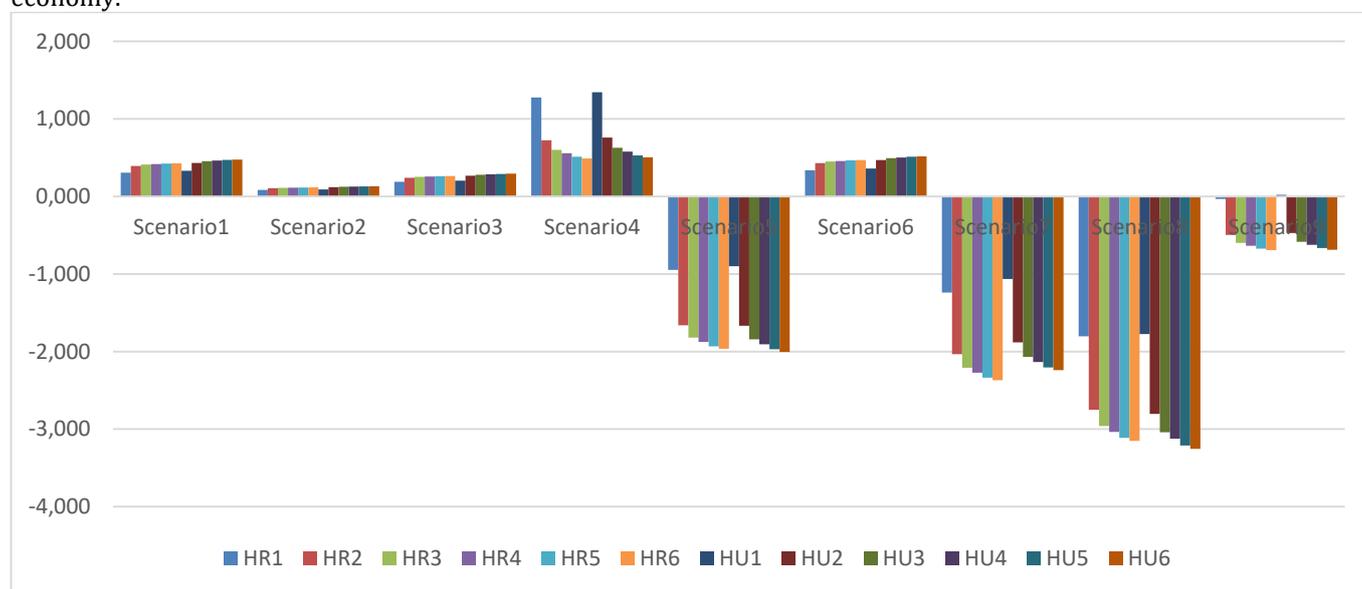
Small changes occur when we moved to scenarios 2 (3.3% increase in new public investment) and 3 (6.7% increase in new public investment), because in these cases externalities are reduced for both sectors, but the order of impact size remains as in the scenario discussed in the previous paragraph. As they share the same production technology, the externalities of the Millet and Rice sectors are the same for all scenarios. Overall, the externalities are higher if the government only increases its investments by 10% compared to debit and taxes funding schemes, although these policy options also have positive and non-neglecting impacts on the economy sectors, as we can see from the columns of scenarios 4 through 9.

**Table 8 - Gap compared to BAU scenario for externalities of public investment (theta) at end of resolution in 2030**

Theta	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
Millet	0.385	0.131	0.262	0.345	0.353	0.377	0.333	0.317	0.304
Sorghum	0.135	0.046	0.092	0.121	0.124	0.133	0.117	0.111	0.107
Maize	0.012	0.004	0.008	0.011	0.011	0.012	0.010	0.010	0.009
Rice	0.385	0.131	0.262	0.345	0.353	0.377	0.333	0.317	0.304
Fonio	0.157	0.054	0.107	0.141	0.144	0.154	0.136	0.129	0.125
Cotton	0.240	0.082	0.163	0.215	0.220	0.235	0.207	0.197	0.190
Other agriculture	0.490	0.167	0.333	0.439	0.449	0.480	0.424	0.403	0.388
Cashew nut	0.296	0.101	0.201	0.265	0.271	0.290	0.256	0.243	0.234
Breeding-hunting	0.394	0.134	0.268	0.353	0.362	0.386	0.341	0.324	0.312
Forestry	0.020	0.007	0.014	0.018	0.019	0.020	0.018	0.017	0.016
Fishery products	0.058	0.020	0.04	0.052	0.054	0.057	0.051	0.048	0.046
Mining	0.068	0.023	0.046	0.061	0.062	0.067	0.059	0.056	0.054
Food and beverages	0.049	0.017	0.034	0.044	0.045	0.048	0.043	0.041	0.039
Other industries	0.042	0.014	0.029	0.038	0.039	0.042	0.037	0.035	0.034
Electricity-water	0.034	0.011	0.023	0.030	0.031	0.033	0.029	0.028	0.027
Construction	0.022	0.008	0.015	0.020	0.020	0.022	0.019	0.018	0.018
Trading and repair	0.064	0.022	0.044	0.058	0.059	0.063	0.055	0.053	0.051
Hotels-restaurants	0.015	0.005	0.010	0.013	0.014	0.014	0.013	0.012	0.012
Transport	0.021	0.007	0.014	0.019	0.019	0.020	0.018	0.017	0.016
Financial services	0.019	0.006	0.013	0.017	0.017	0.018	0.016	0.016	0.015
Services to firms	0.017	0.006	0.012	0.015	0.016	0.017	0.015	0.014	0.014
Public administration	0.017	0.006	0.011	0.015	0.015	0.016	0.014	0.014	0.013

Source: Authors elaboration. Model results.

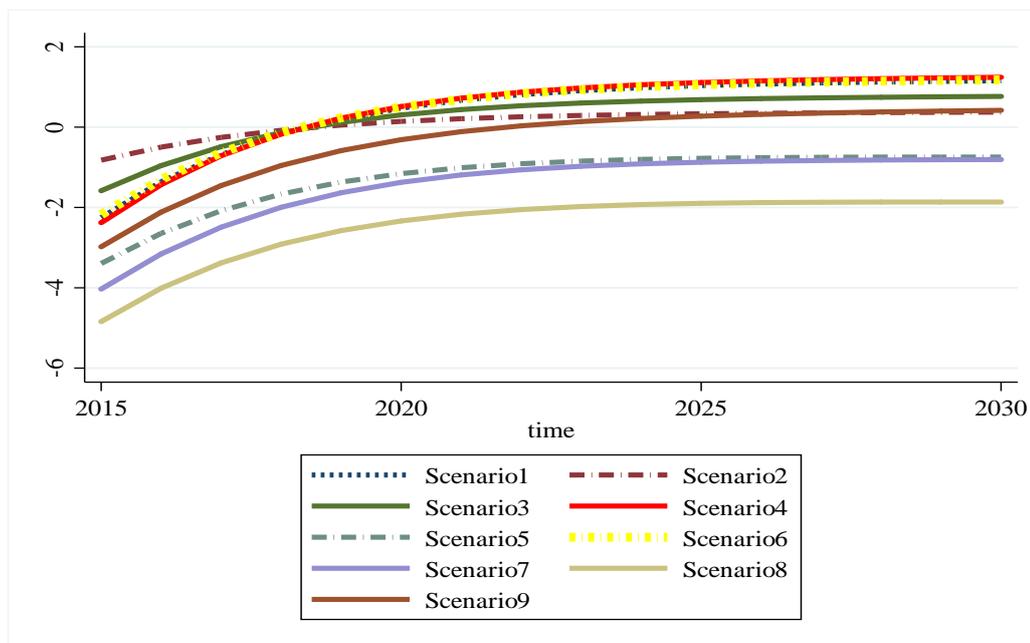
We also assess the results at the household level by focusing on three variables, namely individual income and consumption and the consumer price index. The households' income from 2015 to 2030 are represented in Figure 2, which shows that both policies are different income effects from one household to other. However, we note first that scenarios 1 to 4 and scenario 6 have positive impacts on households' incomes, while scenario 5 and scenarios from 7 to 9 reduced their incomes. Second, scenarios that produce positive effects do so less intensely than scenarios producing negative results, that is, positive percentage variations are deeper than negative percentage variations. Moreover, the percentage of income variation of the poorest households is higher when policies produce positive effects and lower when income-effects are negative. It is worth emphasizing that scenarios 1, 2 and 3 provided best results for this economy.



**Figure 2 – Gap compared to BAU scenario for households' real income**

Source: Authors elaboration. Model results.

The consumer price index (Figure 3) it decreases for the 2015 to 2018 period, increases between 2018-2020 and remains stable until the end of the simulation for all policy options, except for scenario 1 and 6 that present similar price effects as shown by the two overlapping lines in the positive area of the graph.



**Figure 3 - Consumer price index - variation compared to BAU**

Source: Authors elaboration. Model results.

The extent to which new investment and the way they are funding affect the living conditions of the population is a question under investigation. In Table 9, 10% increase in new public investments without specifying the source of funding will further damage the poorest rural and urban households, whose consumption have declined by -0.078% and -0.055% percentage, respectively, compared to the BAU (Column 2). Note that an increase of 3.3% in new public investment, as represented by Columns 3 reduces by -0.026% the consumption of rural households receiving up to 1 minimum wage, by -0.003% the consumption of rural household receiving by up to 2 minimal wages, and by -0.018% the consumption of urban household receiving up to 1 minimum wage. In general, as the wage range grows, more is the positive impacts the household can get from the increase in new public investments. However, this result changes completely when government adopts fiscal instruments since each policy option is producing different impacts on households' consumption.

Funding using 100% of the debt will benefit all households, but the poorest in both rural and rural areas will increase more their consumption than the richest ones, that is, those whose minimal wages is higher (scenario 4 – Column 5). However, when the government uses the mix debit-sales taxes, only the poorest rural household and the poorest urban household were affected as the consumption of other household are reduced: the wealthiest household will have their consumption reduced by -0,739 percent over the BAU scenario. Meanwhile, funding public investment with 50% of external resources and 50% of the official deficit (scenario 6) will reduce by -0,081 and -0,058% the consumption of rural and urban households with less than 1 minimum wage, respectively, while increasing the consumption of their counterparts on the opposite tail by 0.047 and 0.095%.

**Table 9 - Gap compared to BAU scenario for households' real consumption (CH) at the end of simulation in 2030**

Household consumption	Scenario 1	Scenario 2	Scenario 3	Scenario 4	Scenario 5	Scenario 6	Scenario 7	Scenario 8	Scenario 9
Rural household 1: ≤ 1 minimum wage	-0.078	-0.026	-0.053	0.849	0.333	-0.081	0.254	-0.236	0.344
Rural household 2: ≤ 2 minimal wages	0.004	-0.003	-0.002	0.297	-0.391	0.009	-0.553	-1.200	-0.123
Rural household 3: ≤ 4 minimal wages	0.022	0.002	0.009	0.174	-0.552	0.029	-0.732	-1.414	-0.227
Rural household 4: ≤ 6 minimal wages	0.029	0.003	0.013	0.131	-0.609	0.036	-0.796	-1.49	-0.264
Rural household 5: ≤ 8 minimal wages	0.036	0.005	0.018	0.086	-0.668	0.044	-0.862	-1.568	-0.302
Rural household 6: ≤ 10 minimal wages	0.039	0.006	0.02	0.063	-0.698	0.047	-0.895	-1.609	-0.321
Urban household 1: ≤ 1 minimum wage	-0.055	-0.018	-0.037	0.918	0.382	-0.058	0.433	0.551	0.398
Urban household 2: ≤ 2 minimal wages	0.043	0.009	0.024	0.333	-0.398	0.049	-0.399	-0.506	-0.099
Urban household 3: ≤ 4 minimal wages	0.065	0.015	0.038	0.200	-0.576	0.073	-0.589	-0.747	-0.212
Urban household 4: ≤ 6 minimal wages	0.073	0.018	0.043	0.152	-0.64	0.082	-0.657	-0.833	-0.252
Urban household 5: ≤ 8 minimal wages	0.081	0.020	0.048	0.103	-0.705	0.091	-0.727	-0.922	-0.294
Urban household 6: ≤ 10 minimal wages	0.086	0.021	0.050	0.078	-0.739	0.095	-0.763	-0.968	-0.315

Source: Authors elaboration. Model results.

In contrast, we observe that -0.895 and -0.763% are the consumption reductions that incur rural and urban households that receive higher wages in income distribution as a result of increasing firm tax, which will benefit the poorest

households in the city and in the field (scenario 7). If the government funds its policies with tax on household income, it is only the rural household with highest (receiving up to 10) minimum wage that have its consumption increased by 0.551 percent, as the other households have been hit negatively with substantial consumption losses (Scenario 8). Although none of the urban households have obtained substantial gain, overall, this policy negatively affects more the rural households receiving up to 10 minimal wages. In scenario 9 we can see that the Column 8 pattern is repeated, since only the poorest households have experiment positive gains, with percentage change in their consumption of 0.344 for rural and 0.398 for urban households receiving less than 1 minimum wage.

In short, public investment in infrastructure is responsible for increasing the level of economic activity, household consumption, and externalities. This result is in agreement with the findings of Boccanfuso *et al.* (2014), but also with the standard economic literature that states that developing countries that need to accelerate their catch-up process should rely on the participation of public capital, which serve as a kind of complementarity with private capital, instead of substitutes.

When the country is poorer, this complementarity should be more intense in the key economic sectors, such as construction. As a result, increasing new public investment will increase private investment as well as output per worker and may result in self-sustaining economic growth. Scenarios of new types of public investment suggest that these effects are propagated in our model even at micro level. In fact, the new public investment effects persisted over time and spilled over into households' income and consumption gains, including for rural households with the lowest minimal wages.

The simulations of funding mechanisms corresponding to the increase of public investments bring mixed results. While scenarios 5 show that using the already distribute gains to increase finance investments will not bring immediate gains, other scenarios show that redistribution and prosperity gains can be achieved through taxes increase. In both cases, the results show taxation methods as a way to control production and income and increase long-term welfare. Findings in this sense go back to the study by Diamond and Mirrless (1971), and recently Hafner *et al.* (2015) and Bosua *et al.* (2012).

#### 4. CONCLUSIONS

This study aims to analyze the effects of public investments on socioeconomic, sectoral, and household level outcomes based on the Guinea-Bissau government investment program in infrastructure that are in operation since 2015 as to address the numerous development challenges in promoting national comparative advantage and increasing the citizen's standard of living.

Simulation results show that investment in infrastructure has a positive effect on the economy. The impacts are spread from one period to another by increasing the sectoral total productivity and the externalities that have sustained the sectoral production over time. At the beginning of each period, the execution of public investment projects raised the public deficit, but we see that this deficit is drastically smoothed out follow up the depreciation of public capital period. Moreover, the results also show that the poorest households benefited most from the investments made, both in terms of consumption and income, which suggests the potential of this policy to reduce poverty and generally to promote socioeconomic development.

In general, it is suggested that the way in which the government directs its development projects to promote the country's comparative advantages as to reconcile higher sector productivity and employment will be important in determining the economic performance in the following periods, as the sectors responded more or less to the policies adopted. Thus, a national development policy aimed at increasing household aggregate income and income through infrastructure investments can serve to stimulate economic growth, even in long-term, while affecting the pattern of household consumption.

The way as the policies will be funded will be important for the government that wants to maintain its long-term account balance, so that it is possible to carry out its current expenses and signal to its partners its ability to honor the signed external commitments. While external funds seem to help the government to meet its objectives, it can in the long-term become problematic as it depends on external variables such as interest rates which is completely beyond the government's control. Thus, if the official government intends to keep appropriating external resources as a funding source and if the external interest rate rises to such a level as to compromise the ability to pay the current debt, there will be a period when he will be required to declare default. This could damage the country's image in the international creditors' square. Funding by taxation of production and firm is not recommended to develop economies whose sectors are incipient, as it may inhibit the application of private capital and eliminating the initial impacts of the policy. The income taxes-based funding suggests having positive impact on economic activity. However, if the goal is to reduce poverty in the short term, the government should adopt appropriate fiscal instruments that do not weigh on the real budget of households.

However, confirmation of this hypothesis requires more detailed studies. The results of this study indicate that infrastructure investment has positive long-term impact on several socioeconomic variables and productivity, but when the government adopt funding schemes, results shift from one sector to another. Internally, it will be necessary to understand how the design of the institutional situation in Guinea-Bissau has contributed to the country's economic development. As for the model, further studies will be required, introducing more policies options or scenarios and to consider the level of qualification of the worker and how earnings from labor market can be redistributed, including between the gender.

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## A SPATIAL MISMATCH ANALYSIS FOR CURITIBA METROPOLITAN AREA BASED ON ACCESSIBILITY TO FORMAL JOBS INDEXES

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### ABSTRACT

This study investigated potential economic gains in the labour market of the second largest Metropolitan Area of the south of Brazil, the Metropolitan Area of Curitiba, which had a long experience in adopting Transit Oriented Development policies for its urban consolidation. Guided by a Spatial Mismatch Hypothesis, the main objective of this study was to investigate the effects of gravitational accessibility indexes to formal job opportunities in monthly wages for workers of the study in the year of 2017. We applied a consolidated methodology that considers a rich set of geographic information to deal with theoretical issues of determinants of spatial configuration, and allow to observe, in 2SLS models with mincerian specifications, the effects of agglomeration economics by different magnitudes: geographical sub area, educational level and transport mode. The results suggest the existence of potential economic gains related to better accessibility to formal job opportunities. The transport mode and the educational level are also determinant to the magnitudes of such effects on monthly wages for those workers, which related to the spatial unevenness access to job opportunities, might be a source of economic inequality among the Metropolitan Curitiba Area citizens.

### KEYWORDS

Accessibility to Formal Job; Spatial Mismatch Hypothesis; Urban Labour Market

### 1. INTRODUCTION

Cities of emergent countries have had huge issues on their respective urban consolidations since the beginning of most of its processes, mainly in metropolitan areas, where the unevenness spatial distribution of accessibility to opportunities evidence big challenges to suppress economic inequalities (Hernandez, 2017; Fan et al., 2018; Pereira et al., 2020).

The Spatial Mismatch Hypothesis (SMH) claims that spatial unbalances between dwellings and workplaces within some social groups may be harmful for their respective job market outcomes (Kain, 1968). This hypothesis has provided useful analytical fundamentals to better understand the effects of unequal access to job opportunities in economic inequalities (Gobillon et al., 2007; Duarte, Silveira-Neto, 2020; Holzer, 1991; Matas et al. 2010).

This hypothesis has shown adherence for Brazilian large cities, since some of them have evidenced: spatial concentration of job opportunities with non-equitable distribution of transport infrastructure (Haddad and Barufi, 2017); periphery of housing location from essential urban infrastructure to poor individuals (Pacheco, 2019); and concentration of such infrastructures and job opportunities for individuals who live in central areas and aren't low-skilled qualification (Sachsida et al. 2008; Barufi and Haddad, 2017).

In the south of Brazil, the city of Curitiba had planned and implemented an urban expansion process based on Transit Oriented Development (TOD), when hierarchized land use by distance to a road infrastructure, aiming to avoid overloading of such infrastructures. Curitiba also implemented the public transport system so-called Bus Rapid Transit (BRT) since 1974, building exclusive bus lanes, fast landing platforms and bus integration terminals, which together aim to encourage the use of public transport among its citizens and improve the flow of private cars and buses on the whole transport infrastructure. The BRT system has gained increasing popularity worldwide (Cervero and Kang, 2011).

TOD policies in the urban consolidation of Curitiba resulted in an employment polycentric spatial structure (Thomé, 2020), and regional economic policies encouraged the emergence of industrial poles in surrounding cities of Curitiba (Firkoski, 2002; Carmo and Moreira, 2020), which fomented geographical integration for the Metropolitan Area of Curitiba through its transport infrastructure.

The objective of this study is to measure the existence and magnitude of effects of accessibility to formal job opportunities on monthly wages for the Metropolitan Area of Curitiba (MAC), and bring resources to assess the sources of such effects, given that its spatial configuration, together with transport infrastructure - determinant mechanisms for a SMH - show different aspects of other Brazilian Metropolitan Areas (Boijosly et al., 2019; Pereira et al., 2020).

This study used the databases of the Origin-Destination Survey and RAIS for MAC in 2017, in addition to geographical information about its rivers network, aiming to implement the empirical methodology developed by Haddad and Barufi (2017), by estimating the effects of accessibility indexes on wages in mincerian equations, dealing with the endogeneity issue between these two variables with 2SLS models.

The results suggest the existence of positive effects of accessibility on wages. Groups of individuals that had at least frequented a university had lower inequalities in the potential of catching such effects on wages. Transport modes are also determinant for such potential in economic gains.

The six sections of this article are divided in: this introduction, a literature review that grounds this investigation, a brief contextualization of the MAC, the empirical strategy used by this study, the results obtained and the final remarks.

## 2. LITERATURE REVIEW

The urban geography provides useful evidences for understanding economics aspects of regions, such as jobs outcomes and its implications. The Spatial Mismatch Hypothesis, introduced by Kain (1968), aims to investigate labor market outcomes implications of social segregation faced by minority groups on the location of their job and residences. Thus, the interaction of these respective locations with the spatial configuration of the area of interest might be a mechanism that explains social and economics inequalities, as long as they have heterogeneous accessibility conditions.

Differences in accessibility conditions between zones of a city may influence on the choice of location of firms and residences. Fujita and Ogawa (1982) state that firms might endogenously choose areas with higher potential in economic gains due to agglomeration effects. Given that such effects are supposed to provide higher profits to firms, Melo and Graham (2009) defend that in equilibrium, agglomeration effects should increase worker's wages. In this framework, Lucas and Rossi-Hansberg (2002) suggest that the productivity level of zones will be positively related to the employment level of its neighbor zones. Consequently, as long as individuals that work on places with great productivity face higher commuting costs due to the values of their hourly wage, in mixed land use equilibrium, these workers should endogenously choose to live closer to areas with more job's densities.

Geography may also influence on the decision of firms for hiring workers in large urban areas. Zenou (2002) defend that commuting to jobs can be exhaustive for workers, implying that travel time is positively related with this exhaustion, and may negatively influence the respective worker's productivity, and therefore, on firm's profit. Therefore, in the seek of profit maximization, firms will discriminate workers whose dwelling are located too far from their headquarters.

From the above discussion, if we assume that: 1) agglomeration economies have positive influence on urban wages; 2) local of dwellings are endogenously determined by individuals who earn higher wages; and 3) firms discriminate workers based on their respective local of dwelling, jobs that offer the highest wages will be more accessible opportunities to individuals who have economic conditions to live close enough to the respective firms. Therefore, this phenomenon will foster economic inequality in urban areas.

Empirical evidence has shown that this mechanism is reasonably applicable for Brazilian cities. Pereira et al. (2020) discuss that in the 25 largest metropolitan areas of Brazil, higher accessibility to formal jobs opportunities is provided to areas where the residents with higher monthly wages live, and that the spatial distribution of transport infrastructure tends to be concentrated on central regions, which are evidences of a spatial configuration pattern for Brazilian large cities, where poor individuals tend to live on suburbs. Hernandez (2017) defends that structural constraints in urban areas tend to directly affect the potential of individuals to lift their economics conditions up.

As what see to be a consequence of such spatial configuration and urban infrastructure distribution for Brazilian large cities, Barufi and Haddad (2017) found strong negative relation between monthly wages and commuting travel time between residences and job. These authors also claim that wages are higher for individuals that live in work cities than for those who live in dormitory cities, reinforcing evidences that the statement of endogenous choice of place of dwellings near to zones with higher density of jobs (Lucas and Rossi-Hansberg, 2002) holds in Brazilian large cities, such as a pattern of low densities of job opportunities in suburb areas.

However, measuring SMH only by commuting time between place of dwelling and work has analytical weakness. It is important to control for individual characteristics, transport mode and the endogeneity of individuals who choose their respective place of residence (Holzer, 1991, Ihlanfeldt, 1992). Simultaneity between the variable that quantifies the SMH and job's outcomes might bias the effects of the SMH toward zero (Ihlanfeldt and Sjoquist, 1998).

Regional and urban economics studies have been outlining endogeneity issues through the use of econometric instruments that observe geographic and historical characteristics of their respective study areas (Duranton and Turner, 2011; Burchfield, 2006; Baum-Snow, 2007). The power of such approach comes from the reasonably assumption that early regional geographic characteristics play important roles on the respective human occupation.

In a SMH investigation, Haddad and Barufi (2017) have used rivers network information of Metropolitan Area of São Paulo (MASP) as instrument for dealing with simultaneity between accessibility indexes and wages, given that the rivers of that area became important transit corridors for its transport infrastructure network in the early 20<sup>th</sup> century. In a SMH investigation for the city of Recife, Duarte and Silvera-Neto (2020) claimed that the rail roads' network of this area in the 19<sup>th</sup> century were a decisive agent for the present accessibility infrastructure, because it reflected the best routes in the face of soil conditions. In both SMH investigations, the coefficient that represents the measure of accessibility increase after controlling the endogeneity bias between job outcome and the measure of accessibility.

If there is a historical-geographic aspect that exogenously determines the present spatial configuration or infrastructure of an urban area, so this exogenous aspect can be powerful for dealing with the theoretical issue of spatial equilibrium determinants (Lucas and Rossi-Hansberg, 2002; Ihlanfeldt and Sjoquist, 1998, Haddad and Barufi, 2017).

## 3. METROPOLITAN AREA OF CURITIBA, SOME STYLIZED FACTS.

With 1,9 million inhabitants, Curitiba is the main economic city of the Metropolitan Area of Curitiba, which is the second largest metropolitan area in the south of Brazil, with over 3,6 million inhabitants. In the first half of 20<sup>th</sup> century, the city of Curitiba has implemented urban master planning plans that aimed to bring infrastructure and connect its central area with dispersed districts, through large avenues on a linear urban expansion. From 1970's on, Curitiba had adopted urban

master planning plans that focused on sustainable mixed land use, defining the localities of residences and economic activities based on the level of road infrastructure near to them.

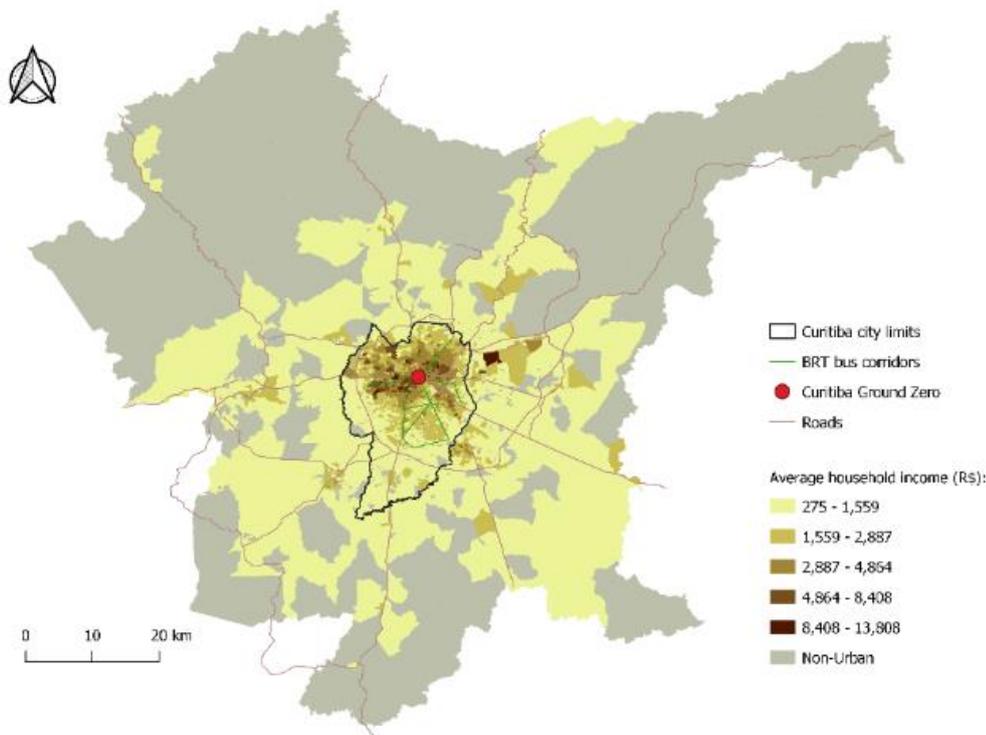
This city has also implemented the public transport system called Bus Rapid Transit (BRT), that built exclusive bus corridors in the main avenues of Curitiba, aiming to provide more speed on travel for both bus and car transport modes. Therefore, the disciplined urban expansion of this city, that conciliated hierarchized land use with the BRT system, followed Transit Oriented Development policies, that aimed to optimize the use of its road infrastructure and promoted poli centric configuration of employment (Thomé and Porsse, 2019).

In the 70's decade, policies for fostering industrial parks resulted in the Industrial park of Curitiba, in its southwestern board, and in the city of Araucária, located in the west board, such as discussed by Carmo and Moreira (2020). Firkoswk (2002) claim that later in the 90's the city of São José dos Pinhais, located in the southeast board of Curitiba, was also benefited by these industrial incentives.

This economic integration designed the Metropolitan Area of Curitiba's geography, with some concentration of qualified jobs in the metropolitan cities located in the limits of Curitiba (Nojima, Moura and Silva, 2009). Since the implementation of the BRT in 1974, the integration of Curitiba's transport system was most focused on the neighbor cities, having its expansion to peripheral metropolitan cities started from the 1990's.

Figure 1 shows that the urban expansion of MAC resulted in a spatial distribution of income in which the central region of the city of Curitiba have most of the high-income residents.

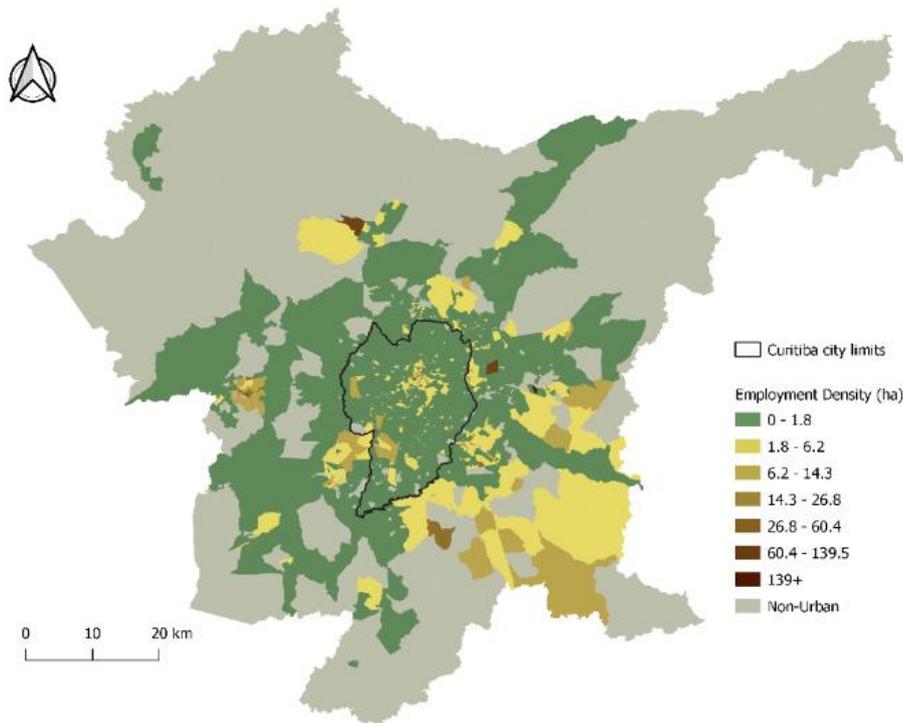
The limiting cities of Curitiba are the ones that show incomes similar to the central region of the Parana's capital at most, evidencing effects of the early economic and physical integration with this city. There is also spatial correlation between BRT corridors and incomes.



**Figure 1 – Income distribution for Metropolitan Area of Curitiba**

Source: Brazilian Census 2010.

Figure 2 shows a dispersed distribution of formal jobs over Metropolitan Area of Curitiba. This might be a result of the industrial policies that had started from the 1970's, as well as the urban planning master plans adopted by the city of Curitiba (Thomé and Porsse, 2019). This distribution over the observed area is favorable for good accessibility to formal job opportunities, if the transport system is effective in connecting the different zones of this Metropolitan Area.



**Figure 2 – Formal Employment density for Metropolitan Area of Curitiba**

Source: RAIS 2017.

#### 4. DATA AND EMPIRICAL STRATEGY

##### 4.1 Data

This study had three different sources to form the databank. Information of individual socioeconomic characteristics, transport mode, travel time, dwelling and work locations came from the 2017 Origin-Destination survey (OD survey) of Curitiba, conducted by the Institute of planning research of Curitiba (IPPUC). This survey collected information about 17 municipalities of Metropolitan Area of Curitiba in 955 zones. For the present analysis, 5,604 observations were used from this sample, representing over 641 thousand residents.

Information about formal jobs<sup>49</sup> came from the 2017 Annual Social Information Relation (RAIS), which is provided by the Brazilian ministry of labor. This databank contains very detailed information about firms and workers, including their respective workplace, allowing for geocoding each<sup>50</sup> formal job of Metropolitan Area of Curitiba, making it possible to estimate the number of jobs in each of the 954 zones of the Origin-destination survey. The third data source consisted of geographic information of rivers in the study area. It is described in the sub-section about the econometric instrument used in this study.

##### 4.2. Empirical Strategy

This empirical analysis used Ordinary Least Square and Two Stage Least Square regressors to evaluate causality between accessibility to formal jobs and monthly wages in MAC. The econometric models follow specifications based on Mincer (1974):

$$\ln W_{imj} = \varphi + A\delta_{imj} + X\beta_{imj} + \varepsilon \quad (1)$$

where  $W$  represents the  $\ln$  of the monthly wage of individual  $i$ , who uses the transport mode  $m$  to reach workplace  $j$ , and is explained by the accessibility index of the individual's workplace zone  $j$ , in addition to an array of individual characteristics  $X$ , which contains: i) a dummy variable that indicates whether the individual is male; ii) a dummy variable that indicates one of the 7 individual's level of education; iii) the age of the individual in  $\ln$ ; iv) the  $\ln$  of the individual's age squared; and v) two dummy variables that give information about the respective work areas of the individuals: one for those who live and work in the same place and another that indicates whether the individual works in a Rural Census Sector.

The quantification of Spatial Mismatch is based on a measure of accessibility, which consists of gravitational accessibility indexes based on Hansen (1959), that aims to observe available opportunities:

$$Amj = \sum_{j=1}^{954} \frac{E_j}{d_{ij}(t)} \quad (2)$$

49 In Brazil, this job category has rights and guarantees by law, being considered as better job opportunities than informal jobs. However, the RAIS database is limited to observe only formal jobs.

50 A total of 89% of the total sample in the RAIS databank was geocoded. 11% of the geocoded jobs did not present consistency of their respective location.

where  $A$  is the accessibility index for workers of zone  $j$ , of modal  $m$ , that is explained by  $E$ , the quantity of formal jobs in zone  $j$ , which is divided by an impedance function  $d$ , that ponders the availability of each formal job by the mobility conditions between zones  $i$  and  $j$ :

$$d_{ij}(t) = e^{\alpha t} \tag{3}$$

thus,  $d_{ij}$  is the linear distance between zones  $i$  and  $j$ , explained by the mean commuting time between these zones in two log-log Ordinary Linear Squared models, for the modes: 1) Private Vehicles, that encompassed cars, taxis and motorcycles trips; and 2) Public Transport, composed by all the trips made by BRT users and Metropolitan buses. The time information for the trips of both observed modes were collected from the OD survey, feeding two quadratic mean travel matrixes, making it possible to have two different estimated  $\alpha$ .

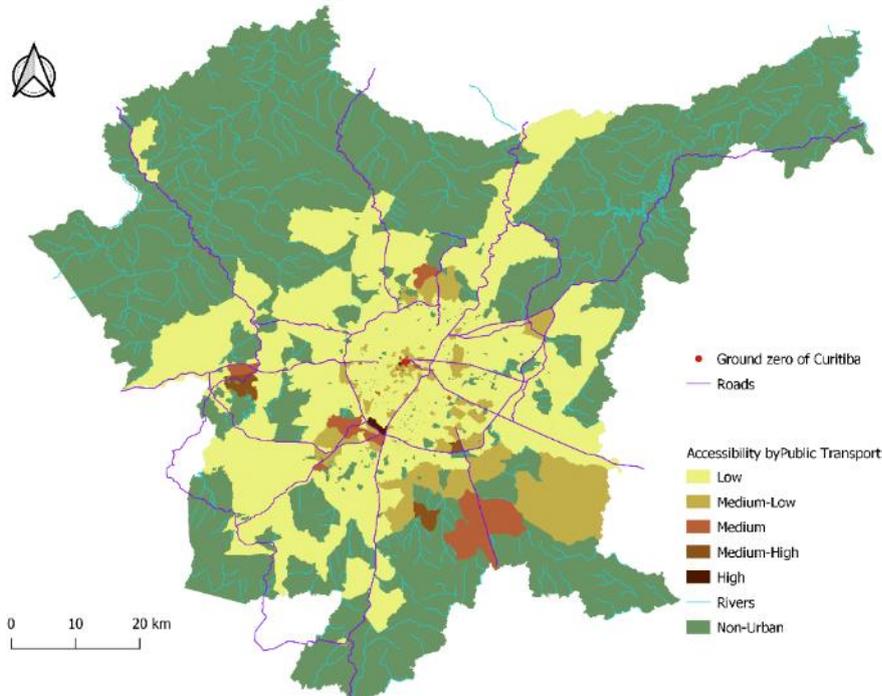
**Table 2 - Descriptive Statistics of the main variables of databank**

	Private		Public		Total	
	Mean	Std. Dev	Mean	Std. Dev	Mean	Std. Dev
Acessibility Private Vehicle	13,098	10,428				
Acessibility Public Transport			8,136	7,842		
Monthly Wage (R\$)	2,519	2,173	1,643	1,477	2,038	1,876
Distance from residence to CBD	11,613	7,842	12,592	7,662	12,219	7,508
Travel time (minutes)	29	20	49	34	40	30
	Individuals	(%)	Individuals	(%)	Individuals	(%)
Expanded Sample	289,614	47,14	351,682	54,83	641,296	100

Source: Own elaboration, from OD survey and RAIS 2017.

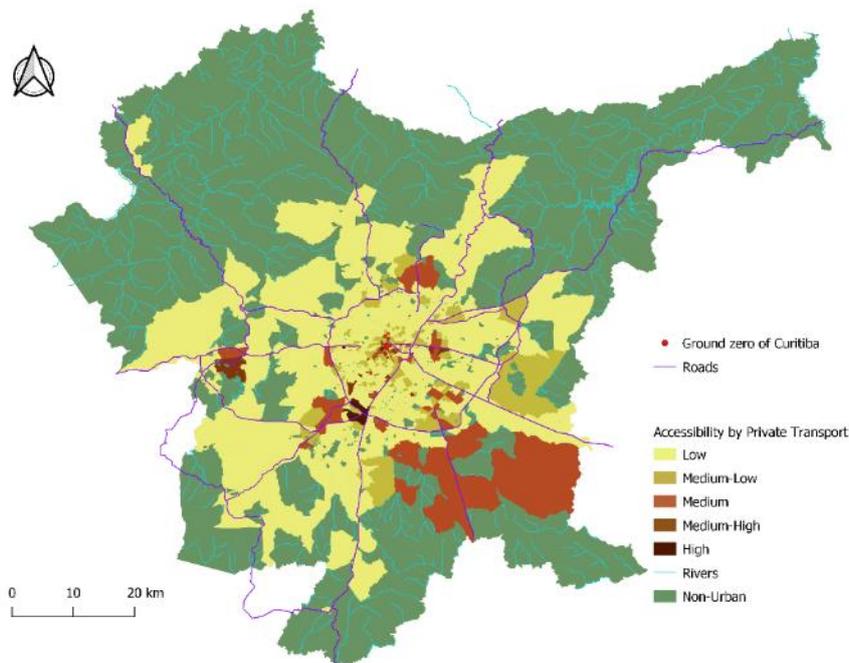
It is shown in Table 2 that accessibility is higher among Private Vehicle users. These individuals also have higher average monthly wages than Public Transport users. Individuals who use Private Vehicles face 20 minutes less than Public Transport users on average.

Taken together, this set of information brings some evidence of implications of mobility conditions on jobs outcomes (monthly wages). The mechanism starts from the travel time, which directly depends of the transport mode. Figures 3 and 4 show the spatial distribution of the accessibility indexes for Private and Public transport modes. These indexes are the observed formal jobs pondered by the impedance function in equation (2). Therefore, in the MAC transport infrastructure, Private Vehicles provide higher accessibility to formal jobs than Public Transport users. Such as the formal job spatial distribution, the accessibility indexes are dispersed over MAC, and they see to be positively related to the road infrastructure. Thus, it is expected that the accessibility indexes have positive effects on monthly wages, as they represent potential effects of economics of agglomeration in the job market (Melo and Graham, 2009; Haddad and Barufi, 2017).



**Figure 4 - Accessibility indexes for Public Transport users in CMA.**

Source: Own elaboration from the data base.



**Figure 5 – Accessibility indexes for Private Vehicle users in CMA.**

Source: Own elaboration, from the data base.

We assume the hypothesis of simultaneity between the accessibility indexes and monthly wages, which might cause bias on an econometric estimation in equation (1). Therefore, Mincerian equations were also tested with 2SLS models, using a geographic instrument.

In addition to the described methodology, we also tested the hypothesis of different magnitudes of such effects on monthly wages, which are based on workers' level of qualification. Therefore, we created two skilled-based groups: 1) Skilled 1, that are individuals who had at least started or even completed a bachelor course, in addition to individuals who had completed a postgraduation education; 2) Skilled 2, with individuals who had completed a bachelor or a postgraduation course. As base line, we created non-skilled groups: for individuals who haven't started a bachelor course in comparison to Skilled 1; and individuals who haven't completed a bachelor course for Skilled 2.

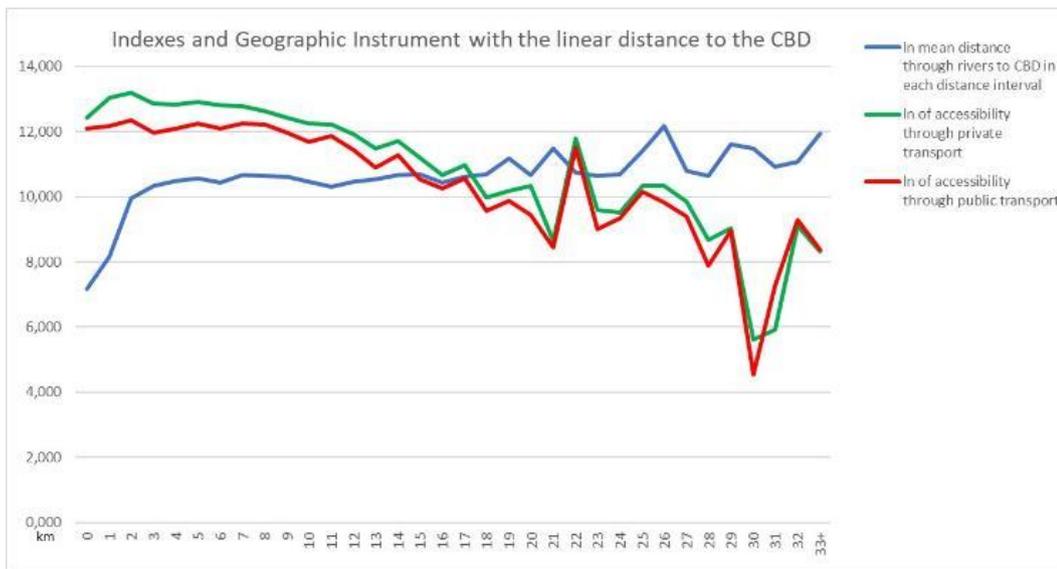
With the skill-based groups indicated by dummy variables, we had interacted them with accessibility indexes predicted in two<sup>51</sup> first stage equation of 2SLS models, that used the geographic instrument as the exogenous variable. After that, four 2SLS models were obtained, with two models for each transport mode, aiming to measure possible differences of the measures of accessibility between non-skilled group against Skilled 1 and and non-skilled group against Skilled 2.

### 4.3 The Instrument

As mentioned in section 2, Regional and Urban studies that face the problem of simultaneity have been outlining such issue with historical and geographical information as instruments. Therefore, the strategy to deal with the issue of simultaneity adopted by the present study is the one developed by Haddad and Barufi (2017) for the MASP, by using geographical information of rivers network, assuming this aspect as being decisive on the present spatial configuration of the observed area by their study.

The Metropolitan Area of Curitiba is located in a very irregular mountain topographic site, which is 935 meters above sea level. This geographical condition implied in strong difficulties for transporting commodities from and to this area at the first steps of its urban consolidation, in the 19<sup>th</sup> century, as discussed by Karpinski (2011). Rivers brought transport solutions for early explorers, and influenced on the location of its first villages and farms, as related by (Schimidlin et al., 2009). Thus, human occupation and transport infrastructure were encouraged to be close of the rivers.

<sup>51</sup> For the Public and Private Transport modes.



**Figure 6 – Accessibility to formal jobs and Linear Distance to Curitiba CBD**

Source: Calculated from the Databank.

Given the historical and geographical configuration of the study area, we assume that rivers exogenously influenced on the present location of its firms and residences. Therefore, as well as Haddad and Barufi (2017), the strategy to observe this variable was by computing the distance of each zone centroid to the closest river, and adding such distance to the distance from the closest river bank to the CBD of the city of Curitiba<sup>52</sup>, traversing the network of rivers shown in Figures 4 and 5. This procedure was made to all of the 954 zones of this study area. The resulted variable from this procedure presents negative correlation with both the accessibility indexes, as is illustrated in figure 6.

## 5. RESULTS

According to the results obtained by the main linear coefficients of interest, there are positive effects of better job accessibility on monthly wages for all of the workers of CMA. There are also higher effects on workers who have commuted to workplace by private vehicles and completed a bachelor course.

### 5.1 The Spatial Mismatch effects on workers of Metropolitan Area of Curitiba

The models in panel A of Table 2 tested the linear prediction of the accessibility indexes by the instrumental variable in addition to the independent covariates set in equation (1). The first stage tests indicate significant linear negative correlation between distance to CBD through rivers and both of the accessibility indexes, which suggests some contribution of the instrument to deal with endogeneity.

In panel B, OLS and 2SLS coefficients predict ln of monthly wages with the *X* set of individual information in equation (1) as control variables. All of the accessibility indexes coefficient are significant at 1% level, and OLS and 2SLS models have different magnitudes of effects of the accessibility to job opportunities in the monthly wages. As we assume endogeneity between monthly wages and the accessibility indexes, due to higher power of dwelling location response to workers who earn higher wages, it is theoretically expected that if an endogenous model computes information of individuals who have chosen to face longer travels to work in order to consume local amenities, then it tends to vanish the effects of the accessibility measure on monthly wages (Sjoquist, 1992; Holzen, 1991).

If the 2SLS models are better than OLS models to estimate the causality of accessibility to formal job opportunities on monthly wages, thus higher magnitudes of the coefficients that observe the Spatial Mismatch on job outcomes are expected, because they correct part of the bias generated by endogeneity. In Panel C, robust F statistics and R partial testes suggest that the models with instrumented variables contribute significantly to predict wages.

<sup>52</sup> The Central Business of this city in the edge of the economic formation of CMA. In the early years of its urban consolidation, merchants used to meet in the CBD to trade commodities, and explorers, to rest from long trips. In the recent spatial configuration, this central area still plays an important role on the location of jobs for the city of Curitiba, as claims Thomé and Porsse (2019).

**Table 2 – Results of OLS and 2SLS models with tests**

Panel A: Main first stage linear coefficients	OLS	OLS		
In Accessibility Index (Dependent Variable)	Private	Public		
In Distance to CBD through Rivers	-0.194***	-0.226***		
Adjusted R squared	0.155	0.186		
F Statistics	3,460	4,589		
Panel B: Main linear coefficients	Model 1	Model 2	Model 3	Model 4
	OLS	OLS	2SLS	2SLS
Transport Mode:	Private	Public	Private	Public
In Accessibility Index	0.038***	0.036***	0.126***	0.112***
Instrumented by distance to CBD through rivers:	NO	NO	YES	YES
Number of observations	2,579	3,025	2,579	3,025
Adjusted R squared	0.267	0.246	0.254	0.227
F Statistics	6,251.96	6,024.78	-	-
Panel C:	Adjusted R2	Partial R2 (Shea)	Robust F statistics	Prob > F
In Distance to CBD through Rivers (Private)	0.155	0.122	15.034	0.000
In Distance to CBD through Rivers (Public)	0.186	0.160	48.661	0.000

Source: Own Elaboration, from the database. Note1: p-Value<0.1\*, p-Value<0.05\*\* and p-Value<0.01\*\*\*.

Obs: Additional controls for Panel B models: age, age squared, gender, level of education dummies, sector of activity, dummies to indicate if the individual works and lives in the same zone, dummies to indicate if he works on an urban zone, constant term. Sampling weights are applied to the estimation.

Therefore, the coefficients obtained in models 3 and 4 in Panel B are used by this analysis to measure the Spatial Mismatch effects in monthly wages of workers in the Metropolitan Area of Curitiba who commuted by private or public transport modes, attributed to economics of agglomeration effects (Melo and Graham, 2009; Haddad and Barufi, 2017).

Given the existence of spatial heterogeneity in the level of accessibility to formal job opportunities (Figures 4 and 5) among zones of work, the values of the 2SLS models indicate economic advantages for specific workers in MAC, due to their respective workplace and transport mode. The hypothesis for such effects on monthly wages is that these accessibility indexes synthesize agglomeration economics effects, mainly from the transport infrastructure and the density of jobs for each zone. Therefore, this structural mechanism for individual economic earnings, related to the spatial configuration of the study area (formed by the distribution of jobs, dwellings and transport infrastructure), is a source for economic inequality among MAC citizens.

Models 3 and 4 suggest some difference on potential earnings due to the transport mode. As long as these linear coefficients represent some sensitivity of the monthly wages by the magnitudes of the accessibility indexes at each workplace, and taking in consideration that workers who commuted by public transport have lower mean wages and accessibility than those who used private transport (Table 2), we found some evidence that transport mode can also be a source for economic inequality in the study area. Transport mode effects on the labor market outcomes corroborate the findings of Haddad and Barufi (2017) and Matas et al. (2010), where the mechanism might be related to lower efficiency in commutation along the urban space for the public transport mode.

**5.2 Results for the Spatial Mismatch within transport mode based on Skill level**

The models in Table 3 aim to investigate more specific effects of agglomeration economics based on groups of educational level: Skilled 1 and Skilled 2. Therefore, by interactions between the accessibility indexes and individual educational levels, the dummy coefficients aim to test the hypothesis of more effects of the measures of accessibility on individuals who had at least started a bachelor course (Models 1 and 2) or concluded bachelor course (Models 3 and 4), with both groups being compared to non-skilled groups.

Within transport mode groups, the results in Table 3 suggest the existence of higher effects of the measures of accessibility on monthly wages for Skilled 1 workers, and even higher effects for Skilled 2 workers.

**Table 3 – Results of 2SLS models and tests, with interaction dummies for skill level**

Models with interaction dummies indicating skill level:				
	Model 1	Model 2	Model 3	Model 4
	Skilled 1	Skilled 1	Skilled 2	Skilled 2
Transport Mode:	Private	Public	Private	Public
In Accessibility Index x Skill dummy	0.100***	0.188***	0.170***	0.210***
In Accessibility Index (Instrumented)	0.087***	0.050***	0.085***	0.072***
Coef. Ratio (Skill dummy x Index and Index):	1.14	3,76	2	2,91
Number of observations	2,561	3,017	2,561	3,017
R squared	0.258	0.256	0.259	0.249
First Stage Tests for In Distance to CBD through Rivers as instrument:				
Adjusted R2	0.155	0.194	0.154	0.192
Partial R2 (Shea)	0.055	0.138	0.079	0.153
Robust F statistics	16,745	56,309	24,756	63,639
Prob > F	0.000	0.000	0.000	0.000

Source: Own Elaboration, from the database. Notes: p-Value<0.1\*, p-Value<0.05\*\* and p-Value<0.01\*\*\*.

Obs: Additional controls for the 2SLS models: age, age squared, gender, level of education dummies, sector of activity, dummies to indicate if the individual works and lives in the same zone, dummies to indicate if he works on an urban zone, constant term. Sampling weights are applied to the estimation. Skilled 1 correspond to individuals who had started or completed a bachelor course, as well as completed a postgraduation course. Skilled 2 correspond to individuals who had completed a bachelor or completed a postgraduation course.

In this comparison within transport mode groups, it is also possible to quantify the differences of magnitudes of such economic gains based on skill level, observing the ratio between the accessibility indexes resulted by dummy interactions and the accessibility indexes. From this, the lowest differences of potential economic gains based on skill level is among private transport users, when potential economic gains between skilled 1 and non-skilled individuals are compared in Model 1.

In models 3 and 1, the differences in potential economic gains between Skilled 2 and the non-skilled individuals that used private cars suggest higher differences in economic gains than between Skilled 1 and non-skilled individuals that also used this transport mode. But the opposite is valid for public transport users in Models 2 and 4, which indicate that within individuals of this transport mode group, skilled 1 workers had higher differences in potential gains.

Therefore, differences in economic gains among skill level-based groups are higher for the public transport users. A reasonable source for such outcome in MAC's job market may be related to spatial equilibrium determinants, as we suppose the existence of endogenous choice of place of residence location for this study area, where wealthier individuals had shown preference to live in areas that with more intense BRT infrastructure (Figure 1).

The differences in economic gains for public transport users may reflect the existence of spatial segregation<sup>53</sup> among them (Hernandez, 2017, Pereira et al., 2020; Gobillon et al., 2007). The spatial and job markets equilibrium determinants discussed by Lucas and Rossi-Hansberg (2002) and Zenou (2002) may also play a role in such differences, if richer individuals have more response power in the housing market, choosing to live in areas with more densities of job opportunities, given that the TOD policies of Curitiba and MAC regional integration had also incentivized the creation and growth of employment centers and industrial poles, with the provision of transport infrastructure (Thomé, 2020; Firkowski, 2002; Carmo and Moreira, 2020).

Therefore, by having a bachelor or postgraduation course, the economic inequality related to the spatial configuration of the study area decreases, because it allows for the access to more job opportunities, and consequently, for more decision-making power for high skilled<sup>54</sup> individuals. Among transport modes, the inequality in potential economic gain is lower for the private transport users, which may reflect more efficiency in intraurban travels, if compared to public transport.

## 6. FINAL REMARKS

There was a trend in Brazilian metropolitan areas, of consolidating their urban spaces under unplanned spatial expansions, with lack of economic resources, that in the present reflect on spatial uneven access to urban infrastructure, resulting in spatial inequalities of economic opportunities. We investigated the effects of heterogeneous accessibility levels among the workers of Metropolitan Area of Curitiba on their respective monthly wage in 2017, in order to understand such economic effects in a metropolitan area that is considered a good reference on urbanization strategies worldwide.

The present investigation found empirical evidence of positive effects of the measures of accessibility to formal jobs on monthly wages for the study area. We attribute such causality to agglomeration effects, related to the spatial density of formal jobs and transport infrastructure. Such effects on the observed uneven spatial distribution of accessibility might be a source of economic inequality in the Metropolitan Area of Curitiba.

We also found different magnitudes of such effects on the monthly wages based on social groups. Skill level and transport mode matter for the accessibility effects of formal job opportunities on economic earnings. High Skilled Individuals that traveled to work by private vehicles had the lowest unequal potential economic gains in the labor market attributed to the observed effects of accessibility. Such inequality in potential economic gains is stronger among public transport users, but it decreases among those who were high skilled.

The implications of the spatial configuration of Metropolitan Area of Curitiba on the job market corroborate a Spatial Mismatch Hypothesis. Therefore, even though the study area has had innovative urban consolidation policies, there is necessity of spatial relocation of job, dwellings or infrastructure, to achieve an urban space that promotes equal opportunities of potential economic gains in such labor market. Future researches could investigate the magnitudes of the needed spatial relocations, as well as identify effective policies to vanish geographic barriers on the local labor market.

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<sup>53</sup> It is important to state that the decision of the local of residence is not necessarily strongly based on the proximity to the near BRT infrastructure in MAC. However, it is reasonable to affirm that in this area, such infrastructures were prioritized to be allocated in central areas, where in parallel, high income individuals lived even before the existence of the BRT system, in 1974. After that, the Curitiba TOD urban expansion policies usually suggested more densities of job and dwellings near BRT infrastructures.

<sup>54</sup> Which were defined in this study as workers who had at least started a bachelor course.

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**ACCESSIBILITY INDEX TO ITALIAN UNIVERSITIES****Massimiliano Rossetti, Greta Scolari, Mario Boffi, Matteo Colleoni**

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**ABSTRACT**

The Italian University Network for Sustainable Development (RUS) has carried out for the first time a national survey about university commuting. Thirty-seven universities joined the survey and almost 70.000 questionnaires have been collected. Years of academic mobility management policies and research show that universities may be seen as important players able to contribute to the definition of urban and metropolitan policies concerning mobility and accessibility. In this connection, the research shows the need to focus on students commuting in a comparative perspective in order to highlights the role of the universities – together with other institutions – in the mobility planning. The linkage between the right to education and the right to mobility makes it essential to sustain the latter in order to promote better academic performances, in a context characterized by high level of commuting and the absence of a serious national housing policy for students. The essay focuses on the definition of three synthetic indices: the accessibility index, the quality of life index and the sustainability index. After having identified the most important university areas within the Italian context, the focus has been on the comparison among them in terms of territorial and structural features and, eventually, of the commuter's behaviour. Even though specific issues characterize each context, students preferably move by public transit. However, the accessibility index shows important differences in the access to the university. The index – which takes into account the time, the cost and the frequency of the travel – shows that the most accessible areas are Siena, Bologna e Pavia, confirming their nature of university towns defined by a high level of transfer students and active travel. The quality of live index – which summarize the accessibility index and the satisfaction of the travel, shows that the areas with the highest level of quality of live are both, the university towns and some regional university areas such as Milan and Turin. To conclude, the sustainability index provides a global assessment of the commute within the areas. In particular, it summarizes the accessibility and the quality of life indices, and additional elements such as structural features (density of public transport) and environmental features (kg of CO2 emitted per year during the commute). According to the quality of life index, the most sustainable areas are the university towns and some regional university areas such as Milan and Rome. The other areas are characterized by low levels of sustainability, due to the use of private modes of transport, greater home to university distance, higher level of CO2 emissions, and higher costs of the commute. In a context characterized by the increasingly relevance of the university in the field of the mobility management, studying university commuting is essential in order to identify new solutions to enhance the accessibility to the university and to promote sustainable mode of transport. In this connection, universities are no longer considered simply as attractors, but as active players within the governance of the mobility.

## **Regular Session: RS04 - Local finance**

**17:30 - 18:45 Tuesday, 25th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/89679862880>**

**Chair Maha Assaad Idrissi**

## THE PRACTICES OF THE MANAGEMENT CONTROL SYSTEM AT THE LEVEL OF LOCAL AUTHORITIES IN THE ERA OF ADVANCED REGIONALIZATION

**Maha Assaad Idrissi<sup>1</sup>, Omar Taouab<sup>2</sup>, Youssra Oudda<sup>2</sup>**

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### ABSTRACT

All over the world, whether in developed or developing countries, decentralization occupies the same space of interest and arouses the same enthusiasms as a social project in order to consolidate local development. Decentralization understood as a technique of administrative organization corresponds, according to Dupuis and Guédon (1991) to "the attribution of a certain autonomy to communities which are administered freely by elected councils, under the control of the government". It therefore implies a transfer of skills from the central level to local authorities. Like businesses, the quest for performance concern also local authorities. For several years, performance has been at the center of modernization and restructuring projects for public organisations, in particular local authorities, with the aim of achieving solid local development. In Morocco, the decentralization process has been initiated since independence, the reform began in a significant way in the local authorities by the adoption in 1976 of the municipal charter until 2011 with the entry into force of the new constitution, then in 2015 with the adoption of advanced regionalization which leads to an administrative division and the adoption of organic laws; Law 111-14 relating to regions, Law 112-14 relating to prefectures and Law 113-14 relating to municipalities. The implementation of these reforms is accompanied by the emergence of new management control practices in local and regional authorities which will be forced to set up an effective management control system to monitor their performance. to implement modern management tools and methods that are used in private organizations and adapted to the specificities of local authorities in order to contribute to local development (new public management). In this research work we will clarify the practices of the management control system at the level of local authorities, its evolution and its impact on their performance. Because of the new strategy adopted on the national level which aims at the implementation and the success of the site of the advanced regionalization. This research project seems interesting to us to deal with, in order to describe the different aspects of the concept of the performance of local authorities and to sketch the different performance tools used in them and see what purpose and mission they meet.

## THE SUBNATIONAL CROWDING OUT EFFECT OF MINING WINDFALLS ON LOCAL TAX EFFORT: DOES THE LEVEL OF LOCAL PROVISION OF PUBLIC GOODS MATTER?

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### ABSTRACT

Although the resource curse offers evidence for the national crowding out generated by resource windfalls from mining, subnational crowding is not fully understood. This knowledge gap is problematic because these windfalls should cover the negative externalities that exist in host zones. Additionally, these communities have different fiscal responsibilities due to the mining industry's environmental, economic, and social costs. This article estimates the subnational crowd out of mining windfalls on local tax collection by considering different levels of fiscal responsibility. We employ panel data for 322 Chilean municipalities between 2008 to 2019 using an exogenous rule for assigning mining windfalls in order to attribute causality. Our results confirm the crowding out hypothesis. First, a US\$1.0 increase in mining windfalls results in a US\$0.2 decrease in the property tax collected. Second, subnational crowding out is twice as high in municipalities with a high level of fiscal responsibility; a US\$1.0 increase in windfalls crowds out US\$0.4 in non-resource revenue. Third, considering the influence of nearby neighborhoods and the spatial interdependence, crowding out is four times higher than non-spatial estimations. These results call for local policies that consider the fiscal capacity of a municipality in order to disincentivize undesirable behavior from extra resource revenues.

### KEYWORDS

Mining windfalls, subnational crowding out, public goods.

### JEL classification

H20, H30, H71, Q32, Q33

### 1. INTRODUCTION

Mining production is intimately related to an extensive list of local negative externalities, which without the presence of institutional compensation mechanisms, would unequivocally affect the quality of life of the local population. The impact on the ecosystem and the environment, namely, an increase in waste production, the depletion of water resources, and a lack of fossil fuel energy sources (Ghorbani and Kuan, 2016; Tapia, Davenport, Townley, Dorador, Schneider, Tolorza and von Tümpling, 2018) are some examples of externalities. The health risks in children and adults exposed to heavy metal dust are especially relevant in those locations close to extraction (Tapia, Valdés, Orrego, Tchernitchin, Dorador, Bolados and Harrod, 2018). In social terms, these communities also have higher levels of economic inequality, alcoholism, AIDS, prostitution, child labor, poverty, and worse educational outcomes among other negative externalities (Pegg, 2006; Luffn, 2015; Oyarzo and Paredes, 2018).

Another considerable effect of the mining industry, albeit less documented, is the strategic behavior developed by low-tier governments in regard to tax collection (for example, van der Ploeg and Poelhekke, 2017; Masaki, 2018). In Chile, the fiscal and institutional capacity to collect local taxes that do not come from the mining industry coupled with low territorial decentralization is particularly concerning as it gives rise to subnational crowding out (Oyarzo and Paredes, 2019).

Governments employ different mechanisms to compensate local host communities, including obligating the mining industry to provide monetary compensation via non-ad valorem property taxes on mineral concessions. In Chile's case, these *mining patents* (hereafter mining windfalls or MWs) are tied to the 1993 Chilean mineral law #19,143 and consist of an annual payment per hectare meant for the extraction and/or exploration of ores. Mining windfalls directly benefit the local governments where the mining concessions exist and by institutional design are not sensitive to price fluctuations; therefore, they represent an essential source of extra income for mining towns. However, the remote location of these mining municipalities, a weak fiscal capacity, and a low presence of qualified human capital in their respective local administrations might be factors in MWs not having a positive influence on their economic development. The literature alludes to this by pointing out that mining municipalities have the worst performance in public education (Oyarzo and Paredes, 2018), a limited local provision of public goods (Paredes and Rivera, 2017), and lower rates of entrepreneurship (Oyarzo, Román, Atienza and Luffn, 2020).

As a particular case of the median-voter model, subnational crowding out corresponds to a cross substitution between an additional income (via a non-matched grant from resource windfalls) and the effort made by host localities in collecting local tax (Mogues and Benin, 2012; Oyarzo and Paredes, 2019). This article improves and deepens what was developed by Oyarzo and Paredes (2019). We use the external grant from MWs to understand to what extent a non-matched grant crowds out local taxes, conditioned to the low-tier government's responsibility to provide public goods. The external grant undoubtedly increases the public-goods provision and should improve key indicators of local development in hosting zones. The conditioned analysis by fiscal responsibility is done for two key reasons. First, strong centralization and continuous central transfers such as fiscal equalization mechanisms from the upper-tier government to subnational governments would allow for a reduction in fiscal efforts that have a high socio-political cost (OECD, 2009). Second, the limited fiscal autonomy that low-tier governments have in budget decisions means that these transferences are insufficient, considering the policy's design and spatial asymmetries are directly related to reducing inequality (OECD, 2013).

Following these arguments, we take advantage of an institutional rule that classifies municipalities according to the local capacity to provide public goods (SUBDERE, 2015).<sup>55</sup> We employ this exogenous criterion to define groups of cities with different capabilities to satisfy the local population's requirements. This allows us to evaluate the magnitude of subnational crowding out with lasting effects on hosting zones, which are negatively impacted, among other things, by the adverse effects of the mining industry on the environment.

We test our hypothesis using 322 Chilean municipalities from 2008 to 2019, which corresponds to approximately 93% of all low-tier governments.<sup>56</sup> The dependent variable corresponds to property tax (PT), one of the primary local incomes for cities in Chile and which accounts for nearly 22% of the Municipal Permanent Income (Ingresos Propios Permanentes or IPP).<sup>57</sup> Additionally, these resources are a direct result of local collection efforts, as budget management is an exclusive responsibility of local administrations. The PT is calculated using a property's appraisal value and is earmarked for low-tier governments (Servicio de Impuestos Internos, 2018). Municipalities can improve the tax system by updating the appraisal values of properties (Servicio de Impuestos Internos, 2020).

To attribute causality between resource windfalls and local taxes, we take advantage of the exogenous allocation rule for assigning MWs in hosting municipalities in order to deal with endogeneity concerns via the spatial distribution of mining exploitation and extra revenues (Dahlberg et al., 2008). This rule earmarks 50% of the mining patents for the low-tier government (municipalities) where mining concessions are located. The remaining 50% goes to the corresponding mining region (Congreso Nacional de Chile, 1992). To deal with the remaining endogeneity from unobservable variables affecting local public expenditures or measurement errors, we use an exogenous rule to classify the subnational governments according to the Under-secretary for Regional and Administrative Development (SUBDERE, 2015). We use High Provision Responsibility (HPR) and Low Provision Responsibility (LPR) classifications to label the municipalities based on their capacity to provide public goods. We then estimate the incidence of resource windfalls over local tax revenues and whether this strategic behavior is maintained vis-à-vis different specifications and econometrics techniques. We also employ static and dynamic estimations which consider the influence of both recent and past resource windfalls on current local tax collection via temporal lags over the dependent variable. We use municipal fixed effects to control for time-invariant unobservable effects such as local leadership characteristics, among other local factors, and we control for heteroskedasticity via a robust variance estimator in cluster form.

The results are robust, and they do not reject crowding out effects. First, a US\$1 increase in MWs results in a US\$0.2 decrease in PT. Second, this subnational crowding out is twice as high in municipalities with a high level of fiscal responsibility. A US\$1.0 increase in MWs crowds out US\$0.4 in non-resource revenue. This result is even more relevant considering that 40% of the mining municipalities correspond to subnational governments with high fiscal responsibility (HPR). The results for cities with LPR are not significant. Third, if we consider the influence of nearby neighborhoods and the spatial interdependence among low-tier governments, the crowding out is four times higher than non-spatial estimations. These results call for local policies that consider the capacity of the local provision of public goods to disincentivize undesirable behavior resulting from extra resource revenues. In addition to the fiscal impact, the mining industry's adverse effects on the ecosystem and the local population is a matter of discussion in the creation of policies that promote economic development without the cost being transferred to future generations.

The paper is organized as follows: the next section presents a literature review on the mining industry's impact on the environment and local populations in developing countries. In section three we describe the data while section 4 describes methodological concerns. We then present the results in section 5. In section 6 we summarize our main findings and the resulting political implications.

## 2. LITERATURE REVIEW

### 2.1 Mining industry and economic sustainability in Chile

The ecological impact of the mining industry in Chile has increased notably since the 1970's when copper-tailings dumps were simply abandoned due to insufficient environmental regulation. For example, in the Elqui river basin of north-

55 For more information see: Resolution No. 178 from BCN Chile. Available here: <https://www.leychile.cl/Navegar?idNorma=1079104>

56 We have excluded some municipalities from the analysis because of information limitations and the presence of islands. The information corresponds to the National Municipal Information System (SINIM).

57 Despite the apparent low contribution of the property taxes on IPPs, it is especially relevant considering that most of the income received by municipalities in Chile comes from conditional grants by the upper-tier government.

central Chile, tailings dumps were left throughout the alluvial plains of the rivers and creeks until the 1990's (Oyarzún et al., 2012; Bastida, 2002). Other examples include the conflicts surrounding the Pascua-Lama gold mining project at the Chilean-Argentinian border in 2009 (Urquiza, 2010), the stakeholder participation process within the Environmental Impact Assessment System in Chile (Lostarnau, 2011) or the development of industrial ecology strategies in the copper mining industry (Reyes-Bozo et al., 2014). The negative impacts on the environment have undoubtedly left an ecological debt. Since 1980, and under the pressure of different NGOs (e.g., the Center for Research and Planning for the Environment and the Institute of Ecology) progress was made in drawing attention to the negative impacts of mining activity on the environment. However, the ambiguous environmental regulation and the lack of a unified environmental protection initiative did not result in robust policy, but rather specific responsibilities assigned to individual institutions. From a national perspective, it was not until 1989 that environmental policy was consolidated under the Chilean Association of Industrial Producers. The subsequent policy managed to encourage, albeit with nuances, mining companies to deal with the harmful effects of the production process. Large companies mostly adopted these initiatives, allowing them to comply with international standards. Smaller mining companies, however, often did not, and so environmental management was not a universal priority. However, the significant ambiguities in regard to environmental responsibility and the central government's lack of coordination to designate a common entity for environmental regulation (at least ten government entities shared that responsibility) maintained a status quo in the industry (Lagos, 1990).

With the arrival of democracy in 1990, the new government administration formed CONAMA, a commission that established a legislative and institutional framework on environmental matters, which was then consolidated into The Environmental Basis Law in 1994. Law 19,300 created an environmental framework for the mining industry, which eliminated certain ambiguities that affected environmental regulation and disincentivized some of the practices that negatively affected the local host zones. It includes standards on emissions and environmental quality as well as procedures (via the Environmental Impact Assessment System, SEIA) for the authorization of new and existing projects that impact the environment. Procedures were regulated for the intervention of entities tasked with regulatory matters that impact the environment, the declaration of saturated areas, pollution prevention, decontamination plans, environmental damage, and compensation claim procedures.

Mining and especially copper production have since experienced substantial growth with Chile being one of the countries with the highest capture of foreign investment (US\$18 billion) between 1990 and 2002 (Ghorbani, 2016). This upward spiral in copper mining inevitably led to increased water and electricity consumption and increased waste production. Another significant milestone in environmental legislation was the enactment of Law No. 20,417 in 2010. These regulations were amalgamated into a legislative framework and include the creation of a single environmental responsibility system and an environmental impact measurement procedure, in addition to improved SEIA procedures. The law also includes regulation regarding the preservation and protection of natural resources, the establishment of protected areas, biodiversity, water resources, as well as bureaucratic matters that facilitate increased transparency and public participation. Chile has since signed a series of agreements that promote sustainable development in mining including one in 2013 with the United States, one of Chile's leading investment partners (Ghorbani, 2016). From a subnational perspective, the compensation mechanism towards mining municipalities aims to deal with the mining production's negative externalities. This mechanism and its implications at the local level are detailed in the next section.

## 2.2 Compensation mechanism and institutional design

Literature on the resource curse acknowledges that revenue from resource windfalls must be used to compensate hosting municipalities for the negative externalities associated with the exploitation of natural resources (Hughes, 1975). This extra income is an essential portion of the local budget of a hosting subnational government and allows them to not raise taxes on inhabitants (Stinson, 1977). The principal resource windfalls in Chile come from the mining industry and the principal benefactors are low-tier governments. For example, the revenue from MWs accounted for nearly 40% of the total local revenue collected in mining municipalities in 2019. This fact illustrates the importance of resources from the mining industry in local finances, especially the local budget and in regard to public management. Nevertheless, the empirical evidence for extra revenues in mining municipalities are mixed: Paredes and Rivera (2017) find that the expenditure in public services for recreational or cultural activities increases by only US\$0.5 for every US\$1 from MWs, while Oyarzo and Paredes (2018) find that in the margin, mining municipalities have a worse educational performance than non-mining municipalities. Although they are less exploited, resource windfalls promote perverse incentives within low-tier governments by crowding out PT in mining municipalities. Each dollar collected from MWs in the current period crowds out between US\$0.6-US\$0.9 of residential PT in the future (Oyarzo and Paredes, 2019). However, this paper does not consider the fiscal responsibility of low-tier governments or the particularities of subnational governments in providing public goods, especially in host zones.

The quality of the institution therefore plays a central role in the wellbeing of the local host community. Papyrakis and Gerlagh (2006) show that windfalls derived from a commodity's price boom crowd out several determinants of long-term incomes. The literature also shows that resource rich countries cannot convert their non-renewable natural resources into productive assets, primarily because of failures in policy. Collier and Goderis (2012) reinforce this aspect via a cross-country analysis in which the combination of poor local governance and high-rent commodities such as minerals and oil can precipitate a resource curse in the long run. For example, Boschini et al. (2007) find that the resource windfalls from minerals are the most detrimental to economic development, especially within the context of weak institutions. On the other hand, Boschini et al. (2013) show that the undesirable effects of the mineral industry can be

reversed by strengthening said institutions. Fiscal responsibility therefore becomes non-trivial, especially when considering the heterogeneity of subnational governments and their particularities.

The theory of political clientelism highlights the use of windfalls in municipalities where an incumbent politician has to decide if resource rents will be consumed or distributed as patronage via an increase in public employment (Robinson, Torvik and Verdier, 2006a, 2014b; Robinson and Verdier, 2013). In this model, the increase in fiscal income is a factor of the resource price which is exogenously determined by the commodities' world markets. In Chile, the national legal normative does not allow low-tier government tax collection from either resource production or profit, but rather through mining patents. Therefore, the international fluctuation in the mineral price has no direct impact on the subnational budget. The literature also highlights that extra incomes can increase public debt and cause political myopia, especially in democracies with re-election prospects. Political myopia in the context of budget management and public debt is depicted in the literature and yields discrepancies in politicians' planning horizons that lead to debt build-up (Acharya and Rajan, 2013; Aguiar et al., 2014; Rieth, 2014). Although there is a growing wave of literature aimed at identifying specific channels impacted by resource windfalls (e.g., van der Ploeg and Poelhekke 2016; Fleming and Measham, 2013; Fleming, Measham and Paredes, 2015), there is no consensus on whether local governments prefer to spend these resources in national or local public goods or rather increase local investment in (or transfers to) public education and health. Therefore, it is important and necessary to consider the quality of institutions, and even more so when resource windfalls represent an essential part of the municipal budget.

### 3. DATA

Our research considers a spatial panel with 322 Chilean municipalities from 2008 until 2019, provided by the National Municipal Information System (SINIM). Table 1 shows the number of High Provision Responsibility (HPR) and Low Provision Responsibility (LPR) aligned using the SUBDERE criterion and by the mining condition. According to the table, the mining municipalities present a low variability when considering the provision of public goods or fiscal responsibility: between 93 to 119 municipalities for HPR and 141 to 172 for LPR. It should also be noted that the non-mining municipalities show more variability and are decreasing over the period under analysis: the HPR group starts with 42 municipalities in 2008 but ends the period with 16.

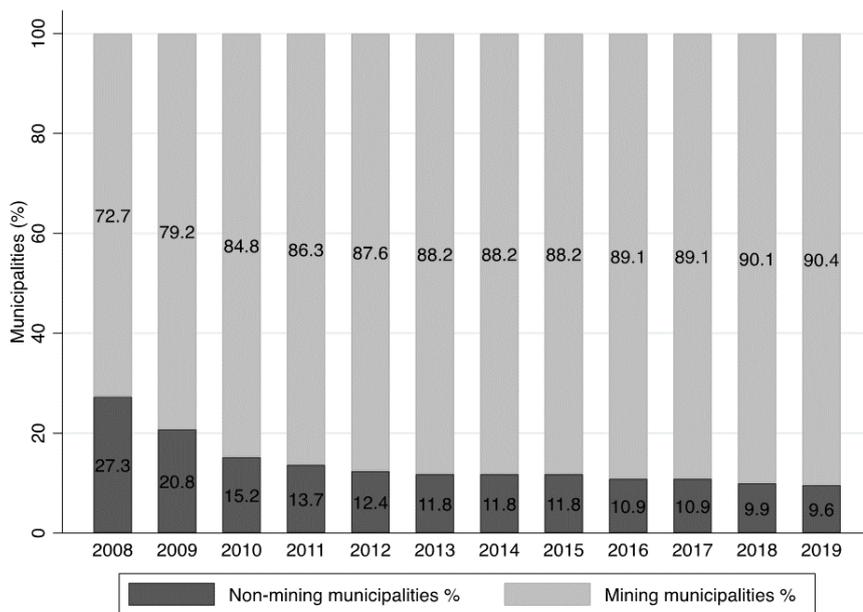
**Table 1. Mining and non-mining municipalities by levels of provision responsibility, 2008-2019**

	Non-mining		N <sub>nm</sub>	Mining		N <sub>m</sub>	N
	HPR	LPR		HPR	LPR		
2008	42	46	88	93	141	234	322
2009	29	38	67	106	149	255	322
2010	28	21	49	107	166	273	322
2011	25	19	44	110	168	278	322
2012	23	17	40	112	170	282	322
2013	20	18	38	115	169	284	322
2014	22	16	38	113	171	284	322
2015	22	16	38	113	171	284	322
2016	21	14	35	114	173	287	322
2017	20	15	35	115	172	287	322
2018	17	15	32	118	172	290	322
2019	16	15	31	119	172	291	322

Note: HRP: High Provision Responsibility; LPR: Low Provision Responsibility. Both are based on SUBDERE Taxonomy, time-invariant. The non-mining and mining conditions are time-variant.

Likewise, the LPR group starts with 46 municipalities but ends the period under analysis with less than half. It is essential to highlight that most of the local governments in this category are mining municipalities as the others do not receive extra income via windfalls.

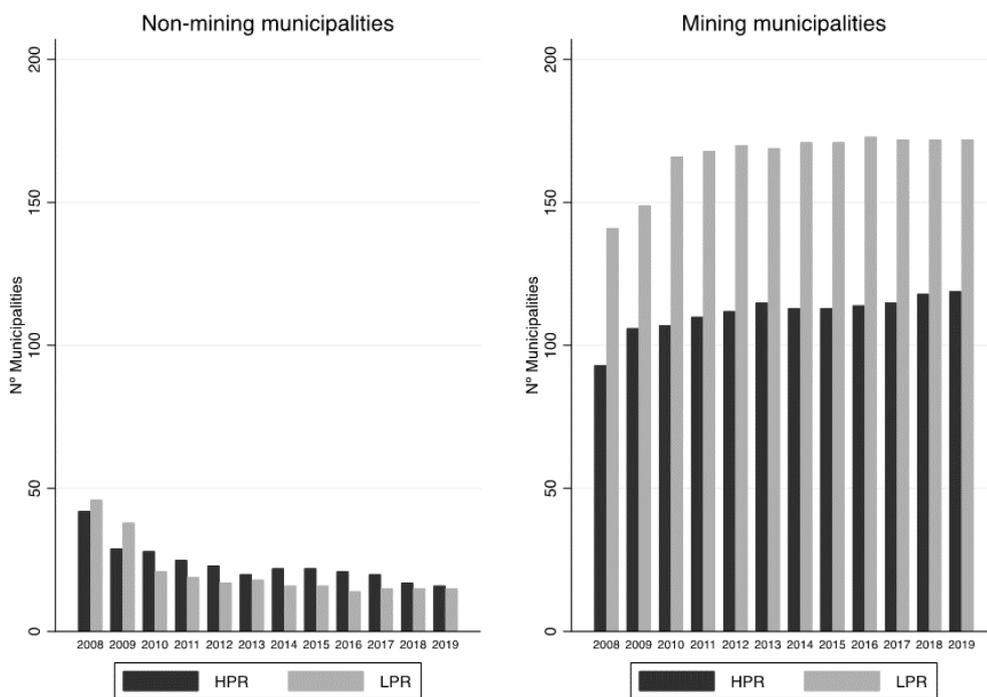
Figure 1 details the participation of mining and non-mining municipalities in the sample. The relative increase of those categorized as mining municipalities stands out, rising from 72.7% to 90.4 at the end of the period under analysis.



**Fig 1. Non-mining and mining municipalities, 2008-2019**

Source: Data from Sinim (2019).

We know consider the categorization of municipalities according to fiscal responsibility (see Figure 2). There are no substantial differences in the number of municipalities in either category (HPR, LPR) for non-mining subnational governments. The opposite is true for mining municipalities: LPR municipalities maintain sustained growth through 2010 and then stabilize until the end of the period.



**Fig 2. Non-mining and mining municipalities by Provision Responsibility, 2008-2019**

Source: Data from Sinim (2019).

Note: HPR: High Provision Responsibility. LPR: Low Provision Responsibility.

### 3.1 Dependent variable

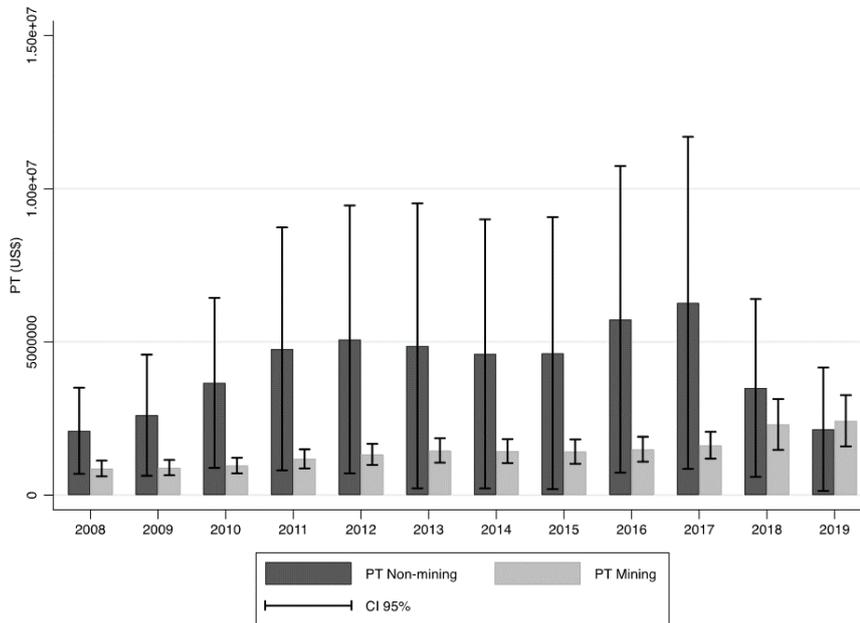
The dependent variable corresponds to the PT collected by each municipality. These resources are generated by local governments, where each municipality has a greater capacity in decision-making. In the context of a non-federal country as Chile, low-tier government can improve the tax system by updating the appraisal values of properties (Servicio de

Impuestos Internos, 2020) or via oversight of commercial PT payments (Biblioteca del Congreso Nacional de Chile, 2018). Municipalities can also invest resources, such as the use of tow trucks to control illegally parked vehicles, although this depends on the provision capacity or fiscal capacity of the local government (Cortes and Paredes, 2016). Table 2 and Figure 3 highlight the summary statistics of PT between 2008 until 2019. Non-mining municipalities have a higher collection of PT than mining municipalities, which constitutes the first sign of significant differences in the collection of local income other than extra income via windfalls. If we consider fiscal responsibility, the previous tendency only persists for the HPR municipalities: non-mining municipalities collect on average US\$7,230,293 while mining municipalities collect less than half (US\$3,209,467). The opposite situation is true for the municipalities classified as LPR: the mining group collected more than twice as much local income (US\$313,464) as non-mining municipalities (US\$115,461).

**Table 2. Summary statistics of the dependent variable. 2008-2019**

Property Tax (US\$)	Non-Mining			Mining		
	Mean	Std. Err	N	Mean	Std. Err	N
All municipalities	3,905,605	486,101	535	1,474,823	70,820	3,329
PT by PR levels:						
HPR	7,230,293	866,431	285	3,209,467	164,894	1,335
LPR	115,461	7,502	250	313,464	10,480	1,994

Note: Property tax at the municipality level (US\$). HPR: High Provision Responsibility; LPR: Low Provision Responsibility. Both are based on SUBDERE Taxonomy, time-invariant.

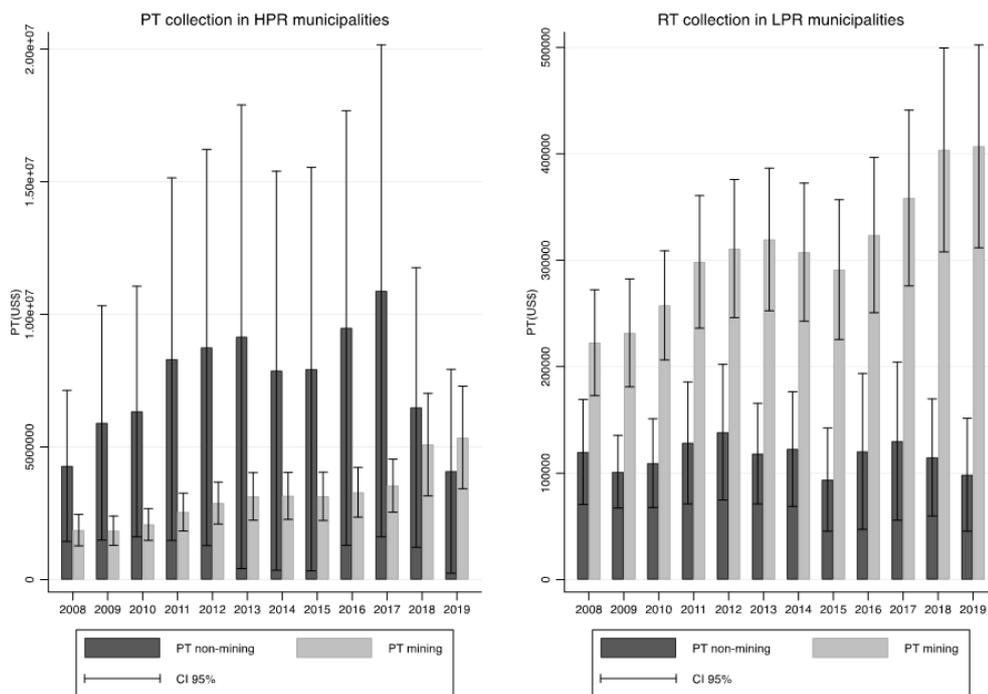


**Fig 3. Descriptive statistics of PT by non-mining and mining municipalities. 2008-2019**

Source: Data from Sinim (2019).

Note: PT: Property Tax.

Figure 4 depicts the dependent variable's descriptive statistics considering the exogenous criterion to define mining municipalities and exogenous taxonomy using SUBDERE criteria to classify the subnational government based on their capacity to provide public goods to the local population. For HPR municipalities and until 2018, the PT collected is higher for non-mining municipalities. Mining municipalities collected more PT in 2019 but the difference is not significant. The opposite case is true for LPR: mining municipalities collected more PT, and the difference is significant according to the confidence interval.

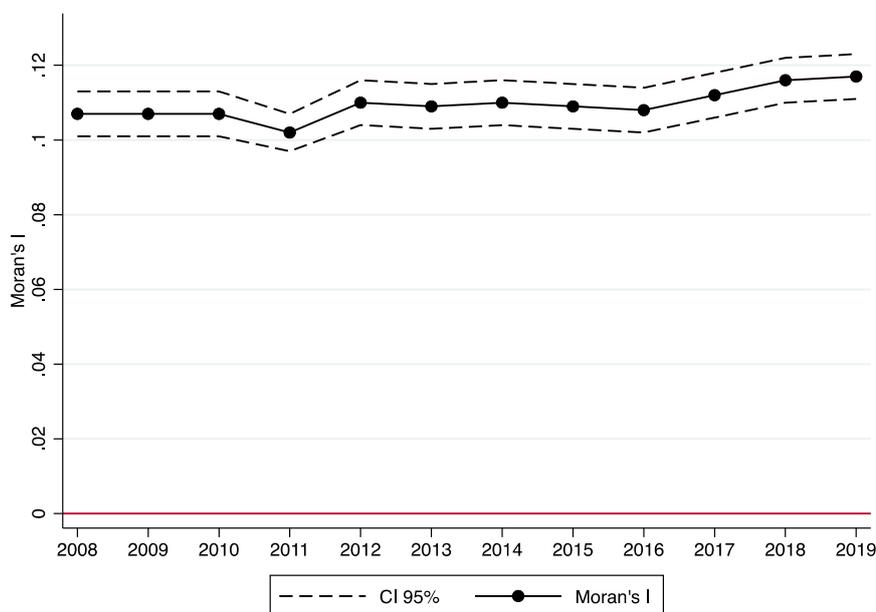


**Fig 4. Descriptive statistics of PT in non-mining and mining municipalities by Provision Responsibility. 2008-2019**

Source: Data from Sinim (2019).

Note: HPR: High Provision Responsibility. LPR: Low Provision Responsibility. PT: Property Tax.

When considering the dependent variable (Figure 5), there is evidence of significant global spatial-temporal autocorrelation via Moran's I throughout the period under analysis. A positive coefficient indicates the presence of spatial autocorrelation in the data (Anselin, 1988). According to Moran's I coefficients, there is a significant and positive correlation between the PT and the spatially lagged PT, which accounts for spatial autocorrelation in the local tax collection, which is persistent over the period under analysis.



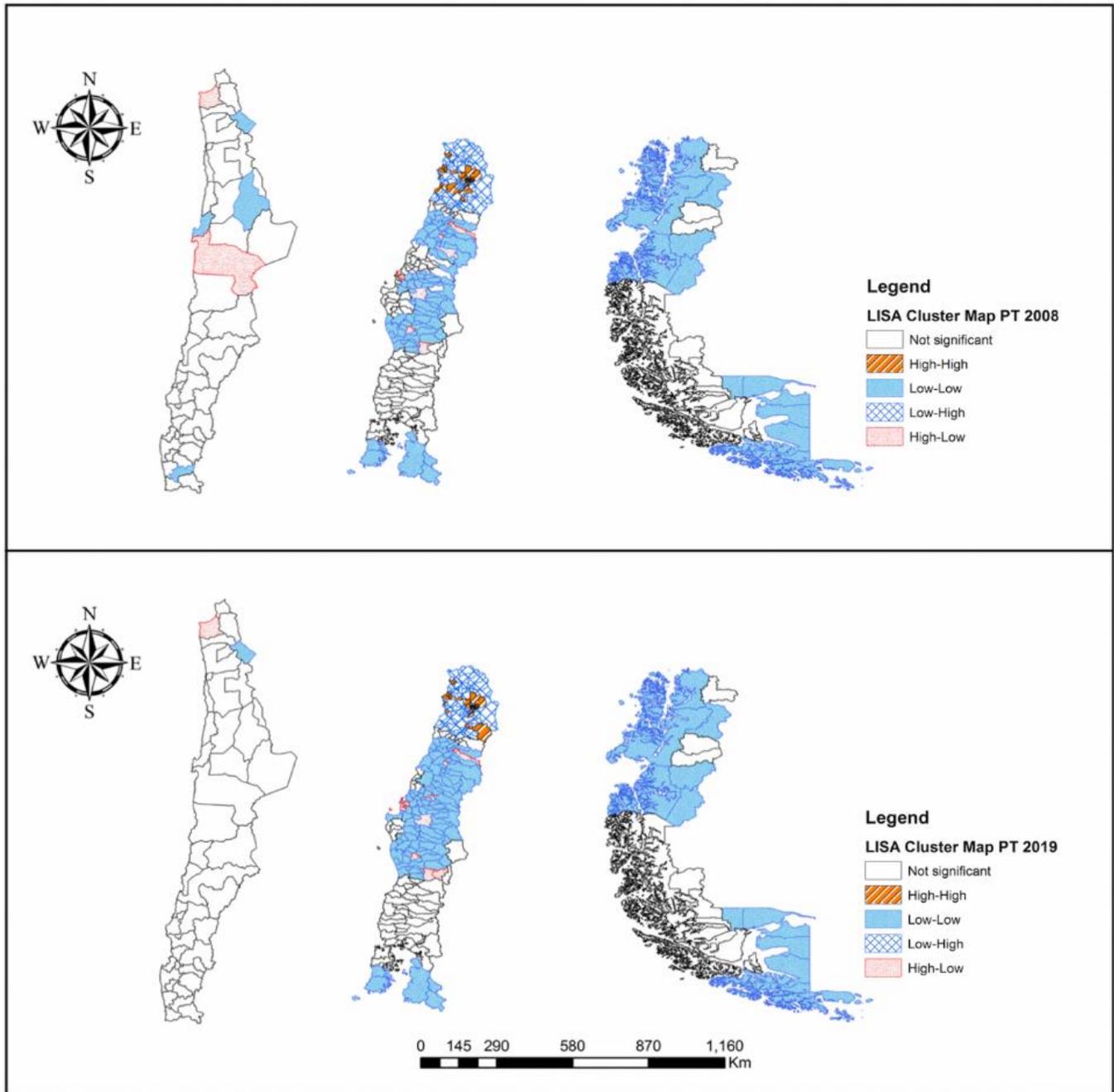
**Fig 5. Spatio-temporal Moran's I for PT across Chilean municipalities, 2008-2019**

Source: Data from Sinim (2019).

Note: The line depicts the Moran's I coefficients estimate considering an inverse distance weight matrix under 9999 random permutations.

At the local level, we present the local Indicator of Spatial Association via a LISA Cluster map in Figure 6 which plots the local Moran's I and which allow us to identify localized map regions where data values are positively or negatively associated with one another (Anselin, 1995). The results show that the clusters high-high (red) and low-low (blue) in the PT collection are persistent over all periods; namely, a spatial cluster concentrated near Santiago with a higher local

collection, and a spatial cluster with a lower local collection in the center-south of the country. These results are persistent and indicate a lasting effect in the local tax capacity over the twelve years.



**Fig. 6. Lisa Cluster Map for PT, 2008–2019**

Source: Data from Sinim (2020).

Note: We consider the inverse distance weight matrix under 9999 permutations. PT: Property Tax.

### 3.2 Explanatory variables

The most important explanatory variable corresponds to the collection of MWs as it allows us to test the crowding out hypothesis, namely, the negative incentive from the resource windfalls on collecting other local income via PT. Subnational governments have limited autonomy in the collection of and management of its income, unless it is local such as PT. We should also highlight the MW collection considering its distribution and heterogeneity through time and between groups according to local provision capacity. Table 3 depicts the summary statistics of the MWs according to the capacity of the provision in public goods. The higher collection of mining patents corresponds to the municipalities categorized as HPR, although the difference is relatively low if we compare it with the other groups.

**Table 3. Summary statistics of MWs in mining municipalities. 2008–2019**

	HPR						LPR						N <sub>M</sub>
	Mean	Std.Err.	P5	Median	p95	N <sub>HPR</sub>	Mean	Std.Err.	P5	Median	p95	N <sub>LPR</sub>	
2008	125,264	41,943	222	8,625	745,099	93	105,976	24,034	331	9,947	704,722	141	234
2009	119,952	37,612	197	8,745	592,736	106	106,995	23,329	506	12,782	696,369	149	255
2010	135,892	41,957	482	10,273	698,632	107	118,691	25,129	864	12,256	640,934	166	273
2011	167,143	50,634	504	12,633	989,168	110	149,836	29,941	527	15,322	798,713	168	278
2012	181,582	55,708	216	12,894	1,070,065	112	168,550	35,373	647	16,655	848,802	170	282
2013	178,227	54,930	202	12,687	1,043,163	115	170,201	35,132	733	16,527	847,389	169	284
2014	168,248	52,137	217	11,792	962,042	113	145,585	31,201	542	12,669	826,731	171	284
2015	145,519	45,655	439	11,167	718,772	113	130,477	28,423	439	9,874	729,315	171	284
2016	140,531	45,027	340	9,813	731,936	114	122,467	26,875	335	9,388	766,580	173	287
2017	144,911	46,688	334	11,172	661,452	115	119,991	26,937	327	9,397	662,071	172	287
2018	146,214	47,789	73	10,362	738,742	118	139,298	30,761	295	7,869	834,524	172	290
2019	134,668	43,835	138	9,857	636,511	119	128,991	28,710	334	7,293	836,838	172	291

Note: Mining windfalls (MWs) (US\$). HRP: High Provision Responsibility; LRP: Low Provision Responsibility. Both are based on SUBDERE Taxonomy, time-invariant.

Table 4 depicts the summary statistics of the explanatory variables. The higher windfall collection of US\$140,552 corresponds to mining municipalities. It is also important to highlight that 53.3% of non-mining municipalities have less capacity to provide public goods as compared with only 40.1% of mining municipalities. To control for other local income, we add the municipality’s own income (net IPP) and a fiscal equalization mechanism (FCM). The net IPP corresponds to the revenue generated autonomously in each low-tier government through local residential and commercial property taxes, (net) MW, local fees (e.g., vehicle registration permits and driver’s licenses), and a gambling tax, among other things. The second local income is the FCM, namely the fiscal equalization mechanism which offsets differences in revenue-raising capacity by redistributing local revenue across subnational governments (Oyarzo and Paredes, 2018, 2019). The higher IPP collection (US\$13,100,000) corresponds to non-mining municipalities with more than double that collected by mining municipalities (US\$ 5,719,076), although with a lower level of heterogeneity. The opposite case is true for the FCM: both groups collect approximately US\$4,800,000 each, although non-mining municipalities have a higher variance. We employ proxies using agglomeration economies via population, density, and socioeconomic characteristics such as the poverty index. In population terms, both groups reach similar levels. However, if we consider density, the differences are significant. Mining communities show a low density since the industry is usually located in peripheral areas with a low population. The figures for municipal poverty are lower for non-mining municipalities, although they are only one percentage point below that of mining municipalities (16.7%).

In regard to the professionalization index, there are no substantial differences between mining and non-mining (25.9% and 28.3%, respectively) groups. The expenditure on municipal workers for non-mining municipalities is double (US\$5,669,787) that of mining municipalities (US\$2,891,346). One-third of mining municipalities are located in coastal areas, while 25% of non-mining subnational governments are located in coastal areas. The distance to Santiago is not significant. In regard to the proxy by political influence, there is a higher level of political alignment between the local and central governments in non-mining municipalities (43.7%) compared to mining municipalities (36%).

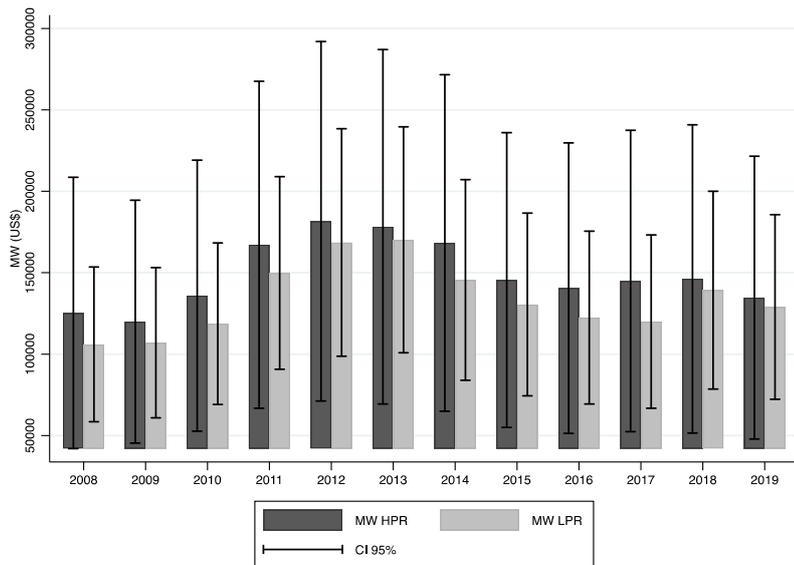
**Table 4. Summary statistics of explanatory variables. 2008–2019**

Variable	Non-Mining		Mining	
	Mean	Std. Err.	Mean	Std. Err.
<b>(1) Local finance and economies of scale</b>				
(US\$) MW	0	0	140,552	7,473
(D) Groups (HPR=1; LPR=0)	0.467	0.022	0.599	0.008
(US\$) Own incomes net (IPP)	13,100,000	1,378,240	5,719,076	222,151
(US\$) Fiscal Eq. M. (FCM)	4,722,331	211,538	4,902,403	117,294
(#) Population	68,391	3,539	51,671	1,513
<b>2) Local social characteristics</b>				
(%) Poverty	15.1	0.5	16.7	0.2
(Km2) Density	4,327	239	389	25
(D) Coastal municipalities	0.247	0.019	0.296	0.008
<b>3) Municipal endowment and favoritism hypothesis</b>				
(%) Professionalization	25.9	0.4	28.3	0.2
(US\$) Municipal workers	5,669,787	393,602	2,891,346	71,758
(Km) Distance to Santiago de Chile	422	24	499	8
(D) Coalition	0.437	0.021	0.360	0.008
N	535		3,329	

Note: Explanatory variables at municipal level (US\$). Professionalization corresponds to the percentage of individuals qualified as professionals (college degree). The coalition is a dummy variable by municipalities aligned to the central government in political terms. D: Dummy variable.

Figure 7 depicts the resource windfalls according to the SUBDERE taxonomy. During the period under analysis the highest collection of MWs corresponds to the municipalities with the most significant capacity to provide public goods,

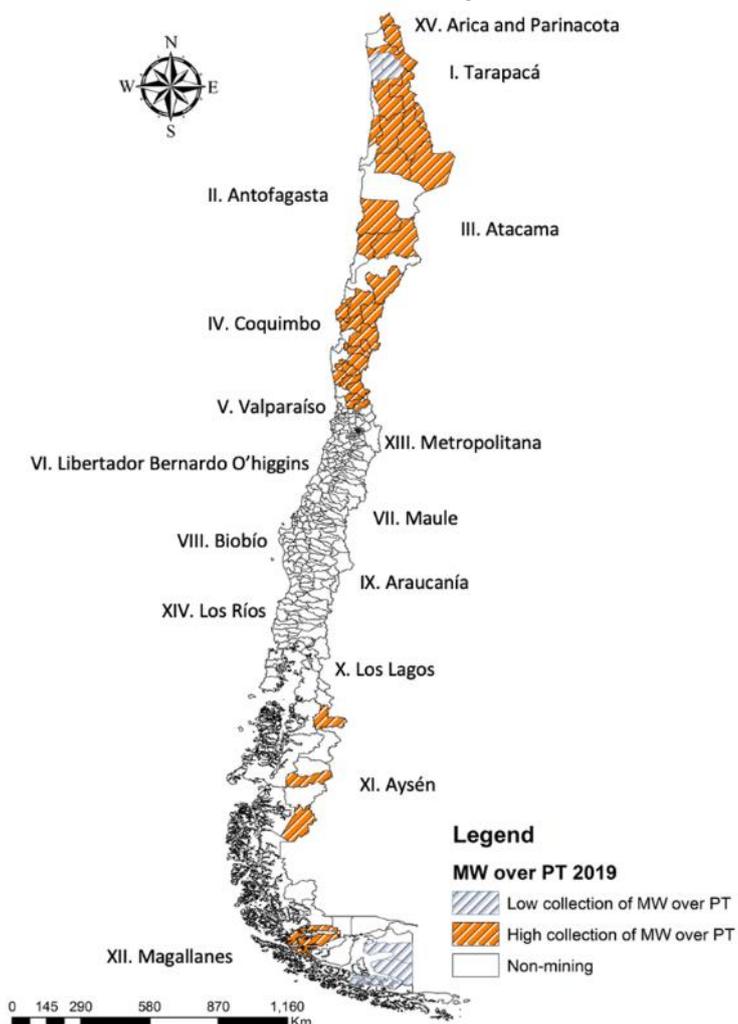
namely HPR. However, between groups, the confidence intervals overlap, indicating the absence of significant differences. This increases the importance of controlling for these differences by considering other variables.



**Fig 7. Descriptive statistics of MW by Provision Responsibility at the municipal level, 2008-2019**

Source: Data from Sinim (2019). Note: MW: Mining Windfalls. HPR: High Provision Responsibility. LPR: Low Provision Responsibility.

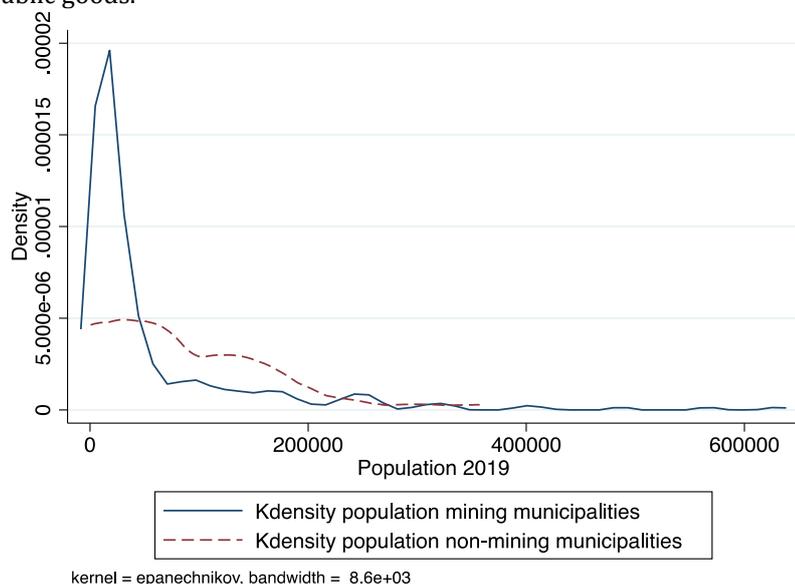
According to Figure 8, in 2019 the spatial distribution of mining patents for municipalities with the highest supply capacity is concentrated in the mining regions in northern Chile. The municipalities with the lowest supply capacity are, to a lesser extent, concentrated in municipalities in the extreme north and south.



**Fig. 8. Spatial distribution of MW over PT in mining municipalities (%) in 2019**

Note: MW: Mining windfalls. PT: Property tax.

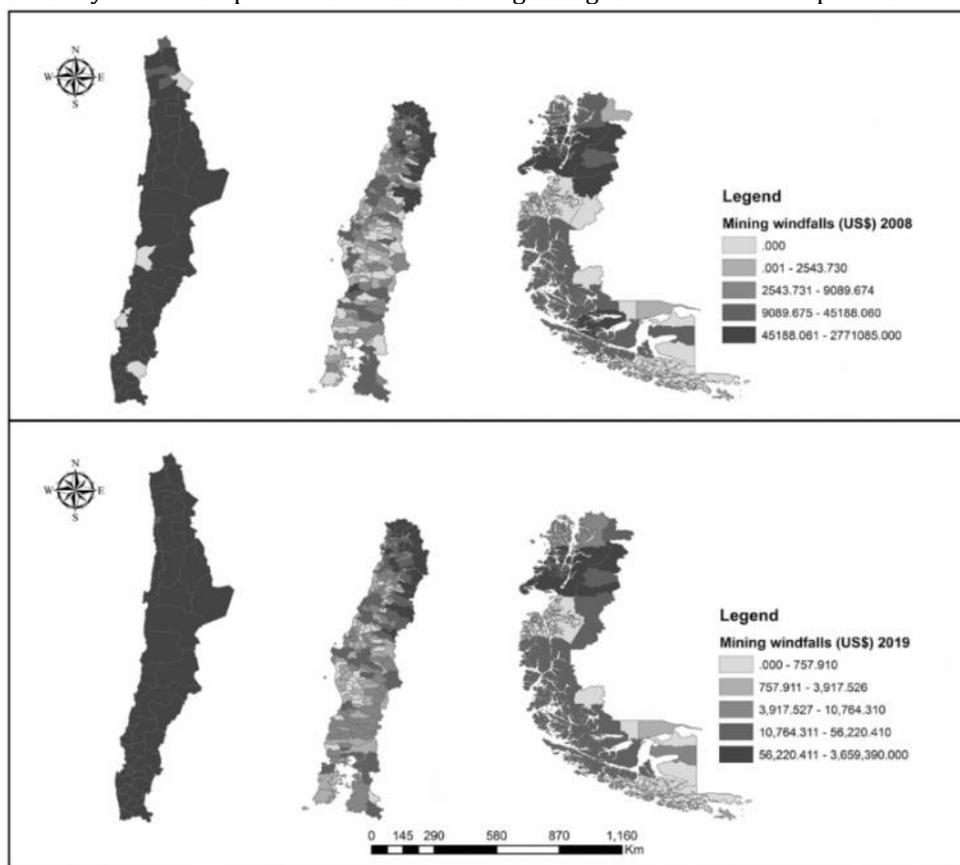
We must also consider economies of scale and how they impact the provision of public goods. Figure 9 shows the empirical distribution via the local population's Kernel density and distinguishes between mining and non-mining municipalities. Mining municipalities present a higher density at the beginning of the distribution, which confirms the low population density in extraction zones. Far fewer highly populated mining municipalities exist. These results highlight the importance of controlling for the size of the population in terms of economies of scale in the provision of public goods.



**Fig 9. Kernel density estimates of the population across mining and non-mining municipalities, 2019**

Source: Data from Sinim (2019).

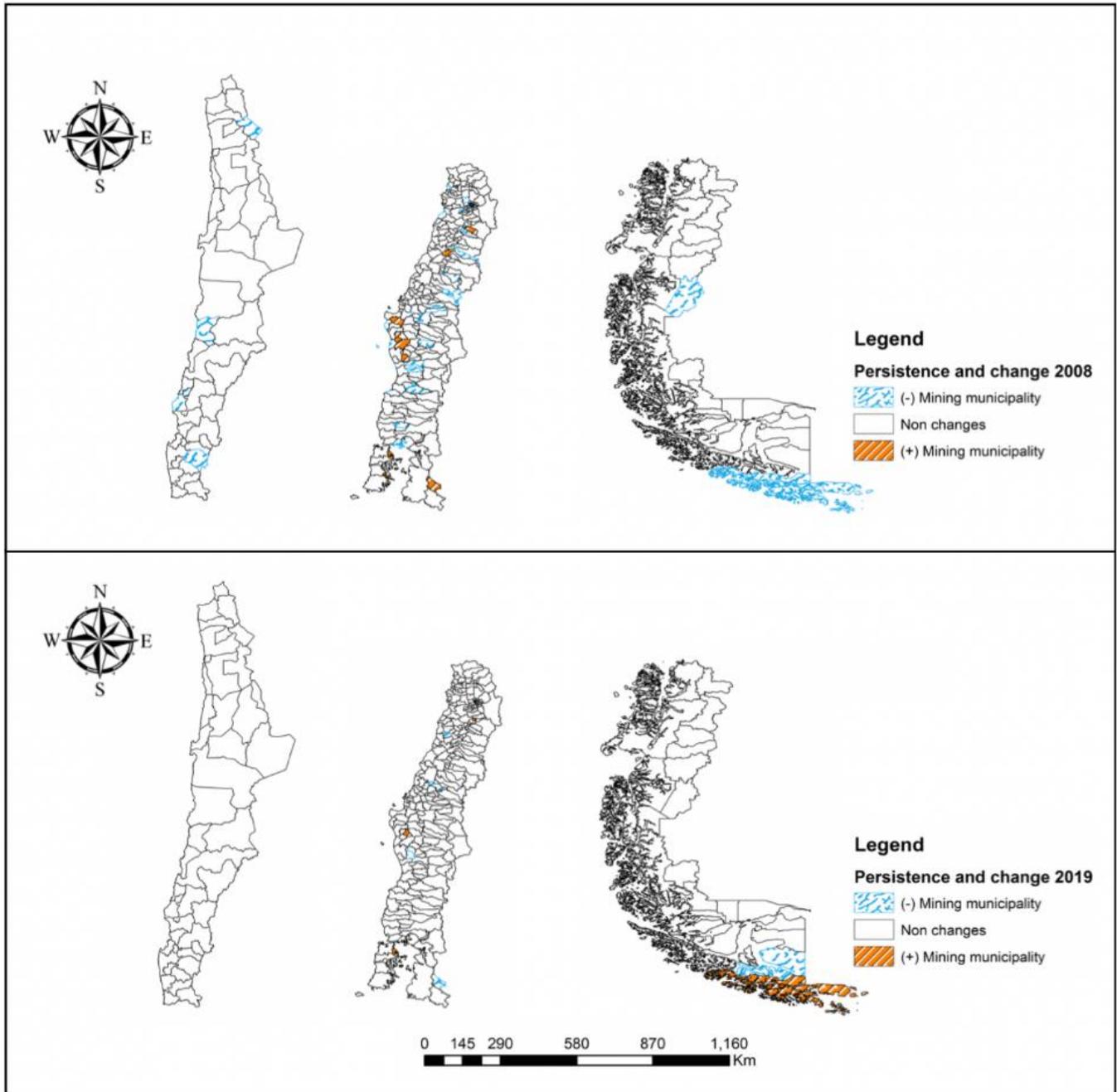
According to Figure 10, when considering quintiles in the spatial distribution of mining patents, the concentration and low variability of the largest tax collections in the northern part of the country are confirmed. This pattern remains relatively stable and persistent both at the beginning and the end of the period.



**Fig 10. Spatial distribution of MW in Chilean municipalities by quintiles, 2008–2019**

Source: Data from Sinim (2019).

Finally, when considering the spatial distribution of the mining municipality category in persistence and change terms between 2009 to 2019 (Figure 11), it is important to note that the municipalities that abandon mining are persistent in the southern part of the country. Whereas when considering the temporal dynamics of becoming a mining locality, there seems to be no such definite pattern.



**Fig. 11. Spatial distribution of mining category, persistence, and changes across Chilean municipalities, 2009-2019**

Source: Data from Sinim (2020).

Note: (+) correspond to municipalities that change of category to mining municipality. (-) correspond to municipalities that change of category to a non-mining municipality.

#### 4. METHODOLOGY

To identify the causal effect of the MWs on the collection of PT we employ two exogenous criteria. Namely, we take advantage of the exogenous allocation rule for categorizing mining municipalities according to the Chilean Mining Code and the exogenous taxonomy proposed by SUBDERE to classify the subnational governments according to their capacity to provide public goods to the local population. Using both criteria, we identify the subnational crowding out hypothesis and evaluate this undesirable effect against different econometric models. Considering that subnational governments consider previous decisions regarding the collection of local taxes when making current decisions (Buettner and

Wildasin, 2006), we first approximate the subnational crowding out between PT and MWs by estimating the following equation (1):

$$PT_{it} = \beta_0 + \beta_1 MW_{it-1} + \beta_2 d_{it} + \beta_3 (MW_{it-1} \times d_{it}) + \mathbf{x}_{it}\boldsymbol{\theta} + t + m_i + \epsilon_{it} \quad (1)$$

Where  $PT_{it}$  corresponds to the property taxes collected by a low-tier government  $i$  in year  $t$ ;  $MW_{it-1}$  represents the MWs collection lagged one period by a mining locality  $i$  in year  $t - 1$ .  $d_{it}$  corresponds to a fixed effect of 1 or 0 according to the exogenous allocation rule and the mining municipality category. To capture the marginal effect of mining patents on mining municipalities, we use the interaction between the MWs collection lagged one period and the fixed effect indicator  $d_{it}$ . The vector  $\mathbf{x}_{it}$  includes control variables accounting for local finance and economies of scale, local social characteristics, municipal endowment, a favoritism hypothesis and all variables that impact the tax collection on the dependent variable under analysis: namely, net IPP and the FCM, population, the population squared, the poverty index, proxies for agglomeration economies, a coastal municipality fixed effect, efficiency and professionalization indicators, and public workers in local governments.  $t$  corresponds to a time fixed effect that accounts for structural shocks and  $m_i$  represents the low-tier government time-invariant random effect. Finally,  $\epsilon_{it}$  corresponds to the error term.

However, the previous equation ignores the effect of providing public goods developed by low-tier governments. The following equation (2) adds this effect:

$$PT_{it} = \beta_0 + \beta_1 MW_{it-1} + \beta_2 d_{it} + \beta_3 tp_{it} + \beta_4 (MW_{it-1} \times d_{it}) + \beta_5 (MW_{it-1} \times PR_{it}) + \beta_6 (d_{it} \times PR_{it}) + \beta_7 (MW_{it-1} \times d_{it} \times PR_{it}) + \mathbf{x}_{it}\boldsymbol{\theta} + t + m_i + \epsilon_{it} \quad (2)$$

Where  $PR_{it}$  corresponds to the dummy variable equal to 1 if the local government is classified as HPR and 0 for LPR. In this sense, we add the interactions between  $(MW_{it-1} \times PR_{it})$ ,  $(d_{it} \times PR_{it})$  and the triple interaction as  $(MW_{it-1} \times d_{it} \times PR_{it})$  to report the marginal effect for mining municipalities categorized with HPR and LPR. The two previous equations do not consider the dynamic component underlying the past collection of local taxes in the current collection. The following dynamic equation (3) is depicted via the Blundell-Bond system-GMM approach (Blundell and Bond, 1998):

$$PT_{it} = \beta_0 + \beta_1 MW_{it} + \beta_2 d_{it} + \beta_3 PR_{it} + \tau PT_{it-1} + \mathbf{x}_{it}\boldsymbol{\theta} + t + m_i + \epsilon_{it} \quad (3)$$

We consider  $PT_{it}$  an additional explanatory variable. The dependent variable lagged in one period  $PT_{it-1}$  serves as an inertia test or inertia hypothesis (Wooldridge, 2010). We present the marginal effects of this equation for all municipalities and HPR and LPR separately against multicollinearity problems.

The specifications above do not consider the spatial autocorrelation or spatial interdependence underlying the variables under analysis. In this context, the MWs are spatially concentrated in mining hosting zones according to Chile's geographical features, namely in the extreme north and south of the country. These particularities will negatively affect the local collection of other non-resource incomes, promoting the substitution of local incomes that might have a higher political and/or economic cost to collect (van der Ploeg and Poelhekke, 2017). To deal with these concerns, we employ a spatial econometric technique in a dynamic panel context that allows us to report the spatial effects, namely, direct, indirect, and total in the short and long run of the MWs via the following equation (Elhorst, 2012):

$$PT_{it} = \beta_0 + \beta_1 MW_{it} + \tau PT_{it-1} + \phi \sum_{j=1}^n w_{ij} PT_{i,t-1} + \rho \sum_{j=1}^n w_{ij} PT_{jt} + \mathbf{x}_{it}\boldsymbol{\theta} + \sum_{k=1}^K \sum_{j=1}^n w_{ij} x_{jtk} \gamma_k + t + m_i + \epsilon_{it} \quad (4)$$

Where  $\phi$  corresponds to the parameter of the dependent variable lagged in space-time,  $w_{ij}$  is a distance-based spatial weights matrix,  $\rho$  is the spatial autoregressive term according to the dependent variable,  $w_{ij} x_{jtk}$  corresponds to the explanatory variables' spatial filter, and  $\gamma$  is the parameter that accounts for the  $k$  spatially lagged explanatory variables. This equation corresponds to the Dynamic Spatial Durbin Model, which allows us to control for an inertia hypothesis, introduce the spatial filters in space-time, and control for bias by omitted variables that potentially exhibit spatial dependence in a general framework (LeSage and Pace, 2009).

While this model allows us to control for potential spatial autocorrelation, it is necessary to obtain the marginal impacts of the variables under analysis (direct, indirect, total) in a dynamic context. The direct impact reports the changes in the  $i$ th unit under the analysis of the  $MW_{it}$  on the local collection of  $RP_{it}$ . This can be seen as the average impact of the MWs on PT. The indirect impact corresponds to the spillover or feedback of the  $j$ th unit under the analysis of the MWs on non-resource incomes ( $j = i$ ), namely the average impact of the nearest neighborhood. The total impact is the direct and feedback effects of the MWs on PT. We obtain the marginal effects of standard errors using MC simulation (Belotti et al., 2013). Finally, this model considers the sequential effects of the dependent variable over their current values lagged in time, space, and space-time.

## 5. RESULTS

Table 5 depicts the results for equation 1 and includes the robust and corrected standard errors in parenthesis. According to our hypothesis, we expect past resource windfalls via MWs to crowd out the contemporaneous collection of the PT. The three columns present static panel estimations and the marginal effect of mining patents on the dependent variable considering controls in progressive form. The first column considers only controls for local finance and economies of scale (1), meanwhile the second and third columns consider (1) + (2) local social characteristics and (3) municipal endowment and a favoritism hypothesis. In all estimations, the effect of the past collection of MWs ( $d_{it} = 1$ ) harms the contemporaneous collection of local taxes. However, our results are only significant when all of the controls are considered; for each dollar collected via mining patents in  $t - 1$ , US\$0.2 is crowded out in the current collection of PT.

Table 5. Static panel data estimation results for PT

	RE (Eq 1)	RE (Eq 1)	RE (Eq 1)
	(1)	(2)	(3)
$MW_{it-1}$	-0.0974	-0.125	-0.136
	(0.112)	(0.114)	(0.108)
$d_{it}$	42753.3	42004.7	34809.2
	(44044.3)	(43474.2)	(43776.2)
$MW_{it-1} \times d_{it}$	-0.0721	-0.0727	-0.0768 <sup>+</sup>
	(0.0476)	(0.0463)	(0.0433)
Marginal Impacts for $MW_{it-1}$			
$d_{it} = 1$	$\beta_1 + \beta_3$	$\beta_1 + \beta_3$	$\beta_1 + \beta_3$
	-0.169	-0.197	-0.213 <sup>+</sup>
	(0.123)	(0.126)	(0.118)
$d_{it} = 0$	$\beta_1$	$\beta_1$	$\beta_1$
	-0.0974	-0.125	-0.136
	(0.112)	(0.114)	(0.108)
Controls <sup>9</sup>	(1)	(1) + (2)	(1) + (2) + (3)
Yearly F.E.	Y	Y	Y
N	3542	3542	3542
R <sup>2</sup>	0.870	0.871	0.872

Note: All variables at the municipal level.  $MW_{it-1}$  represents the mining patents collected by a mining municipality  $i$  lagged one period.  $d_{it}$  correspond to fixed-effect by mining municipalities. <sup>9</sup>Controls by columns: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km2, coastal municipalities (D), plus (1). **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), distance to Santiago (km), coalition (D), and (1) + (2). All estimations include yearly dummies. Robust standard errors in parentheses.<sup>58</sup> Significance levels: <sup>+</sup>  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ ,\*\*\*  $p < 0.001$ .

Figure 12 depicts the results in graphical terms. The confidence intervals for the mining municipalities are stable and confirm the crowding out hypothesis but only for regression 3 (R3).

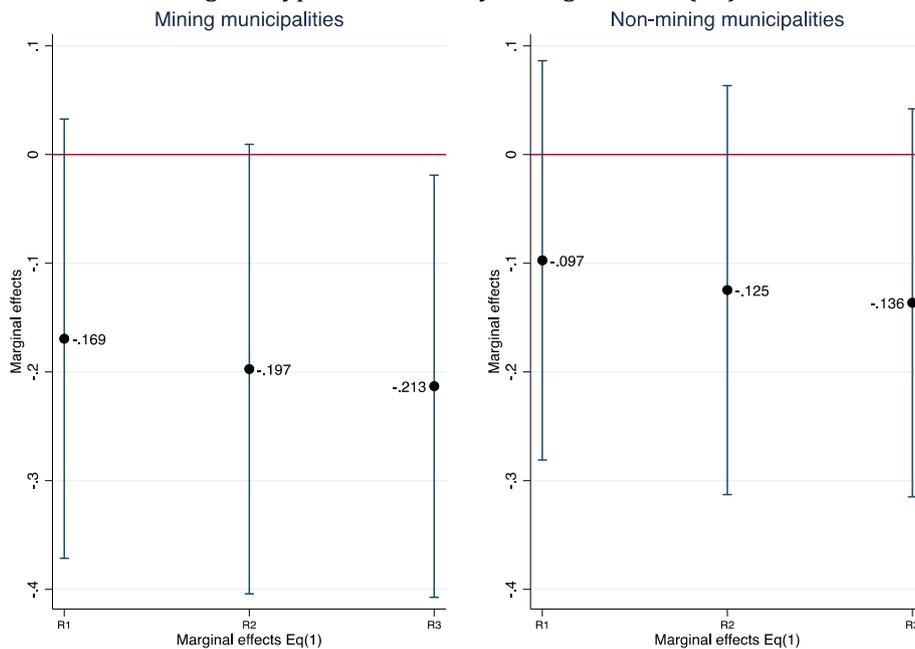


Fig. 12. Marginal effects on PT model 1, 2008-2019. (Eq 1)

Source: Data from Sinim (2020). Note: R1, R2, and R3 consider different specifications adding controls in the progressive form: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km2, coastal municipalities (D), plus (1). **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), distance to Santiago (km), coalition (D) and (1)+(2). CI 90%.

Equation (2) includes the effect of the level of fiscal capacity in the local provision of public goods, and Table 6 reports these results. The last two columns confirm the crowding out hypothesis and the importance of the local capacity in the provision of public goods, namely for HPR ( $d_{it} = 1 \times PR_{it} = 1$ ) each dollar collected via MWs in the past crowded out

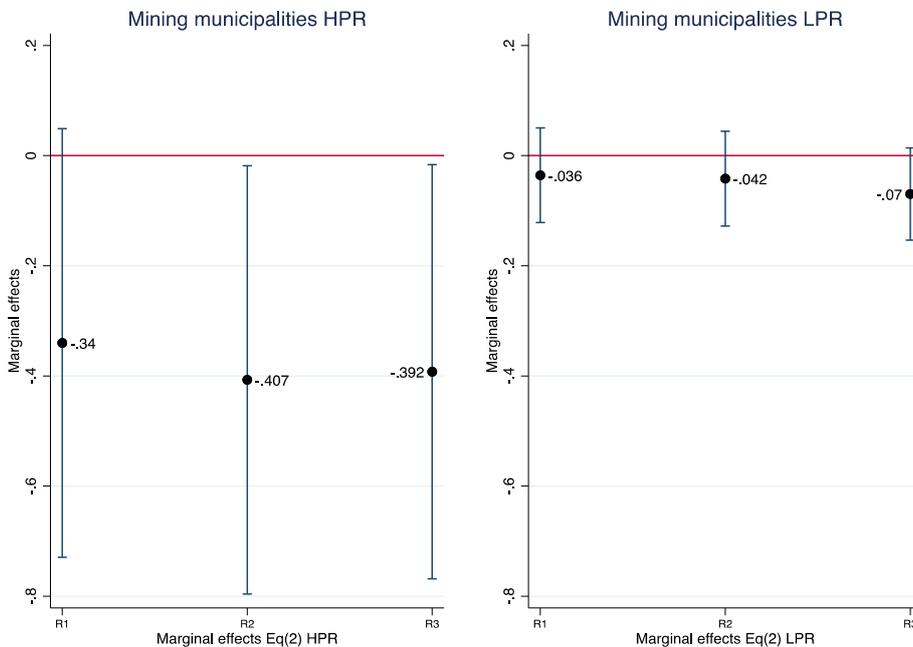
<sup>58</sup> We present only fixed effects estimations that do not include time-invariant factors: distance to Santiago, coastal municipalities and the fixed effect by subnational governments. The results for random effects estimations are available and can be requested from the authors (only for static models).

US\$0.4 in the current collection of local taxes. This result is significant as the crowding out effect is almost double the previous table, which illustrates the importance of considering a local government’s capacity in terms of provision. Figure 13 also depicts the stability of the estimations for the HPR group. The mining municipalities are otherwise categorized as LPR without significant results in any of the estimations.

**Table 6. Static panel data estimation results for PT by groups: HRP-LRP**

	RE (Eq 2)	RE (Eq 2)	RE (Eq 2)
	(1)	(2)	(3)
$MW_{it-1}$	0.00512	-0.00250	-0.0227
	(0.0612)	(0.0603)	(0.0579)
$MW_{it-1} \times d_{it}$	-0.0408	-0.0393	-0.0471 <sup>+</sup>
	(0.0275)	(0.0268)	(0.0245)
$MW_{it-1} \times PR_{it}$	22.15	21.94	20.15
	(21.36)	(21.07)	(20.67)
$d_{it} \times PR_{it}$	69766.2	63085.2	46873.7
	(150969.7)	(149138.5)	(150632.5)
$MW_{it-1} \times d_{it} \times PR_{it}$	-22.45	-22.31	-20.47
	(21.34)	(21.03)	(20.61)
Marginal Impacts for $MW_{it-1}$			
$d_{it} = 1 \times PR_{it}$ (HPR)	$\beta_1 + \beta_4$	$\beta_1 + \beta_4$	$\beta_1 + \beta_4$
	-0.340	-0.407 <sup>+</sup>	-0.392 <sup>+</sup>
	(0.237)	(0.236)	(0.229)
$d_{it} = 1 \times PR_{it}$ (LPR)	$\beta_1 + \beta_4 + \beta_7$	$\beta_1 + \beta_4 + \beta_7$	$\beta_1 + \beta_4 + \beta_7$
	-0.0357	-0.0418	-0.0698
	(0.0523)	(0.0524)	(0.0510)
Controls <sup>9</sup>	(1)	(1) + (2)	(1) + (2) + (3)
Yearly F.E.	Y	Y	Y
N	3,542	3,542	3,542
R <sup>2</sup>	0.871	0.872	0.872

Note: All variables at the municipal level.  $MW_{it-1}$  represents the mining patents collected by a mining municipality  $i$  lagged one period.  $d_{it}$  correspond to fixed-effect by mining municipalities.  $PR_{it}$  represents a fixed effect by HPR and LPR. <sup>9</sup>Controls by columns: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km2, coastal municipalities, plus (1). **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), distance to Santiago (km), coalition (D), and (1)+(2). All estimations include yearly dummies. Robust standard errors in parentheses. Significance levels: <sup>+</sup>  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ ,\*\*\*  $p < 0.001$ .



**Fig. 13. Marginal effects on PT model 2 by levels of fiscal responsibility, 2008–2019. (Eq 2)**

Source: Data from Sinim (2020). Note: R1, R2, and R3 consider different specifications adding controls in the progressive form: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km2, coastal municipalities (D), plus (1). **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), distance to Santiago (km), coalition (D) and (1)+(2). CI 90%.

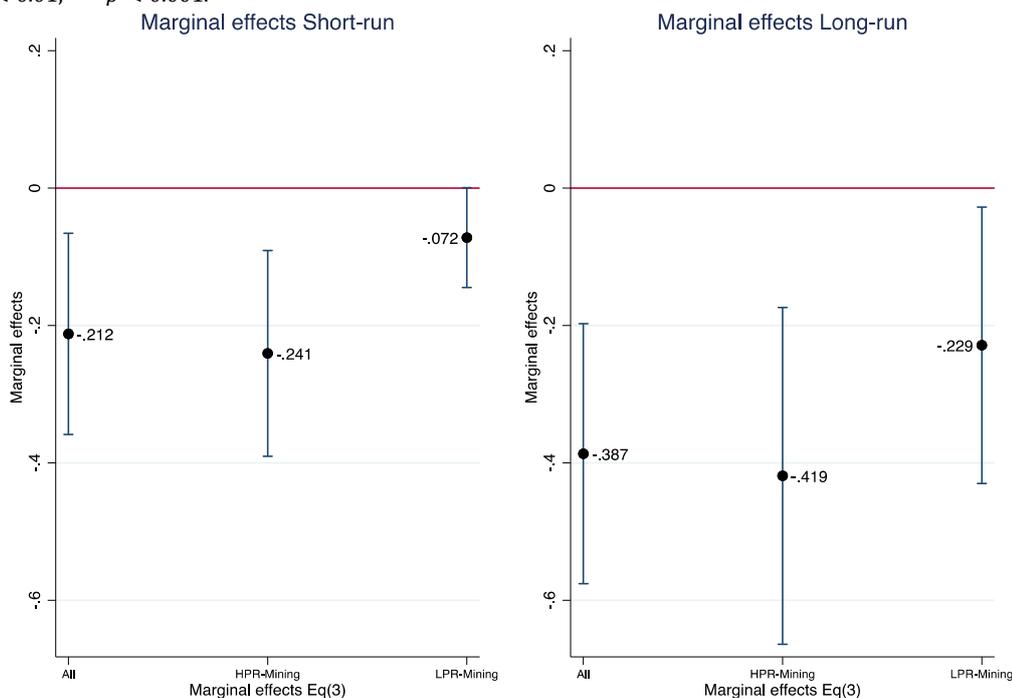
Table 7 depicts the results for equation 3 and correspond to the dynamic panel via system GMM. The results for all municipalities as well as for HPRs in the short and long term depict the crowding out hypothesis: for each dollar collected

via MWs (mining patents), US\$0.2 in local taxes is crowded out in the short run. In the long run, this increases to US\$0.4. We should also highlight that the results for the LPR group were significant (US\$0.2) but only in the long term. These results are available in Figure 14. The confidence intervals are also much tighter now.

**Table 7. Dynamic panel data estimation results for PT**

	System GMM (Eq 3) All municipalities	System GMM (Eq 3) HPR-Mining	System GMM (Eq 3) LPR-Mining
	(1)	(2)	(3)
$PT_{it-1}$	0.451***	0.426***	0.684***
	(0.131)	(0.101)	(0.076)
$MW_{it-1}$	-0.212*	-0.241**	-0.072
	(0.089)	(0.0911)	(0.044)
$d_{it}$	-132,382.7	-	-
	(130,488.3)		
$PR_{it}$	-32,110.5	-	-
	(56,186.2)		
Marginal Impacts for $MW_{it-1}$			
	$\beta_1$	$\beta_1$	$\beta_1$
Short-run	-0.212*	-0.241**	-0.0722
	(0.089)	(0.0911)	(0.0442)
Long-run	$\frac{\beta_1}{(1-\tau)}$	$\frac{\beta_1}{(1-\tau)}$	$\frac{\beta_1}{(1-\tau)}$
	-0.387***	-0.419**	-0.229+
	(0.115)	(0.149)	(0.122)
Controls <sup>9</sup>	(1) + (2) + (3)	(1) + (2) + (3)	(1) + (2) + (3)
Yearly F.E.	Y	Y	Y
AB Test for AR (1) pv	0.121	0.002	0.000
AB Test for AR (2) pv	0.317	0.241	0.141
Hansen test p-v	0.009	0.106	0.003
Difference Hansen test p-v	0.050	0.188	0.262
N	3,542	1,200	1,776

Note: All variables at the municipal level.  $MW_{it-1}$  represents the mining patents collected by a mining municipality  $i$  lagged one period.  $d_{it}$  correspond to fixed-effect by mining municipalities.  $PR_{it}$  represents a fixed effect by HPR and LPR. <sup>9</sup>Controls: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km2. **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), and coalition (D). All estimations include yearly dummies. Instruments for the first difference equation according to the lags in system GMM-type. Robust standard errors in parentheses according to Windmeijer standard error correction (Windmeijer, 2005).<sup>59</sup> Significance levels: \*  $p < 0.1$ , \*\*  $p < 0.05$ , \*\*\*  $p < 0.01$ , \*\*\*\*  $p < 0.001$ .



**Fig. 14. Marginal effects on PT dynamic panel estimations, 2008–2019. (Eq 3)**

59 Windmeijer, F. (2005). A finite sample correction for the variance of linear efficient two-step GMM estimators. *Journal of Econometrics* 126: 25-51.

Source: Data from Sinim (2020). Note: The dynamic panel estimations consider controls: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km<sup>2</sup>. **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), and coalition. CI 90%.

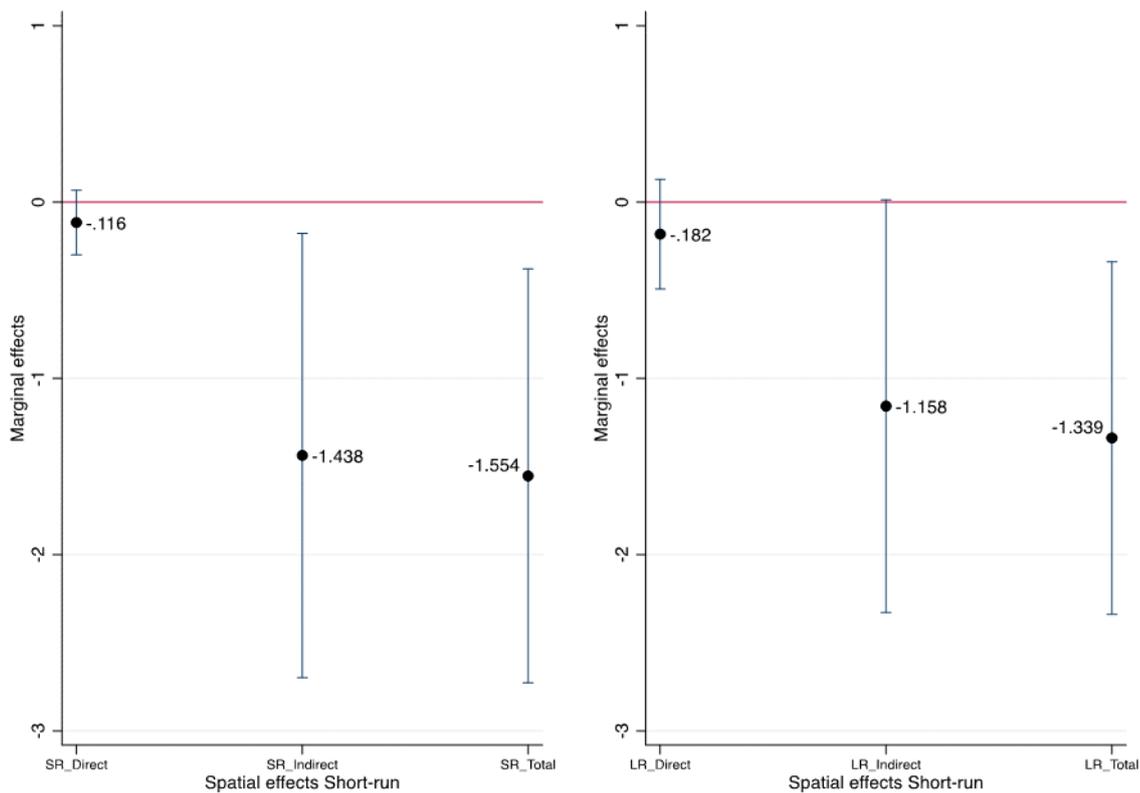
The spatial autocorrelation underlying our variables of interest as well as the spatial interrelation amongst low-tier governments might also influence our results. Chile's geographical characteristics and the spatial clusters of the PT collection affect these estimations. We cannot rule out the spatial autocorrelation in the PT collected by municipalities because of the previous evidence regarding the general and local spatial autocorrelation. In order to account for this hypothesis, we employ an econometric model that considers the spatial autocorrelation independent and explanatory variables and the inertial hypothesis via the Dynamic Spatial Durbin Model (DynSDM). This model allows us to report the spatial impacts on the short and long term over the interest variables. Table 8 depicts the results according to equation 4 which considers three specifications by columns, two of which are restricted and one complete: 1) a time-lagged dependent variable in the model ( $\tau PT_{it-1}$ ); 2) a space-time lagged dependent variable ( $\phi \sum_{j=1}^n w_{ij} PT_{i,t-1}$ ); and 3) both a time-lagged and space-time lagged dependent variable ( $\tau PT_{it-1} + \phi \sum_{j=1}^n w_{ij} PT_{i,t-1}$ ) in free form. For the three specifications, the autoregressive coefficient  $\rho$  is significant and within the limits of stability.

We analyze the unrestricted model (see Table 8, column 3) based on the information criteria. As we indicated in the methodology section, the coefficients are not directly interpretable. For this reason, Figure 15 depicts the marginal impacts according to the spatial effects, namely direct, indirect, and total in the short and long term. We fail to obtain significant results for the direct marginal effect at either temporal location. The opposite is true for the indirect and total effect which are both significant and negative in the short and long term. In the short term, for each dollar in MWs collected for a nearby neighborhood, approximately US\$1.4 of PT is crowded out in  $t + 1$ . The total impact considers the feedback and spillover effect and in this situation US\$1.6 of PT is crowded in the short term. Finally, in regard to the subnational crowding out in the long term, the results for the indirect and total effects are negative and significant. Both effects indicate that the subnational crowding out as a cross substitution between PT for MWs in  $t$  is around US\$1.2 and US\$1.3 in  $t + 1$ .

**Table 8. Dynamic Spatial Durbin Model estimation results for PT**

	DynSDM (Eq 4) $\phi = 0$	DynSDM (Eq 4) $\tau = 0$	DynSDM (Eq 4) <i>unrestricted</i>
	(1)	(2)	(3)
$MW_{it}$	-0.130	-0.267*	-0.123
	(0.100)	(0.110)	(0.0988)
$W \times MW_{it}$	-0.603	-0.963+	-0.947*
	(0.471)	(0.516)	(0.466)
$PT_{it-1}$	0.363***		0.399***
	(0.0114)		(0.0117)
$W \times PT_{it-1}$		-0.267*	-0.511***
		(0.110)	(0.0455)
$\rho$	0.386***	0.353***	0.283**
	(0.0922)	(0.0968)	(0.0940)
Marginal Impacts for $MW_{it-1}$			
<i>Short-run</i>	Direct Impact	-0.137	-0.116
		(0.0953)	(0.0937)
	Indirect Impact	-1.018	-1.438*
	(0.806)	(0.775)	(0.643)
	Total Impact	-1.155	-1.554**
		(0.766)	(0.599)
<i>Long-run</i>	Direct Impact	-0.219	-0.182
		(0.153)	(0.159)
	Indirect Impact	-2.148	-1.158+
		(13.27)	(0.597)
	Total Impact	-2.367	-1.339**
		(13.300)	(0.510)
Controls <sup>9</sup>	(1) + (2) + (3)	(1) + (2) + (3)	(1) + (2) + (3)
AIC	10,0431.1	10,1116.4	10,0340.3
BIC	10,0820.0	10,1622.6	10,0735.3
R2	0.964	0.901	0.952
N	3,542	3,542	3,542

Note: All variables at the municipal level.  $MW_{it-1}$  represents the mining patents collected by a mining municipality  $i$  lagged one period. <sup>9</sup>Controls: **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km<sup>2</sup>. **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), and coalition (D). Marginal effects standard errors in parentheses computed via MC simulation for 1 and 3 columns, the standard error to the column 2 computed via delta method. We consider the inverse distance weight matrix. Significance levels: +  $p < 0.1$ , \*  $p < 0.05$ , \*\*  $p < 0.01$ , \*\*\*  $p < 0.001$ .



**Fig. 15. Spatial effects of MW on PT for unrestricted DynSDM model (Eq 4)**

Source: Data from Sinim (2020). Note: We consider the inverse distance weight matrix. *Controls:* **(1) Local finance and economies of scale:** Net IPP (US\$), FCM (US\$), population (#), and square population. **(2) Local social characteristics:** % poverty, density per km<sup>2</sup>. **(3) Municipal endowment and favoritism hypothesis:** professionalization (%), municipal workers (US\$), and coalition (D). Marginal effects standard errors computed via MC simulation.

## 6. DISCUSSION AND CONCLUSION

This research evaluates to what extent extra revenue from resource windfalls crowds out PT collection, considering two exogenous criteria, namely mining category according to the Chilean Mining Code and a SUBDERE taxonomy to classify low-tier governments according to their capacity of provision of public goods. The windfalls that a mining municipality receives correspond to non-matched grants for those that have a significant non-renewable resource extraction. By their very nature, mining activities generate adverse effects on the environment; however, mining patents represent a compensation mechanism for negative externalities and are primarily aimed at improving the living conditions of the local population. We use panel data for twelve years, namely 2008-2019, and we test the crowding out hypothesis on mining patents and the local collection of PT. To evaluate this impact, we define a control group as non-mining municipalities that do not receive extra incomes as well as a subcategory HPR or LPR to ensure causality in our estimates. To test the robustness of the results, we use different econometrics models, and we add autoregressive terms that account for an inertia hypothesis via a dynamic estimator for panel data and spatial dynamic econometric models.

Our results are robust and confirm the crowding out hypothesis in relation to the intensity of the local provision of public goods. First, for each US\$1 increase in MWs, there is a US\$0.2 decrease in PT. Second, this subnational crowding out doubles in municipalities with a high level of fiscal responsibility. A US\$1.0 increase in MWs crowds out US\$0.4 in non-resource revenue. The results for municipalities categorized with a low level of fiscal responsibility are not significant. Third, if we consider the influence of nearby neighborhoods and the spatial interdependence amongst low-tier governments, the crowding out is four times higher than non-spatial estimations. The cross substitution between MWs for PT reaches US\$1.6 and US\$1.3 on average in the short and long run. Our results imply that windfalls from the Chilean mining industry generate undesirable incentives for the future collection of PT. This aligns with Oyarzo and Paredes (2019) who identify the crowding out hypothesis but do not consider the importance of fiscal responsibility. However, it should be highlighted that we have 12 years of municipal level self-reported data from SINIM to capture the undesirable behavior, and so the results should be taken with caution.

Our research highlights several implications for Chilean low-tier governments, specifically in relation to municipal local tax collection behavior. Local policies should consider municipal capacity in the local provision of public goods and/or the fiscal responsibility to disincentivize undesirable behavior resulting from extra resource revenues, rather than spatially blind policies that reinforce regional inequalities (Atienza et al, 2020). The results also suggest that subnational tax collection actions are dependent on past actions where the spatial heterogeneity of the country plays a relevant role

in the collection, especially in extreme areas of the country, in municipalities with multiple shortcomings and asymmetries such as in the provision of public goods, the endowment of human capital, and the cost of living.

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## EFFECTS OF BANKING CONCENTRATION ON MICRO AND SMALL FIRMS IN BRAZIL

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### ABSTRACT

The objective of the article is to analyze the effect of concentration at the local level on the supply and credit costs of micro and small firms in Brazil. In addition, an evaluation will be made of how concentration affected by profits firms. The literature indicates that the banking monopoly increases credit restrictions for smaller firms. However, this same literature also signals that large banks facilitate credit conditions for young firms. The database consists of information from the banking system, micro and small firms and the regional characteristics of each municipality. The bank concentration index were calculated at the level of municipalities. The literature uses primary data, but this study uses secondary data. The application of secondary data encouraged the use of weights to construct the supply and credit cost variables of micro and small firms at the municipal level. The methodology will be used in the application of four econometric models. The first three analyzes verify the impacts of the banking structure on the finances of micro and small firms, controlling the heterogeneity of the municipalities and the problems of similarity. The results show a low supply and a high cost of credit, in addition to a reduction in the profitability of micro and small firms in the face of the power of banking monopoly. The results differ from the creditor-debtor literature. On the other hand, they approach of traditional literature. In view of this evidence, the fourth analysis evaluating efficiency banking as a hypothesis for rationing credit to smaller firms from the monopoly power of banks. The study verifies the cost efficiency of banks at the municipal level through the analysis of the stochastic frontier. The efficiency index found is higher than 1. The literature indicates that when efficiency indexes are higher than 1, banks operate with above average costs. Thus, the last model estimates the impact of the bank inefficiency index on the credit cost of micro and small firms. The results show that the increase in bank inefficiency increase credit costs for small, medium and large firms in Brazil. Another verification this study was the combination of monopoly and bank inefficiency indexes. The results show that the increase in monopoly power increases the cost of credit and continues to grow with increasing sector inefficiency, but in proportion less. Thus, this study signals the rationing of credit to micro and small firms in Brazil is more explained by the monopoly power of banks than the inefficiency of the sector. However, it is necessary that future studies analyze the correlation between monopoly power and the inefficiency of the Brazilian banking sector.

## **Regular Session: RS05 - Location theory and applications**

**17:30 - 18:45 Tuesday, 25th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/85836987366>**

## LOCATION DETERMINANTS AND SUSTAINABILITY: AN EXPLORATORY APPROACH

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### ABSTRACT

This paper analyses location determinants of firms at local level focusing on role played by sustainability issues in shaping these decisions. The contribution to empirical literature is the identification of specific locational patterns driving decisions of sustainability-oriented firms. This is accomplished by using data for new firm entries in Catalan municipalities between 2004 and 2013. This paper is about this type of example, municipalities of the same country with no relevant differences in terms of environmental policies easily explained due to lack of local attributions on that issue. In these cases, the switch to environmental-friendly activities is no longer explained by policy decisions, but by spatial characteristics that favour some activities over others in view of asymmetries at industry level and act as location determinants.

Firms' location determinants have received an increased attention in recent years in view of the positive role played by entering firms over job creation and GDP expansion. Although empirical contributions have considered both internal or external location determinants, in this paper we will focus on the later. Concretely, we will analyse the role played by characteristics of the areas where firms locate or may locate. As these previous determinants have been largely discussed by several scholars we do not attempt to go further in that direction, but to explore a new path that has received little attention until now. We refer to the way in which sustainability dimension and changing social attitudes in developed countries may boost firm creation (and, therefore, location) in these industries. We hypothesize that not all territories have the same capacity to attract new firms, and not all firms locate following the same areas, giving priority to certain industries may benefit some areas. As there is a growing pressure towards specialisation in more sustainable activities, our results proxy future trends for firms' location patterns in many European countries.

## SPATIAL ORGANISATION OF THE INNOVATIVE BUSINESS IN THE URBAN AREA – NEW FRAMEWORK

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### ABSTRACT

Empirical analysis suggest that the spatial organization of the innovative industry is not stable over time. Over the years clusters of firms are shifting in terms of shape, density and their relative importance. All those alterations look like an evolutionary change in the spatial pattern of the business setting. Location decisions of the individual firms from the innovative industry aggregate into a herd-like behavior of the whole branch. Dynamic actions of the large group of companies are not really explainable by the current theoretical consensus.

In this paper I will analyse the spatiotemporal pattern of the location choices in a highly innovative business branch situated within an urban area. Although it may seem that for such a progressive industry like technological start-ups the office location should not play any major role, there is an evidence that this industry as a whole is creating intriguing non-random spatial patterns, that are gradually changing over time. I will investigate this non-stable spatial structure using a dataset consisting of individual-level information about the technological start-ups founded in Warsaw between 2010-2018. The empirical analysis will be conducted with a usage of machine learning methods supplied with more traditional econometrical framework. I will discuss the fluctuations in the general structure, presence of clusters, their location within the city and their temporal (in)stability.

Considering the evolutionary changes in the entrepreneurial herd behaviour I will propose a new framework which will allow for a deeper understanding of the urban organisation in the innovative business branches. Creating of such is needed due to the shortcomings of the currently prevailing theories. Classical and behavioural theories, New Economic Geography, evolutionary and co-evolutionary approaches – all of these are modelling the individual decisions about where to locate business in a context of unbounded space. Anyhow it seems that considering only stable-state, individual level solutions does not allow for deciphering the group behaviour of entrepreneurs. Especially in a restricted urban area those models do not seem to explain the temporal changes of the firms' organisation very well. In this paper there will be a solution proposed to tackle those shortcomings.

## **Regular Session: RS10.3 - Regional development**

**17:30 - 18:45 Tuesday, 25th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/88538303825>**

**Chair Juliana Cristofani**

## THE GEOGRAPHY OF MANUFACTURING PRODUCTIVITY SHOCKS IN COLOMBIA

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### ABSTRACT

The objective of this paper is to understand how productivity shocks in the manufacturing sectors propagate across Colombian regions. According to Caliendo et al. (2018), fluctuations in aggregate economic activity may come from a wide variety of aggregate and disaggregated events. These events can reflect underlying changes that are sectoral in nature or are actually specific to a sector and a region. The heterogeneity of these potential changes at the sectoral and regional levels implies that the sectoral and regional composition of an economy is fundamental to determinate their aggregate impact. In this paper, we quantify, through a detailed CGE model of the Colombian economy (BM-COL model), the impacts of changes in the total factor productivity (TFP) on its manufacturing sectors. We evaluate the impacts of changes in productivity in the manufacturing sectors, classified according to their technological intensities, in each Colombian Department. Mapping of regional TFP elasticities will bring additional insights to the understanding of the role regional-specific policies related to manufacturing activities play in the Colombian economy. From the simulation results, it is possible to identify potential trade-offs between regional equity and efficiency. While some manufacturing sectors promote GDP growth and reduce inequality, others only foster economic growth at the expense of higher inequality. It is also possible to analyze the existing patterns of regional competition and complementarity. There is a more intense pattern of competition among Colombian regions, since increases in productivity of the manufacturing sectors in a given region, in most cases, tend to have a negative impact on GRP elsewhere. The analysis also reveal different dimensions of Colombia's economic concentration: Bogotá D.C., as capital of the country, plays a prominent role, followed by the regions of Antioquia and Valle del Cauca, with higher shares of GDP (together, these territories concentrate approximately 50% of the country's GDP). From a sectoral point of view, manufacturing sectors with a higher technological intensity (also more capital intensive) are concentrated in these regions as well, posing further structural challenges for pursuing a higher-quality insertion on global value chains with less spatially concentrated benefits.

## THE ROUTINE TASKS IN LABOR MARKETS AND THE GENDER WAGE GAP IN BRAZIL

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### ABSTRACT

Despite the increase in female participation in the Brazilian labor market and a reduction in the average wage gap between men and women, there are gender inequalities in the distribution of workers within sectors and occupations and different degrees of formalization of employment (Bruschini, 2007; Itaboraí; Ricoldi, 2016). Some studies associate the reduction of the wage gap with a set of skills of women in certain occupations, making them more able to face technological challenges (Black; Spitz-Oener, 2010). We aim to identify the factors that are related to the reduction in the wage gap by turning our attention to the tasks performed by men and women. Could tasks associated with occupations with a greater female presence allow women better reactions in terms of variation in the rate of wages and the rate of formal employment in the face of a series of technological challenges? Tasks are classified into three types (Gonzaga; Guazioli, 2019): non-routine abstract (NRA), non-routine manual (NRM), and routine (R). Non-routine tasks are expected to be positively related to increased rates of variation in wages when there is greater access to the internet. The empirical strategy uses the National Census (Censo), and involves two steps. Firstly we estimate the variation in the average wages of men and women, considering the characteristics of the labor market in each 412 micro-regions between 2000 and 2010. We do it to attempt to reduce the influence of the demographic changes and unobservable characteristics of individuals. Secondly, we verify whether there is a relationship between the variation in wages and the type of task performed in each occupation. The results indicate that in markets more specialized in routine tasks the growth of wages and job formality for women is higher than for men. The results are robust to the inclusion of regional internet density as an independent variable. Moreover, we find that internet density is positively correlated to higher wage growth for women.

### KEYWORDS

Brazil; Gender; Internet; Routine Tasks; Wage Gap.

### 1. INTRODUCTION

In the last two decades, we have seen increasing female participation in the Brazilian labor market and a slight reduction in the average wage gap between men and women. In 2010 women received 67.7% of men's income and in 2019 occupying 43.7% of jobs they received only 77% of the value of men's income (IBGE, 2010; 2020). The average monthly income of employed women (IBGE, 2010) in 2010 was R \$ 1074.00 (US \$ 606.78) and the men's was R\$ 1587.00 (US \$ 896.61). In 2019, average women's earnings were R\$ 1,985.00 (US \$ 503.07), 77.69% of men's ones which were R \$ 2,555.00 (US \$ 647.67) (IBGE, 2020).

The wage gap is more expressive in some sectors of activity. In the Scientific and Technical sector, in 2010 women occupied 45% of jobs and received an average of 63% of the men's earnings. The sector of personal and domestic services, which is the worst average earnings, women are 84% of the employed workforce, earning an average of 52% of the men's (IBGE, 2010). In the domestic services sector, with informality involving 72.5% of workers, only 26.5% of employed women are in the formal market, receiving 92% of men's income. In the informal market, women receive only 82% of the men's equivalent income.

The literature identified a strong relationship between occupational segregation and wage differential (Anker, 1998; García-Mainar, Montuenga and García-Martin, 2019). Thus, the concentration and the segregation's drives are studied as part of the inequalities concerns and politics (Browne, 2006; Borrowman and Klasen, 2020; Das and Kotikula, 2019). Blau e Kahn (2016) suggest that explanations reported in the literature, e.g. schooling, experience, activities, type of occupation are not enough to understand the phenomena and new factors would be used to explain the differences in outcomes.

In most developed countries we can observe a rising segregation by skill specifically in employment prospects with impacts over the local labor market (Schlitte, 2011). The segregation does not seem to be fully explained by differences in skill levels between men and women. However, women concentration in certain occupations with lower wages, fewer opportunities for promotion is associated with the wage gap but it also might be an indicator that women's work is socially and culturally devalued (García-Mainar; Montuenga; García-Martín, 2018).

In development countries there still are several and diverse kind of constraints to women's participation in labor market (Leone and Baltar, 2006; Bruschini, 2007; Madalozzo, 2010; Itaboraí; Ricoldi, 2016) hence it is important assess whether the drivers to the segregation and gender inequality in Brazilian labor market could affect women's abilities to face the contemporary competition of jobs.

Within the many possible approaches to gender inequality in the labor market, the analysis of the characteristics of the tasks performed in each type of occupation might not be explored enough. Cognitive tasks, which require greater skills that are not easily replaced by technology, in turn, would be negatively correlated with the probability of being informal and would be an important feature in explaining the wage gap between formal and informal sectors (Sullzbach, 2020).

The task approach has also been applied to the analysis of the effect of new technologies on the labor market. One of the possible effects is the educational and training requirements to apply for jobs (Spitz-Oener, 2006; Zeyer-Gliozzo, 2020). Another one is about the changing abilities to face new technologies and the new requirements to survive through the changes in the world of work (Acemoglu and Restrepo, 2019; Autor and Price, 2013).

We aim to identify the factors that are related to the reduction in the wage gap by turning our attention to the tasks performed by men and women. Could tasks associated with occupations with a greater female presence allow women better reactions in terms of wage growth and increased formal employment, in the face of a technological challenge?

To answer the question our empirical strategy uses Brazilian National Census (Censo). We generate an instrumental variable (iv) similar to Autor, Dorn, and Hanson (2015) and Autor and Dorn's (2013) strategies to have measured how specialized in routine job activities a local market is. We consider the characteristics of the labor market in every 412 micro-regions between 2000 and 2010 attempting to reduce the influence of the demographic changes and individuals' unobservable characteristics. We verify whether there is a relationship between the variation in wages and the type of task performed in each occupation.

Our results indicate a positive and significant correlation between women's salary growth and non-routine manual tasks and a negative correlation with routine tasks. It means that when women are concentrated on activities that involve non-routine tasks, the rates of change in wages are positive. Otherwise, the concentration on routine tasks is correlated with the fall in the change in wages.

The paper is organized in three sections, beyond the introduction and final remarks. The first presents an overview of the participation of women in the Brazilian labor market, according to the sectors of activity in and also according to the type of task performed. The goal of the second is to suggest an approach to technological influence over the local labor markets. The third describes the model and its results.

## 2. BRAZILIAN WOMEN IN LABOR MARKET

### 2.1 Activities

The activity rate<sup>60</sup> in Brazil in 2010 was 76% for men and 55% for women, according to data from the Demographic Census (IBGE). Female activity increased by 6 percentage points in relation to data from the previous census (2000), indicating an increase in female participation in the labor market. But there are gender inequalities that persist in all sectors of economic activity. Some of these inequalities are related to the industry or sector of economic activity in which men and women are inserted, as well as their wages and rate of formalization of employment.

As for the sector of activity, there is a higher proportion of women employed in Personal and Domestic Services, Education and Health, as illustrated in Figure 1. This figure shows the proportion of women in relation to the total number of employees in each sector of economic activity in the Brazil in 2000 and 2010.

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60 Proportion of population of working age, employed or looking for a job

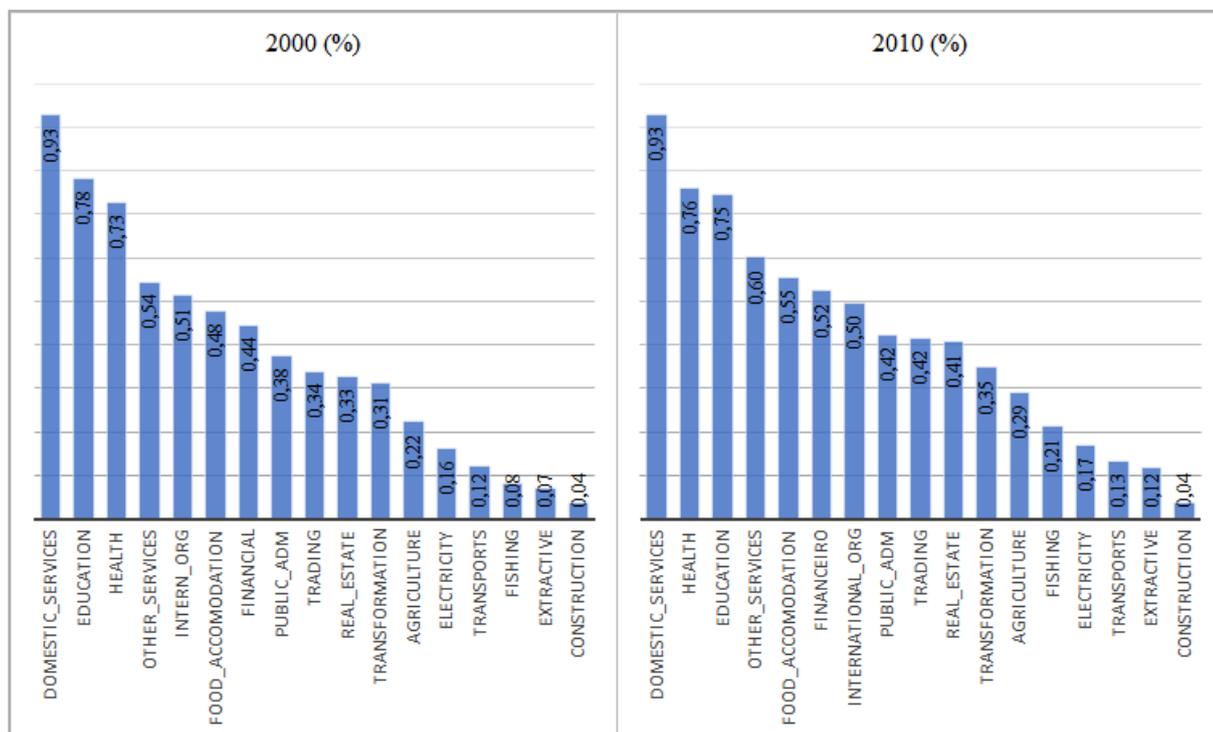


Figure 1: Women insertion on the labor market in Brazil (2000 - 2010)

In the two years represented in the previous figure, the sector with the highest female participation was that of Domestic Services. This sector is the one with the lowest average earnings (with average monthly values below those of a minimum wage<sup>61</sup>) and the worst rate of formalization of employment (Figure 2) among non-agricultural sectors, according to data from the last two demographic censuses.

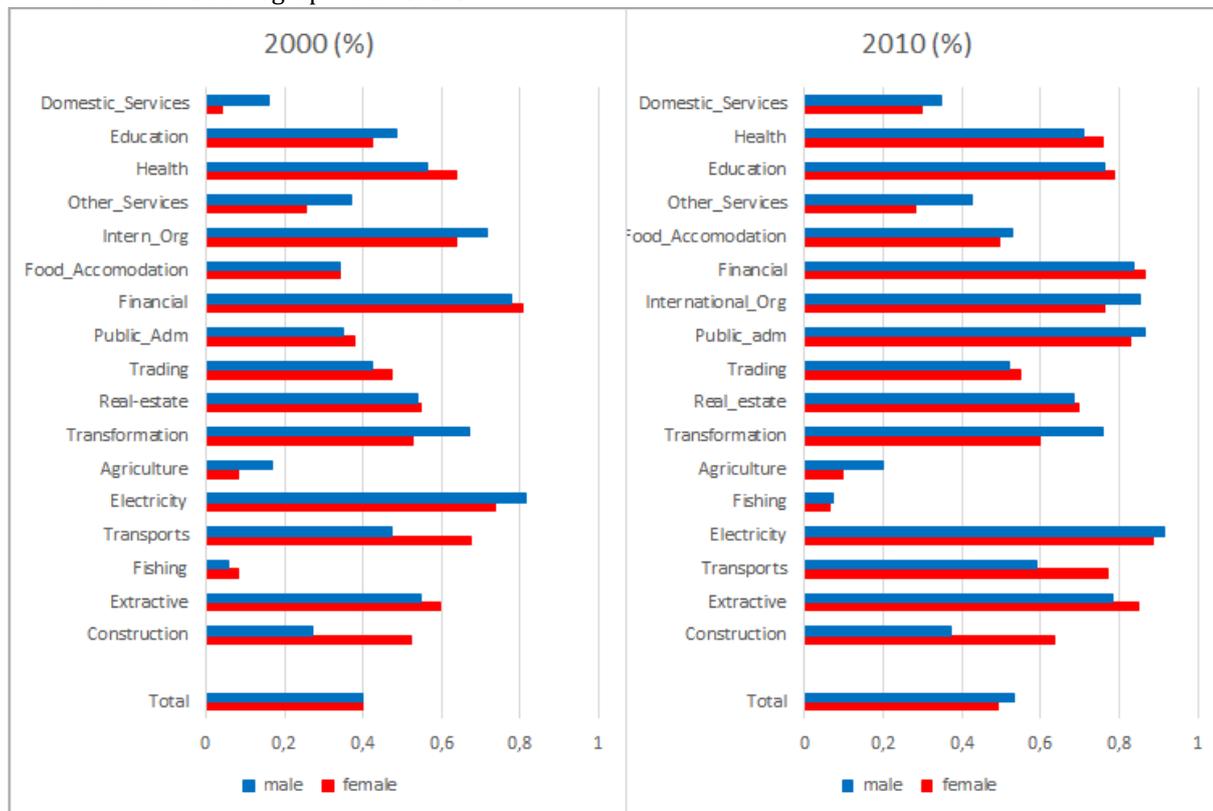


Figure 2: Formalization of employment by sector of activity (Brazil, 2000 - 2010)

61 The Brazilian minimum wage was R\$ 360.00 in 2000, in updated values for 2010. Women employed in the Domestic Services sector received average salaries of approximately R\$ 180.00, and men, R\$ 240.00. In 2010, the minimum wage was R\$ 510.00 per month. The average salary of women employed in the Domestic Services sector was R\$ 450.00, and that of men, R\$ 650.00.

Regarding employment status, there was an increase in formalization in the period from 2000 to 2010, for both women and men (Table 1). This positive variation in the number of formal job positions increases social security for workers in all sectors of activity.

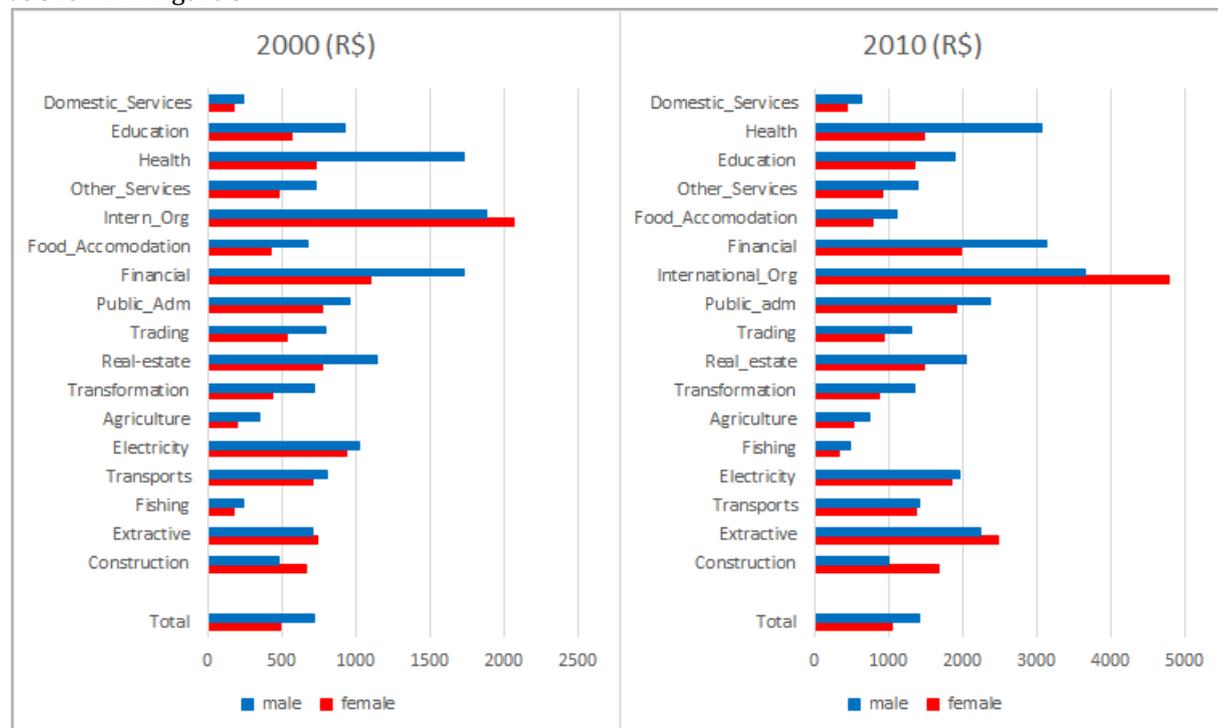
Despite the positive consequences on the way in which women enter the labor market, the scale of the change was not sufficient to reduce gender inequalities. The increase of 7% observed in the formalization rate among women was less than the 10% observed among men.

**Table 1: Status of employment, proportion of workers by gender (Brazil, 2000 - 2010)**

Status of employment	2000 (%)			2010 (%)		
	Male	Female	Total	Male	Female	Total
Employees (formal contract)	39	41	40	49	48	48
Military <sup>a</sup>	05	09	06	04	08	06
Employees (no formal contract)	23	29	25	18	25	21
Self employed	30	18	25	26	18	23
Employers	04	02	03	02	02	02
Total number of workers	37,432,477	22,266,415	59,698,892	46,747,788	33,753,227	80,501,015

Source: IBGE, demographic census data (2000 and 2010). Note: (a) Military and statutory civil servants.

Gender inequalities are a structural feature of the Brazilian labor market. In general, regardless of the sector of activity, women receive lower incomes than men in the same occupation. According to data from the 2010 demographic census, the average monthly income of employed women was R \$ 1,074.00 (US \$ 1,879.50), while that of men was R \$ 1,587.00 (US \$ 2,777.25). This difference in remuneration between women and men is more expressive in some sectors of activity, as shown in Figure 3.



**Figure 3: Wages by sector of activity (Brazil, 2000 - 2010)**

The female workers, however, have a higher level of education than the average for men. These data can be checked in Table 2, that presents statistics on the Brazilian labor market in 2000 and 2010.

**Table 2: Statistics for the Brazilian labor market, 2000 - 2010**

Panel A: Mean, 2000				
Variable	Women		Men	
	Informal	Formal	Informal	Formal
age(years)	35,08	33,52	35,33	34,15
education(years)	7,07	9,07	5,73	7,72
income_occupation(R\$)	416,70	583,00	601,06	882,48
hours_occupation	38,20	42,06	45,87	47,04
married	0,57	0,50	0,65	0,69
urban (%)	0,80	0,94	0,71	0,90
inschool (%)	0,15	0,15	0,11	0,11

Panel B: Mean, 2010				
	Women		Men	
Variable	Informal	Formal	Informal	Formal
age(years)	36,71	35,11	36,71	35,50
education(years)	7,37	10,80	6,44	8,98
income_occupation(R\$)	747,42	1330,91	1116,43	1662,80
hours_occupation	34,60	39,73	40,39	43,21
married	0,59	0,55	0,62	0,66
urban (%)	0,81	0,96	0,74	0,93
inschool (%)	0,16	0,16	0,14	0,12

Source: prepared by the authors based on demographic census data (2000 and 2010).

Higher education among women does not guarantee that they will enter the labor market in formal positions, nor that they are better paid. Despite suggesting that there has been a reduction in inequality in educational access, this phenomenon contributes to the perpetuation of gender inequalities in labor relations.

### 2.2 The tasks

The tasks are classified into two groups depending on the skills required from a worker to perform them: (i) routine tasks; (ii) non-routine tasks. According to Spitz- Oener (2006), non-routine tasks can be more analytical, interactive or manual intensive. Hence, it is possible to find more than one classification criteria. To describe the Brazilian labor market, we classify tasks into three groups: non-routine abstract (NRA), non-routine manual (NRM) and routine (R) tasks.

The set of skills demanded from workers that perform NRA tasks on a daily basis includes creation, evaluation and interaction, which cannot be simulated by a computer. One typical example of an NRA-intensive occupation is the activity of a teacher. NRM tasks depend on manual skills and don't follow a specific pattern, so workers that perform this kind of task can't be easily replaced by machines either, as is the case of a bus driver, for example. Finally, routine (R) tasks are the ones that can be performed by a computer or a machine instead of a person. These basic characteristics of tasks are the reason why non-routine tasks (NRA and NRM) are expected to positively relate to wage growth when there is greater access to the Internet, because these tasks are complemented by technology, unlike routine tasks, which are replaced by technology.

Figure 4 illustrates the proportion of tasks that workers performed on their main jobs in a daily basis in Brazilian labor markets (2000 and 2010). There is an evident change in the distribution of tasks among women in the informal labor market. Between 2000 and 2010, women apparently switched from performing more routine tasks to concentrate in non-routine tasks. In the formal labor market, they are more often performing NRA tasks, while in the informal market, they perform more NRM tasks. The distribution of tasks among men remained similar over the years. We also note that men do more routine than non-routine tasks.

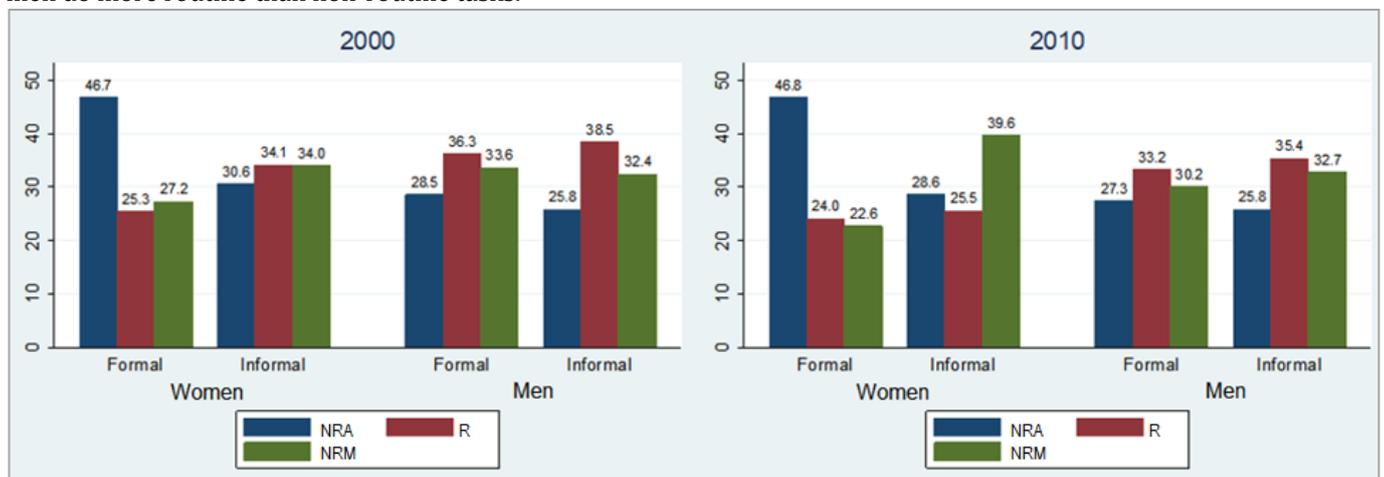


Figure 4: Proportion of Tasks (Brazil, 2000 - 2010)

We also analyze workers' characteristics according to the type of task they usually perform more frequently. Table 3 shows the distribution of workers by gender and status of employment, in three scenarios established based on the relative importance of tasks in the main occupation. We take the 75th percentile of each task proportion, and interpret that group of workers as "people who are very concentrated in this type of task, compared to other tasks".

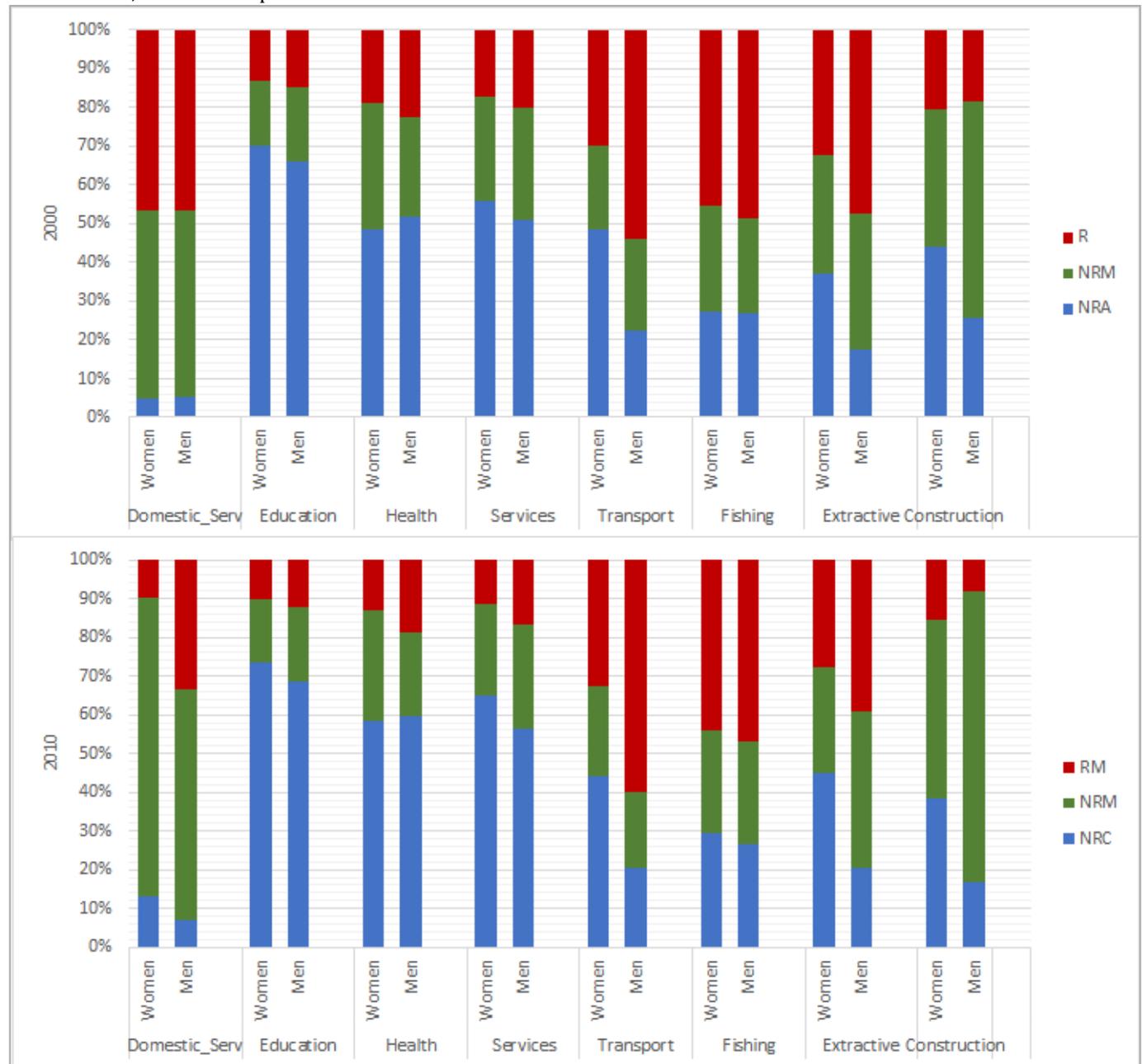
In Panel A (Table 3) we analyze the distribution of workers who do much more routine tasks than non-routine tasks ( $R > 0.75$  means that among all the tasks performed by these workers, the proportion of routine tasks is bigger than 75%). In Panels B and C, we analyze the distribution of workers with  $NRA > 0.75$  and  $NRM > 0.75$ . Note that the female participation is bigger in these two groups than in the first one. This means women are more concentrated in non-routine tasks, while men seem to be more frequent among workers who concentrate in routine tasks.

**Table 3: Proportion of workers by gender and status of employment according to the type of task they execute the most**

	Female, 2000		Male, 2010		Female 2010		Male, 2010	
	Mean	sd	Mean	Sd	Mean	sd	Mean	sd
Panel A: R > 0.75								
Informal	0.2647	0.0407	0.5294	0.0919	0.2633	0.0429	0.4108	0.0966
Panel B: NRA > 0.75								
Formal	0.2039	0.0223	0.2888	0.0449	0.2544	0.0308	0.3493	0.0213
Informal	0.2223	0.0334	0.2850	0.0335	0.1975	0.0268	0.1988	0.0228
Panel C: NRM > 0.75								
Formal	0.1254	0.0529	0.2317	0.0946	0.1858	0.0504	0.2948	0.0748
Informal	0.2328	0.0436	0.4101	0.1055	0.2224	0.0380	0.2970	0.0853

Source: prepared by the authors based on demographic census data (2000 and 2010).

Figure 5 shows how skills demanded from women and men differ in some industries. Note that the first four sectors of activity (Domestic Services, Education, Health and Other Personal Care and Social Services) are the ones with the greatest female participation in the Brazilian labor market. The next four (Transports, Fishing, Extractive and Construction) are the sectors with the least proportion of female workers. In all sectors with a greater participation of women (the stereotypes of female work), we found a greater presence of NRA and NRM tasks. In other sectors, women also perform more non-routine activities than men.



**Figure 5: Proportion of tasks by gender in selected sectors (Brazil, 2000 - 2010)**

3. MEASURING THE LOCAL MARKETS EXPOSURE TO TECHNOLOGY

The variable indicating exposure to computerization was constructed following Autor, Dorn and Hanson (2015) and Autor and Dorn (2013) and measures the degree to which local markets are historically specialized in routine job activities. We start with 594 4-digit occupational categories in the 2010 census that were classified by Reis (2016) according to the description of job tasks given by the Brazilian Code of Occupation (COD). Each occupation is described by a set of tasks separated into routine, manual, and abstract categories. The variable  $RTI_k$  is an index increasing in the participation of routine tasks in the occupation  $k$ :

$$RTI_k = \ln \ln (T_{k,t}^R) - \ln \ln (T_{k,t}^M) - \ln \ln (T_{k,t}^A)$$

Where  $T_k^R$ ,  $T_k^M$  and  $T_k^A$  are, respectively, the routine, manual, and abstract tasks inputs in occupation  $k$  in year  $t$ . To distinguish high and low participation of routine tasks in each occupation, we use a binary indicator for occupations in the upper 66th percentile of the  $RTI_k$  distribution. The final variable used in the regressions is the microregion  $j$  employment share measure equal to the fraction of the local market’s employment assigned to routine task-intensive occupations:

$$RSH_{jt} = \left[ \sum_{k=1}^K L_{jkt} I(RTI_k > RTI^{p66}) \right] \left( \sum_{k=1}^K L_{jkt} \right)^{-1}$$

Where  $L_{jkt}$  is total employment in microregion  $j$ , at time  $t$ , in occupation  $k$ , and  $I(\cdot)$  is an indicator function taking value equal to one if the occupation was classified as routine intensive.

We expect that historical differences in industry specialization across microregions persist over time, suggesting an instrumental variable approach that uses information in previous decades regarding the routine task intensity in different industries. Consider the share of routine tasks among workers in industry  $i$  given by  $R_{i,t-1}$  and the employment in industry  $i$  in the local market  $j$  given by  $E_{i,j}$ . The instrumental variable suggested by Autor and Dorn (2013) follows a Bartik-type structure that combines the national value of  $R_{i,t-1}$  in all Brazilian states except the one that includes microregion  $j$  and the industry employment in the region, so that the instrument is given by:

$$ivRSH_j = \sum_{i=1}^I E_{i,j,t-1} R_{i,-j,t-1}$$

Information on occupations in the Brazilian census is less extensive than in developed countries since codes and definitions have changed over time. It is possible to map the occupational codes in the 2010 census to the 2000 data and 1991 data using cross-paths made available from the Brazilian Institute of Geography and Statistics (IBGE). To incur in minimal loss of information, the construction of  $RSH_j$  and  $RTI_k$  use the 2000 census and the 1991 census data is used in the  $ivRSH_j$  variable. The availability of personal computers in the early nineties was severely halted by import tariffs, which declined in the first half of the decade with a broad trade liberalization program. We are comfortable using the 1991 industry structure as an instrumental variable correlated to potential computerization inside firms in the following decade.

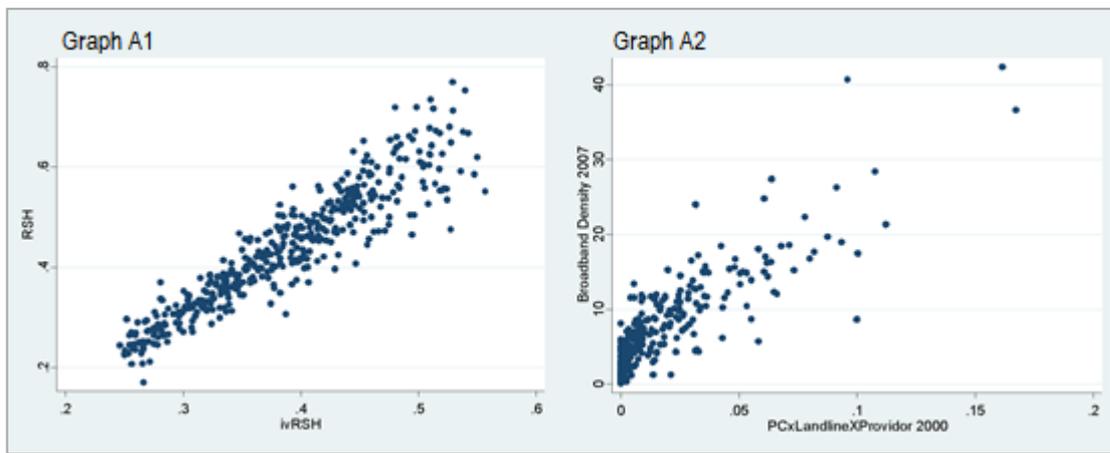
The second technological change in the labor market we consider in this article is the roll-out of broadband internet. Starting in 2007 the Brazilian Communications Regulatory Agency (Anatel) provided information per municipality for the number of broadband internet subscriptions. The variable used in our exercise is the density of access which counts the subscriptions per 100 households.

The variables used to construct the instrument for  $Internet_{j,2007}$  come from the 2000 census and include the average household ownership rate of personal computers and the ownership of telephone landlines. We link this information to the 1999 MUNIC data from IBGE on infrastructure at the city level, which indicates the presence of internet providers in the municipality. In the early 2000s the main mode of internet access was dial-up services. We create an instrument for internet density in 2007 that uses the chance of access to dial-up in area  $j$  in 2000. That final variable consists of the following product:

$$ivInternet_{j,2000} = Computers_{j,2000} \times Telephones_{j,2000} \times Provider_{j,1999}$$

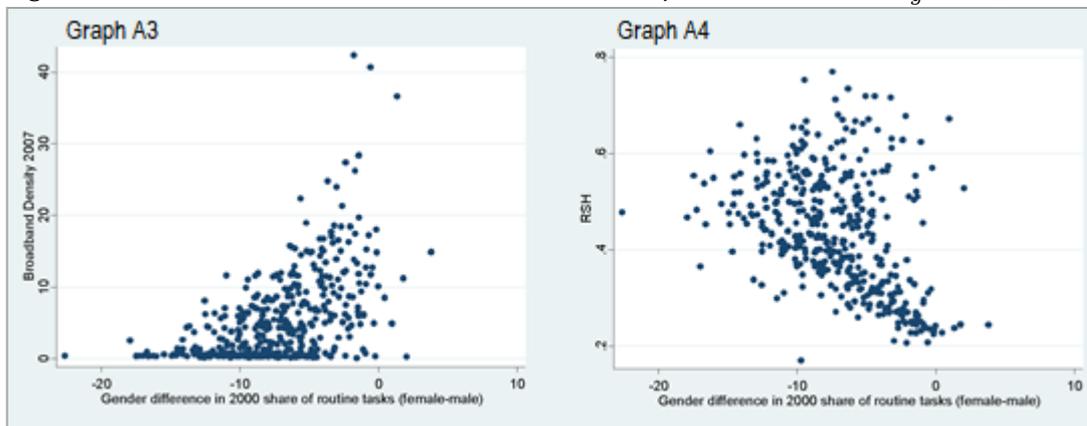
Figure 6 (Graphs A1 and A2) shows the correlation between instruments and variables of interest in the data. One should note that the chance of connecting to the internet in 2000 is small and varies across regions. Even though the technology of access changed from 2000 to 2007, both in quality and access mode,  $ivInternet_{j,2000}$  and  $Internet_{j,2007}$  are positively correlated.

The statistical offices in Brazil do not collect data on information technology (IT) investment at the establishment level. The intuition behind our choice is that historical knowledge of computers should persist in a region, providing workers with higher affinity to IT once the latter is adopted by firms. Moreover, there is substantial heterogeneity in technology provision across regions since the initial expansion of network services relied on the local infrastructure of landlines bought by each private company from regional-level public services.



**Figure 6: Correlation between instruments and variables of interest in the data**

Finally, we provide a check of the mechanism linking gender gaps in the labor market and technology exposure. Our working hypothesis is that in markets where women concentrate on non-routine tasks, female labor should be in an advantageous position facing technological changes. Figure 7 (Graphs A3 and A4) shows in the horizontal axis the regional difference in female minus male share of routine job tasks in 2000 or  $\Delta_g Share\_routine_{2000j}$ .



**Figure 7: Gender gaps in the labor market and technology exposure**

As expected, there are differences across markets, but the average value of  $\Delta_g Share\_routine_{2000j}$  is negative. Interestingly, the correlation between  $\Delta_g Share\_routine_{2000j}$  and  $RSH_{j2000}$  is negative, and the relationship between  $\Delta_g Share\_routine_{2000j}$  and  $Internet_{j2000}$  is positive. The data suggest that broadband expansion could have benefited women in markets where their relative participation in non-routine tasks was higher and possibly complemented by internet use. We assess this relationship in the next section with regression exercises.

#### 4. ECONOMETRIC ANALYSIS

The empirical strategy of this study was developed in two stages. In the first stage we estimate the variation between 2010 and 2000 average wages and job formality of men and women, considering the characteristics of the workers in the local labor market. In the second stage, we check whether there is a relationship between the growth in wage and formalization of employment and the type of task most frequently performed in the region.

For each census year and gender group we run the following regression with ordinary least squares:

$$\log(y_i) = b_0 + b_1 age_i + b_2 age_i^2 + \sum_1^k \alpha_k edu\_dummy_{ik} + \mu_j + u_i \quad (1)$$

$$emp_i = b_0 + b_1 age_i + b_2 age_i^2 + \sum_1^k \alpha_k edu\_dummy_{ik} + \mu_j + u_i \quad (2)$$

where  $y_i$  are earnings of worker  $i$ , and  $emp_i$  is a dummy indicating with one whether the worker has a formal job. The covariates include age, age squared, dummies for educational levels, and a dummy for each microregion  $\mu_j$ . The coefficients for  $\mu_j$  capture average log wages in equation (1) and formalization rate in equation (2) in the local labor market, netting out the demographic changes in experience and education of workers. This first step serves to calculate the decennial growth of wages and formal employment:  $\Delta \mu_j = \mu_{2010j} - \mu_{2000j}$ .

The dependent variable for the second step of the exercise is the difference over time between women's and men's average outcomes or  $\Delta \mu_j$ , given by  $\Delta_g \Delta \mu_j$ . We call this difference the gender gap, since a higher  $\Delta_g \Delta \mu_j$  indicates that women's situation is improving, or their average wages (or job formalization) are growing faster than men's average wages (or job formalization).

We estimate the following equation using two-stage least square:

$$\Delta_g \Delta \mu_j = \delta_0 + \delta_1 RSH_{2000j} + \chi_j \beta + \gamma_s + \varepsilon_j \quad (3)$$

Where  $RSH_{2000j}$  is constructed as the proxy developed in Autor and Dorn (2013) for the specialization in routine tasks in a local market. The instrument for RSH uses the product of the industry employment structure in the previous decade and the routine share of jobs in the industry in the 1991 census. We include in the specification the dummies for states  $\gamma_s$ , and covariates  $x_j$  that represent the characteristics of the area such as changes between 2010 and 2000 in the logs of industry, services, and agriculture output, and the changes in the share of unskilled workers, share of high-school drop-out, share in workers in urban areas, share of young workers, and share of young unskilled male workers.

As discussed previously, routine tasks are prone to be substituted by technology while also concentrating male workers. We conjecture that in markets specialized in routine tasks the growth of wages and job formality for women will be higher than for men, hence we expect a positive  $\delta_1$  estimate in equation (3).

To further the argument that technology has improved women’s position in the labor market by a greater extent than men’s position, we consider a more direct measure of technological advancement given by the density of access to broadband internet. We have information for the number of subscriptions per 100 households for broadband access in each Brazilian city starting in 2007, which we aggregate to form  $Internet_{2007j}$ . We estimate the relationship between the difference in women’s and men’s  $\Delta\mu_j$  and internet density in the local market. As discussed previously, internet access only expanded in Brazil after the privatization of telecommunications companies starting in 1999.

We run the following extension of equation (3) in the regression with two-stage least square:

$$\Delta_g\Delta\mu_j = \delta_0 + \delta_1 RSH_{2000j} + \delta_2 Internet_{2007j} + x_j\beta + \gamma_s + \varepsilon_j \tag{4}$$

We also perform a check of the mechanism that connects the reduction of the gender gap and the realization of job tasks by women. Using the distribution of jobs in 2000 we calculate the difference between the share of routine tasks in jobs held by women in the local market  $j$  minus the share of routine tasks in jobs held by men in the same region in 2000, given by  $[\Delta_g Share\_routine_{2000j}]$ . We estimate the following equation with ordinary least square:

$$\Delta_g\Delta\mu_j = a_0 + a_1 \Delta_g Share\_routine_{2000j} + x_j\beta + \gamma_s + \varepsilon_j \tag{5}$$

We expect that in markets where women start with a higher relative concentration in routine tasks the improvement in the gender gap over the decade will be smaller, hence  $a_1$  should be negative. Table 4 shows the basic statistics of the variables of interest. We stress that the growth in earnings for women was higher than for men across the board. Nevertheless, female labor is still allocated more heavily in informal positions and this source of inequality in job quality has not improved over the decade.

**Table 4: Basic statistics of the variables of interest**

	(1)	(2)	(3)	(4)
	$\Delta_g\Delta_t$ Log earnings	$\Delta_g\Delta_t$ Formal job	RSH	Internet Density
Mean	3.43	-0.04	0.34	12.84
Std dev.	0.39	0.04	0.08	11.44
	$\Delta_g$ Share routine	Provedor	Computer	Telephone
Mean	-4.51	0.61	0.10	0.37
Std dev.	3.58	0.29	0.07	0.19

Note: Author's calculations with census data. All variables are dated from the beginning of the period in 2000. Gender gaps in wages and job formality consider the change between the 2010 minus 2000 census. 413 observations from microregion level. Population weighted statistics.

Table 5 shows the results for coefficient estimates in equations (3) to (5). In the first two columns we have the values for  $\delta_1$  where the dependent variables are gender gaps in wages and job formalization rates, respectively. Comparing two local markets, an increase of 1 percentage point in the presence of routine-intensive jobs improves the gender gap in 19 percentage points for wages and 16 percentage points for formalization rates. The results are robust to the inclusion of internet density in the model specification. In effect, a local market with 10 more internet connections corresponds to 2 percentage points relative gain for female wages, while there is no gain in female job formalization. Finally, in columns (5) and (6) we show estimates for  $a_1$ . In a local market where women started with an extra 10 percentage points higher share of routine tasks, we find that the gender gap in wages has worsened by 3.5 percentage points.

**Table 5: Results for coefficient estimates**

	(1)	(2)	(3)	(4)	(5)	(6)
	Wages	Formal job	Wages	Formal job	Wages	Formal job
Variables	$\Delta_g\Delta\mu_j$	$\Delta_g\Delta\mu_j$	$\Delta_g\Delta\mu_j$	$\Delta_g\Delta\mu_j$	$\Delta_g\Delta\mu_j$	$\Delta_g\Delta\mu_j$
$RSH_{2000j}$	0.190964** (0.078341)	0.154877*** (0.044568)	0.267898*** (0.088006)	0.174543*** (0.047855)		
$Internet_{2007j}$			0.001985** (0.000825)	0.000507 (0.000448)		
$\Delta_g Share\_routine$					-0.003516** (0.001450)	-0.0010 (0.0008)
	IV	IV	IV	IV	OLS	OLS
K-P stat.	394	394	142	142	-	-
Observations	413	413	413	413	413	413

Note: Robust standard errors in parentheses. Statistical significance denoted by \*\*\*  $p < 0.01$ , \*\*  $p < 0.05$ , \*  $p < 0.1$  Author's calculations with census data. Population weighted regressions. Columns (1) and (2) show coefficient estimates from equation (3), columns (3) and (4) show estimates from equation (4), and columns (5) and (6) show estimates from equation (5), respectively.

## 5. FINAL REMARKS

The Brazilian labor market's statistics indicate that jobs remain segregated and unequal, as expected in the gender literature. We searched for potential explanations to the reduction in gender wage gap since the 2000s studying the tasks usually performed in different occupations. Analyzing the distribution of workers and tasks in Brazil we present evidence that women are performing more non-routine tasks than men instead of routine tasks.

Bearing this in mind we shed light on the relationship between the routine task-intensity in local labor markets, the use of technologies, and gender wage gaps. We contribute to the gender wage gap studies by using instrumental variables to analyze the mechanism that connects the reduction of the gap and the realization of job tasks by women. The independent variable of interest (share of local employment in intense routine occupations) and the instrumental variable used are already established in the literature.

Our application of the technique to analyze the improvement of women's situation in the labor market is the novelty in the study. The results indicate that in markets more specialized in routine tasks the growth of wages and job formality for women is relatively higher than for men. Moreover, we find that when comparing local labor markets, in places where women perform more routine tasks, their relative growth in wages is reduced.

The findings are robust to the inclusion of regional internet density as an independent variable in the specification. We use internet density as a proxy to the recent technological changes the labor market and find that job changes related to this technology seem to not affect negatively women's earnings or formalization of employment. In effect, internet density is positively correlated to the relative improvement of female wages.

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## CHINA SHOCK AND FEMALE LABOR MARKET PARTICIPATION IN BRAZIL

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### ABSTRACT

Brazil was a successful case of economic growth based on import substitution. At the end of last century and after a period of growth stagnation, trade liberalization became a policy to help lower inflation by increasing competitiveness. Recently, with the China shock, the country economy has been exposed to greater competition. In a similar period, an increase of 12 percent in the proportion of formalized female workers took place on Brazilian labor market. The effects of China shock in the US labor market have been widely researched, but there are not so many studies of these impacts in the developing world. Since Brazil has been affected by trade with China through two channels – increase in exports and imports – there may have been some compensatory effects in Brazil that lead to different results from those observed in developed countries. This paper explores the variation of China Shock between Brazilian local labor markets (or microregions), to identify whether the expansion of Chinese participation on international trade was able to improve the women's conditions in the Brazilian labor market between 2000 and 2013 – measured by the proportion of women formalized, the wage ratio of female to male workers – being the first study to assess how the two channels of China shock affected the outcomes of Brazilian women, with data from the Brazilian formal labor market (Rais) and information on trade flows between Brazil and China (BACI database).

### KEYWORDS

China shock, Female formal workers, Gender wage ratio.

### 1. INTRODUCTION

Brazil remained closed to international trade to promote its economic growth (World Bank, 2008). Even though it carried out a trade liberalization in the 1990s, focusing on an inflation control policy based on the pegged exchange rate, the country retreated, reestablishing the protectionist import tariff policy (Kume, 1998). At the beginning of this century, Brazil intensified its trade relations with China, with the latter becoming one of Brazil's main economic partners (Pautasso, 2010). The commodity boom and the increase in Chinese demand boosted the Brazilian economy (Hiratuka and Sarti, 2016), with China positively affecting the Brazilian labor market via commodity exports (Costa et al., 2016). The Brazilian trade liberalization in the 1990s resulted in the worsening of the Brazilian workforce outcomes (Cavalcanti et al., 2020; Gaddis; Pieters, 2017). However, it produced an improvement in the relative position of women in the labor market since they were less affected than men (Gaddis and Pieters, 2017). Cavalcanti et al. (2020) observe a drop in wage premiums for men and women due to the tariff reduction of the 1990s related to a greater drop in the wages of male workers.

Unlike the trade liberalization in the 1990s, the intensification of trade with China coincides with a growth in formal employment (Maciel and Oliveira, 2018). In the same period, we observe an improvement in the participation of female workers in the formal sector by 12% between 2000 and 2013 (Rais, 2021). However, Benguria and Ederington (2017) observed a wage reduction in the Brazilian workforce, with the adverse effects pulled by men, reducing wage differences in favor of women. The reason for the smaller impact would be associated with the greater presence of female workers in less affected sectors (Benguria and Ederington, 2017).

In this context, this paper explores the variation of China Shock between Brazilian local labor markets to identify whether Chinese international trade expansion was able to improve the female formal labor market conditions in Brazil between 2000 and 2013. The identification strategy used was developed by Autor et al. (2013) and Costa et al. (2016), creating variables that relate the changes in trade flows between Brazil and China to the Brazilian employment outcomes. This is the first study to analyze how the two channels of China Shock affected the relative position of Brazilian female workers. We use administrative data from the Ministry of Labor (Rais) and information about the trade flows between Brazil and China from the BACI database developed by the *Centre d'Etudes Prospectives et d'Informations Internationales* (CEPII). The unit of measurement of this analysis is the microregion, which is a grouping of economically integrated municipalities, allowing the use of a panel data structure for the estimations. To check female labor market conditions, this paper explores female formal employment and female to male wage ratio. We also control by microregional factors such as age, schooling, average wages of the formal labor force, and a cubic polynomial of income per capita, during the initial period. Our findings suggest that the China Shock has worsened the entry of women into the formal market in Brazilian microregions most affected, especially due to the imports channel. For those who remained in the formal market, the

influx of Chinese imports has improved the relative position of women in terms of their average monthly wages. To a certain extent, the exports channel also impacts women in the formal market, but in an adverse way.

## 2. TRADE SHOCKS IN BRAZIL AND GENDER DIFFERENCES IN LABOR MARKET

This paper is related to the literature on labor market adjustment to trade shocks. The Brazilian labor market adjustment to trade shocks provides an interesting contrast to the case of developed countries due to the differences in labor market structures (Dix-Carneiro, 2019; Costa et al., 2016). Indeed, Brazil has a large informal sector, comprising about half of the workers in 2000 (Costa et al., 2016). However, there is a positive labor market adjustment – in terms of wage gains and formalization – due to a boom in the demand for commodities (Costa et al., 2016).

In the trade liberalization in early 1990, Brazil experienced a gradual and uneven reduction in import tariffs (Dix-Carneiro, 2019; Kovak, 2013), but it remains a relatively protected economy (Dix-Carneiro, 2019; Kume, 1998). Depending on the period analyzed, the average import tariff dropped from 55 in 1987 to 10 percent in 1994 (Kume et al., 2000), and from 31 in 1990 to 13 percent in 1995 (Dix-Carneiro, 2019).

Assessing the main results for Brazil, the literature finds that the effects of the 1990's trade opening are negative for the workforce. Arbache and Corseuil (2004), using a household survey (PNAD), find that the penetration of imports from this period reduced the industrial workforce's employment and wages. With a different approach, using the Brazilian demographic censuses of 1991 and 2000, Kovak (2013) shows that workers from regions more exposed to the tariff reductions of 1990 experienced a greater relative drop in wages, when compared to those less exposed to trade.

This shock also influences informality and unemployment. According to Ulyssea and Ponczek (2018), in the medium term, the tariff reduction causes an increase in the proportion of informal workers and unemployment in more exposed regions. In line with this, Dix-Carneiro and Kovak (2017), when monitoring data from the formal market (Rais) and censuses, find that the adverse effects tend to persist in the medium and long term, concluding that in regions most affected by tariff drops, workers in the formal sector displaced by the shock, after long periods without a job, tends to be employed in informal jobs.

The rise of China was an important event in global economy (Dix-Carneiro, 2019; Costa et al., 2016; Autor et al., 2013). After the seminal paper of Autor et al. (2013), the series of adverse trade shocks in the U.S. economy was known as China Shock. Most papers have consistently identified that the rising competition in manufactured goods from China has damaged the U.S. manufacturing labor market, with the regions and industries most exposed to this trade shock experiencing relatively greater declines in employment and wages (Autor et al., 2013; Acemoglu et al., 2016; Brussevich, 2018).

The Brazilian trade liberalization and the China Shock are events unlike to be experienced again soon (Dix-Carneiro, 2019). Even though Brazil remains a relatively protected economy (Dix-Carneiro, 2019; Kume, 1998), it has experienced another trade shock after its liberalization with the rise of China (Costa et al., 2016). China became Brazil's major trade partner (Pautasso, 2010; Costa et al., 2016). Using a Brazilian household survey data, Paz (2019) finds that the Chinese imports penetration reduces the level of employment and the hourly wages of the workforce. At the same time, with demographic census data, Costa et al. (2016) show that manufacturing workers from Brazilian microregions that were more exposed to the Chinese import penetration face a slower growth in their wages, when compared to those less exposed regions.

However, as well noticed by Costa et al. (2016) and Pautasso (2010), China has also been a source of a large demand shock. Indeed, the Brazil-China trade partnership has adversely affected the labor market regions where imports from China have risen in competition and has positively affected the labor market of commodities exporter regions with faster wage growth and job formalization (Costa et al., 2016). These authors find that, between the years 2000 and 2010, a US\$ 1,000 per worker increase in exports to China led to a 1.58 percentage points growth in the workforce wages (Costa et al., 2016).

Although there is a lot of interest in the adjustment of labor markets to trade liberalization and China's shock to Brazil, little attention has been given to the impact of these labor market adjustments on the relative position of women in the labor market. Regarding the 1990 trade liberalization, two papers look at the changes in the relative position of women in the labor market: Gaddis and Pieters (2017) and Cavalcanti et al. (2020). The first one found that a decline in trade protection by 1 percentage point tends to reduce the female labor force participation by 2 percentage points, while for male workforce, this value is more than 4 pp (Gaddis and Pieters, 2017). Meanwhile, Cavalcanti et al. (2020) observed that men face a wage reduction that is 0.531 pp higher than the wage reduction for women, reducing the gender wage gap over time.

Benguria and Ederington (2017) found that the labor market adjustment to the China Shock due to increasing imports competition in Brazil impacted positively the gender wage gap, with a relative decline of around one percentage point in the regions more exposed to trade. Our paper is the first to measure the impact on women's labor market relative position due to labor market adjustments to the rise of exports and imports from China.

## 3. EMPIRICAL STRATEGY

### 3.1 Identification Strategy

We use the identification strategy of Autor et al. (2013) e Costa et al. (2016). This strategy is based on a trade theoretical model<sup>62</sup> which considers each local labor market as a small open economy, allowing the creation of metrics that relate the variations in trade flows between Brazil and China with the structure of the local labor market in the period prior to the shock (2000, in this case). Here, we define local markets as microregions, which is a grouping of economically integrated municipalities (Costa et al., 2016; Dix-Carneiro et al., 2018).

China Shock in Brazil is spread by two exogenous channels. On the first channel, an increase in competition of local markets is expected, due to the influx of Chinese manufacturers in the country. On the second channel, there is an increase in Chinese demand for Brazilian commodities, which tends to have a positive impact on the local economy, especially in agricultural sectors (Autor et al., 2013; Costa et al., 2016).

By adopting some simplifications developed by Autor et al. (2013) and Costa et al. (2016), we obtain the following variables, which measure how the formal employment of each Brazilian microregion is exposed to trade between Brazil and China.  $IS_{mt}$  represents the influx of Chinese imports in Brazil, and  $XD_{mt}$ , the increase in Chinese demand for Brazilian exports:

$$IS_{mt} = \sum_j \frac{L_{jm,2000}}{L_{j,2000}} \frac{\Delta I_j}{L_{m,2000}} \quad (1a)$$

$$XD_{mt} = \sum_j \frac{L_{jm,2000}}{L_{j,2000}} \frac{\Delta X_j}{L_{m,2000}} \quad (1b)$$

$\Delta I_j$  represents the variation in the volume of Chinese imports to Brazil between 2000 and 2013 in thousands of US\$ ( $\Delta I_j = V_{CjB,2013} - V_{CjB,2000}$ ) while  $\Delta X_j$  shows the variation in the volume of Brazilian exports to China ( $\Delta X_j = V_{BjC,2013} - V_{BjC,2000}$ ). Then, we weighted the trade flows by the formal workforce structure in Brazil during 2000, where  $L_{jm,2000}$  is the total workforce in sector  $j$  and microregion  $m$ ,  $L_{j,2000}$  the total workforce in sector  $j$  and  $L_{m,2000}$  the total workforce in microregion  $m$ .

Thus, using the microregion ( $m$ ) and year ( $t$ ) as the unit of measurement, we apply a first difference model for the estimates, represented by the following equation:

$$\Delta Y_{mt} = \beta_1 IS_{mt} + \beta_2 XD_{mt} + Z'_{m2000} \beta_3 + \varepsilon_{mt} \quad (2)$$

On the right side of the equation, we have  $IS_{mt}$  and  $XD_{mt}$ , which are the metrics of competitive exposure created by Autor et al. (2013). We also control for the formal workforce characteristics by microregion in 2000 - represented by the vector  $Z'_{m2000}$  - such as the average age, the proportion of workers with a high school degree, and a college degree, and their average monthly wages. To represent the productive structure of microregions in the period prior to the shock, we use a cubic polynomial of income per capita (Costa et al., 2016).

On the left side, the dependent variable ( $\Delta Y_{mt}$ ) takes on two different formats. To estimate how the China Shock has influenced women's entry in the formal labor market,  $\Delta Women_{participation}$  represents the variation between 2000 and 2013 in the proportion of female workers in the formal market by microregion ( $m$ ). To assess whether there has been a wage advance for these women in relation to men, the dependent variable is transformed into  $\Delta \ln Wage_{female/male}$ , which indicates the log change in the ratio of female to male wages in each microregion ( $m$ ).

Following Costa et al. (2016), to control for possible unobserved state trends that may be linked to the dependent variables, we add fixed effects for the twenty-seven Brazilian states in some specifications. Standard errors are also clustered by mesoregions, allowing the existence of spatial correlation between microregions. We expect the parameters of interest ( $\beta_1$  and  $\beta_2$ ) to be positive and statistically significant, as it would be an indication that more women are occupying the formal labor market and getting better wages compared to their male counterparts, due to the China Shock. We also consider the possibility that variations in the pattern of trade between Brazil and China (represented by  $\Delta I_j$  and  $\Delta X_j$ ) are capturing changes in the Brazilian economy - such as productivity growth in a specific sector  $j$ , or changes in consumption patterns associated with increased income in Brazil (Costa et al., 2016). To deal with this possible endogeneity, we employ the instrumental variables strategy, suggested by the literature (Autor et al., 2013; Acemoglu et al. 2016; Costa et al., 2016).

Thus, we instrumentalize the  $IS_{mt}$  and  $XD_{mt}$  metrics, replacing the variations in trade flows between Brazil and China by  $\Delta I_j^*$  and  $\Delta X_j^*$ , which are calculated by the variation (2000 - 2013) of how much China exports (imports) to all countries in the BACI database, except Brazil. This strategy is valid, since the China Shock in Brazil maintains a correlation with trade flows between China and the rest of the world, but these flows are exogenous to the Brazilian labor market in 2000. We have the following instruments:

$$ivIS_{mt} = \sum_j \frac{L_{jm,2000}}{L_{j,2000}} \frac{\Delta I_j^*}{L_{m,2000}} \quad (5a)$$

$$ivXD_{mt} = \sum_j \frac{L_{jm,2000}}{L_{j,2000}} \frac{\Delta X_j^*}{L_{m,2000}} \quad (5b)$$

### 3.2 Data

We use administrative data from the Ministry of Labor (Rais), which is a census of the Brazilian formal labor market at an individual level, collected annually. For the dependent variables, we use the number of workers and their respective average monthly wages, disaggregated by gender in the years 2000 and 2013. We also use a consumer price index (IPCA), sourced from the Brazilian Institute of Geography and Statistics (IBGE), to deflate the wages in 2000, so that they are represented in 2013 reais.

<sup>62</sup>See Autor et al. (2013).

For the controls, we use characteristics of the Brazilian formal workforce during 2000 available at Rais, and to calculate the cubic polynomial of income per capita, we use data from the 2000 Brazilian demographic census, sourced from IBGE, which contains information about formal and informal labor market and other socioeconomic aspects.

The unit of analysis for this study is the microregion, which is a regional classification developed by IBGE by grouping economically integrated municipalities, defined by the literature as Brazilian local labor markets (Costa et al., 2016; Dix-Carneiro et al., 2018). To ensure that there were no major variations in the microregion’s boundaries between the years 2000 and 2013, we use the minimally comparable areas (AMC), provided by Dix-Carneiro et al. (2018), which group some microregions that changed between 1980 and 2010. By matching the municipalities of Rais with the AMCs, we obtain a sample of 411 Brazilian microregions<sup>63</sup>.

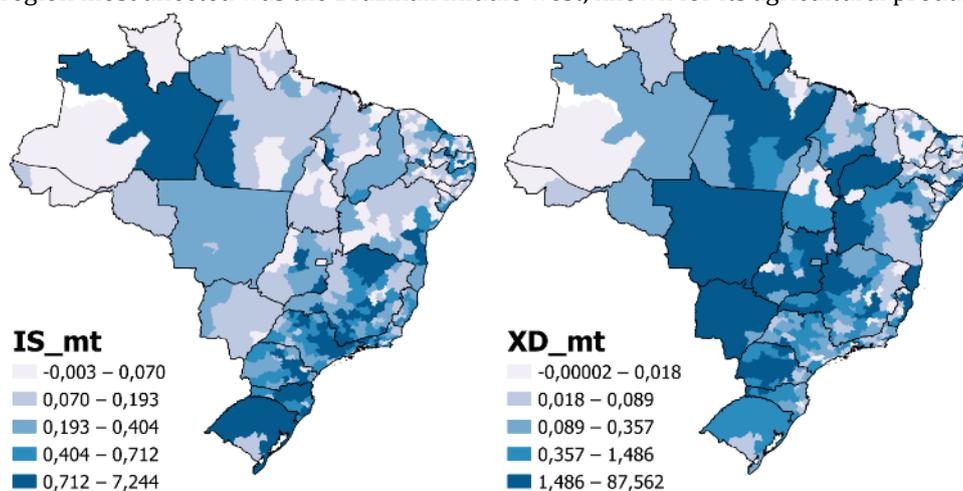
We use trade data between countries from the BACI database, developed by the *Center d’Etudes Prospectives et d’Informations Internationales* (CEPII), which reconciles the information declared by importing and exporting countries to the UN statistical division (Comtrade). They have information on the total annual value of bilateral trade flows between more than 200 countries in current US\$ 1,000, for products classified under the six-digit Harmonized System (HS6) since 1995.

To calculate the metrics of China Shock and its instruments, we use the variation between 2000 and 2013 of Brazilian imports from (exports to) China in thousands of dollars (US\$), as well as the variation of all other BACI’s countries exports to (imports from) China. We deflate this data using the US GDP deflator, provided by the US Bureau of Economic Analysis, considering 2013 as the base year. To finish the calculation of the  $IS_{mt}$  and  $XD_{mt}$  metrics, we had to transform the BACI data of tradable products into  $j$  sectors of activity. For this reason, we construct a concordance between the BACI product codes (HS6) and the Rais economic activity codes (CNAE 95), obtaining 227 tradable sectors<sup>64</sup>.

### 3.3 Descriptive Analysis

When calculating the China Shock metrics for each of the Brazilian microregions, as described in equations (1a) and (1b), we construct figure 1, which shows how these regions trade with China, both in terms of imports (left side) and exports (right side). We observe that the Brazilian microregions trade with China in different ways, depending on their productive structure in the period prior to the shock, corroborating the empirical strategy adopted.

As expected, regions more intensive in manufacturing production during the year 2000 were relatively more affected by the China Shock imports channel, with emphasis on the states located further south and southeast of Brazil, marked in dark blue on the left-side map of Figure 1. For the exports channel, we observe on the map on the right side that the region most affected was the Brazilian middle west, known for its agricultural production.



**Figure 1 - Geographic Distribution of China Shock’s Metrics ( $IS_{mt}$  e  $XD_{mt}$ ) by quintile**

Sources: Rais microdata and BACI database, 2021.

Analyzing the descriptive statistics of women’s participation in the formal labor market and the wage ratio between male and female formal workers, it is possible to notice a positive evolution in favor of female workers. Table 1 contains information on the variables that represent the formal labor market in each of the Brazilian microregions, during the years 2000 and 2013, used to estimate the main models of this study.

63 We dropped *Lencois Maranhenses* and *Japura*, tiny microregions registering only services on Rais. Because of that, their China Shock metrics were missing.

64 Waste and scrap (HS6) could not be concorded with the CNAE, as they are not inputs for the recycling industry. As Costa et al. (2016), we remove these HS6 from  $IS_{mt}$  and  $XD_{mt}$ , and consider recycling as non-tradable (services).

**Table 1 – Description and Summary of Variables by Microregion**

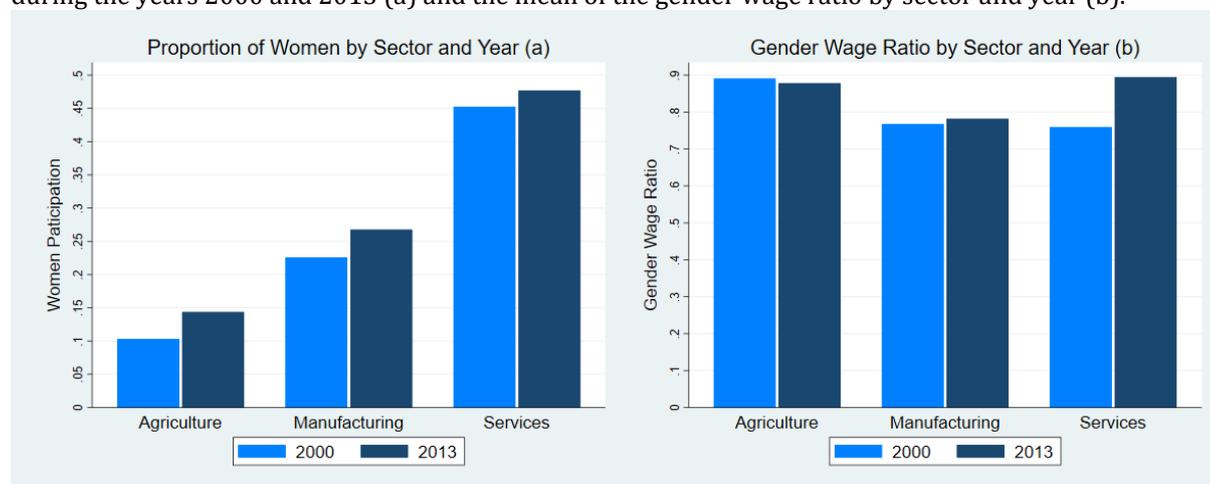
Variable	Mean	Std. Dev.	Min	Max
$\Delta$ Women <sub>participation</sub>	0.0387	0.0805	-0.2492	0.3167
Women Participation 2000	0.3823	0.1177	0.1049	0.7867
$\Delta$ lnWage <sub>female/male</sub>	0.1269	0.2405	-1.0249	1.3017
Gender Wage Ratio 2000	0.7818	0.1588	0.2247	2.5808
Gender Wage Ratio 2013	0.8806	0.1346	0.4256	1.6676
$IS_{mt}$	0.4986	0.7096	-0.0029	7.2440
$XD_{mt}$	2.1594	7.7427	0.0000	87.5621
$ivIS_{mt}$	24.3211	32.3083	0.0087	316.8055
$ivXD_{mt}$	34.4260	100.9242	-0.5021	1,579.38
Average Monthly Wages 2000	0.4168	0.1574	0.1023	1.1770
Average Age 2000	34.2680	2.0377	29.4057	43.4854
% Workers with High School	0.2445	0.0831	0.0727	0.5754
% Workers with College Education	0.0513	0.0327	0.0040	0.3129
Income per Capita	158.01	91.07	27.55	571.51

Sources: Rais microdata, Brazilian Census and BACI database, 2021.

Observing the evolution of the dependent variables used for the estimates, there was an increase in the participation of female formal workers. In the initial period, about 38.23% of the formal workforce was made up of women, with this proportion increasing around four percentage points, from 2000 to 2013. For the wage ratio between female and male workers, there was also a positive evolution of approximately 10 percentage points over the same period in favor of women, with these earning about 78.18% of what their male colleagues received during the initial year.

Based on these data, it is also possible to understand some characteristics of the formal labor workforce in each Brazilian microregion in 2000. These workers were, on average, 34 years old, and had low levels of education, with only 24.45% of the workforce achieving a high school degree, and 5.13% of them getting a college degree. The average monthly wages of these workers were also low, with a nominal average wage of 416 reals and the highest wage in the period at R\$ 1,176.95. In turn, the average income per capita, considering the entire population, reached the average nominal value of R\$ 158, 01.

Women and men are usually concentrated in different sectors of activities, with more women occupying the services sector (Madalozzo, 2010). Figure 2 shows the mean proportion of women in the formal market employed in each sector, during the years 2000 and 2013 (a) and the mean of the gender wage ratio by sector and year (b).



**Figure 2 – Outcomes of Women in the Formal Market by Sector of Activities – 2000 and 2013**

Sources: Rais microdata, 2021.

In terms of participation, women were much more concentrated in services activities during both years, where about 48% of workers in this sector were women in 2013, while in agriculture and extractive activities, the proportion of female workers was only 14% at this same year. In manufacturing activities, 27% of workers were women in 2013.

However, when we compare how women’s participation is evolving through time, we notice that in tradable sectors, which are directly affected by China Shock, the proportion of female workers has grown by approximately four percentage points in agriculture, extractive and manufacturing activities, while in the sector with the highest concentration of women (services), the growth was of 2 percentage points.

Observing the gender wage ratio, the wage gap between men and women is bigger in the manufacturing sector, with women receiving a little less than 80% of what men received in both years. In the agriculture and extractive sector, the wage inequality among genders is small, with women receiving 90% of their male colleagues’ wages, without significant

variations during the period. Lastly, in services activities, we can see the biggest variation, with women receiving 78% of a man’s wage in 2000 and in the next period, this value was about 89%.

4. RESULTS

4.1 Main Results

In this section, we present the estimates of the China Shock effects on the proportion of women in the formal market (Panel A, Table 2) and on the female to male gender wage ratio (Panel B, Table 2) by microregion, between the years 2000 and 2013. The coefficients and standard errors of all tables are multiplied by 100, so that they can be interpreted as the approximate effect of an increase of US\$ 1,000 in imports (exports) per formal worker on variations of the dependent variables in percentage points. Besides, through underidentification and weak identification tests, we corroborate the validity of instruments.

Table 2 – Main Results: Effects of China Shock on Female Formal Workers by Microregion

	OLS	OLS	2SLS	2SLS
	(1)	(2)	(3)	(4)
<i>Panel A: ΔWomen<sub>participation</sub></i>				
<b>IS<sub>mt</sub></b>	-0,699*	-0,832***	-0,720**	-0,647*
	(0,361)	(0,264)	(0,340)	(0,334)
<b>XD<sub>mt</sub></b>	-0,0522**	-0,0700**	-0,0173	-0,0294
	(0,023)	(0,029)	(0,077)	(0,060)
<i>Panel B: ΔlnWage<sub>female/male</sub></i>				
<b>IS<sub>mt</sub></b>	2,00**	2,95**	2,44**	2,54**
	(0,931)	(1,26)	(1,01)	(1,06)
<b>XD<sub>mt</sub></b>	-0,139*	-0,0949	-0,129	-0,288
	(0,075)	(0,065)	(0,168)	(0,222)
State Fixed effects	No	Yes	No	Yes

**Notes:** This table displays estimated effects of China Shock ( $IS_{mt}$  and  $XD_{mt}$ ) on changes between 2000 and 2013 in women’s participation in the Brazilian formal labor market (Panel A) and in the gender wage ratio of formal workers (Panel B). Column (1): Estimation by OLS; Column (2): Estimation by OLS, with state fixed effects; Column (3): Estimation by 2SLS; Column (4): Estimation by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers and a cubic polynomial of per capita income per microregion in 2000. N = 411 microregions. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Sources: Rais microdata and BACI database.

Panel A in Table 2 summarizes the estimates of the first difference model, reporting the impact of  $IS_{mt}$  and  $XD_{mt}$  - and their respective instruments -  $ivIS_{mt}$  and  $ivXD_{mt}$  - on the proportion of female workers in each microregion  $m$ . The results indicate that the China Shock produces a negative effect on the entry of female workers into the formal labor market in Brazil.

When estimating the model by ordinary least squares (OLS, Column 1), we observe that the microregions most affected by the  $IS_{mt}$  channel incurred a drop of 0.699 pp in the participation of women in the formal market, while in the places most affected by  $XD_{mt}$ , the effect on women was -0.052 pp, with greater significance. After adding state fixed effects (Column 2), the results are maintained, but with higher magnitudes.

Using the two-stage least squares (2SLS) strategy, in the last two columns, the results for microregions most affected by the export channel lose statistical significance, while for those more intensive in Chinese imports, the effects are relatively less robust when compared to OLS models. In our preferred specification - 2SLS model with state fixed effects (Column 4) - an increase of US\$ 1,000 in imports of Chinese products per worker led to a drop of 0.647 percentage points in the proportion of female formal workers, with 10% of statistical significance.

On the second panel of Table 1, we notice that the impact of the imports channel was positive and significant (5%) on the gender wage ratio in all specifications, while the exports channel was significant only in Column 1, estimated by OLS. In Column 4, with estimations using 2SLS and state fixed effects, we find that an increase of US \$ 1,000 in imports of Chinese products per worker led to a rise of 2.54 percentage points in the gender wage ratio, in favor to women.

By these results, it seems that the China Shock has worsened the entry of women into the formal market in Brazilian microregions, with the effects of the import channel being relatively greater on this population. For those who remained in the formal market, there are indications that the influx of Chinese imports in Brazilian microregions has improved the relative position of women in terms of their wages, when compared to their male colleagues.

To a certain extent, the exports channel also impacts women in the formal market, but in an adverse way. This result must be interpreted with caution, since we find significance only in models estimated by OLS, which may be contaminated by some Brazilian economic aspects that happened in the same period (Costa et al., 2016).

These conclusions are compatible with the literature of trade shocks impacts on women in Brazil, in which Gaddis and Pieters (2017) find adverse effects on the participation of both men and women, due to the 1990 trade opening. Benguria and Ederington (2017) find that the increase in Brazilian demand for Chinese imports, linked to the China Shock, reduced the total labor force wages in Brazil, reaching men more intensely, causing a relative improvement for women.

Considering the possibility that China Shock has affected Brazilian economic sectors in different ways, the literature has carried out empirical tests to check whether trade shocks have led to a reallocation of workers among sectors (Costa et al., 2016). In this way, we subdivided the sample into three major sectors (*s*): agriculture and extractive activities, manufacturing, and services, repeating the estimates from the previous section, using the same microregional controls in the initial period and the China Shock metrics.

Table 3 summarizes the results estimated by 2SLS with state fixed effects for women’s formal participation (Panel A) and the gender wage ratio (Panel B) for each sector of activities and microregion. In general, we could not find strong statistical evidence that there has been a relocation of women in the formal market among sectors during this period.

**Table 3 – Results: Effects of China Shock on Female Formal Workers by Sector and Microregion**

	Agricult. + Extract.	Manufacturing	Services
	(1)	(2)	(3)
<i>Panel A: <math>\Delta W_{participation}</math></i>			
$IS_{mt}$	-0,576 (0,578)	0,489 (1,00)	-0,856** (0,398)
$XD_{mt}$	0,002 (0,06)	0,091 (0,096)	-0,070 (0,077)
<i>Panel B: <math>\Delta \ln Wage_{female/male}</math></i>			
$IS_{mt}$	-1,80 (2,28)	1,65 (1,95)	1,61 (1,95)
$XD_{mt}$	-0,364 (0,377)	-0,529* (0,294)	-0,423 (0,284)
Observations (Panel A)	401	408	411
Observations (Panel B)	378	404	411

**Notes:** This table displays estimated effects of China Shock ( $IS_{mt}$  and  $XD_{mt}$ ) on changes between 2000 and 2013 in women’s participation in the Brazilian formal labor market (Panel A) and in the gender wage ratio of formal workers (Panel B) by major sector and microregion. All models were estimated by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). Column (1): Effects on agricultural and extractive sectors; Column (2): Effects on manufacturing sector; Column (3): Effects on services sector. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Sources: Rais microdata and BACI database.

Regarding women’s participation in formal work – represented by the variation between periods (2013-2000) of the relative concentration of female workers in sector *s* and microregion *m* – we found significance only for the services sector (Column 3, Panel A), suggesting that an increase of US\$ 1,000 in imports from China is associated with a 0.856 pp drop in the participation of women in this sector of activities.

Analyzing the evolution of the relative wages of women in the formal market – calculated as the variation between 2000 and 2013 of the gender wage ratios for each sector and microregion – we find again some significance for only one of the sectors: manufacturing. According to the second column of Panel B, an increase of US\$ 1,000 in exports would have reduced the gender wage gap by 0.529 pp, disadvantaging women in terms of wages.

We may not find consistent effects of China Shock on women's outcomes across major sectors because the sectorial composition of employment did not change throughout this period. However, if the services sector has become more developed in these thirteen years that we have evaluated, due to the shock, the effect may be positive for women allocated to this sector.

To check this possibility, we estimate the effect of China Shock on total formal employment of each sector, through a simple regression (OLS) and compare these results with the share of women in the formal market in each sector in 2000. If the sector more affected by the China Shock is the same which employed more women in 2000, we corroborate our hypothesis. The resulting coefficients and the share of female workers in each major sector during 2000 are shown in Table 4.

**Table 4 – Testing the Composition Effect**

Major Sectors	$IS_{mt}$ Coefficient (1)	$XD_{mt}$ Coefficient (2)	Women’s Share: 2000 (3)
Agriculture + Extractive	-0.00163	-0.0709	0.141
Manufacturing	-1.33**	0.0265	0.279
Services	1.41**	0.0475	0.406

**Notes:** This table displays estimated effects of China Shock ( $IS_{mt}$  and  $XD_{mt}$ ) on changes between 2000 and 2013 in total formal workforce participation in the Brazilian labor market by major sector and microregion, in Columns 1 and 2, estimated by OLS. Standard errors in parentheses, clustered by mesoregions (91 clusters). Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. In Column 3, we have the share of women in the formal market by major sector in 2000. Sources: Rais microdata and BACI database.

When comparing the coefficients that indicate the effects of the China Shock on the total employment of each sector with the share of women allocated to them in 2000, we find evidence that favors our hypothesis. Although we did not find

effects for the  $XD_{mt}$  channel, we observe that the other channel ( $IS_{mt}$ ) shows an increase on the participation of formal workforce in services by 1.41 percentage points, with 40.6% of the workforce being made up of women in 2000. In this way, women are being affected due to the income effect: China Shock increases the income of families, which demand more services. As this sector employs relatively more women, they are more benefited in the formal labor market.

#### 4.2 Heterogeneities

In the previous section, we observed the average effects of China Shock on the female insertion in the formal labor market, in each Brazilian microregion (Table 2). However, as these regions have different structural and productive characteristics, it is important to verify whether the effects on women also vary, depending on these characteristics. We have selected some microregional structural characteristics in 2000, and separated the data into terciles, to know the effects on women of regions more or less affected by the chosen characteristics. In all specifications, models are estimated by two-stage least squares (2SLS), with all controls. Table 5 shows the results for women in microregions with a higher proportion of more educated and less educated workers (Columns 1 and 2), in the richest and the poorest microregions (Columns 3 and 4), and those regions more or less populated (Columns 5 and 6).

**Table 5 – Heterogeneity Results by Structural Characteristics: Effects of China Shock on Female Formal Workers by Microregion**

	More Educated	Less Educated	Richest Microregions	Poorest Microregions	More Populated	Less Populated
	(1)	(2)	(3)	(4)	(5)	(6)
<i>Panel A: <math>\Delta Women_{participation}</math></i>						
$IS_{mt}$	-0,158 (0,285)	-1,13** (0,568)	-0,671 (0,529)	0,385 (0,991)	-0,085 (0,245)	-0,455 (1,10)
$XD_{mt}$	0,035 (0,068)	0,018 (0,054)	0,076** (0,031)	0,031 (0,344)	0,250 (0,185)	0,012 (0,118)
<i>Panel B: <math>\Delta \ln Wage_{female/male}</math></i>						
$IS_{mt}$	0,684 (1,02)	4,35** (1,85)	3,32*** (1,25)	7,44** (2,98)	1,82* (0,936)	7,79** (3,13)
$XD_{mt}$	-0,086 (0,131)	-0,462*** (0,147)	-0,057 (0,135)	-1,94 (1,87)	-0,012 (0,300)	-0,415 (0,307)
Observations	137	137	137	137	137	137

**Notes:** This table displays estimated effects of China Shock ( $IS_{mt}$  and  $XD_{mt}$ ) on changes between 2000 and 2013 in women’s participation in the Brazilian formal labor market (Panel A) and in the gender wage ratio of formal workers (Panel B) by microregion. All models were estimated by 2SLS, in microregions more (1) and less (2) educated, richest (3) and poorest (4) and in more (5) and less (6) populated. As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. \*\*\* p <0.01, \*\* p <0.05, \* p <0.1. Sources: Rais microdata and BACI database.

Regarding the evolution of the participation of women in each microregion, only a few specifications were significant, according to Panel A. For the gender wage ratio (Panel B), we find interesting results, especially through the imports channel ( $IS_{mt}$ ), since most of the coefficients were higher than those of the main specifications – 2.54 pp with 5% of significance (Table 2, Panel B, Column 4).

In Panel B, we found no evidence that the gender wage ratio in microregions with a higher concentration of employees who have a college degree were affected by the China Shock. On the other hand, we find that the trade shock has been quite positive for female formal workers from low education regions in terms of wages, since the  $IS_{mt}$  channel has an effect of 4.35 pp on the gender wage ratio, and a slightly negative effect due to the  $XD_{mt}$ , of -0.462 pp.

Regarding regional differences in income per capita, both in richer and poorer microregions, the effect of  $IS_{mt}$  on relative average women’s wage was positive, but to a greater extent in the poorest regions, with a 7.44 pp increase in gender wage ratio at 5% significance (Panel B, Column 4). For microregions with different population sizes, the effects are similar, with the  $IS_{mt}$  increasing the gender wage ratio by 7.79 pp in less populated areas at 5% significance (Panel B, Column 6), and by 1.82 pp in the most populated microregions (Panel B, Column 5), with less significance.

In Table 6, we create terciles for each of the major economic sectors defined in the previous section, separating the microregions more intensive in the production of agricultural and extractive goods (1), in manufacturing (2), and in services (3). In microregions specialized in manufacturing, the effects were significant in both panels, with results presenting the same conclusions as the main specifications.

**Table 6 – Heterogeneity Results by Productive Characteristics: Effects of China Shock on Female Formal Workers by Microregion**

	Specialized in Agricult. + Extract.	Specialized Manufacturing	in	Specialized in Services
	(1)	(2)		(3)
<i>Panel A: <math>\Delta Women_{participation}</math></i>				
IS <sub>mt</sub>	-0,331	-1,38*		-0,489
	(0,572)	(0,705)		(0,543)
XD <sub>mt</sub>	-0,041	0,206		-0,210***
	(0,072)	(0,186)		(0,079)
<i>Panel B: <math>\Delta \ln Wage_{female/male}</math></i>				
IS <sub>mt</sub>	3,36	1,98*		1,33
	(2,42)	(1,11)		(1,00)
XD <sub>mt</sub>	0,538	-0,899**		-0,516
	(0,371)	(0,382)		(0,363)
Observations	137	137		137

**Notes:** This table displays estimated effects of China Shock (IS<sub>mt</sub> and XD<sub>mt</sub>) on changes between 2000 and 2013 in women’s participation in the Brazilian formal labor market (Panel A) and in the gender wage ratio of formal workers (Panel B) by microregion. All models were estimated by 2SLS, in microregions specialized in agriculture and extractive activities (1), in manufacturing (2) and in services (3). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Sources: Rais microdata and BACI database.

We already expected this result on the gender wage ratio, since the influx of Chinese imports tends to be negative for the total manufacturing workforce (Costa et al., 2016). However, as there are fewer women in this sector of activity, they tend to be less affected than men by the shock, with relative wage improvements (Brussevich, 2018).

### 4.3 Robustness Checks

In the robustness test, we made modifications to the instruments (5a and 5b), to see how sensitive the results are to changes in the countries that trade with China. We chose three different groupings of countries. The first is the variation in trade flows between China and South American countries (Argentina, Bolivia, Chile, Colombia, Ecuador, Paraguay, Peru, Uruguay, and Venezuela), chosen by Benguria and Ederington (2017) as their main instrument. Then, we added another 10 countries<sup>65</sup>, to verify the trade between China and Latin America. Finally, we analyze the trade variations between China and the other BRICS countries: Russia, India, and South Africa.

Table 7 summarizes the test results. All models were estimated by 2SLS, with fixed state effects, and after underidentification and weak identification tests, we confirmed the validity of the instruments. In Column 1, we have the results of our preferred specification, for comparative purposes, and in the other columns, we have the results using the South American (2), Latin American (3) and BRICS (4) instruments.

**Table 7 – Robustness Results: Effects of China Shock on Female Formal Workers by Microregion, with Different Instruments Variables (IV)**

	Main Specification	South America Instrument	Latin America Instrument	BRICS Instrument
	(1)	(2)	(3)	(4)
<i>Panel A: <math>\Delta Women_{participation}</math></i>				
IS <sub>mt</sub>	-0,647*	-0,942***	-0,542	-0,751**
	(0,334)	(0,298)	(0,470)	(0,298)
XD <sub>mt</sub>	-0,0294	-0,0568	-0,0532	0,0245
	(0,060)	(0,129)	(0,134)	(0,0916)
<i>Panel B: <math>\Delta \ln Wage_{female/male}</math></i>				
IS <sub>mt</sub>	2,54**	3,45***	2,95***	3,42**
	(1,06)	(1,02)	(1,01)	(1,41)
XD <sub>mt</sub>	-0,288	2,57e-03	0,0225	-0,326
	(0,222)	(0,344)	(0,350)	(0,251)

**Notes:** This table displays estimated effects of China Shock (IS<sub>mt</sub> and XD<sub>mt</sub>) on changes between 2000 and 2013 in women’s participation in the Brazilian formal labor market (Panel A) and in the gender wage ratio of formal workers (Panel B) by microregion. All models were estimated by 2SLS, using the Frisch-Waugh-Lovell Theorem (FWL) to partialize exogenous regressors (state dummies). In Column (1) we have our main specification, using the IV with all countries (except Brazil). In the others, we use IV with South American countries (2), with Latin American countries (3) and BRICS countries (4). As controls, we use the average age, proportion of workers with at least high school degree or at least college degree, and the average monthly wage of formalized workers and a cubic polynomial of per capita income per microregion in 2000. Standard errors in parentheses, clustered by mesoregions. Coefficients and standard errors are multiplied by 100, so that they roughly represent percentage point changes. \*\*\* p < 0.01, \*\* p < 0.05, \* p < 0.1. Sources: Rais microdata and BACI database.

<sup>65</sup> Costa Rica, El Salvador, Guatemala, Honduras, Mexico, Nicaragua, Panama, Cuba, Haiti, Dominican Republic.

In general, the signs of the results were the same in most specifications, with some changes in magnitude and significance, when compared with the main estimates. As in the latter, the results suggest that China Shock reduced the participation of women in the formal market (Panel A), while for those who remained employed, it improved their salary relative to that of men (Panel B).

## 5. CONCLUSIONS

This paper explores the variation of China Shock between Brazilian local labor markets to identify whether Chinese international trade expansion was able to improve the female labor market conditions in Brazil between 2000 and 2013 – measured by the participation of women in the formal market and the wage ratio of female to male workers. Brazil is an interesting case to study because China Shock effects are spread by two channels: the rise of commodities exports to China, and the rise of imports from China. This is the first study to assess how these two channels affected the outcomes of Brazilian women.

Our findings suggest that the China Shock has worsened the entry of women into the formal market in Brazilian microregions most affected, and for those who remained in the formal market, this shock has improved their relative position in terms of their average monthly wages, mostly by the imports channel in both cases. To a certain extent, the exports channel also impacts women in the formal market, but in an adverse way.

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## **Special Session: SS10 - Regions and cities at the edge of the new technological era**

**17:30 - 18:45 Tuesday, 25th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/88394645535>**

**Chair Camilla Lenzi**

## EUROPEAN REGIONS, RESILIENCE AND LABOUR DISLOCATION IN THE AGE OF THE FOURTH INDUSTRIAL REVOLUTION.

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### ABSTRACT

This paper aims at studying the resilience of the EURO area regions' labour markets to the 2007-2008 crisis from a structural change perspective. Building on the shift-and-share analysis and on the notion of adaptive resilience, and sourcing from the Eurostat regional database data on 150 NUTS 2 EURO regions over the period 1998-2019, we show that both Industrial Mix and Spatial Dependence played a key role in the asymmetric reaction of European regional labour markets to the crisis. Standard and spatial econometric analysis confirms that the pre-crisis structural composition of employment was instrumental in determining the size of the shock at regional level whereas the post-crisis recovery was mainly determined by the kind of structural change each region followed and by competition among regions in hosting Knowledge Intensive Services.

## GEOGRAPHIC VARIATIONS IN AUTONOMOUS VEHICLE INTEREST AND PERCEIVED BENEFITS

[Elizabeth Mack](#)

Michigan State University, USA

### ABSTRACT

Survey based work has uncovered differences in the willingness to adopt and pay for autonomous vehicles. This body of work finds that men and people with higher incomes are more willing to pay for the features of AVs. Analytical results are less conclusive for people of various ages. In particular, research finds conflicting evidence about older adults' willingness to pay for AVs. Aside from individual characteristics that drive AV adoption, another important, but underexplored aspect of work to this point is how the geographic location of people impacts their propensity to adopt and use AVs. To provide some information about geography and its impact on the perceived utility of and the propensity of people to adopt AVs, this study will leverage survey data from the Michigan State of the State survey to test three hypotheses. One, geography impacts people's interest in AVs. Two, geography impacts people's perception of the importance of using AVs to go places. Three, people's perception that AVs will reduce traffic. Regression models are estimated and policy implications of the results discussed. To provide some information about geography and its impact on the perceived utility of and the propensity of people to adopt AVs, this study will test three hypotheses. One, geography impacts people's interest in AVs. Two, geography impacts people's perception of the importance of using AVs to go places. Three, people's perception that AVs will reduce traffic. Regression models are estimated and policy implications of the results discussed.

**REGIONAL PATTERNS OF 4.0 TECHNOLOGICAL TRANSFORMATION.  
CONCEPTUAL REFLECTIONS AND EMPIRICAL EVIDENCE FROM  
EUROPEAN REGIONS**

**Roberta Capello, Camilla Lenzi**

Politecnico di Milano, Italy

**ABSTRACT**

The creation and adoption of the new 4.0 technologies such as artificial intelligence, intelligent robotics, analytics, just to name a few, are expected to drive pervasive transformations and, potentially, radical impacts on the economy and the society.

Socio-economic changes are particularly affecting the domain of production and application of 4.0 technologies, i.e. sectors and markets that adopt (and under certain conditions co-invent) such technologies.

In particular, three main completely different structural transformations are at place: 1) the automation of industrial production processes (Industry 4.0); 2) the creation of new digital services (servitisation); 3) new service delivery and new traditional industry activities (digitalisation of traditional activities).

The territorial dimension of these phenomena has been so far neglected in the literature. This paper aims at filling this gap from both a conceptual and an empirical perspective. On conceptual grounds, the paper elaborates on the territorial dimension and impact of the three different 4.0 technological transformations. On empirical grounds, the paper documents these transformations in European NUTS-2 region over the period 2008-2016.

## HOW CAN COMPLEXITY THEORY AND DATA SCIENCE ASSIST SMART CITY GOVERNANCE? A REVIEW

Yiqiao Chen, Elisabete Silva

University of Cambridge, United Kingdom

### ABSTRACT

'Smart city' is a new label for cities worldwide, aiming to use the information and communications technology and enhance sustainability. Smart cities are adopting 'smart governance' policies in addressing complex social, political, economic issues, with the help of digital means. Data Science plays a key role in transforming a city into digital and smarter systems. As urban issues are nonlinear and dynamic, seeing a city as a complex adaptive system is popular among smart city literature, which requires understanding cities through Complexity Theory. Through the lens of Complexity Theory and Data Science, cities can be better understood, simulated and governed. The transportation sector is the backbone of a city and smarter transportation governance can offer better livability, workability and sustainability in smart cities; therefore, we zoom into smart mobility as an example in smart city governance to illustrate the functions of Complexity Theory and Data Science. This article reviews existing literature on Complexity Theory and Data Science in urban planning, presenting a portfolio of main authors, concepts, theories and their contributions to smart city governance, with a special focus on transportation. The review is aided by bibliometric analysis and key linkages among Complexity Theory, Data Science and Smart City Governance are identified. Complexity theory can provide both the theoretical framework and practical tools for smart city governance. Data science can enhance the management of complex systems in cities through advanced data collecting, processing and modelling techniques. Guided by complexity theory and data science, we conclude that smart city governance requires a theoretical framework of adaptive spatial planning to manage the complex urban systems. This adaptive planning framework can be integrated into dynamic simulation models to better analyze, simulate and ultimately enhance smart city governance. The article also concludes that the integrated framework of adaptive spatial planning and dynamic simulation models has great potential in assisting smart mobility and smart city governance but has rarely been applied in urban practice.

**Wednesday, 26 May 2021**

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# PARALLEL SESSIONS (6)

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## National Session: SS57 - Regional Science in Bangladesh



**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/86856640416>**

**Chair Md. Musleh Uddin Hasan**

## PRIORITIZATION CITIES IN BANGLADESH FOR BUS RAPID TRANSIT (BRT) DEVELOPMENT

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### ABSTRACT

In Bangladesh 30 district/divisional cities, apart from the capital Dhaka, have population above 100,000. None of these cities have a good, high-capacity public transport system. But considering their socio-economic, demographic and urban characteristics and comparing with other cities in the world having Bus Rapid Transit (BRT) system, it is thought that in some of them BRT should be introduced. But a simple and least data requiring methodology - without going to detailed traffic and transportation surveys - to identify and prioritize cities for BRT development is absent. The study has developed a methodology based on available data. At first 27 criteria, having implications in operation of BRT in different cities of the world, had been identified. In consultation with experts and considering local context the number of criteria was reduced to 15 and they were divided in 5 broad categories. In the 2<sup>nd</sup> round the same experts were requested to put weightage to each broad category and factors in each category. Using AHP the priority of each category and factors were calculated. The respective priority scores for the five categories and factors within each category are as follows: economy 0.262 (inverse of poverty rate in the district 0.166, no. of non-agricultural establishment 0.096); regional/ surrounding context of the city 0.215 (number of 'A' & 'B' type municipalities 0.091, number of growth centers on or within 500 meter of RHD/upazila road 0.124); major activity center/ land use 0.193 (number of EPZ and economic zone in the district 0.046, number of universities/tertiary education & Vocational centers 0.051, number of specialized hospitals 0.095); transport related factors 0.173 (presence of airport in the district 0.056, number of upazilas/sub-districts having railway station 0.047, motorized passenger traffic volume in the RHD road 0.019, average commercial vehicle per day in the upazila road 0.029, total number of registered motor vehicles in the district for the last 10 years 0.021); and demography 0.157 (average population density of 'A' type municipalities 0.040, share of population engaged in industrial activity 0.074, growth rate of population engaged in non-agricultural activity 0.043). Based on these criteria and weightages composite weighted index for 30 cities were made. It has been found that in one city - Chattogram, BRT is an overdue, while among the rest six cities currently require BRT, 13 cities require in near future and 10 cities yet to require.

### KEYWORDS

Analytical Hierarchy Process, Bus Rapid Transit, Developing cities, Prioritization

### 1. INTRODUCTION

#### 1.1 Background of the Study

Cities in developing countries are growing rapidly and becoming automobile-dominated and less sustainable "Pojani (2015)". By 2030, the world is projected to have 43 megacities with more than 10 million inhabitants, most of them in developing regions "UN (2019)". The urban population in developing countries is set to double from 2010 to 2050 while remaining stable in developed countries "UN (2019), UNDESA (2018)". The fastest-growing urban agglomerations are medium-sized cities with less than one million inhabitants, and will be located in Asia and Africa "UNDESA (2018)". Rapid growth of population causes negative impacts on urban residents especially by creating transport related challenges including pollution, congestion due to not having suitable public transportation system, climate change and lack of accessibility for the poor "Gwilliam (2002)". Now more than 170 cities in the world are using BRT as a Public Transport solution; among them 48 cities are from Asian and developing countries "ITDP (2017), Global BRT database (2019)".

As per Census 2011, currently Bangladesh has 43 cities with population above 100,000. Among them four cities, namely Dhaka, Chittagong, Khulna and Sylhet have population more than 500,000. For Dhaka city RSTP (2015) recommends five Mass Rapid Transit (MRT) Lines (MRT Line 1, 2, 4, 5 & 6) and two Bus Rapid Transit (BRT) Lines (BRT Line 3 & 7) in greater Dhaka city region i.e. area under the jurisdiction of Dhaka Transport Coordination Authority (DTCA). Many other cities of Bangladesh being in the category of medium sized towns from a global perspective and hence having potential to expand in the fastest growing urban agglomeration, do not have any strong public transport system at all. But government of Bangladesh is committed through national and sectoral strategies and plans and international commitments, to provide efficient, accessible and affordable public transport options for the citizens of all the cities in Bangladesh. Considering socio-economic, demographic and urban characteristics of cities, in the world, having BRT there may be scopes for introducing high occupancy public transport system like BRT in other cities in Bangladesh. But question comes which cities should the government consider first. In fact, each year transport sector receives one of the



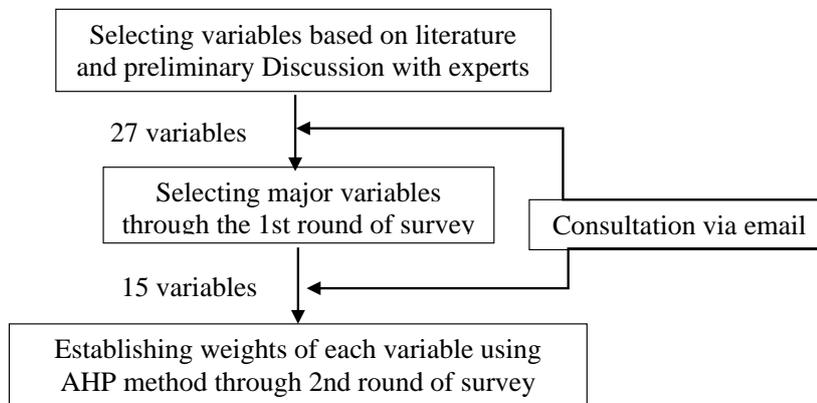
**2. LITERATURE REVIEW**

“Levinson (2003)” stated that factors influencing development of BRT systems in a city include (1) the intensity and growth prospects and patterns of the urbanized area; (2) the existing and potential future demand for public transportation; (3) expansion of the urbanized area; (4) street width continuity, capacity, and congestion; (5) opportunities for off-street running ways; (6) bus operating speeds and reliability; (7) locations of major employment centers and residential developments in relation to potential BRT routes; (8) community attitudes; and (9) community resources are important for BRT development.

“Banai (2006)” used Analytic Hierarchy Process (AHP) for multicriteria analysis to assess light rail transit (LRT) corridor and route alternatives. Three broad criteria and nine sub criteria were used to determine the best LRT corridor alternative: (1) mobility to job centers, (2) TOD impact, and (3) operating cost. “Kittelson & Associates (2007)” has provided a general guideline for BRT practitioners for BRT development. They have included some key steps including (a) Establishing need (b) Identifying the Market (c) Selecting Type of Running Way (d) Recognizing Public Preferences (e) Integrating BRT with Existing Bus Services (f) Considering Funding Availability (g) Exploring Development Opportunities etc. for developing and analyzing BRT service alternatives. “MDTA (2011)” has identified four screening criteria including (1) Existing daily bus trips, (2) Percent of corridor within a 1/2-mile radius having BRT-supportive density under future conditions, (3) Presence of major attractors/activity centers and (4) Regional transit connectivity. “Talebian (2014)” distinguished successful cities around the world with respect to transportation and similar city to Isfahan, Iran in his study. He suggested Size of the city, Urban Structure, Operation, Climate, Terrain and Economy as criteria for Sustainable Transportation Policies for Isfahan. “Salavati (2016)” wanted to define appropriate criteria for the systematic approach to evaluate and prioritize multiple candidate corridors for public transport investment in Isfahan, Iran. 12 criteria were described in his paper, such as- alleviating traffic congestion in city streets and highways, traffic safety improvement especially pedestrian safety, and reliability improvement in transportation systems regarding schedule adherence, trip comfortability, accessibility to transportation systems, attractiveness of the transportation system, facilitation of a sense of living in a modern city, mode choice diversity in city trips, efficient response to transportation demand, reducing energy consumption in city transportation sector, reducing travel time, and trip cost. A few studies have been conducted in Bangladesh related to Mass Rapid Transit (MRT). “Ahsan (1990)” studied Mass Transit in Metropolitan Dhaka in which particular attention was given to examine the necessity of a functional and cost effective ‘Mass Transit’ system. “Hoque and Hossain (2003)” suggested to introduce Tramway in Dhaka. They emphasized on the augmentation of mass transit system is a necessity to ensure mobility need, road safety, and liable urban environment for Dhaka city in future. “Mahmud and Anwar (2012)” suggested MRT and BRT will be needed as proposed in STP. But in spite of having huge benefit and large potentials, Insufficient Road Width, Insufficient Space for BRT Station, Uncontrolled and Excessive Access Road are some of the conflicting and constraining issues for implementing BRT in Dhaka. “Nasrin (2015)” combined a mixed qualitative and quantitative methodology to understand potential uptake of BRT by commuters in Dhaka for their work trip in her PhD thesis. “Rahman (2017)” studied Dhaka-Narayanganj and Dhaka-Gazipur these two routes to analyze the mode choice behavior of the commuters who regularly travel to Dhaka from its suburban areas using public transportation. The study found that suburban commuters spend a substantial amount of time for access and egress.

**3. METHODOLOGY**

Consultation with 10 experts, in transport authority, academia and practice, has been carried out to set criteria and priority matrix. It has been done in two stages. At first a list of 27 potential factors affecting choice (or non-choice) of BRT in a city, identified based on literature, is shared with experts and was requested to identify factors relevant in the context of Bangladesh. Thus, a total of 15 factors were found (Figure 2) Then these factors are categorized in five categories.



**Figure 2: Variable and data collection process with multiple surveys**

Using AHP, experts are requested to give priority to each category and sub categories in each category. Table 1 shows the categories and 15 variables, categorized under these 5 categories. Data for studies cities are collected from different census reports published by Bangladesh Bureau of Statistics (BBS), Local Government Engineering Department (LGED), Roads and Highways Department (RHD), Bangladesh Road Transport Authority (BRTA) etc.

**Table 1: Fifteen variables were extracted for Analytical Hierarchy Process (AHP) analysis from the survey**

Category	Variable	Source of Data
1. Demography	Average Population density of 'A' Category Municipalities	"BBS (2018)"
	Share of population Engaged in industrial activity	"BBS (2016)"
	Annual growth rate of population engaged in non-agricultural activity	"BBS (2016)"
2. Regional/ Surrounding Context	Number of 'A' & 'B' type municipalities	"LGED (2019)"
	Number of Growth Centers on or within 500 meter of RHD/Upazila road	"LGED (2019)"
3. Transport	Presence of Airport in the district	"BBS (2013)"
	No. of Upazilas having Railway station	"BBS (2013)"
	Motorized Passenger Traffic volume in the RHD road	"RHD (2019)"
	Average Commercial Vehicle per day (CVD) in the Upazila road	"LGED (2019)"
	Total No. of Registered motor vehicles in the district	"BRTA (2019)"
4. Major Activity center/ land use	Number of EPZ, Economic Zone in the District	"BBS (2013)"
	Number of Universities, Tertiary education & Vocational centers	"BBS (2013)"
	Number of Specialized Hospitals	"BBS (2013)"
5. Economy	Inverse of Head count ratio (HCR) rate in the district	"BBS (2009)"
	Number of Non-agricultural establishments	"BBS (2016)"

**3.1 Priority of categories and weighted index for sub-factors**

Overall priority vectors of all the categories of factors have been shown in Table 2 (details can be found in Annex tables).

**Table 2: Overall Priority of the Categories of Factors**

Category	Overall Priority	Remarks
Economy	0.262	Most significant factor
Regional/ Surrounding Context	0.215	Second most significant factor
Major Activity Center/ Land use	0.193	Third most significant factor
Transport	0.173	Fourth most significant factor
Demography	0.157	Least significant factor
<b>SUM</b>	<b>1</b>	

Ranking of sub factors of Demography, Regional/Surrounding Context, Transport, Major activity center/ Land use and Economy have been done by following the same procedure. Priority vector of the sub factors, i.e. 15 variables selected by the experts in the first phase, are provided in Table 3.

**Table 3: Priority vector of the Sub-Factors**

Category (Factor)	Sub Factors (variables)	Priority vector of Sub Factors
<b>Demography</b>	Avg. Population density of 'A' Category Municipalities	0.255
	Share of population Engaged in industrial activity	0.474
	Growth rate of population engaged in non-agricultural activity	0.271
	<b>Total</b>	<b>1.0</b>
<b>Regional/ Context</b>	Number of 'A' & 'B' type municipalities	0.424
	Number of Growth Centers on or within 500 meter of RHD/Upazila road	0.576
	<b>Total</b>	<b>1.0</b>
<b>Transport</b>	Presence of Airport in the district	0.327
	No. of Upazilas having Railway station	0.274
	Motorized Passenger Traffic volume in the RHD road	0.110
	Avg. CVD in the Upazila road	0.170
	Total No. of Registered motor vehicles in the dist. (Last 10 years)	0.119
	<b>Total</b>	<b>1.0</b>
<b>Major Activity Center/ Land use</b>	No. of EPZ, Economic Zone in the District	0.240
	No. of Universities, Tertiary education & Vocational centers	0.266
	No. of Specialized Hospitals	0.494
	<b>Total</b>	<b>1.0</b>
<b>Economy</b>	Inverse of Poverty rate in the district	0.632
	No. of Non-agricultural establishment	0.368
	<b>Total</b>	<b>1.0</b>

The variables are in different units. So, weighted index method has been applied in order to convert the values to the same unit. For this, values of each factor have been classified into five equal classes (Table 4). Equal interval method has been used for classification of values. This classification scheme divides the range of attribute values into equal sized sub ranges.

**Table 4: Score Classification for each variable or sub-factor**

Factor	Subfactors	Score Classification				
		0.2	0.4	0.6	0.8	1.0
Surrounding Demography	Avg. Population density of 'A' Category Municipalities	<2000	2001-4000	4001-6000	6001-8000	>8000
	Share of population Engaged in industrial activity (in %)	<10	10.1-20	20.1-30	30.1-40	>40
	Annual growth rate of population engaged in non-agricultural activity (in %)	<2.50	2.51 to 5.0	5.1 to 7.5	7.51 to 10.0	>10.1
Regional/ Context	Number of 'A' & 'B' type municipalities	<2 or, =2	3-4	5-6	7-8	>8
	Number of Growth Centers on or within 500 meter of RHD/Upazila road	0-15	16-30	31-45	46-60	>60
Transport	Presence of Airport in the district	0	N/A	N/A	N/A	>1 or, =1
	No. of Upazilas having Railway station	<2 or, =2	3 to 4	5 to 6	7 to 8	>9 or, =9
	Motorized Passenger Traffic volume in the RHD road	<100,000 or, =100,000	100,001-200,000	200,001-300,000	300,001-400,000	>400,000
	Avg. CVD in the Upazila road	< 100 or, =100	101-200	201-300	301-400	>400
	Total No. of Registered motor vehicles in the dist. (Last 10 years)	<20,000 or, = 20,000	20,001-40,000	40,001-60,000	60,001-80,000	>80,000
Major Activity Center/ Land use	No. of EPZ, Economic Zone in the District	<2	3-4	5-6	7-8	>8
	No. of Universities, Tertiary education & Vocational centers	0-40	41-80	81-120	121-160	>160
	No. of Specialized Hospitals	0-100	101-200	201-300	301-400	>400
Economy	Inverse of Poverty rate in the district	>40	31 to 40	21 to 30	11 to 20	<10 or, =10
	No. of Non-agricultural establishment	<65,000	65,001-130,000	130,001-195,000	195,001- 260,000	>260,001

After calculating priority vector of each factor (i.e. categories) and subfactors (i.e. variables), they have been multiplied in order to get corresponding weight of the sub-factors (Table 5).

**Table 5: Weighted Index of Sub factors**

Factors	Priority vector of Factors (i)	Sub Factors	Priority vector of Sub Factors (ii)	Weighted Index (i)×(ii)
<b>Demography</b>	0.157	Avg. Population density of 'A' Category Municipalities	0.255	0.040
		Share of population Engaged in industrial activity	0.474	0.074
		Growth rate of population engaged in non-agricultural activity	0.271	0.043
<b>Regional/ Surrounding Context</b>	0.215	Number of 'A' & 'B' type municipalities	0.424	0.091
		Number of Growth Centers on or within 500 meter of RHD/Upazila road	0.576	0.124
<b>Transport</b>	0.173	Presence of Airport in the district	0.327	0.056
		No. of Upazilas having Railway station	0.274	0.047
		Motorized Passenger Traffic volume in the RHD road	0.110	0.019
		Avg. CVD in the Upazila road	0.170	0.029
		Total No. of Registered motor vehicles in the dist. (Last 10 years)	0.119	0.021
<b>Major Activity Center/ Land use</b>	0.193	No. of EPZ, Economic Zone in the District	0.240	0.046
		No. of Universities, Tertiary education & Vocational centers	0.266	0.051
		No. of Specialized Hospitals	0.494	0.095
<b>Economy</b>	0.262	Inverse of Poverty rate in the district	0.632	0.166
		No. of Non-agricultural establishment	0.368	0.096

**4. CALCULATING COMPOSITE INDEX FOR EACH CITY**

Corresponding score for each variable has been assigned for each city (Table 6). Calculated weighted index and respective score was then multiplied to get the composite index for each city. Then the multiplication result for each factor has been added up to determine the composite index for each city (Table 7).

**Table 6: Score assigned for each city**

Sl. No.	City/ District	Demography			Regional/ Surrounding Context			Transport			Major Activity Center			Economy		
		Avg. Population density of 'A' Category Municipalities	Share of population Engaged in industrial activity (in%)	Annual growth rate of population engaged in non-	Number of 'A' & 'B' type municipalities	Number of Growth Centers on or within 500 meter of	Presence of Airport in the district	No. of Upazilas having Railway station	Motorized Passenger Traffic volume in the RHD road	Avg. CVD in the Upazila road	Total No. of Registered motor vehicles in the dist. (Last 10 years)	No. of EPZ, Economic Zone in the District	Number of universities, tertiary education & vocational centers in the district	Number of specialized hospitals or centers higher than upazila	Inverse of Poverty headcount ratio (%)	No. of Non-agricultural establishment
1	Chattogram	0.6	0.6	0.8	1.0	1.0	1.0	0.6	0.8	0.4	0.4	0.8	1.0	1.0	0.8	1.0
2	Khulna	-	0.4	0.6	0.2	0.6	0.2	0.2	0.4	0.4	0.4	0.2	0.6	0.4	0.4	0.6
3	Sylhet	0.2	0.4	0.6	0.2	0.6	1.0	0.4	0.4	0.2	0.6	0.2	0.4	0.2	0.6	0.6
4	Rajshahi	0.2	0.2	0.6	1.0	0.6	1.0	0.6	0.4	0.2	0.6	0.2	1.0	0.4	0.4	0.6
5	Bogura	0.4	0.4	0.8	0.6	0.8	0.2	0.6	0.8	0.4	0.8	0.2	0.8	0.4	0.8	0.8
6	Mymensingh	0.6	0.4	0.8	1.0	0.8	0.2	0.8	0.4	0.6	0.6	0.4	0.6	0.6	0.2	1.0
7	Barishal	0.2	0.4	0.6	0.6	0.6	1.0	0.2	0.4	0.4	0.4	0.2	0.6	0.4	0.2	0.4
8	Rangpur	-	0.2	0.6	0.2	0.6	0.2	0.4	0.4	0.2	0.6	0.2	0.6	0.4	0.2	0.6
9	Cumilla	0.4	0.4	0.4	0.8	1.0	0.2	1.0	0.6	0.6	0.6	0.2	0.8	0.6	0.4	0.8
10	Jashore	0.6	0.4	0.4	0.8	0.6	0.2	0.4	0.4	0.6	0.4	0.2	0.8	0.4	0.4	0.6
11	Cox's Bazar	1.0	0.2	0.6	0.4	0.4	1.0	0.4	0.2	0.6	1.0	0.2	0.6	0.4	0.4	0.4
12	Brahmanbaria	0.8	0.2	0.6	0.4	0.4	1.0	0.2	0.4	0.4	0.2	1.0	0.2	0.4	0.6	0.4
13	Dinajpur	0.4	0.2	0.6	0.6	0.6	0.2	0.6	0.6	0.4	0.2	0.2	0.2	0.4	0.4	0.8
14	Narsingdi	0.8	0.6	0.6	0.4	0.4	0.2	0.8	0.4	0.4	0.8	0.2	0.8	0.4	0.6	0.4
15	Chapai Nawabganj	0.4	0.2	0.8	0.4	0.4	0.2	0.2	0.2	0.6	0.2	0.2	0.4	0.4	0.6	0.4
16	Chandpur	0.4	0.4	0.6	0.6	0.4	0.2	0.2	0.2	0.4	0.2	0.2	0.4	0.2	0.2	0.4
17	Tangail	0.6	0.4	0.6	1.0	0.6	0.2	0.2	0.6	1.0	0.2	0.2	0.4	0.4	0.6	0.8
18	Sirajganj	0.6	0.6	0.4	0.4	0.4	0.2	0.6	0.6	0.4	0.6	0.2	0.6	0.6	0.4	0.6
19	Feni	0.6	0.4	0.6	0.6	0.4	0.2	0.2	0.4	0.6	0.4	0.2	0.2	0.2	0.6	0.4
20	Naogaon	0.6	0.2	0.6	0.4	0.4	0.2	0.2	0.4	0.2	0.6	0.2	0.6	0.4	0.8	0.6
21	Jamalpur	0.4	0.2	0.8	0.6	0.4	0.2	0.6	0.2	0.2	0.4	0.2	0.4	0.4	0.2	0.6
22	Pabna	0.4	0.4	0.6	0.8	0.6	0.2	0.4	0.6	0.4	0.6	0.2	0.6	0.4	0.4	0.6
23	Nilphamari	0.4	0.2	1.0	0.4	0.4	1.0	0.4	0.2	0.4	0.4	0.2	0.4	0.2	0.4	0.6
24	Noakhali	0.6	0.2	0.8	0.8	0.4	0.2	0.4	1.0	0.4	0.4	0.2	0.4	0.4	1.0	0.6
25	Chuadanga	0.4	0.2	0.6	0.4	0.4	0.2	0.4	0.4	0.8	0.4	0.2	0.2	0.2	0.6	0.2
26	Faridpur	0.4	0.4	0.4	0.4	0.6	0.2	0.4	0.4	0.4	0.2	0.4	0.4	0.4	0.4	0.4
27	Satkhira	0.4	0.2	0.6	0.2	0.6	0.2	0.2	0.6	0.4	0.8	0.2	0.4	0.4	0.2	0.4
28	Jhenaidah	0.4	0.2	0.4	0.6	0.4	0.2	0.2	0.6	0.4	0.4	0.2	0.4	0.4	0.6	0.4
29	Kushitia	0.6	0.4	0.4	0.4	0.4	0.2	0.6	0.2	0.6	0.6	0.2	0.6	0.4	1.0	0.4
30	Kishoreganj	1.0	0.2	0.6	0.4	0.6	0.2	0.6	0.2	0.8	0.2	0.2	0.4	0.4	0.6	0.6

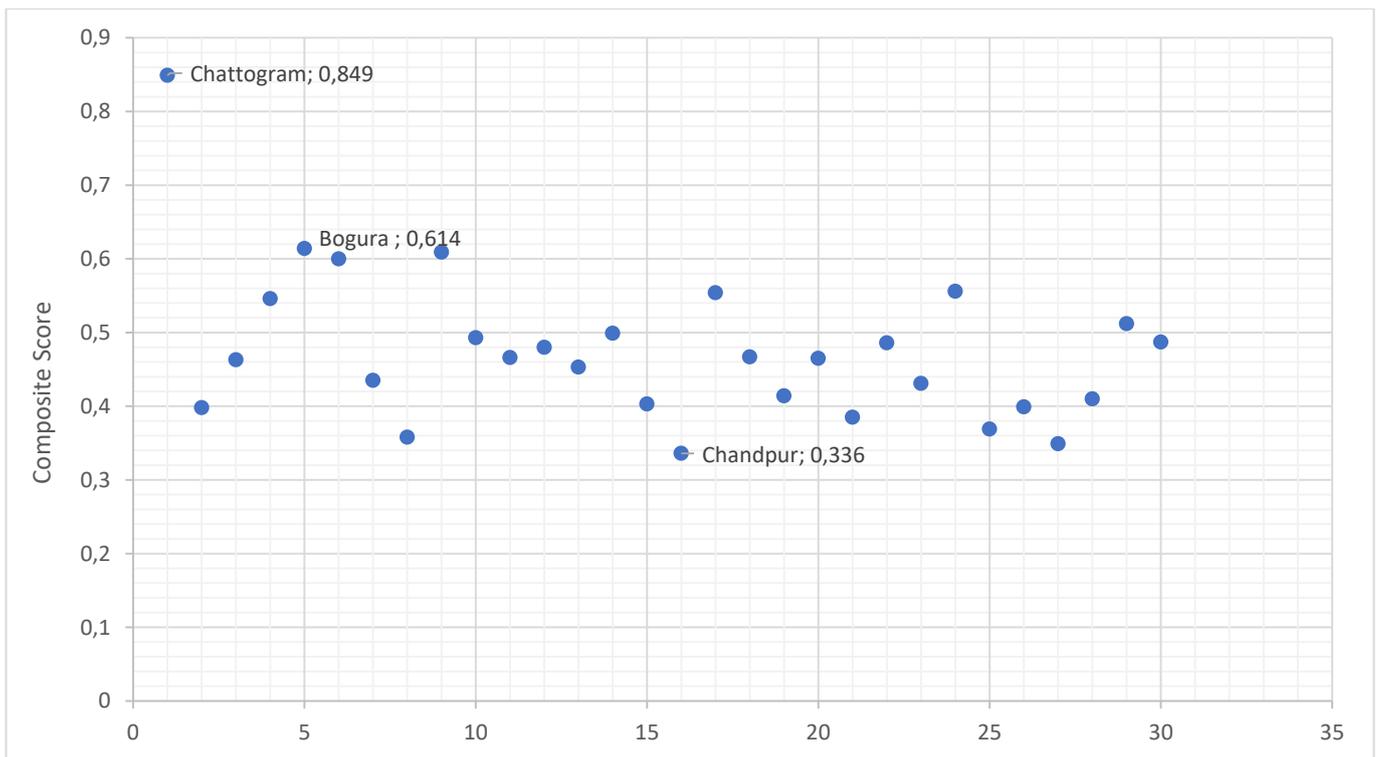
Table 7: Composite Score of each city

Sl. No.	City/ District	Demography			Regional/Surrounding Context	
		Avg. Population density of 'A' Category Municipalities	Share of population Engaged in industrial activity (in%)	Annual growth rate of population engaged in non-agricultural activity (in %)	Number of 'A' & 'B' type municipalities	Number of Growth Centers on or within 500 meter of RHD/Upazilla road
1	Chattogram	0.024	0.044	0.034	0.091	0.124
2	Khulna	-	0.030	0.026	0.018	0.074
3	Sylhet	0.008	0.030	0.026	0.018	0.074
4	Rajshahi	0.008	0.015	0.026	0.091	0.074
5	Bogura	0.016	0.030	0.034	0.055	0.099
6	Mymensingh	0.024	0.030	0.034	0.091	0.099
7	Barishal	0.008	0.030	0.026	0.055	0.074
8	Rangpur	-	0.015	0.026	0.018	0.074
9	Cumilla	0.016	0.030	0.017	0.073	0.124
10	Jashore	0.024	0.030	0.017	0.073	0.074
11	Cox's Bazar	0.040	0.015	0.026	0.036	0.050
12	Brahmanbaria	0.032	0.015	0.026	0.036	0.050
13	Dinajpur	0.016	0.015	0.026	0.055	0.074
14	Narsingdi	0.032	0.044	0.026	0.036	0.050
15	Chapai Nawabganj	0.016	0.015	0.034	0.036	0.050
16	Chandpur	0.016	0.030	0.026	0.055	0.050
17	Tangail	0.024	0.030	0.026	0.091	0.074
18	Sirajganj	0.024	0.044	0.017	0.036	0.050
19	Feni	0.024	0.030	0.026	0.055	0.050
20	Naogaon	0.024	0.015	0.026	0.036	0.050
21	Jamalpur	0.016	0.015	0.034	0.055	0.050
22	Pabna	0.016	0.030	0.026	0.073	0.074
23	Nilphamari	0.016	0.015	0.043	0.036	0.050
24	Noakhali	0.024	0.015	0.034	0.073	0.050
25	Chuadanga	0.016	0.015	0.026	0.036	0.050
26	Faridpur	0.016	0.030	0.017	0.036	0.074
27	Satkhira	0.016	0.015	0.026	0.018	0.074
28	Jhenaidah	0.016	0.015	0.017	0.055	0.050
29	Kushtia	0.024	0.030	0.017	0.036	0.050
30	Kishoreganj	0.040	0.015	0.026	0.036	0.074

Sl. No.	City/ District	Transport					Major Activity Center			Economy		Composite score= $\sum$ Weighted Index $\times$ Score
		Presence of Airport in the district	No. of Upazilla as having Railway station	Motorized Passenger Traffic volume in the RHD road	Avg. CVD in the Upazilla road	Total No. of Registered motor vehicles in the dist. (Last 10 years)	No. of EPZ, Economic Zone in the District	Number of universities, tertiary education & vocational centers in the district	Number of specialized hospitals or centers higher than upazilla health complex in the district	Inverse of Poverty headcount ratio (%)	No. of Non-agricultural establishments	
1	Chattogram	0.056	0.028	0.015	0.012	0.008	0.037	0.051	0.095	0.133	0.096	0.849
2	Khulna	0.011	0.009	0.008	0.012	0.008	0.009	0.031	0.038	0.066	0.058	0.398
3	Sylhet	0.056	0.019	0.008	0.006	0.013	0.009	0.020	0.019	0.100	0.058	0.463
4	Rajshahi	0.056	0.028	0.008	0.006	0.013	0.009	0.051	0.038	0.066	0.058	0.546
5	Bogura	0.011	0.028	0.015	0.012	0.017	0.009	0.041	0.038	0.133	0.077	0.614
6	Mymensingh	0.011	0.038	0.008	0.017	0.013	0.018	0.031	0.057	0.033	0.096	0.600
7	Barishal	0.056	0.009	0.008	0.012	0.008	0.009	0.031	0.038	0.033	0.038	0.435
8	Rangpur	0.011	0.019	0.008	0.006	0.013	0.009	0.031	0.038	0.033	0.058	0.358
9	Cumilla	0.011	0.047	0.011	0.017	0.013	0.009	0.041	0.057	0.066	0.077	0.609
10	Jashore	0.011	0.019	0.008	0.017	0.008	0.009	0.041	0.038	0.066	0.058	0.493
11	Cox's Bazar	0.056	0.019	0.004	0.017	0.021	0.009	0.031	0.038	0.066	0.038	0.466
12	Brahmanbaria	0.056	0.009	0.008	0.012	0.004	0.046	0.010	0.038	0.100	0.038	0.480
13	Dinajpur	0.011	0.028	0.011	0.012	0.004	0.009	0.010	0.038	0.066	0.077	0.453
14	Narsingdi	0.011	0.038	0.008	0.012	0.017	0.009	0.041	0.038	0.100	0.038	0.499
15	Chapai Nawabganj	0.011	0.009	0.004	0.017	0.004	0.009	0.020	0.038	0.100	0.038	0.403
16	Chandpur	0.011	0.009	0.004	0.012	0.004	0.009	0.020	0.019	0.033	0.038	0.336
17	Tangail	0.011	0.009	0.011	0.029	0.004	0.009	0.020	0.038	0.100	0.077	0.554
18	Sirajganj	0.011	0.028	0.011	0.012	0.013	0.009	0.031	0.057	0.066	0.058	0.467
19	Feni	0.011	0.009	0.008	0.017	0.008	0.009	0.010	0.019	0.100	0.038	0.414
20	Naogaon	0.011	0.009	0.008	0.006	0.013	0.009	0.031	0.038	0.133	0.058	0.465

Sl. No.	City/ District	Transport					Major Activity Center			Economy		Composite score= $\sum \text{Weighted Index} \times \text{Score}$
		Presence of Airport in the district	No. of Upazilla as having Railway station	Motorized Passenger Traffic volume in the RHD road	Avg. CVD in the Upazilla road	Total No. of Registered motor vehicles in the dist. (Last 10 years)	No. of EPZ, Economic Zone in the District	Number of universities, tertiary education & vocational centers in the district	Number of specialized hospitals or centers higher than upazilla health complex in the district	Inverse of Poverty headcount ratio (%)	No. of Non-agricultural establishments	
21	Jamalpur	0.011	0.028	0.004	0.006	0.008	0.009	0.020	0.038	0.033	0.058	0.385
22	Pabna	0.011	0.019	0.011	0.012	0.013	0.009	0.031	0.038	0.066	0.058	0.486
23	Nilphamari	0.056	0.019	0.004	0.012	0.008	0.009	0.020	0.019	0.066	0.058	0.431
24	Noakhali	0.011	0.019	0.019	0.012	0.008	0.009	0.020	0.038	0.166	0.058	0.556
25	Chuadanga	0.011	0.019	0.008	0.023	0.008	0.009	0.010	0.019	0.100	0.019	0.369
26	Faridpur	0.011	0.019	0.008	0.012	0.004	0.009	0.020	0.038	0.066	0.038	0.399
27	Satkhira	0.011	0.009	0.011	0.012	0.017	0.009	0.020	0.038	0.033	0.038	0.349
28	Jhenaidah	0.011	0.009	0.011	0.012	0.008	0.009	0.020	0.038	0.100	0.038	0.410
29	Kushtia	0.011	0.028	0.004	0.017	0.013	0.009	0.031	0.038	0.166	0.038	0.512
30	Kishoreganj	0.011	0.028	0.004	0.023	0.004	0.009	0.020	0.038	0.100	0.058	0.487

Composite Scores are shown in Figure 3. Chattogram has highest score (0.849) and other cities lie in between 0.336 and 0.614 (i.e. score of Chattogram is like an outlier and it has to be addressed separately). Chattogram has very much potential and developing BRT network has become overdue for the city. Other cities still have potential for BRT development in near future.



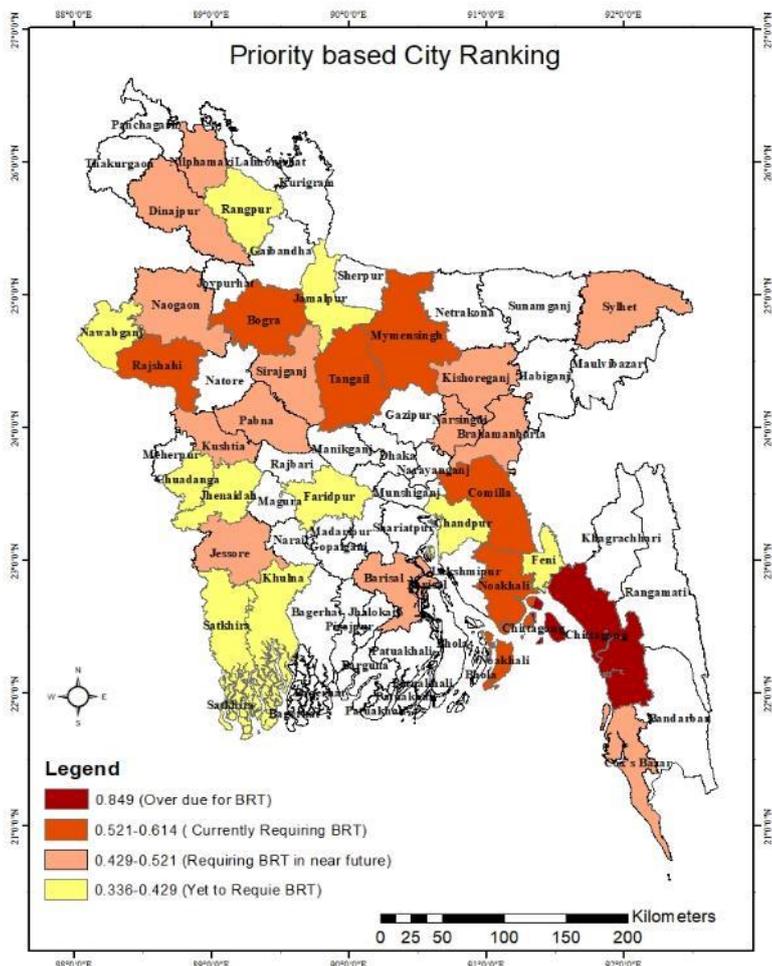
**Figure 3: Composite Scores of Cities**

Composite scores are grouped into three equal distributed range and shown in Table 8 and Figure 4. 10 cities fall under Composite Score range 0.336 to 0.429, 14 cities fall under Composite score range 0.429 to 0.521 and 6 cities fall under Composite score range 0.521 to 0.614.

**Table 8: Priority Rank group**

City/ District	Composite Score	Categorization as per Score	Remarks
Bogura	0.614	1	Currently Requiring BRT
Cumilla	0.609		
Mymensingh	0.600		
Noakhali	0.556		
Tangail	0.554		
Rajshahi	0.546		
Kushtia	0.512	2	Requiring BRT in near future
Narsingdi	0.499		
Jashore	0.493		
Kishoreganj	0.487		
Pabna	0.486		
Brahmanbaria	0.480		
Sirajganj	0.467		
Cox's Bazar	0.466		
Naogaon	0.465		
Sylhet	0.463		
Dinajpur	0.453		
Barishal	0.435		
Nilphamari	0.431		
Feni	0.414		
Jhenaidah	0.410		
Chapai Nawabganj	0.403		
Faridpur	0.399		
Khulna	0.398		
Jamalpur	0.385		
Chuadanga	0.369		
Rangpur	0.358		
Satkhira	0.349		
Chandpur	0.336		

Priority based map for Potential cities for BRT development has been shown in Figure 4.



**Figure 4: Caetgorization of cities based on the composite scores**

## 5. CONCLUSION

A total number of 30 cities of Bangladesh has been studied. The study has enlisted five major factors, namely, Demography, Regional/Surrounding Context, Transport, Major Activity Center/ Land Use and Economy. Relevant data and information have been collected for the considered factors and their sub factors. Analytic Hierarchy Process (AHP) has been applied for prioritizing the factors. This study shows that, Chattogram has highest composite value (0.849) and it has very much potential but developing BRT network has become overdue for the city. Other cities still have potential for BRT development in near future. As per analysis Bogura, Cumilla, Mymensingh, Noakhali, Tangail and Rajshahi city needs BRT immediately.

## ANNEX TABLES

**Annex Table 1: Development of Pair-wise Comparison Matrix**

Broad Category	Demography	Regional/ Context	Surrounding	Transport	Major Activity Center/ Land use	Economy
Demography	1	0.33		3	8	1
Regional/ Context	3	1		3	5	1
Transport	0.33	0.33		1	1	0.33
Major Activity Center/ Land use	0.13	0.20		1	1	0.20
Economy	1	1		3	5	1
Sum	5.458	2.87		11.00	20.00	3.53

Source: Expert survey, 2019.

**Annex Table 2: Priority Vectors of Selected Factors**

Factor	Demography	Regional/ Surrounding Context	Transport	Major Activity Center/ Land use	Economy	Row total	Priority Vector
Demography	0.183	0.116	0.273	0.400	0.283	1.255	0.251
Regional/ Surrounding Context	0.550	0.349	0.273	0.250	0.283	1.704	0.341
Transport	0.061	0.116	0.091	0.050	0.094	0.413	0.082
Activity Center/ Land use	0.023	0.070	0.091	0.050	0.057	0.290	0.058
Economy	0.183	0.349	0.273	0.250	0.283	1.338	0.268
Total							1.00

**Annex Table 3: Consistency Ratio of the Judgments**

Broad Category	Demography	Regional/ Surrounding Context	Transport	Major Activity Center/ Land use	Economy	Priority Vector	Consistency Measure
Demography	1	0.33	3	8	1	0.251	1.370
Regional/ Surrounding Context	3	1	3	5	1	0.341	0.977
Transport	0.33	0.33	1	1	0.33	0.082	0.908
Major Activity Center/ Land use	0.13	0.20	1	1	0.20	0.058	1.161
Economy	1	1	3	5	1	0.268	0.945
						$\lambda_{max}$	5.361
						For n=5, CI	0.0902
						=	
						RI=	1.12
						CR=	0.0806 (8%)

**Annex Table 4: Priority vector of the Factors According to Experts' Judgments**

Factors		Demography	Regional/ Surrounding Context	Transport	Major Activity Center/ Land use	Economy	Sum of Priority Vectors
Priority vector	Expert 1	0.047	0.109	0.175	0.225	0.444	1
	Expert 2	0.159	0.313	0.136	0.133	0.260	1
	Expert 3	0.032	0.103	0.279	0.272	0.314	1
	Expert 4	0.068	0.098	0.116	0.298	0.420	1
	Expert 5	0.318	0.181	0.274	0.080	0.147	1
	Expert 6	0.251	0.341	0.082	0.058	0.268	1
	Expert 7	0.122	0.351	0.122	0.197	0.209	1
	Expert 8	0.076	0.107	0.134	0.374	0.309	1
	Expert 9	0.354	0.211	0.232	0.128	0.076	1
	Expert 10	0.144	0.336	0.175	0.171	0.173	1

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## ECONOMIC ANALYSIS OF SOLAR IRRIGATION PUMPS: EVIDENCE FROM NORTHERN REGION OF BANGLADESH

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### ABSTRACT

Bangladesh is heavily dependent on traditional energy sources and imported fossil fuels. Renewable energy technologies are promoted to satisfy the country's rural energy needs mainly as a form of solar home system (SHS) and solar irrigation pump (SIP). As an agriculture-based country, irrigation is vital for ensuring agricultural production sustainability in Bangladesh. Solar irrigation pumps (SIPs) can be a reliable option in this regard. It protects the environment from air and sound pollution as well as water contamination by diesel based fuel. However, there is significant dearth of studies in this regard that provide economic analysis of the solar irrigation pumps. Thus, this study investigates the economic feasibility of the solar irrigation pumps being operated in the northern region of Bangladesh. The study is mainly based on primary data collected from the users of solar irrigation pumps. The data have been collected from four unions under two Upazilas of Dinajpur and Rangpur districts. 30 solar irrigation pumps (SIPs) with different capacities are selected randomly from the study areas after collecting the list of all solar irrigation pumps from the Infrastructure Development Company Ltd (IDCOL). The SIPs are categorized into large, medium, and small pumps. The standard financial indicators and the environmental benefit of different solar pumps are measured in this study. The financial analysis revealed that small SIPs are the most profitable option for investment. Large SIPs are found moderately profitable and their profitability can be improved only when introduced to additional uses. The financial analysis showed that medium SIPs are not a viable option for investment. Thus, 'the fees for ownership model' is found to be more profitable than 'the fees for service model'. The net environmental benefit of SIP is found greater than the given subsidy for installing it. Lastly, it is found that net environmental benefit per kilowatt peak (kWp) is highest for the small SIPs. Therefore, the government should continue giving grants for installing SIPs, especially small SIPs, for their quick spread at the root level.

### KEYWORDS

Bangladesh, Environmental Impact, Financial Analysis, Renewable Energy, Solar Irrigation Pumps.

### 1. INTRODUCTION

Bangladesh is one of the most densely populated countries (1116 persons/km<sup>2</sup>) in the world, having 162.20 million population as per the 2011 census (Blaauw, 2014). According to the world population prospect of the United Nations, the population of the country will continue to increase up to the year 2050. Thus, it poses a challenge for the country to ensure food security for this vastly growing population. One of the most important solutions in this regard is to increase crop productivity and cropping intensity of the cultivable land. The total cultivable land of the country is 8.52 million hectares, of which the total cropped area is 14.943 million hectares (Ministry of Power, 2008). Out of the 8.52 million hectares of cultivable land, about 7.76 million hectares have already come under irrigation facility (Ministry of Power, 2008) and adoption of irrigation plays a vital role in ensuring efficient use of cultivable land to safeguard food security for the vast population. As the country suffers from scarcity of enough surface water, especially in the dry seasons, underground water has become the primary source of irrigation. The farmers mainly use diesel and grid-connected water pumps for irrigation. Over 1.57 million irrigation pumps are being used in the country for this purpose, of which 80% are diesel engines operated and 20% are electricity operated (BADC, 2020). As the pumps are mostly diesel engines operated, every year Bangladesh has to import about 1.06 million tons of diesel. The government usually provides subsidies in diesel prices to afford irrigation, which creates extra budgetary pressure. Thus, use of solar irrigation pumps can reduce foreign currency expenditure significantly, and a recent report has shown that thirteen hundred solar irrigation pumps can save about \$3.2 million every year by replacing the diesel pumps (BADC, 2020).

On the other hand, the grid-connected irrigation pumps also have some problems in Bangladesh due to low voltage and load shedding. Bangladesh faces an acute shortage of energy, especially in the peak irrigation period and the whole country faces an energy crisis of 1248 MW (BBS, 2018). The total generation capacity of electricity in the country was about 15000 MW in 2018. However, the maximum generation was 10958 MW due to fuel supply constraints (BBS, 2018). The primary source of electricity in Bangladesh is fossil fuels. The contribution of the gas-based power generation is 61.37% (6725 MW), diesel and furnace oil is 24.72% (2708 MW), the coal-based power plant is 2.70% (295 MW), and hydro-electric generation is 1.63% (220 MW) in the total production of electricity in Bangladesh (BBS, 2018). Thus, the primary sources of electricity generation in Bangladesh are natural gas, diesel, and furnace oil-based power plants. Due to the reducing reserve of natural gas of the country and oil price volatility in the international market, these sources have become non-sustainable and vulnerable. To overcome the problem, Bangladesh government has set the vision to

generate 10% of its total power by renewable sources within the year 2021, and it would increase to 20% percent by 2030 (BPDB, 2017). Solar energy can play an essential role in fulfilling the vision because solar radiation is richly available in Bangladesh, with an average variation between 4 and 6.5 kW/m<sup>2</sup>/day (Hossain et al., 2015). The maximum solar insolation occurs during February–June, and the minimum occurs during October–February in Bangladesh (Rofiqul Islam et al., 2008). The average bright sunshine hours vary from 6 to 9 h/day, which is one of the significant positive indications of solar irrigation pumps' viability.

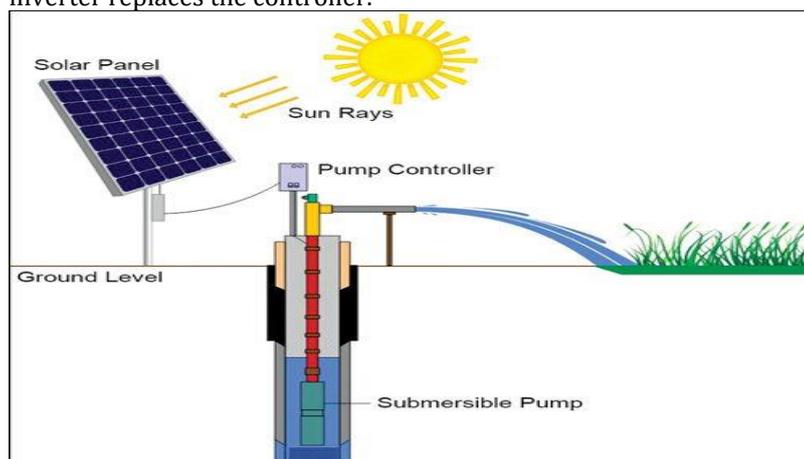
Besides, diesel and grid based irrigation pumps cause CO<sub>2</sub> emission in Bangladesh's as agricultural activities increase day by day. It rose to 7814 thousand tons in 2012 from 705 thousand tons in 1983, which means about 11 folds increase in CO<sub>2</sub> emission from diesel and electricity run irrigation pumps within 30 years (Al-Masum et al., 2017). It can be checked by introducing solar irrigation pumps instead of conventional pumps. For these purposes, the Bangladesh government has established the Infrastructure Development Company Limited (IDCOL) in 1997. Its purpose was to bridge the financing gap for developing medium to large-scale infrastructure for renewable energy projects. Moreover, IDCOL already has taken a target to replace 50000 diesel pumps with solar irrigation pumps within 2025 (Power Division, 2017). SIPs have almost negligible operational and maintenance cost, and installation of solar irrigation pumps certainly reduces carbon emissions.

Nevertheless, SIP's installation is not free from problems, and the main problem is the high initial capital investment required to install it. Further, the lack of technically trained personnel and supply chains for components and parts of solar photovoltaic (PV) systems in rural areas can lead to low maintenance and delays in repairs (Mahtab & Morshed, 2018). It can affect system lifetime and economic viability as well. Leah C. Kelley et al. (2010) found from a lifecycle cost analysis that solar-powered irrigation is economically viable. However, the PV panels' high costs involve a high initial cash outlay, which needs financing (Kelley et al., 2010). In the developing nations, the capital cost is still the main hindrances to the widespread use of SIPs (Meah et al., 2008). In Bangladesh, Hoque et al. (2016) found that under the current financial scheme for SIPs (20% equity investment, 40% credit support, and the remaining 40% grant), the payback period is 5.43 years, NPV is 13,756 Tk, and IRR is 18%. However, without any support, these projects are not economically attractive. The payback period for this case is about 18 years (Hoque et al., 2016). Thus, solar pumps become financially unviable for farmers without any subsidy than conventional electric and diesel-run pumps. Moreover, solar irrigation pumps are less efficient compared to diesel-operated pumps. A solar pump of 3 horsepower (hp) working for 8 hours a day gives the same water output as a standard 3 hp pump working on grid power or diesel engine for 5 hours a day (Kumar, 2014). Thus, a precise assessment of the economic feasibility of SIPs in Bangladesh is made in this study through providing an economic analysis of the solar irrigation pumps operating in the Northern region of Bangladesh.

The paper is organized as follows: section 2 provides information about the features of solar irrigation pump and its installation; section 3 explains the methodology; section 4 provides the results; and finally, section 5 concludes.

## 2. KEY FEATURES OF SOLAR IRRIGATION PUMP

Daily water delivery of a solar pump (also known as a photovoltaic pump, PVP) depends on the installed PV panels' number and the water depth. The inter-connected PV panels turn sunlight into direct current (DC), and the electricity is transferred to the solar water pump through a controller. Some solar water pumps use alternating current (AC), so an inverter replaces the controller.



**Figure 1: Features of a Solar Irrigation Pump (VEIPL, 2018)**

The capacity of a solar pump depends on the number of total installed solar modules. A 1.8 kWp solar pump is equal to the number of solar modules multiplied by each module's capacity ( $24 \times 75 \text{ W}_p$ ) = 1800 Wp. A tracking structure, a submersible pump, controller, installation materials, and pipe are necessary to install a solar irrigation pump (VEIPL, 2018).

**Table 1: System Components of a 1.8 kWp Solar Irrigation Pump**

Sr. No.	Description	Quantity
1	Solar Modules/panels 75 Wp	24
2	Array tracking structure	1
3	Submersible pump 2 HP	1
4	Motor/pump Controller	1
5	Installation kit	1
6	2" HDPE pipe (meter)	10

Source: Vatio Energy India Private Limited (2018) (VEIPL, 2018).

Solar panel cost is a vital part of the total investment for a SIP, covering about 45% of the total cost. The installation and pump cost account for 18% and 16% of the total cost, respectively.

## 2.1 Solar Irrigation Pumps in Bangladesh

IDCOL (Infrastructure Development Company Ltd. BD) is a wholly government-owned financial institution, which is implementing the installation of solar irrigation pumps in Bangladesh. Starting its operation in 1997, it is the largest financier and monitoring authority of the renewable energy sector in Bangladesh. IDCOL receives funds from the government of Bangladesh and multiple development partners like the WB (World Bank), KfW ([German government-owned development bank](#)), KOICA (Korea International Cooperation Agency), JICA (Japan International Cooperation Agency), ADB ([Asian Development Bank](#)), USAID (United States Agency for International Development), GPOBA (Global Partnership of Output-Based Aid) and BCCRF (Bangladesh Climate Change Resilience Fund) (IDCOL, 2019). All solar irrigation projects are supported and implemented at the users' level by partner organizations (POs) like Grameen Shakti, Jagorani Energy, ARS Bangladesh, REB, Electro Solar Power Ltd (IDCOL, 2019).

The average bright sunshine hours vary from 6 to 9 hours per day in Bangladesh. Thus, solar energy is richly available in the country with a variation of average solar insolation between 4 and 6.5 kW/m<sup>2</sup>/day (Tanvir et al., 2017). The insolation rate is one of the essential positive indications of solar irrigation pumps' viability. The northern part of the country has the highest level of average solar insolation rate. That is why 618 out of 832 SIPs have been installed in the region. The total number of approved SIPs in Bangladesh was about 1140. Among them, the number of installed SIPs was 832 up to 2019. The information provided by IDCOL is given in Table 2.

**Table 2: Division-wise Number of SIPs up to 2019**

Region	Approved	Installed
Rangpur	705	574
Rajshahi	104	44
Khulna	325	211
Chittagong	2	2
Dhaka	4	1
Total	1140	832
<b>Capacity in MW</b>	<b>13.90</b>	<b>8.72</b>

Source: IDCOL (2019) (IDCOL, 2019).

However, the government initially aimed to generate at least 150MW electricity from solar irrigation pumps within 2020 and gradually set to increase the installed capacity of SIPs by projecting irrigation pumps within 2025 to be about 50000 (Ministry of Power, 2008), which would be illustrated year by year in Table 3.

**Table 3: Installation Projection of Solar irrigation Pumps**

Year	No. of Solar Irrigation Pump (SIPs)
2013	09
2014	80
2015	300
2016	450
2017	661
2018	1013
2019	1519
2020	2278
2021	3417
2022	5126
2023	7689
2024	11533
2025	15925
<b>Total</b>	<b>50000</b>

Source: IDCOL (2019) (IDCOL, 2019).

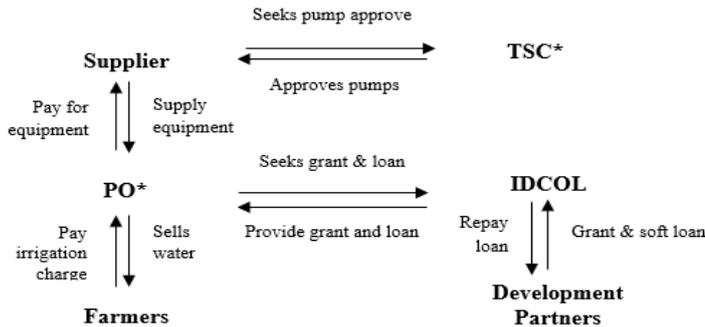
Thus, the total number of projected solar irrigation pumps will be about 50000 within 2025, is a minimal share of 1.57 million conventional irrigation pumps (Hossain et al., 2015). In 2019, the number of installed SIPs was 832, but the projected number of SIPs was 1519. Thus only about half of the targeted SIPs have been installed up to 2019 (IDCOL, 2019).

## 2.3 Two Models for Solar Irrigation Pump Program

IDCOL proposed two different models, such as 'fees for service model' and 'fees for ownership model' for installing and managing solar irrigation pumps in the country.

### Fees for Service Model

In the 'fees for service model,' partner organizations (POs) collect solar irrigation pumps from suppliers and install them, and farmers purchase water for irrigation from POs. POs receive grants and loans from IDCOL, and IDCOL collects those grants and loans from development organizations and government. This is depicted in Figure 2.

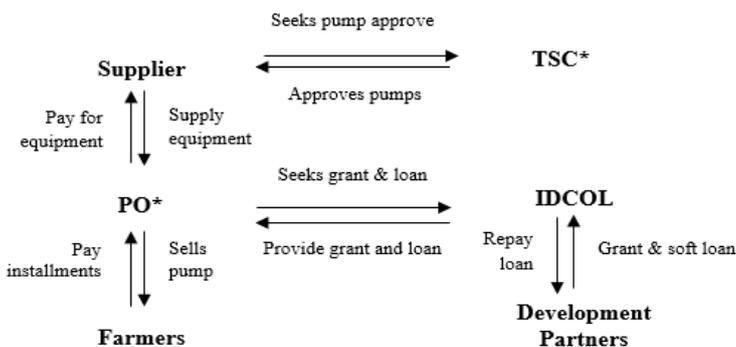


**Figure 2: Fees for Service Model of SIP (Rahman, 2015)**

Notes: \*TSC: Technical Standards Committee of World Bank. PO\*= Partner Organization

### Fees for Ownership Model

The ownership model is almost the same as the service model. Here POs sell the pump on cash or credit instead of selling irrigation water to the farmers. Also, the farmers pay installments for purchasing the SIP rather than paying irrigation charges to POs. Other functions of the model remain unchanged. The SIP capacity in the ownership model is lower than the service model (For example, the panel capacity for the ownership model would be around 4 kWp, and it would be around 15 kWp for the service model). This model is illustrated in Figure 3.



**Figure 3: Fees for Ownership Model of SIP (Rahman, 2015)**

\*TSC: Technical Standards Committee of World Bank. PO\*= Partner Organization

## 2.4 Financing Structure of Solar Irrigation Pump (SIP)

IDCOL provides up to 40% subsidy and arranging 40% soft loan with the aid of donor agencies. Under this program, POs or individual investors must invest only 20% of the SIP's cost as a down payment (Rahman, 2015). Table 4 shows the financing structure for the implementation of solar irrigation pumps proposed by IDCOL.

**Table 4: Financing Structure of Solar Irrigation Pump**

Particulars	Percentage
Grant	40%
Debt	40 %
Equity (Down payment)	20%
<b>Total</b>	<b>100%</b>

Source: IDCOL (2019) (IDCOL, 2019).

**3. METHODOLOGY**

In this study, information about the small, Medium, and large SIPs were collected from the four unions of two Upazilas namely Birganj under Dinajpur district and Badarganj under Rangpur district of Bangladesh. Several partner organizations (POs) such as Gazi, Solargao, and Gram installed the solar irrigation pumps in the visited areas. A total of 30 solar irrigation pumps are selected from the list of total installed solar pumps of IDCOL with different capacities. Secondary information about the SIPs have been collected from IDCOL, SREDA and PO.

**3.1 Financial analysis of different solar irrigation pumps**

In this study, the standard methods of financial analysis such as **a)** Net Present Value (NPV), **b)** Simple Pay Back Period (PBP), **c)** Internal Rate of Return (IRR), and **d)** Benefit-Cost Ratio (BCR), have been calculated to determine the economic viability of different type of solar irrigation pumps (SIPs) in the study area. The methods are as follows:

**3.1.1 Net Present Value (NPV)**

NPV is defined as the difference of the present values (PVs) of the total cash inflows (benefits) and the cash outflows (costs). If all future cash flows are incoming and the only outflow of cash is the purchase price (PP), the NPV is simply the present value of future cash inflows minus the purchase price.

$$NPV = \sum_{t=1}^T \frac{CF_t}{(1+d)^t}$$

Where, CF = Cash flow, PP = Purchase price, t = Period of cash flows, d = Discount rate. NPVs is calculated at the discount rates of 6%, 9%, and 12%, which symbolize typical bank interest rates. Thus, we can compare the gains between buying a solar irrigation pump by using money and saving the same amount of money in a scheduled bank.

**3.1.2 Payback Period (PBP)**

The payback period refers to the period required for the return on an investment to "repay" the sum of the original investment. For example, a \$2000 investment, which returned \$500 per year, will have a four-year payback period.

$$PBP = \frac{II}{NCI/Y}$$

II = Initial Investment    NCI/Y= Net cash inflow per year

**3.1.3 Internal Rate of Return (IRR)**

The internal rate of return (IRR) of a potential investment is the discount rate of interest that makes the net present value equal to zero. If the IRR becomes 15 percent (for buying a SIP with a lifetime of 20 years), buying a SIP brings enough revenue in 20 years to pay its cost and grants a return of 15 percent on the invested capital. Therefore, in this case, borrowing the required capital at less than 15% interest rate and finance it for buying the SIP would be a profitable investment.

Formula of IRR:

$$0 = CF_0 + \frac{CF_1}{(1+IRR)} + \frac{CF_2}{(1+IRR)^2} + \frac{CF_3}{(1+IRR)^3} + \dots + \frac{CF_n}{(1+IRR)^n}$$

$$0 = NPV = \sum_{n=0}^N \frac{CF_n}{(1+IRR)^n}$$

CF<sub>0</sub> = Initial investment                      CF<sub>1</sub>, CF<sub>2</sub>, CF<sub>3</sub> . . . CF<sub>n</sub> = Cash flows  
 n = Each period                                      N = Holding period  
 NPV = Net present value                      IRR = Internal rate of return

**3.2 Environmental Impact of Solar Irrigation Pump**

The environmental benefits, and the environmental costs of SIPs, are calculated in the study. According to the Intergovernmental Panel on Climate Change (IPCC) guidance, the most common methodological approach to calculate the environmental impact of any investment is to combine information about human activities (called activity data or AD) with coefficients that quantify the emissions per unit activity (Roberta Q, 2006). These are called emission factors (EF). The basic equation is, therefore, is as follows:

$$\text{Emissions} = AD \cdot EF$$

AD= Activity data/ substituted amount of diesel

EF= Emission factors/carbon content

For this study, the activity data (AD) is the substituted amount of diesel by solar irrigation pumps, and emission factors (EF) are the diesel's carbon content. Therefore, CO<sub>2</sub> emissions can be estimated based on the total amount of fuels combusted and the fuels' average carbon content. The environmental benefit of a solar irrigation pump (EBSIP) in terms of CO<sub>2</sub> emission reduction is shown below:

$$EBSIP = TDU \times 2.8 \text{ kg} \quad [1\text{-liter diesel} = 2.8 \text{ kg CO}_2] \text{ (Dev, 2014)}$$

TDU = Total diesel used in 20 years in the liter

The environmental benefit of solar irrigation pump (EBSIP) can be expressed in monetary terms as follows:

$$EBSIP \text{ in Monetary terms} = \frac{EBSIP}{1000} \times CRCO_2$$

Where, EBSIP = Environmental benefit of a solar irrigation pump, CRCO<sub>2</sub> = cost of removal of CO<sub>2</sub> per ton . David W Keith et al. (2018) calculated the cost of removing per ton CO<sub>2</sub> from the atmosphere is about 100 USD in their up-to-date study (Keith et al., 2018). On the other hand, according to the study of Krauter and Ruther (2004), the corresponding emission of CO<sub>2</sub> for the manufacturing of each kWp of PV panels by poly-crystalline silicon is 170 KgCO<sub>2</sub>/kWp. This information are used to calculate SIPs' environmental costs. Finally, the solar irrigation pump's net environmental impact has been calculated by subtracting the pump's environmental benefit and degradation.

## 4. DISCUSSION OF RESULTS

### 4.1 Financial Feasibility of Large, Medium, and Small Solar Irrigation Pumps (SIPs)

The visited solar irrigation pumps (SIPs) have been categorized equally into three groups such as large, medium, and small SIPs. The capacities of these three groups are as follows:

1. Large solar irrigation pump (with more than 20 kWp solar panels)
2. Medium solar irrigation pump (with 6 to 20 kWp solar panels)
3. Small solar irrigation pump (with 1 to 5 kWp solar panels)

After installation, the partner organizations (POs) own the large and medium SIPs, and the farmers usually possess the small solar irrigation pumps (SIPs). The large and medium SIPs are the example of 'fees for service model' and the small SIP is the example of 'fees for ownership model'. Several POs such as Gazi, Solargao, and Gram installed the solar irrigation pumps in the visited areas. POs appoint an operator for each large and medium solar pump to operate and collect the irrigation fees from farmers. The operator's compensation is TK.3000 per month to ensure the pump's security and 20% of the total collected irrigation fees as commission per year.

The information about costs or *cash outflows* and returns or *cash inflows* of solar pumps has been collected from the installers and farmers. The cash outflows and inflows are the main components for the financial analysis of the pumps.

#### 4.1.1 Basic Information of a Large Solar Irrigation Pump

Large solar irrigation pumps are installed under the 'fees for service model' by partner organizations (PO) at the field level. A large SIP with 30kWp solar panels (120 solar panels each with 250W capacity) and 15kW pump can deliver about 1800000 liter water per day. IDCOL offers 40% of the total price as a grant, the other 40% as a soft loan, and the remaining 20% of the pump's total price has to be paid as a down payment. The total installation cost of the large SIP after receiving a 40% grant becomes about TK.2793840. It can provide irrigation facility to 100 bigha land for Boro cultivation and more than 120 bigha land for other crops cultivation. The irrigation charge for Boro cultivation is TK.3500 per bigha for one season, and for other crops is TK.250 per bigha for one irrigation. The pump provides irrigation facilities on average 200 days in a year. Other days of the year, the pump remains unused. Frequently, this type of large solar irrigation pump without alternative use needs 20 decimal land to install. The necessary information on large solar irrigation pump has given in Table 5.

**Table 5: Basic Information of a Large Solar Irrigation Pump**

Subject	Information
<b>Panel capacity:</b>	30 kWp (250W×120 panels)
<b>Pump capacity:</b>	15 kW (7.5 kW ×2 Pumps)
<b>Water flow:</b>	1800 m <sup>3</sup> /day or 1800000 Liter/day
<b>Offers:</b>	Irrigation facility to 100 bigha land for Boro and 120 bighas for other crops cultivation
<b>Purchasing pattern:</b>	40% grant, 40% loan and 20% down payment
<b>Total cost:</b>	TK.2793840 (after receiving 40% grant)
<b>Irrigation Charge:</b>	3500Tk/bigha/season for Boro and 250Tk/bigha/irrigation for other crops.
<b>Installed by:</b>	Solargao/ Gazi/ Gram
<b>Facility:</b>	Irrigation only
<b>Number of farmers:</b>	30
<b>Required land:</b>	20 decimal
<b>Operating days:</b>	200/ year
<b>Cultivable crops:</b>	Amon, Boro, mustard, potato, corn, etc.

Source: field survey 2019; (here, 1 bigha=50 decimal).

The main cash outflows are the installation and operating cost, and the main cash inflow is the irrigation fees for this large pump without any alternative use.

#### 4.1.2 Basic Information of a Large Solar Irrigation Pump with Alternative Use

Large solar irrigation pump with alternative use is installed and maintained at the field level by partner organizations (PO). It is also operated under the 'fees for service model.' Generally, alternative provisions like husking and grinding machines have been introduced with the large solar irrigation pump. During off-irrigation time, the solar energy is used for the husking or grinding purpose. The husking machine's power is 10 HP or 7.5 kW, equal to each pump's power. Thus, one pump and the husking machine can run simultaneously by solar electricity. After receiving a 40% grant from IDCOL, the solar irrigation pump's price with the paddy husking facilities became Tk.2903840. About 30 decimal land is

necessary to install this pump with the alternative use. The necessary information on a large solar irrigation pump with a husking machine has given in Table 6.

**Table 6: Basic Information of a Large SIP with Alternative Use**

Subject	Information
<b>Panel capacity:</b>	30 kWp (250W×120 panels)
<b>Pump capacity:</b>	15 kW (7.5 kW ×2 Pumps)
<b>Water flow:</b>	1800 m <sup>3</sup> /day or 1800000 Liter/day
<b>Offers:</b>	Irrigation facility to 100 bigha land for Boro and 120 bighas for other crops cultivations
<b>Purchasing pattern:</b>	40% grant, 40% loan and 20% down payment
<b>Total cost:</b>	2903840 Tk (after receiving 40% grant)
<b>Irrigation Charge:</b>	Tk.3500/bigha/season for Boro and TK.250/bigha/irrigation for other crops.
<b>Installed by:</b>	Solargao/ Gazi/ Gram
<b>Alternative use:</b>	Paddy husking at the rate of 15Tk/Maund. (1 Maund=40kg)
<b>Facility:</b>	Irrigation and husking
<b>Number of farmers:</b>	30
<b>Required land:</b>	30 decimal
<b>Cultivable crops:</b>	Amon, Boro, mustard, potato, corn, etc.

Source: field survey 2019; (here, 1 bigha=50 decimal).

For this large solar pumps with alternative use, the main cash outflows are the installation and operating cost, without any repairing costs for four years and the main cash inflows are the irrigation and paddy husking fees.

#### 4.1.3 Basic Information of a Medium Solar Irrigation Pump (SIP)

Medium solar irrigation pumps are also installed and maintained by partner organizations (PO) and operated under the 'fees for service model.' A medium SIP with 15kWp solar panels (60 solar panels each with 250W capacity) with a 7.5kW pump can deliver about 1100000 liter water per day. It can provide irrigation facility to 50 bigha land for Boro and more than 70 bigha land for other crops cultivation. IDCOL offers 40% of the total price as a grant, the other 40% as a soft loan and the remaining 20% of the pump's total price has to be paid as a down payment. Thus, the total installation cost of the medium SIP after receiving a 40% grant becomes about 1881948Tk. The pump's irrigation charge for Boro cultivation is TK.3500 per bigha for one season. For the other crop, the charge is TK.250 per bigha per irrigation. The pump is operated on average 200 days a year. On the other days of the year, the pump remains unused. Ten decimal land is necessary to install this type of medium SIP. The summary of the basic information of a medium SIP has given in Table 7.

**Table 7: Basic Information of a Medium Solar Irrigation Pump**

Subject	Information
<b>Panel capacity:</b>	15 kWp (250W×60 panels)
<b>Pump capacity:</b>	7.5 kW (3.75×2 Pumps)
<b>Water flow:</b>	1100 m <sup>3</sup> /day or 1100000 Liter/day
<b>Offers:</b>	Irrigation facility to 50 bigha for Boro and 70 bigha for other crops cultivation
<b>Purchasing pattern:</b>	40% grant, 40% loan and 20% down payment
<b>Total cost:</b>	1881948 Tk (after receiving 40% grant)
<b>Irrigation Charge:</b>	TK.3500/bigha/season for Boro and TK.250/bigha/irrigation for other crops.
<b>Installed by:</b>	Solargao/ Gazi/ Gram
<b>Facility:</b>	Irrigation only
<b>Number of farmers:</b>	20
<b>Required land:</b>	10 decimal
<b>Operating days:</b>	200/ year
<b>Cultivable crops:</b>	Amon, Boro, mustard, potato, corn, etc.

Source: field survey 2019; (here, 1 bigha=50 decimal).

For this medium solar pump, the main cash outflows are the installation and operating cost; then again, the only cash inflow is the irrigation fees.

#### 4.1.4 Basic Information of a Small Solar Irrigation Pump (SIP)

Small solar irrigation pump's financial structure is designed for 'fees for ownership model.' A typical small SIP with 4kWp solar panels (16 solar panels each with 250W capacity) and 2.5kW pump can deliver about 350000 liter water per day. It can provide irrigation facility to 16 bigha land for Boro cultivation and more than 30 bigha land for other crops cultivation. IDCOL offers 40% of the total price as a grant, the other 40% as a soft loan, and the remaining 20% of the pump's price has to be paid as a down payment. Thus, the small SIP's total cost after receiving a 40% grant becomes about 406128Tk. IDCOL also offers TK.270752 as a loan, and the remaining TK.82000 has to be paid as a down payment. After purchasing, the farmer can save his irrigation cost and rent out the facility to the adjacent farmers. Thus, he can earn from the irrigation charge at 3500Tk per bigha per season for Boro cultivation and TK.250 per bigha per irrigation

for other crop cultivation. Only 2-3 decimal land is necessary for the installation of a small solar irrigation pump. The basic information of a small SIP has been given in Table 8.

**Table 8: Basic Information of a Small SIP**

Subject	Information
<b>Panel capacity:</b>	4kWp (250W×16 panels)
<b>Pump capacity:</b>	2.5 kW
<b>Water flow:</b>	350 m <sup>3</sup> /day or 350000 Liter/day
<b>Offers:</b>	Irrigation facility to 16 bigha land for Boro and 30 bigha land for other crops cultivation.
<b>Purchasing pattern:</b>	40% grant, 40% loan and 20% down payment
<b>Total cost:</b>	TK.406128 (after receiving 40% grant)
<b>Irrigation Charge:</b>	TK.3500/bigha/season for Boro and TK.250/bigha/irrigation for other crops.
<b>Installed by:</b>	Solargao/ Gazi/ Gram
<b>Facility:</b>	Irrigation only
<b>Number of farmers:</b>	05
<b>Required land:</b>	2-3 decimal
<b>Operating days:</b>	200/ year
<b>Cultivable crops:</b>	Amon, Boro, mustard, potato, corn, etc.

Source: field survey 2019; (here, 1 bigha= 50 decimal).

#### 4.2 Financial Indicators of Different Solar Irrigation Pumps

The information about cash outflows and cash inflows has been utilized to compute the financial indicators such as NPV (net present value), PBP (payback period), and IRR (internal rate of return) of the SIPs. The indicators help to realize which one is the most feasible option for investment. NPVs have been calculated at the discount rates of 6%, 9%, and 12%, which symbolize typical bank interest rates. Therefore, the comparison between the gains of installing the solar irrigation pump and saving the money in a scheduled bank will be possible. IRR helps show the actual return rate at which the net present value of an investment becomes zero. The PBP shows the time required for covering the project's total cost, and after the period, the project starts to earn a profit. The findings of the financial analysis are depicted in Table 9.

**Table 9: The Outcomes of the Financial Analysis of Different SIPs**

Solar irrigation pump (SIP)	NPV (6%) Tk	NPV (9%) Tk	NPV (12%) Tk	IRR (%)	Payback period (years)
1. a) Large SIP	990167	224460	-316227	10.13	8.10
1. b) Large SIP with alternative use	1135324	320069	-255617	10.54	7.82
2. Medium SIP	-109868	-469166	-722579	5.27	12.91
3. Small SIP	555470	358393	219356	20.1	4.84

Source: Author's calculation based on field survey data, 2019.

In Table 9, large and medium SIPs (1 & 2) represent 'fees for service model' because partner organizations (PO) install, own, and manage these solar irrigation pumps. Under this model, POs sell water to the farmers and collect irrigation fees from them. Besides, small SIP (3) represents the 'fees for ownership model' because an individual farmer can buy the pump from the PO. Table 9 demonstrates the results of all financial indicators of large, medium, and small SIPs. The findings of the financial indicators are as follows:

##### 4.2.1 Large Solar Irrigation Pumps

Without and with alternative use (1a, 1b), the large solar irrigation pumps were found moderately profitable. The NPVs at 6% and 9% were positive, but the values were negative at 12% interest rate. NPVs increased by more than TK.1,00,000 due to the introduction of alternative use of solar panels. The IRRs were 10.13% and 10.54% for large SIPs without and with alternative use. Therefore, after introducing an alternative service, the real return has been increased by about 0.50%. The simple payback period of the large solar irrigation pump with alternative use became 7.82 years. It found 8.10 years without any alternative use. Therefore, the large pump's financial outcome with alternative use seems more viable than the pump without any alternative use. A higher financial gain is possible by introducing more alternative use such as delivering water for fish cultivation, households, and hotel usages, supplying excess solar electricity to the national grid, etc.

##### 4.2.2 Medium Solar Irrigation Pump

The financial indicators of a medium SIP have not seemed attractive. The NPVs at all interest rates were found negative, IRR was at less than 6%, and the simple payback period was more than 12 years of a medium SIP. The causes of the pump's unattractive financial indicators are the high installation cost, operator's salary, and 20% commission on collected irrigation fees. Hence, installing a medium solar irrigation pump would not be a viable option for investment. Though the financial analysis indicates that installing and operating a medium solar irrigation pump is not profitable, POs have installed 186 medium solar irrigation pumps in the Dinajpur and Rangpur districts (IDCOL, 2019). They operate

186 medium solar irrigation pumps as 93 pairs of the pumps. A pair of medium solar irrigation pumps' irrigation coverage, total panel, and pump capacity are the same as a large solar irrigation pump. However, according to the price list of IDCOL, the installation costs of a medium and a large solar irrigation pump are around Tk.3000000 and Tk.5000000, respectively. So, a pair of medium solar irrigation pumps' installation cost is almost TK.6000000, and a large solar irrigation pump's cost is around TK.5000000. The difference in the installation cost of 2 medium and 1 large SIP is more than TK.1000000. Therefore, the installers (POs) received about TK.400000 as a grant (40% of total cost) and another TK.400000 as a soft loan (40% of total cost) from a pair of medium pumps from this excess price. Moreover, from the 93 pairs of medium SIPs, the POs received more than TK.37200000 as a subsidy and the other Tk.37200000 as a soft loan. So, the price structure should be revised to save the given subsidy and soft loan from the medium SIPs. Then, it should be utilized to install the small solar irrigation pump for the farmers' consumption.

#### 4.2.3 Small Solar Irrigation Pump

The small solar irrigation pumps' financial indicators were better than the medium and large solar irrigation pumps. NPVs at all three interest rates for a small SIP were positive. The payback period was less than 5 years, and the IRR was more than 20%. Therefore, the indicators of a small SIP were found attractive. So, it seems that the 'fees for ownership model' is more feasible than the 'fees for service model'. The total installation cost of a small solar irrigation pump (4kWp) offers by IDCOL is TK.676880, which will be about TK.406128 after receiving a 40% subsidy. It still looks expensive for the individual farmer to consume it. Nevertheless, it would be possible to reduce the solar pump's installation cost. As some provisions like underground pipelines, brick-built room are not essential for small SIPs. Besides, a personal solar irrigation pump's total price can be reduced by decreasing the panel and pump capacity. For example, a personal solar pump with 2.50 kWp panels and 1.2 kW pump can provide irrigation facilities to 10 bigha land for Boro cultivation. The market price of this type of small solar pump is about Tk.200000. At present, the solar panel's market price is 40-50 Tk/W. However, the price list of IDCOL shows that the price is about TK.60/W. Thus, by revising the price structure and capacity, small SIP's price can be reduced to around TK.200000. After a 40% subsidy on this price, it would be an attractive investment option for farmers.

#### 4.3 Environmental Impact of Solar Irrigation Pump (SIP)

SIPs have some direct potential to reduce greenhouse gas (GHG) emissions from irrigation activities by replacing fossil fuels with solar energy. At present, solar irrigation pumps substitute diesel-operated irrigation pumps in the country. Thus, diesel consumption is reducing substantially due to the introduction of solar energy. As a result, CO<sub>2</sub> emission is decreased with the reduction of diesel consumption. From the field survey, it was found that on average, 37.5 liter and 3 liter diesel is necessary for Boro and other crops cultivation for one bigha land in a season. The environmental benefit is estimated using the information that 1 liter diesel produces 2.8 kg CO<sub>2</sub> and the cost of removing 1 ton CO<sub>2</sub> from the atmosphere is 100 USD. The calculated environmental benefit of the large, medium and small solar irrigation pumps is shown in Table 10.

**Table 10: Environmental Benefit of Large, Medium and Small SIP in 20 Years**

Pumps	Coverage for Boro (bigha)	Required diesel (Liter)	CO <sub>2</sub> emission reduction (Ton)	Cost of CO <sub>2</sub> reduction (Tk)
Large	100	89400	250.32	<b>2002560</b>
Medium	50	45900	128.52	<b>1028160</b>
Small	16	15600	43.68	<b>349440</b>

Author's calculation based on field survey data, 2019; Here, 1 bigha=50 decimal, 1USD=80Tk.

The tentative total environmental benefits of the large, medium and small solar irrigation pumps in 20 years are about TK.2002560, TK.1028160, and TK.349440, respectively. On the other hand, the solar irrigation pump's main environmental cost is the emitted amount of CO<sub>2</sub> from solar PV panels' production process. Generally, the emitted amount of CO<sub>2</sub> is 170 Kg/kWp in manufacturing poly-crystalline silicon PV panels. Thus, the large, medium, and small solar irrigation pumps produce 5.1 ton, 2.55 ton, and 0.68 ton CO<sub>2</sub>; the removal cost of these amounts of CO<sub>2</sub> is about TK.40800, TK.20400, and TK.5440, respectively. Therefore, the large, medium and small solar irrigation pumps' tentative net environmental gains are Tk.1961760, Tk.1007760, and Tk.344000, respectively.

#### 4.4 Comparison of the Subsidy and Environmental Benefit of Solar Irrigation Pump

At present, 40% of a solar irrigation pump's total price is provided as a subsidy. The summary of the comparison between the given subsidies and the net environmental benefits of solar pumps has given in Table 11.

**Table 11: Subsidy and Environmental Benefit of Different Solar Irrigation Pumps (Tk)**

SIP	Panel capacity (kWp)	Price (Without subsidy)	Price (With subsidy)	Subsidy (40% of price)	Subsidy/ kWp	Net Env. benefit in 20 years	Net Env. benefit /kWp
Large	30	4656400	2793840	1862560	<b>62085</b>	1961760	<b>65392</b>
Medium	15	3136580	1881948	1254632	<b>83642</b>	1007760	<b>67184</b>
Small	4	676880	406128	270752	<b>67688</b>	344000	<b>86000</b>

Source: Author's calculation based on field survey data, 2019; PO= Partner Organization, 1USD=80Tk.

Table 11 shows that the given subsidy is almost equal to the pumps' net environmental benefit in 20 years. The net environmental benefit per kWp of the large and medium solar irrigation pumps is almost equal at around TK.65000. However, the small solar irrigation pump's net environmental benefit per kWp is more than TK.85000. So, the calculated net environmental benefit per kWp of small SIP has become the highest. Finally, the environmental benefit has been calculated by considering only the substituted amount of diesel by solar energy. If the reduction of sound pollution and water contamination with diesel were considered, the solar pump's actual gain would be more than the calculated benefit.

## 5. CONCLUSION

In this study, an economic analysis of solar irrigation pumps' in the Northern region of Bangladesh has been performed. The financial analysis provides that small solar irrigation pumps' economic feasibility was found the most profitable option for investment. Large solar irrigation pumps' economic feasibility is also found moderately profitable, and it has been improved after the introduction of alternative use of the panels. However, the financial indicators do not give viable results in the case of medium SIPs. Therefore, the 'fees for ownership model' found a more profitable option than the 'fees for service model' for the solar irrigation pumps. 'Fees for ownership model' is also more effective in bringing the benefits of given subsidies and soft loans to the farmers. Moreover, the solar irrigation pump's net environmental benefit is greater than the given subsidy to install it. Thus, the provided grant has been justified for this investment. The government should continue providing subsidies for solar irrigation pumps, especially for small pumps, to promote the 'fees for ownership model'. It would ensure the quick dissemination of the solar pump and help to improve the condition of the country's farmers, agriculture, and environment.

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## ENVIRONMENTAL AMENITY AND RENTAL VALUE OF HOUSES IN RAJSHAHI CITY: A HEDONIC PRICING APPROACH

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### ABSTRACT

Environmental amenities are great economic resources and important determinants of rental value of houses, because environmental dis-amenities reduces the rental demand for houses. However, measuring the value of environmental amenities is a complex issue and studies on the assessment of the value of environmental amenities (or dis-amenities) in house rental market of Bangladesh are scarce. In the empirical studies, a variety of methods were employed by the environmental economists to measure the value of environmental amenities in the case of house renting. However, the findings of the studies provoked considerable debates over the methods and approaches of measuring such amenities. As environmental amenity in case of house renting is a matter of mental satisfaction, it cannot be measured directly using the conventional methods. Thus, this study is an effort to investigate the determinants of rental value of houses and to measure the value of environmental amenities in connection with renting of houses based on Hedonic Pricing Approach. The study is based on primary data collected from 210 city dwellers who are living in rented houses in various areas of Rajshahi City Corporation in Bangladesh on the basis of random sampling method. The estimation results showed that there are four types of factors- income of tenant, house structure characteristics, neighborhood characteristics and environmental amenities including ventilation, open space proximity, drainage management, waterlogging and landfill by wastes which affect house rent. The disaggregated results show that in the planned housing areas, the influence of proximity to open spaces on house rent is 29.04% higher than that of unplanned housing areas, and the influence of ventilation on house rent in planned residential area is 15% higher than that of unplanned area. The willingness to pay or hedonic valuation for environmental amenities in overall, planned and unplanned areas are estimated as BDT146.16, BDT333.16, and BDT50.69, respectively. Tenants living in planned residential areas are more conscious about environmental amenities and their hedonic valuation for environmental amenities is higher than tenants living in unplanned areas. Finally, this study recommends that improving environmental quality boosts house rent, which in turn fascinates environment-friendly urbanization.

### KEYWORDS

Valuation, Environmental Amenity, Hedonic Pricing, House Rental, Bangladesh.

### 1. INTRODUCTION

Valuation of environmental amenities (dis-amenities) is one of the central issues of study to the environmental economists. Environmental amenities mean the quality of environmental goods and services that reduces the adverse impact on health of the residents, or the environmental attributes that increase their economic welfare. However, the valuation of environmental attributes is a complex task and one cannot estimate market value of environmental attributes directly. Environmental attributes are often designated as environmental amenities or dis-amenities which have non-excludable and non-rival features and these implicitly determine the rental value in the house rent market. If the environmental amenities related to a house increase, the rental value of that house will increase and vice versa (Zoppi et al., 2015). In addition, environmental characteristics are also considered as a normal good which appeals more income generating tenants to choose their houses having much neighborhood and environmental facilities (Carriazo, Ready, & Shortle, 2013). Basic microeconomic theories explain that environmental amenities shift demand curve outward and thus, increases the rental value of houses (Dawkins & Nelson, 2002). Having a house is the basic constitutional right of the people in Bangladesh. Being one of the densely populated country in the world, Bangladesh has been experiencing severe house shortage for its citizens, especially in the urban areas.

Thus, a large portion of the urban residents have to depend on rented houses and there is a huge gap between demand for and supply of housing in the country (Barua, Mridha & Khan, 2010). Due to rapid migration of people in the urban areas creates huge shortage of houses ready for living. There are two types of urbanization where planned urbanization stimulates social and economic expansion through the advancement of physical arrangement, employment generation, enhancement in basic services and standard of living. In contrast, the unplanned urbanization increases urban poverty, joblessness, and environmental degradation (Loton, 2004). Bangladesh has been facing a rapid growth of both planned and unplanned urbanization in the recent years. Planned urbanization improves quality of roads, houses, schools, hospitals, and many other socio-economic structures. On the contrary, unplanned urbanization creates severe pressure on the physical and social infrastructure, deterioration of the urban environment and increase in road-noise, social crime and unrest (Ardeshiri, Radfar, & Shormasty, 2016). The rate of annual urbanization in Bangladesh was 3.17 percent in

2018 (World Bank, 2019). About 38.2 percent of the people of Bangladesh is now living in urban areas and it will be 50 percent by the year 2025 and 56 percent by 2050 (World Bank, 2019). One of the major consequences of rapid urbanization is the increased demand for houses and house rents in the housing market of urban areas.

The rental value of houses generally depends on structural, neighborhood, and environmental attributes (Babalola, Umar, & Sulaiman, 2013; Zoppi, Argiolas, & Lai, 2015). Irfan (2007) and Ooi, Le, & Lee (2014) observed that structural and neighborhood features explicitly determine house rents. Environmental amenities including an improved sewerage system, increases house rent while an environmental dis-amenity like open sewerage condition decreases house rents (Irfan, 2007). Other environmental amenities like parks, urban green spaces and watersheds have positive influence on house rents (Schlapfer, Waltert, Segura, & Kienast, 2015; Poor et al., 2007; Jim & Chen, 2006). Chen (2006) found that the proximity of open space to houses within 1 km increases house rents by 0.08 percent. Similarly, proximity of regional and metropolitan park within 600 meters increases houses rent by 1.9 and 2.9 percent, respectively (Smith, 2010). In contrast, landfilling by wastes decreases value of houses and distance of houses from landfill sites increases house price (Hite, Chern, Hitzhusen, & Randall, 2001).

In the theory of environmental valuation, there are several methods such as Contingent Valuation Method (CVM), Travel Cost Method (TCM), Hedonic Pricing Method (HPM) etc. that can be used to measure the value of environmental amenities. Among them Hedonic Pricing Model is widely used to measure the effects of environmental amenities on the rental value of houses. However, all the studies are mostly concerned with the developed country scenario and there is a dearth of literature on the effects of environmental amenities on house rent in the developing countries like Bangladesh. Rajshahi is one of the largest cities in Bangladesh. Because of rapid urbanization and growing scopes for income earning activities, there is found an increasing inflow of migrant people into the city. Unable to buy a house, most of these people have to rent houses and the payment for houses depends on their valuing of environmental amenities. Therefore, this study aims at estimating the hedonic value of environmental amenity and making comparison of house rents between planned and unplanned residential areas resulting from varying environmental amenity focusing on the house rent market in Rajshahi City Corporation area of Bangladesh. This study uses house rent as proxy variable to estimate the economic value of environmental amenities and dis-amenities.

The rest of the paper is organized as follows: section 2 describes the methodology of the study; section 3 provides the results and their interpretations; section 4 gives concluding remarks.

## 2. METHODOLOGY

### 2.1. Study Area and Survey Design

Rajshahi City Corporation is taken as the sample area for this study. It is one of largest city corporations in Bangladesh which is lived by peoples of different occupations, income levels and education. The respondents of the study area are the tenant households who have rented houses for living in different residential areas of the city. Rajshahi city corporation area is a typical area like other areas where income is the most relevant factor that determine the rental value of the respondent residence. However, there are some other factors as well which determine the rental value. For this study, primary data are collected from the respondents living in the study area based on simple random sampling method, and most of them have been living in multistoried buildings in planned and unplanned residential areas. A total of 210 respondents are taken where are 100 from planned residential areas and 110 from unplanned residential areas from five *thanas*: *Boalia, Rajpara, Motihar, Shah makhдум and Chandrima* of Rajshahi City Corporation. The interview is conducted with the household head or any other member who usually participates in the household decision-making process. A semi-structured questionnaire with both open and close-ended questions were used for data collection. Data are collected in a very sensitive way so that they can be fitted for estimation of specified models in this study.

### 2.2: Theoretical Background

In the hedonic pricing approach, household's willingness to pay for differentiated environmental amenities is computed through maximizing their utility function with respect to budget constraint as follows. The utility function of a household in the hedonic model is:

$$U = U(C, H, N, E) \tag{1}$$

Where,  $C$  is a composite good index,  $H$  refers to structural attributes of house ( $H = H_1, H_2, \dots, H_n$ ),  $N$  refers to the neighborhood attributes ( $N = N_1, N_2, \dots, N_n$ ), and  $E$  refers to the environmental attributes ( $E = E_1, E_2, \dots, E_n$ ). We maximize households' utility, reported in equation (1) subject to the following budget constraint.

$$I - CP_c - R = 0 \tag{2}$$

Where,  $R$  denotes the prices of consumption goods included into the index and refers to monthly house rents. With the rapid progression of urbanization, renting built houses is quite common in Rajshahi City. Therefore, this study has used rental price instead of sales value by following two recent studies, Van den Berg and Nauges (2012) and Dendup and Tshering (2015). These studies suggest house rent is the function of structural, neighborhood and environmental attributes and thus, rent function is defined as follows.

$$R = R(H, N, E) \tag{3}$$

$$I - CP_c - R(H, N, E) = 0 \tag{4}$$

For maximizing the utility function, we differentiate equation (1) with respect to revised budget constraint as shown in equation (4). From this process, the following implicit price for each environmental attribute can be derived as follows:

$$\frac{dR}{dE} = \frac{dU/dE}{dU/dC} \tag{5}$$

Equation (5) represents the marginal rate of substitution (MRS) between environmental attributes  $E$  and a composite good index  $C$ , and setting them equal to the rate through which household can exchange  $E$  for  $C$  in the housing market.

**2.3 Econometric Model**

This study followed the Dendup and Tshering (2015) approach for choosing appropriate functional forms among the alternatives- linear, logarithmic and semi-logarithmic forms of hedonic models. Since equation (5) shows that house rent depends on environmental attributes  $E$  and a composite good index  $C$ , we can re-write the equation (5) in the form of population regression function as follows:

$$R_i = X_i\alpha + \varepsilon_i \tag{6}$$

Where, subscripts  $i$  specifies households while  $R_i$  is the natural log of monthly house rent. Vector  $X_i$  denotes a set of independent variables including housing and neighborhood featured as composite goods  $C$  and environmental attributes  $E$ . Whereas,  $\alpha$  is the vector of the coefficient to be estimated and  $\varepsilon_i$  is the stochastic error term. Simplification of equation (6) can be done as follows:

$$R_i = \alpha_0 + \alpha_1(\text{income}) + \alpha_2H_{ij} + \alpha_3E_{im} + \alpha_4N_{in} + \varepsilon_i \tag{7}$$

where, income represents the monthly income of the head of the households;  $H$  represents the structural attributes – age of the building, the numbers of room and garage within the house;  $E$  includes the environmental attributes including ventilation, open space, waterlogging and landfills, and  $N$  refers to the neighborhood attributes including school and workplace distances. Including these components, the specified form of the hedonic pricing equation which is used in this study is given by Equation (8):

$$\ln Y_i = \alpha_0 + \alpha_1X_{1i} + \alpha_2X_{2i} + \alpha_3X_{3i} + \alpha_4X_{4i} + \alpha_5X_{5i} + \alpha_6X_{6i} + \alpha_7X_{7i} + \alpha_8X_{8i} + \alpha_9X_{9i} + \alpha_{10}X_{10i} + \alpha_{11}X_{11i} + u_i \tag{8}$$

In the above Equation (8) it is specified that  $\ln Y_i$  is natural logarithm of monthly house rent;  $\alpha_0$  is the intercept or constant and  $\alpha_0 \dots \alpha_{11}$  are the parameters to be estimated;  $X_1, X_2, \dots X_{11}$  are the explanatory variables that affect monthly earning of the households and  $u_i$  is the stochastic disturbance term. The regression function expressed by the equation (8) is a linear multiple regression model and this equation can be estimated by the Ordinary Least Square (OLS) method. The functional form of the regression model is semi-logarithmic more definitely log-linear.

**2.4 The Willingness to Pay Value**

Willingness to pay (WTP) is been defined as the maximum amount of money a customer is willing to spend for a product or service (Cameron and James, 1987; Krishna, 1991. Economists refer to WTP as the reservation price (Monroe, 1990). A few studies have tested willingness to pay in relation to product development and market pre-tests (Cameron and James, 1987). Studies of willingness to pay have also been conducted in the food area (Loureiro *et al.*, 2002; Moon and Balasubramanian, 2003). Several approaches can be used to elicit consumers’ willingness to pay for products or services including contingent valuation, experimental auctions, conjoint analysis and hedonic price methods (Lee and Hatcher, 2001). This study has tried to find out the willingness to pay for different environmental attributes as well as other attributes on house rent estimated from equation (8) and a threshold level of environmental (dis)amenities. Following Van den Berg and Nauges (2012) and Yusuf and Koundouri (2005), the WTP is measured as follows:

$$WTP_j = R(e^{\hat{B}_j} - 1) \tag{9}$$

Where  $R$  is average monthly rent of a house, and  $\hat{B}_j$  is estimated coefficient of environmental and other attributes (in equation 8).

**2.5 Data and Explanation of the Key Variable**

The following Table list and defines the dependent and explanatory variables with a unit of measurement used in the interview schedule. The first section introduces the outcome variable and the rest four sections contain explanatory variables of this study. The outcome variable is the monthly house rent. In this study, household income accounts for the accumulated income of all earning members of the households and it is measured in BDT per month. The house rent is expected to be strongly and positively associated with household income. This is because households with higher income usually prefer to rent costlier houses as suggested by basic microeconomic theory.

**Table 1: Explanation of the Key Variables**

Variable Name	Explanation	Mea.Unit	Expe.Sign
Rent	Monthly house rent	BDT/month	
Income	Household income	BDT/month	+
<b>Structural Characteristics</b>			
Age of the building	Years from building built to date	Years	-
Room numbers	Number of bedrooms	Number	+
Garage	Availabilities of garage within house	Yes/No(1/0)	+
<b>Neighborhood Characteristics</b>			
Workplace distance	Distnce between house and workplace	Kilometers	-
School distance	Distane between house and school	kilometers	-
<b>Environmental characteristics</b>			
Open space	Distance of at least a small play ground	meters	-
Ventilation	Strongly unsatisfactory to srongly satisfactory	5-point scale	+
Waterlogging	Availability of waterlogging	Yes/No(1/0)	-
Landfill	Availability of Landfill	Yes/No(1/0)	-

Drainage/Sewage	Strongly unsatisfactory to strongly satisfactory	5-point scale	+
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For accounting the effect of physical structure on rent, the number of rooms and the presence of garages are expected to impact the house rents positively while age of the house is expected to impact it negatively. On the other hand, the neighborhood characteristics account the distances from houses to the work place and nearest school. In all these cases, the expected signs are negative, implying, the higher the distance to the nearest neighborhood variables is expected to reduce rents. The final section of the Table lists and defines the variables associated with the environmental characteristics including ventilation, proximity to open space, waterlogging, landfill and drainage or sewage system. For constructing 'ventilation' and 'drainage' variable, we take a perception measurement by using 5-point Li-kert scale from the strongly unsatisfactory to strongly satisfactory of ventilation service of air and light flow and drainage condition respectively. In addition, we measured the distance from house to open spaces i.e. park, playground or public garden in meter. We expect a positive association between ventilation and rent and similarly drainage and rent, while increase in distance of open space is expected to reduce rent in the house market. However, variables representing environmental dis-amenities such as waterlogging and landfill are also constructed through category variable where '0' indicates the absence and '1' indicates the presence of these factor. Therefore, house rent is also expected to have inverse association with the increase in waterlogging and landfill degradation level.

### 3. RESULTS AND DISCUSSIONS

#### 3.1. Summary Statistics

**Table 2: Summary Statistics of Key Variables**

Variables		Overall Area	Planned area	Unplanned Area
	Measurement	Mean	Mean	Mean
Rent	BDT/Month	10226.19	13940	6850
Income	BDT/Month	61190.48	78650	45954
Age of house	Years	8.63	6.44	10.25
Room number	Number	3.49	4.24	2.70
Garage space	0=No	53.81%	31%	36.36%
	1=Yes	46.19%	69%	63.64%
Work place dis.	Kilometer	2.08	1.12	2.60
School distance	Kilometer	1.53	0.96	2.15
Open space dis.	Meter	138	83	144
Ventilation	1-5 scale	3.19	3.29	2.81
Waterlogging	0=No	57.14%	79%	66.36%
	1=Yes	42.86%	21%	33.64%
Landfill	0=No	59.52%	91%	80%
	1=Yes	40.48%	9%	20%
Drainage/Sewage	1-5 scale	3.22	3.58	2.61

Source: Author's Own Calculation Based on Field Survey, 2020.

The summary statistics of housing attributes in the overall, planned and unplanned residential area in Rajshahi City Corporation are presented in Table 2. In overall residential area, average house rent is around BDT 10226.19 per month varying from BTD 5000 to 18000. The house rent payment in planned residential area is higher than unplanned residential area because higher income earning people live in planned residential area. The monthly household income of overall residential areas is 61190 per month varying from BTD 30000 to 100000. Table 2 depicts that average age of the houses in overall area is around 8 years and varying from 2 to 20 years in overall areas in the Rajshahi City Corporation. The most of the buildings in planned area are newly built while most of the building in unplanned areas are old-aged. In addition, a three-room-flat dominates the housing rent market and there is also difference is observed in this attribute across the planned and unplanned areas. In planned residential areas, most of the neighborhood attributes are closer to access while in unplanned areas are opposite in this regard. For one of the most important sets of attributes is environmental attributes in the housing market. Table 2 reports that the average distance of open space proximity is around 138 meter in overall area and varying from 5 to 300 meter. The average ventilation and drainage system score in overall area is around 3.19 and 3.22 respectively. The average waterlogging and landfill presence in overall area is around 79 and 91 percent respectively. There is a quite difference regarding environmental attributes in planned and unplanned residential areas where comparatively higher ventilation scores, closer proximity to open spaces, improved drainage system, less severity of waterlog and landfill exist in to unplanned residential areas.

#### 3.2 The Determinants of House Rent in Overall Rajshahi City Corporation Area.

The environment of Rajshahi City is quite suitable for living because of its natural beauty and cleanliness. For this reason, this city is known as clean city. As a result, there is a large number of people are migrated from another city to this city. Thus, there is rapid urbanization in the city and growing up housing industry. Besides, there is also a threat of environmental degradation. This study is based on hedonic pricing method to find out the determinants of rental value of houses and valuation for environmental amenities. The results estimated from the hedonic pricing approach of equation (8) are reported in Table 3. It is found that the value of R<sup>2</sup> is 0.9543. This value of R<sup>2</sup> indicates that about 95% of variations in the dependent variable are explained by the variations in explanatory variables taken in the model.

Multicollinearity problem is diagnosed by VIF test and partial correlation matrix. The value of VIF is 4.07, which indicates that the regression model is free from multicollinearity problem. From the obtained result it is also revealed that the sum (as its mean=0) of residual is equal to zero and the distribution of residual is normal.

**Table 3: Regression Result of the Hedonic Pricing Model of Overall Area**

Variables	Coefficient	Robust Std. Err.	t-ratio	P-Value
Income	0000039.***	00000063.	6.14	0.000
Age of house	-0.0050***	0.0020	-2.99	0.003
Room Number	0.0102***	0.0032	3.13	0.002
Garage	0.0110	0.0139	0.80	0.427
Work place distance	-0.0066**	0.0029	-2.28	0.024
School distance	-0.0039	0.0099	-0.40	0.688
Open space distance	-0.0052*	0.0027	-1.90	0.060
Ventilation	0.0121**	0.0059	2.05	0.042
Waterlogging	-0.0151*	0.0083	-1.82	0.070
Landfill	-0.0101	0.0075	-1.36	0.176
Drainage/Sewage	0.0222***	0.0053	4.18	0.000
Constant	3.6671	0.0449	81.66	0.000

N= 210; F(11,198); = 669.82; Prob.>F= 0.0000 ; R<sup>2</sup> = 0.9543; VIF=4.07

Note: Significant at: \*\*\*p<0.01, \*\*p<0.05, \*p<0.1. Source: Author’s Own Calculation, 2020.

In the above table, it is observed that the determinants of house rent are classified by four attributes. We found income is positively and highly significant associated with house rent at 1 percent level of significance, if all other things being constant, as expected. In regarding structural attributes, it depicts that, the age of building, the number of rooms, space for garages are the most relevant factors that determine the extent of house rent. Here, the number of rooms are significant at 5 percent level of significance which implies that, a one additional unit increase in the number of room is associated with rise in house rent by 1 percent, being remain constant other factors. The work place distance is significant at 5% level of significance and negatively influence on house rent. The most important and relevant attribute is the environmental attributes which include distance of open space; at least a small playground from house, the condition of ventilation of house which is measured by 1-5 point scale where 1 indicates the strongly unsatisfactory condition and 5 indicates strongly satisfactory condition, waterlogging and landfill are categorical variable where 0 indicates absence of that factor and 1 indicates presence of that factor, and drainage/sewage system which is also measured by 1-5 point scale where 1 indicates the strongly unsatisfactory condition and 5 indicates strongly satisfactory condition. Here, distance of open space; at least a small playground from house is significant at 10% level of significance and negatively associated with house rent. Truly speaking, tenant are less agreed to pay more for the house if open space distance increases. It implies that a one unit increase in the open space distance is associated with reduce in house rent by 0.5 percent, being remain constant other factors. The ventilation and drainage are measured by 1-5 point scale and it is observed that they are positively significant at 5 and 1 percent level of significance respectively. It implies that a one unit increase in the condition of ventilation and drainage is associated with rise in house rent by 1 and 2 percent respectively, being remain constant other factors. The rest of the factors like waterlogging and landfill are negatively associated with house rents. It implies that a one unit increase in waterlogging and landfill associated with reduce house rent by 1and 1percent respectively, being remain constant other factors. This result is very similar to the results found by earlier studies conducted by previous researchers, (Schlapfer, Waltert, Segura, & Kienast, 2015; Poor at el., 2007; Jim & Chen, 2006).

**3.3 Determinants of House Rent in Planned Area, Rajshahi City Corporation**

The planned residential area where everything is monitored by central authority.

**Table 4: Regression Result of a Hedonic Pricing Model of Planned Area**

Explanatory variable	Coefficient	Robust Std. Err.	t-ratio	P-Value
Income	.0000011***	.0000003	3.22	0.002
Age of house	-0.0044***	0.0016	-2.68	0.009
Room number	0.0039**	0.0017	2.23	0.028
Garage	0.0137***	0.0043	3.16	0.002
Work place distance	-0.0100***	0.0030	-3.33	0.001
School distance	-0.0217	0.0165	-1.32	0.192
Open space distance	-0.0117***	0.0038	-5.25	0.000
Ventilation	0.0117***	0.0027	4.27	0.000
Waterlogging	-0.0118*	0.0062	-1.91	0.059
Landfill	-0.0028	0.0041	-0.68	0.497
Drainage/Sewage	0.0046**	0.0022	2.05	0.043
Constant	4.0504	0.0410	98.76	0.000

N= 100; F(11,88); = 196.69; Prob>F= 0.0000 ; R<sup>2</sup> = 0.9531; Root MSE= 0.01605; VIF=3.52

Note: Significant at: \*\*\*p<0.01, \*\*p<0.05, \*p<0.1. Source: Author's Own Calculation, 2020.

It is found that income is positively and highly significant associated with house rent at 1 percent level of significance, remaining other factor constant in planned residential area. Among the three structural attributes, the number of rooms are significant at 5 percent level of significance which implies that, a one unit increase in the number of room is associated with rise in house rent by 0.3 percent, being remain constant other factors. The work place distance is significant at 1% level of significance and negatively influence on house rent. Here, distance of open space; at least a small playground from house is significant at 1% level of significance and negatively associated with house rent. It implies that a one unit increase in the open space distance is associated with reduce in house rent by 1.1 percent, being remain constant other factors. The ventilation and drainage are measured by 1-5 point scale and it is observed that only ventilation is positively significant at 1 percent level of significance. It implies that a one unit increase in the condition of ventilation is associated with rise in house rent by 1.1 percent, being remain constant other factors. The drainage is significant at 5 percent level of significance and its sign is positively related to determine the extent of house rent. The rest of the factors like waterlogging and landfill are negatively associated with house rents. This result is very similar to the results found by earlier studies conducted by previous researchers, (Schlapfer, Segura, & Kienast, 2015; Poor at el., 2007).

### 3.4 Determinants of House Rent in Unplanned area, Rajshahi City Corporation.

The unplanned area can be defined as every socio-economic activities are not governed by a central authority. Here, distance of open space; at least a small playground from house is significant at 5 % level of significance and negatively associated with house rent. The ventilation and drainage are measured by 1-5 point scale and it is observed that only drainage is positively significant at 10 percent level of significance. Unfortunately the ventilation is not significant but its sign is positively related to determine the extent of house rent. The rest of the factors like waterlogging and landfill are negatively significant at 10 and 10 percent level of significance respectively. It implies that a one unit increase in waterlogging and landfill associated with reduce house rent by 1 and 1 percent respectively, being remain constant other factors. This result is very similar to the results found by earlier studies conducted by previous researchers, (Schlapfer, Waltert, Segura, & Kienast, Jim & Chen, 2006).

**Table 5: Regression Result of the Hedonic Pricing Approach of Unplanned Area**

Explanatory variable	Coefficient	Std. Err.	t-ratio	P-Value
Income	00000104.*	.0000005	1.85	0.068
Age of house	-0.00008	0.0019	-0.05	0.964
Room number	0.0202*	0.0110	1.83	0.070
Garage	0.0081	0.0079	1.02	0.309
Work place distance	-0.0050 *	0.0029	-1.73	0.087
School distance	-0.0035	0.0265	-0.14	0.893
Open space distance	-0.0066**	0.0032	-2.03	0.045
Ventilation	0.0094	0.0079	1.18	0.240
Waterlogging	-0.0104*	0.0062	-1.67	0.098
Landfill	-0.0146*	0.0075	-1.93	0.056
Drainage/Sewage	0.0114*	0.0059	1.94	0.055
Constant	3.6834	0.1237	29.78	0.000

N= 110; F(11,98); = 99.79; Prob.>F= 0.0000 ; R<sup>2</sup> = 0.8798; Root MSE= 0.02678; VIF=3.59

Note: Significant at: \*\*\*p<0.01, \*\*p<0.05, \*p<0.1. Source: Author's Own Calculation, 2020.

### 3.5 The Willingness to Pay for Environmental (Dis) amenities in Overall, Planned and Unplanned Area, Rajshahi City Corporation

In this section, this study shows the tenant's willingness to pay value of environmental (dis)amenities and other attributes from estimated coefficients of equation (8) and (10) and a set of threshold values for these parameters reported in Table 6. In overall area, the tenants are willing to pay more BDT 0.039 from their average rent because of an additional unit increase in income remaining other attributes constant. In case of structural attributes including age of house, the tenants are willing to pay less BDT 60.33 from their average rent associated with an additional unit increase in the age of house. The tenants also willing to pay more for room number, and garage availability are BDT 104.307 and BDT 112.48 respectively from their average rent. In case of neighborhood attributes including workplace and school proximity, the tenants are willing to pay more BDT 61.35 and BDT 30.37 from their average rent because of an additional unit of closer proximity.

**Table 6: Results of Willingness to Pay Analysis**

Attributes	Overall Area		Planned Area		Unplanned Area	
	WTP(BDT)	HV(BDT)	WTP(BDT)	HV(BDT)	WTP(BDT)	HV(BDT)
Income	0.039	0.039	0.015	0.015	0.007	0.007
<b>Structural Attributes</b>						
Age house	-60.33		-61.33		-0.54	
Room number	104.307	156	54.36	289.94	138.37	192.63
Garage availability	112.48		181.22		54.8	

Neighborhood Attributes						
Work place proximity	61.35	92.02	139.4	168.27	34.25	58.22
School proximity	30.67		29.27		23.97	
Environmental Attributes						
Open space proximity	51.13		306.68		41.1	
Ventilation availability	123.73		163.09		64.39	
Waterlog presence	-153.39	146.16	-164.49	333.16	-68.5	50.69
Landfill presence	-103.28		-27.88		-68.5	
Proper drainage	227.97		055.76		82.5	

Source: Author's Own Calculation, 2020.

The most important environmental attributes including open space proximity, tenants are willing to pay more BDT 51.13 from their average rent with an additional unit of closer proximity. In accordance with ventilation facilities and proper drainage management system, the tenants are willing to pay more BDT 123.73 and BDT 227.97 from their average rent because of an additional unit increase in 5-point scale from strongly unsatisfactory to strongly satisfactory. In contrast, tenants are willingness to pay less BDT 153.39 and BDT 103.28 from their average rent because of an additional unit increase in waterlog and landfill availabilities. Here, the hedonic value of structural, neighborhood and environmental (dis) amenities are BDT 156, BDT92.02, and BDT 146.16 respectively. Since in Bangladesh People are not much conscious of environmental issues, tenants are valuing first structural attributes and then environmental attributes in the study area.

Again, in planned area, the tenants are willing to pay more BDT 0.015 from their average rent because of an additional unit increase in income remaining other attributes constant. In case of structural attributes including age of house, the tenants are willing to pay less BDT 61.33 from their average rent associated with an additional unit increase in the age of house. The tenants also willing to pay more for room number, and garage availability are BDT 54.36 and BDT 181.22 respectively from their average rent.

In case of neighborhood attributes including workplace and school proximity, the tenants are willing to pay more BDT 139.4 and BDT 29.27 from their average rent because of an additional unit of closer proximity. The most important environmental attributes including open space proximity, tenants are willing to pay more BDT 306.68 from their average rent with an additional unit of closer proximity. In accordance with ventilation facilities and proper drainage management system, the tenants are willing to pay more BDT 163.09 and BDT 55.76 from their average rent because of an additional unit increase in 5-point scale from strongly unsatisfactory to strongly satisfactory. In contrast, tenants are willingness to pay less BDT 163.09 and BDT 163.49 from their average rent because of an additional unit increase in waterlog and landfill availabilities. Here, the hedonic value of structural, neighborhood and environmental (dis) amenities are BDT 289.94, BDT 168.27, and BDT 333.16 respectively. Since in planned area tenants are much conscious of environmental issues, tenants are valuing first environmental amenities and then structural attributes in the study area. In unplanned area, the tenants are willing to pay more BDT 0.007 from their average rent because of an additional unit increase in income remaining other attributes constant. In case of structural attributes including age of house, the tenants are willing to pay less BDT 0.54 from their average rent associated with an additional unit increase in the age of house. The tenants also willing to pay more for room number, and garage availability are BDT 138.37 and BDT 54.58 respectively from their average rent. In case of neighborhood attributes including workplace and school proximity, the tenants are willing to pay more BDT 34.25 and BDT 23.97 from their average rent because of an additional unit of closer proximity. The most important environmental attributes including open space proximity, tenants are willing to pay more BDT 41.1 from their average rent with an additional unit of closer proximity. In accordance with ventilation facilities and proper drainage management system, the tenants are willing to pay more BDT 64.39 and BDT 82.5 from their average rent because of an additional unit increase in 5-point scale from strongly unsatisfactory to strongly satisfactory. In contrast, tenants are willingness to pay less BDT 68.5 and BDT 68.5 from their average rent because of an additional unit increase in waterlog and landfill availabilities. Here, the hedonic value of structural, neighborhood and environmental (dis) amenities are BDT 192.63, BDT 58.22, and BDT 50.69 respectively. Since in unplanned area, tenants are not much conscious of environmental issues, tenants are valuing first structural attributes and neighborhood attributes and then environmental attributes in the study area. This result is very similar to the results found by earlier studies conducted by previous researchers, such as *Md. S. Islam, et al. (2017), Smith (2010) and Van den Berg, C., & Nauges, C. I. (2012).*

#### 4. CONCLUSION

In the planned areas, tenants are much conscious of environmental issues, tenants are valuing first environmental amenities and then structural attributes in the study area. In contrast in unplanned area, tenants are not much conscious of environmental issues, tenants are valuing first structural attributes and neighborhood attributes and then environmental attributes in the study area. This study has found the determinants of house rents and the value of environmental (dis)amenities in the housing area of Rajshahi city. In this regard, I have adopted a widely used hedonic pricing approach. To my best knowledge, this is the first attempt to investigate the determinants of house rents and the value of environmental (dis)amenities in the housing market of Rajshahi city. On the basis, these findings, some policies can be suggested on these issues like policy maker of the urban area and developers may be conscious about the importance and necessity of the residential structures, location and environmental quality. In the contrary, policy makers, government and non- government authorities may take necessary steps to improve urban residential environment and

ensures the better living standard for the people living in the Rajshahi City. However, there may be common mistakes in case of measurement. It is expected that, future researchers would pay proper attention to the limitations of this study.

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## National Session: SS51.2 - Sustainable Regional Development in China



**09:30 - 10:45 Wednesday, 26th May, 2021**

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**Chair Jian Wang**

**SPATIAL AGGLOMERATION AND FIRM PRODUCTIVITY: DOES TRADE STATUS MATTER?**

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**ABSTRACT**

This study uses micro-level panel data from Chinese manufacturing firms to investigate the impact of urban agglomeration on firm productivity taking a firm's engagement in international trade into consideration. Embracing firm heterogeneity in trade status, we find that non-exporters benefit from urban agglomeration through manufacturing specialisation whereas little effect of local specialisation on productivity is found among exporters. The findings mainly are driven by processing exporters involved in straightforward assembly. These findings increase the understanding of heterogeneous productivity gains from urban agglomeration and the spatial economy in China.

## RESEARCH ON THE EFFICIENCY OF TECHNOLOGICAL INNOVATION IN CHINESE INDUSTRIAL ENTERPRISES

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### ABSTRACT

This paper mainly studies the technological innovation efficiency of Chinese industrial enterprises. First, use the SBM-DEA model to measure and analyze the two-stage and comprehensive technological innovation efficiency of industrial enterprises from 2011 to 2019; secondly, use the method of spatial statistics to analyze the spatial correlation of the comprehensive technological innovation efficiency; finally, use the tobit measurement model to empirically analyze the influencing factors of the comprehensive technological innovation efficiency. Through analysis, it is concluded that the overall level of comprehensive innovation efficiency of Chinese industrial enterprises is not high, the gap between regions and provinces is obvious, and the efficiency of technological innovation in the two stages is not coordinated. The comprehensive technological innovation efficiency level is highest in the eastern region, and the lowest in the northeast. From the perspective of spatial statistical analysis, the comprehensive technological innovation efficiency of inter-provincial industrial enterprises has obvious spatial agglomeration. From the perspective of factors affecting the efficiency of technological innovation, the eastern region is mainly affected by R&D capital investment; the central region is mainly affected by the investment of R&D personnel, high-speed rail density, enterprise scale and economic development level; the western region is mainly affected by government intervention and R&D capital investment and R&D personnel; Northeast China is mainly affected by the density of high-speed rail, the scale of enterprises and the level of regional economic development.

### KEYWORDS

Industrial enterprise; technological innovation efficiency; spatial statistical analysis

### 1. INTRODUCTION

At present, China's economic development is facing a new normal, and the driving force of economic development is changing from factor-driven and investment-driven to innovation-driven (Xiao Renqiao, Wang Zongjun, Qian Li, 2015:190-201). Industrial enterprises are the most important industrial carriers of technological innovation, and their technological innovation efficiency level not only determines the technological innovation level of the industry in which they are located, but to a large extent also determines the efficiency of technological innovation in the entire country. In the context of increasing investment in technological innovation of industrial enterprises, what is the efficiency of technological innovation? How is it distributed in space, and what is the relationship? Analyzing the status quo of technological innovation efficiency of industrial enterprises and finding out the existing problems are of great significance to the transformation and upgrading of industrial enterprises. Based on this, this paper selects inter-provincial industrial enterprises above designated size (from 2011, industrial enterprises above designated size whose main business income is 20 million yuan and above) as the research object, analyze their technological innovation efficiency, and try to find out Factors that affect the efficiency of technological innovation of industrial enterprises, so as to better promote the high-quality development of industrial enterprises.

### 2. LITERATURE REVIEW

The research on the efficiency of technological innovation has always been a hot topic in the academic circles. The research on the efficiency of technological innovation of industrial enterprises mainly focuses on the following aspects: ①Evaluation of the innovation efficiency of industrial enterprises in different regions. Chen Wei et al. (2017:66-71) took large and medium-sized industrial enterprises in Northeast China as the research object, and used the Malmquist index method to analyze the dynamic trend of technological innovation efficiency and its influencing factors. Xu Min and Xie Lingling (2012:74-76) analyzed the efficiency of technological innovation by taking Chinese large and medium-sized industrial enterprises as the research object. ②The measurement of technological innovation efficiency of industries and industrial enterprises of different ownerships. Feng Genfu (2006:46-51) selected 35 industries from 1996 to 2004 as samples, and used SFA methods to conduct empirical research on the R&D efficiency and influencing factors of Chinese industrial enterprises. Xiao Renqiao (2015:190-201), etc., based on the perspective of two-stage value chain, constructed a two-stage association network DEA model and index system, and used panel data to calculate the staged and overall efficiency value of technological innovation of different industrial enterprises in China. ③Study on the influencing factors

of technological innovation efficiency of industrial enterprises. Du Kang et al. (2019:41-48), taking Anhui industrial enterprises as an example, used Malmquist productivity index method to empirically analyze its total factor productivity and its influencing factors. Wu Shijian et al. (2018:181-189) empirically analyzed the technological innovation efficiency of industrial enterprises and its influencing factors based on the two-stage DEA model.

The existing literature enriches the research results of technological innovation efficiency of industrial enterprises, but it also has some shortcomings: ①In the research content, it basically focuses on the input-output single-stage mode, which usually regards the innovation process of enterprises as a "black box". Although some literatures begin to study from the perspective of R&D-transformation, quantitative analysis methods need to be further supplemented in this field. ②From the perspective of time and space, existing research focuses on the time dimension, ignoring the spatial changes of the research objects. Therefore, this paper uses the two-stage network DEA model to divide the innovation process into two stages: technological research and development and technological achievements transformation, which opens the "black box" of enterprise innovation activities to a certain extent and provides help for finding the lack of efficiency in the process of technological innovation; And use the method of spatial statistics to analyze its spatial characteristics to understand its spatial relevance.

### 3. EFFICIENCY EVALUATION METHOD AND TWO-STAGE MODEL

#### 3.1. Network SBM-DEA model

The traditional DEA model regards the decision-making unit as a "black box", and the input is transformed into output through the "black box", without considering the operation and integration of internal resources in the "black box", which is not suitable for processes involving multiple subsystems; In addition, the traditional DEA model is a radial model, and the improvement of input-output must be equal, without considering the influence of input and output relaxation variables. The network SBM-DEA model proposed by Tone and Tsutsui (2009:243-252) is used to evaluate the efficiency of the whole decision-making unit and its constituent departments. This model has the characteristics of non-radial, and overcomes the limitation of "input-output" and other proportions (non-equal proportions), thus making the efficiency measurement more accurate and reasonable.

#### 3.2. Construction of two-stage model

##### 3.2.1. *The division of two stages in the process of technological innovation*

Because of the different perspectives and contents of the research on technological innovation, there is no uniform standard to divide the technological innovation process in academic circles. Based on the research of Dou Chao, Xiong Xi et al. (2019:77-85) and Du Debin, Liu Shufeng et al. (2019:173-182), this article believes that the innovation process of industrial enterprises is based on the existing innovation knowledge, and develops new knowledge, technology, etc., and then apply the new technology to the company's own services and products, so as to bring profits to the company. Therefore, this article divides the technological innovation process of industrial enterprises into two stages: technological research and development and technological achievement transformation. By measuring the efficiency value of each stage, find the specific links that lead to inefficiency.

##### 3.2.2. *Selection of lag period*

Most studies have found that the impact of R&D investment on R&D output generally has a time lag of 1-2 years. This paper summarizes the principle analysis and time lag setting of innovation activities by scholars such as Nasierowski (2003: 215-234), Yu Yongze (2013:6-20) and Xiao Renqiao (2015:190-201). Combined with the characteristics of technological innovation in industrial enterprises, the time lag period of both stages is set to 1 year, and the lag period of the whole innovation process is 2 years. That is to say, the data of 2011-2017 are used for investment in technology R&D stage, 2012-2018 for output in technology R&D stage and 2013-2019 for output in technology transformation stage. In this way, the entire research period (2011-2019) of this article is divided into 7 periods: the first period (2011-2013), the second period (2012-2014), the third period (2013-2015), the fourth period (2014-2016), the fifth period (2015-2017), the sixth period (2016-2018), and the seventh period (2017-2019).

#### 3.3. Selection of indicator system

##### 3.3.1. *Investment indicators for technology research and development stage*

The investment in technology R&D stage mainly includes manpower and capital elements, and manpower elements mainly refer to the input of R&D personnel in this stage. In this paper, the full-time equivalent of R&D personnel, which is commonly used in the world, is used to measure the input of R&D personnel. As for the investment of capital elements, most scholars at home and abroad choose the internal expenditure of R&D funds as the index to measure the capital investment, and this general practice is followed in this paper.

##### 3.3.2. *Output index of technology research and development stage*

The output index of the technology research and development stage is both the output variable of the first stage and the input variable of the second stage. Scholars (Chen H, Xu R, Feng Z, 2013: 3169-3173; Zhang Baichun, Fan Decheng, Sheng Nan, 2018: 901-912) mostly choose the number of patent applications or the number of patent grants as a measure of

output at this stage. Taking into account that patents are easily affected by other factors from application to grant, they cannot show the true results of enterprise technological innovation activities in a timely manner, and the number of patent applications can better reflect the company's R&D results, so the number of patent applications is selected as the output indicator at this stage.

### 3.3.3. *Input indicators in the transformation stage of technological achievements*

In the transformation stage, besides the output of the previous stage as input, it also needs the input of manpower and capital.

Generally speaking, the exploratory and professional aspects of the achievements transformation stage are relatively lower than those of the R&D stage, and more personnel input is needed. Referring to the research of Liu Hui, Huang Fen and others (2015:19-33), the number of personnel in R&D institutions is selected to represent the personnel input at this stage.

The technology transformation stage is mainly to use new technologies to develop new products, so it requires investment in new product development funds. In addition, the core technologies of some industries and fields need to be purchased to make up for their deficiencies. In addition, the transformation from technology to products still requires digestion, absorption, and transformation to promote the practical application of scientific and technological achievements (Zhang B, Luo Y, Chiu Y H, 2018). In this paper, the four items of industrial enterprise technology introduction, digestion and absorption, domestic purchase and transformation expenditures are summed into technical expenditures as another aspect of this stage of expenditures. Therefore, the funding for this stage includes new product development funding and technical funding.

### 3.3.4. *Output indicators in the transformation stage of technological achievements*

The stage of technological transformation is the process that enterprises transform technological innovation value into product innovation value and realize commercialization. The new products produced by industrial enterprises reflect the innovative value of technology application and commercialization through technological innovation (Chen K, Kou, Fu X, 2018).

## 3.4. **Data sources and processing**

### 3.4.1. *Data sources*

In this paper, the data of industrial enterprises above designated size in 27 provinces of Chinese mainland from 2011 to 2019 are taken as research samples (excluding Xinjiang, Tibet, Qinghai and Hainan). The data used in the efficiency evaluation part comes from China Science and Technology Statistical Yearbook and China Statistical Yearbook from 2012 to 2020. If there is any missing data in the intermediate years, it should be filled by interpolation. If the data of boundary year is missing, it will be filled by extrapolation.

### 3.4.2. *Data processing*

In order to avoid the impact of price fluctuations on the analysis results, using 2011 as the base period, the nominal variables were deflated using the price indices of the corresponding years in each province. The sales income of new products is deflated using the ex-factory price index of industrial products; the internal expenditure of R&D expenditure is deflated using the R&D expenditure price index. For the R&D expenditure price index, this article refers to Lobe, P., and V.lin (1997: 272-278), Zhu Pingfang and The research of Xu Weimin (2003(6)) et al, structured it according to the detailed composition ratio of internal R&D expenditures.

According to the use of internal R&D expenditures in the "China Science and Technology Statistical Yearbook", the R&D expenditures are divided into two categories: daily expenditures and asset expenditures. Since the internal expenditures of R&D expenditures use data from 2011-2017, the calculation of 2011- In 2017, these two types of expenditures accounted for the proportion of internal R&D expenditures, and finally got the R&D expenditure price index=0.89\*consumer price index+0.11\*fixed asset investment price index; technical expenditures and new product development expenditures were also deflated according to this method.

## 4. MEASUREMENT OF TECHNOLOGICAL INNOVATION EFFICIENCY OF INDUSTRIAL ENTERPRISES

Based on the evaluation index system of technological innovation efficiency established above, this paper measures and analyzes the technological innovation efficiency of China's industrial enterprises as a whole, four major regions and provinces by using the network SBM-DEA model. The efficiency values of the four regions are obtained by averaging the efficiency values of the provinces in each region, and the national efficiency values are obtained by averaging the efficiency values of the 27 provinces in China. The four major regions are East, Central, West and Northeast China, among which the eastern region includes Beijing, Tianjin, Hebei, Shanghai, Jiangsu, Zhejiang, Fujian, Shandong and Guangdong; The central region includes Shanxi, Anhui, Jiangxi, Henan, Hubei and Hunan; The western region includes Inner Mongolia, Guangxi, Chongqing, Sichuan, Guizhou, Yunnan, Shaanxi, Gansu and Ningxia; Northeast China includes Liaoning, Jilin and Heilongjiang. The software used in the analysis is dea-solver pro13.

This part first analyzes the two-stage technological innovation efficiency, and then takes the technological innovation process as a whole and analyzes the comprehensive technological innovation efficiency. In order to reflect the change trend and overall characteristics of the efficiency value of the country and each region, a line chart of the efficiency value

of the country and the four major regions has been drawn. In order to understand the average level of technological innovation efficiency of each province during the study period, the average value of technological innovation efficiency of each province was calculated, and with reference to the research of related scholars (He Yingwei,2019), the technological innovation efficiency was divided into five levels: relatively effective (efficiency value is 1), high level [0.8,1], medium level [0.6,0.8], medium level [0.4,0.6] and medium level. Specific analysis is as follows:

**4.1. Analysis of the efficiency of technological innovation in the technological research and development stage**

It can be seen from Table 1 that the overall level of technological innovation efficiency in the R&D stage from 2011 to 2019 is 0.535, 46.5% of the innovation resource input has not been effectively used, the overall level of efficiency is not high, and there is still greater development potential. The overall national technological innovation efficiency is on a downward trend, but its fluctuations are relatively stable, with efficiency values varying between 0.5 and 0.6.

Table1 Value of technological innovation efficiency in technological research and development stage of Chinese industrial enterprises

area	the first period (2011-2013)	the second period (2012-2014)	the third period (2013-2015)	the fourth period (2014-2016)	the fifth period (2015-2017)	the sixth period (2016-2018)	the seventh period (2017-2019)	average value	rank
Beijing	0.811	0.701	0.629	0.602	0.603	0.565	0.528	0.634	8
Tianjin	0.496	0.505	0.445	0.383	0.347	0.321	0.343	0.406	17
Hebei	0.341	0.351	0.320	0.293	0.321	0.314	0.351	0.327	21
Shanghai	0.554	0.537	0.477	0.367	0.371	0.391	0.407	0.443	16
Jiangsu	1.000	1.000	1.000	1.000	0.856	0.581	0.673	0.873	4
Zhejiang	1.000	1.000	1.000	1.000	0.709	0.612	0.633	0.851	5
Fujian	0.451	0.485	0.479	0.477	0.523	0.546	0.499	0.494	14
Shandong	0.386	0.385	0.365	0.294	0.287	0.339	0.355	0.344	20
Guangdong	1.000	1.000	0.947	0.845	1.000	1.000	1.000	0.970	3
East area	0.671	0.663	0.629	0.585	0.557	0.519	0.532	0.594	
Shanxi	0.310	0.373	0.322	0.248	0.263	0.279	0.299	0.299	25
Anhui	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Jiangxi	0.288	0.452	0.500	0.585	0.712	1.000	1.000	0.648	7
Henan	0.333	0.336	0.312	0.283	0.277	0.330	0.383	0.322	23
Hubei	0.385	0.440	0.388	0.363	0.385	0.390	0.450	0.400	18
Hunan	0.584	0.530	0.480	0.446	0.394	0.427	0.454	0.474	15
Central Region	0.483	0.522	0.500	0.488	0.505	0.571	0.598	0.524	
Neimenggu	0.270	0.259	0.246	0.263	0.244	0.273	0.307	0.266	27
Guangxi	0.362	0.509	0.523	0.461	0.535	0.497	0.592	0.497	13
Chongqing	0.736	0.789	0.433	1.000	0.428	0.372	0.315	0.582	10
Sichuan	0.808	0.743	0.416	0.424	0.421	0.458	0.354	0.518	11
Guizhou	0.823	0.794	0.383	0.377	0.388	0.409	0.376	0.507	12
Yunnan	0.683	0.646	0.702	0.731	0.710	0.708	0.676	0.694	6
Shanxi	0.414	0.449	0.376	0.346	0.359	0.381	0.389	0.388	19
Gansu	0.622	0.657	0.642	0.539	0.559	0.600	0.696	0.616	9
Ningxia	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Western Region	0.635	0.650	0.525	0.571	0.516	0.522	0.523	0.563	
Liaoning	0.340	0.372	0.331	0.229	0.270	0.298	0.299	0.306	24
Jilin	0.382	0.337	0.324	0.282	0.304	0.306	0.348	0.326	22
Heilongjiang	0.289	0.311	0.293	0.266	0.272	0.243	0.223	0.271	26
North-east area	0.337	0.340	0.316	0.259	0.282	0.282	0.290	0.301	
Nationwide	0.580	0.591	0.531	0.522	0.501	0.505	0.517	0.535	

Source: The original data comes from the "China Science and Technology Statistical Yearbook" (2012-2019), calculated by dea-solver pro 13 software, and finally compiled according to the calculation results.

**4.1.1. Analysis of the efficiency value of technological innovation in the four major regions**

It can be seen from Table1 that the average efficiencies of the east, middle, west and northeast regions are 0.594, 0.524, 0.563, and 0.301, respectively, decreasing in order. The overall level of efficiency in each region is low and there are certain differences; the highest value of the four regions in the first period there is a difference of 0.334 from the lowest value, and a difference of 0.284 for the seventh period. The difference between regions shows a shrinking trend. It can be seen from Figure 1 that during the study period, the efficiency values of the eastern and northeastern regions continued

to decline from the first period to the sixth period, and only increased slightly in the last period; the western region was in a fluctuating downward trend; the central region's efficiency values were from the first period to the first period. The fourth period is in a fluctuating downward trend, but since the fourth period, there has been a significant increase, and after the fifth period, it surpassed other regions and became the region with the highest efficiency value in the country. Generally speaking, the initial value of the efficiency value of the eastern region is the highest, but the decline is the fastest. The initial value of the efficiency value of the central region is low, but the rise is the fastest. The efficiency value of the northeast region has been at the lowest level in the country. The efficiency values of the four regions range from "Eastern>West>Central>Northeast" in the first period to "Central>Eastern>West>Northeast" in the seventh period.

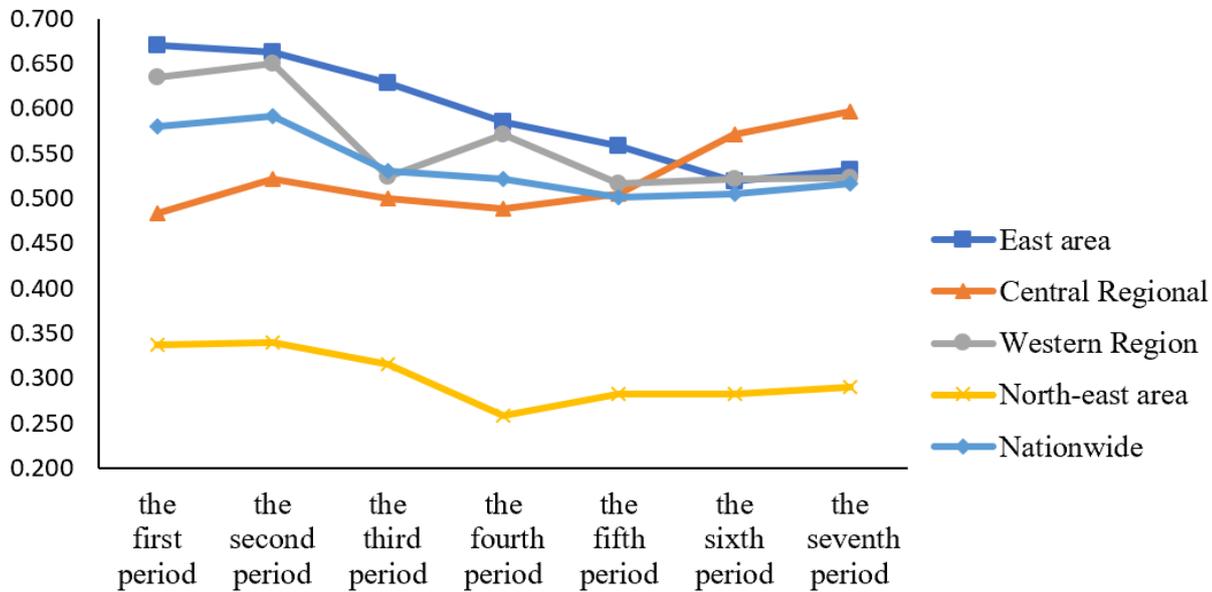


Figure 1 Technical Innovation Efficiency of Chinese Industrial Enterprises in Technology R&D Stage

**4.1.2. Analysis of the Efficiency Value of Inter-provincial Technological Innovation**

From the provincial level, it can be seen from Table 1 that the number of provinces with effective efficiency value in each period remains at 2-5, and only Anhui and Ningxia are at the forefront of efficiency in each period of the whole study period; The minimum value is 0.266, and the difference between the maximum value and the minimum value is 0.734. The average efficiency value of 17 provinces is below the national average level, accounting for 63% of the total samples, which indicates that the technology R&D resources in most provinces have not been effectively utilized and there is a serious waste of resources.

From the average point of view, the provinces distributed in the middle and low levels are the most, with 9 in each, accounting for 66.7% of all provinces; there are 3 and 4 provinces with high and medium-high levels respectively; only two DEA are effective. On the whole, the average level of innovation efficiency in the stage of technology research and development is mainly concentrated in the middle and low levels.

**4.2. Analysis of the Efficiency of Technological Innovation in the Stage of Technological Transformation**

From a national perspective, the overall efficiency level in the stage of technology transformation is 0.743, which is at a medium-to-high level, which is higher than the average efficiency value of 0.535 in the technology research and development stage, indicating that the efficiency of the combination of technology and economy in industrial enterprises is relatively good, but overall there is a slight decline trend, from 0.750 in the first period to 0.721 in the seventh period.

Table 2 Value of technological innovation efficiency in the stage of technological transformation of Chinese industrial enterprises

area	the first period (2011-2013)	the second period (2012-2014)	the third period (2013-2015)	the fourth period (2014-2016)	the fifth period (2015-2017)	the sixth period (2016-2018)	the seventh period (2017-2019)	average value	rank
Beijing	1.000	1.000	0.770	1.000	1.000	1.000	1.000	0.967	12
Tianjin	0.847	1.000	1.000	0.868	1.000	1.000	0.993	0.958	13
Hebei	0.397	0.396	0.365	0.373	0.442	0.444	0.451	0.410	22
Shanghai	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Jiangsu	0.998	0.996	0.997	1.000	1.000	1.000	1.000	0.999	10
Zhejiang	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Fujian	0.490	0.575	0.651	0.762	0.798	0.816	0.660	0.679	16
Shandong	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Guangdong	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
East area	0.859	0.885	0.865	0.889	0.916	0.918	0.900	0.890	
Shanxi	0.312	0.375	0.485	0.202	0.238	0.232	0.217	0.294	24
Anhui	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Jiangxi	0.699	0.709	1.000	1.000	1.000	1.000	1.000	0.915	15
Henan	0.472	0.513	0.509	0.500	0.501	0.564	0.581	0.520	21
Hubei	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Hunan	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Central Region	0.747	0.766	0.832	0.784	0.790	0.799	0.800	0.788	
Neimenggu	0.240	0.207	0.201	0.187	0.215	0.261	0.239	0.221	27
Guangxi	0.991	1.000	1.000	1.000	1.000	1.000	1.000	0.999	10
Chongqing	1.000	1.000	0.376	1.000	0.324	0.291	0.287	0.611	18
Sichuan	0.700	0.255	0.222	0.290	0.278	0.283	0.206	0.319	23
Guizhou	1.000	0.339	1.000	0.207	0.143	1.000	0.145	0.548	20
Yunnan	0.523	1.000	1.000	1.000	1.000	1.000	1.000	0.932	14
Shanxi	0.241	0.257	0.251	0.247	0.280	0.293	0.267	0.262	25
Gansu	0.525	0.643	0.549	0.456	0.519	0.699	0.512	0.558	19
Ningxia	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Western Region	0.691	0.633	0.622	0.599	0.529	0.647	0.517	0.605	
Liaoning	0.584	0.636	0.620	0.618	0.654	0.679	0.658	0.636	17
Jilin	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Heilongjiang	0.240	0.261	0.220	0.195	0.216	0.237	0.254	0.232	26
North-east area	0.608	0.632	0.613	0.604	0.623	0.639	0.637	0.622	
Nationwide	0.750	0.747	0.749	0.737	0.726	0.770	0.721	0.743	

Source: The original data comes from the "China Science and Technology Statistical Yearbook" (2013-2020), calculated by dea-solver pro 13 software, and finally compiled according to the calculation results.

**4.2.1. Analysis of the efficiency value of technological innovation in the four major regions**

It can be seen from Table2 that the efficiency values of the eastern and western regions are 0.890 and 0.788, respectively, which are higher than the overall level of the country; the efficiency values of the central and northeastern regions are 0.605 and 0.622 respectively, which are lower than the overall level of the country, and the development of each region is uneven. The difference between the highest and lowest values in the first period of the four major regions was 0.251, and the difference in the seventh period was 0.383. The differences between regions showed an expanding trend.

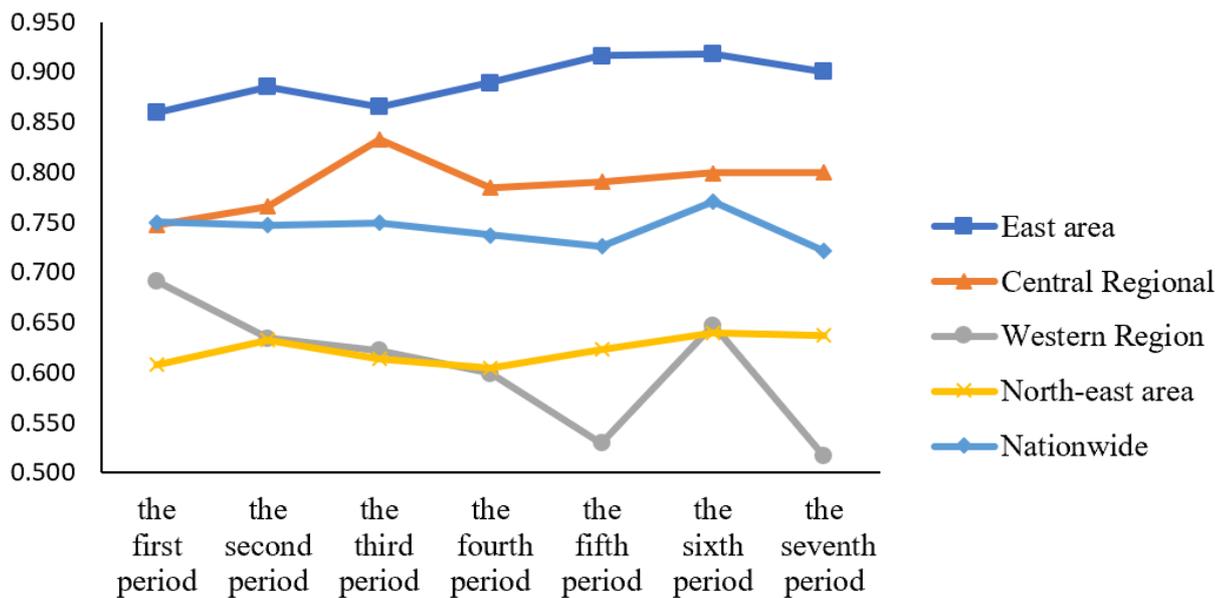


Figure 2 Technological innovation efficiency of Chinese industrial enterprises in the stage of technological transformation

During the study period, the changes in the efficiency values of the eastern and northeastern regions were relatively stable; the central region saw a significant increase in the third period, and then fell significantly in the fourth period, and then remained in a stable state of development; the western region has the largest fluctuation range, except for the increase in the sixth period, the other periods all declined. The efficiency values of the four regions range from "Eastern>Central>West>Northeast" in the first period to "Eastern>Central>Northeast>West" in the seventh period. The efficiency value of the eastern region has always been at the highest level, and the efficiency value of the western region has declined the fastest, and by the seventh period it became the region with the lowest efficiency value in the country.

**4.2.2. Analysis of the efficiency value of inter-provincial technological innovation**

At the provincial level, 9 provinces, including Shanghai, Zhejiang, Shandong, and Guangdong, were all in a valid state during the study period, and the number of valid provinces in each period remained at 12-15. The minimum value of the average efficiency is 0.221, and there is a large gap between the maximum value and the minimum value. The average efficiency value of 15 provinces is higher than the national average, accounting for 55.6% of the total number of samples, indicating that more than half of the provinces can well convert knowledge output into economic output. From the perspective of the average value of efficiency, the provinces with efficiency values at the effective level are the most, with 9; provinces with high, medium-high, medium, and low-level levels are 6, 3, 4, and 5 respectively. Among them, provinces with effective DEA and high-level levels account for 55.6% of all provinces, and the overall level is relatively high, which is better than the average level of the technology research and development stage.

**4.3. Comprehensive technological innovation efficiency**

It can be seen from Table3 that the average efficiency of comprehensive technological innovation in China is 0.634, and 36% of the investment in innovation resources has not been effectively utilized. The efficiency value decreased from 0.657 in the first period to 0.613 in the seventh period, showing a downward trend as a whole, and the efficiency value varied between 0.6 and 0.7, with stable fluctuation.

**4.3.1. Analysis of efficiency values in the four major regions**

It can be seen from Table3 that the average efficiency values of the east, middle, west and northeast regions are 0.734, 0.657, 0.568, and 0.453, respectively, decreasing in order. The eastern and central regions are higher than the national average, and the western and northeastern regions are lower than the national average. Regional development is not balanced. The difference between the highest and lowest values in the first period of the four major regions is 0.303, and the difference in the seventh period is 0.265. The differences between regions show a shrinking trend. During the study period, the eastern region has been at the highest level in China, and its change trend is similar to that of the whole country, showing a downward trend on the whole. The central region as a whole showed an obvious upward trend, exceeding the national average efficiency value after the second period, and had a tendency to catch up with the eastern region. The western region fluctuated greatly and showed a downward trend as a whole. Northeast China has always been at the lowest level in China.

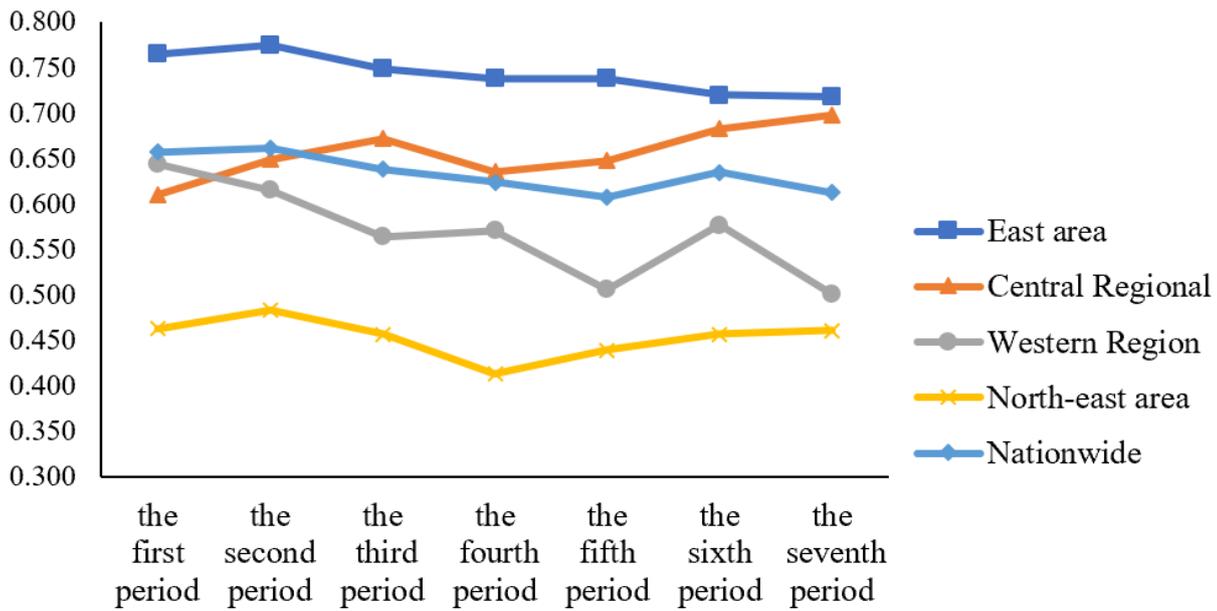


Figure 3 Comprehensive technological innovation efficiency of Chinese industrial enterprises

**4.3.2. Analysis of inter-provincial efficiency value**

At the provincial level, the number of provinces that are valid in each period remains at 3-5, and only Anhui and Ningxia are in the DEA effective state in each period. The minimum value of the mean value of efficiency is 0.232, and there is a large gap between the maximum value and the minimum value. From the average point of view, there are the most provinces in the middle and high level, with 9; the provinces at the high level and the middle level are both 5, and there are 6 provinces at the low level. There are 16 provinces at middle and high level and above, accounting for 59.26% of all provinces. The average value of 15 provinces is above the national overall level, while the remaining 12 provinces are below the national overall level, indicating that some provinces still face many problems in the transformation and upgrading of industrial enterprises, and there is still a certain gap from the innovative growth mode.

Table 3 Comprehensive technological innovation efficiency value of Chinese industrial enterprises

area	the first period (2011-2013)	the second period (2012-2014)	the third period (2013-2015)	the fourth period (2014-2016)	the fifth period (2015-2017)	the sixth period (2016-2018)	the seventh period (2017-2019)	average value	rank
Beijing	0.906	0.850	0.702	0.801	0.801	0.783	0.764	0.801	7
Tianjin	0.660	0.753	0.722	0.626	0.674	0.661	0.668	0.681	13
Hebei	0.376	0.380	0.350	0.345	0.395	0.389	0.414	0.378	23
Shanghai	0.777	0.769	0.739	0.683	0.686	0.696	0.704	0.722	11
Jiangsu	0.999	0.998	0.999	1.000	0.928	0.790	0.837	0.936	4
Zhejiang	1.000	1.000	1.000	1.000	0.855	0.806	0.817	0.925	5
Fujian	0.472	0.536	0.572	0.619	0.661	0.684	0.583	0.590	17
Shandong	0.693	0.692	0.682	0.647	0.643	0.669	0.678	0.672	14
Guangdong	1.000	1.000	0.973	0.923	1.000	1.000	1.000	0.985	3
East area	0.765	0.775	0.749	0.738	0.738	0.720	0.718	0.743	
Shanxi	0.312	0.375	0.425	0.211	0.244	0.243	0.236	0.292	25
Anhui	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Jiangxi	0.453	0.598	0.750	0.793	0.856	1.000	1.000	0.779	8
Henan	0.412	0.434	0.426	0.408	0.397	0.449	0.499	0.432	21
Hubei	0.692	0.720	0.694	0.681	0.692	0.695	0.725	0.700	12
Hunan	0.792	0.765	0.740	0.723	0.697	0.714	0.727	0.737	9
Central Region	0.610	0.649	0.673	0.636	0.648	0.684	0.698	0.657	
Neimenggu	0.248	0.219	0.211	0.205	0.223	0.264	0.256	0.232	27
Guangxi	0.584	0.755	0.761	0.731	0.767	0.748	0.796	0.735	10
Chongqing	0.868	0.895	0.402	1.000	0.363	0.320	0.297	0.592	16
Sichuan	0.748	0.391	0.290	0.331	0.316	0.330	0.248	0.379	22
Guizhou	0.912	0.498	0.692	0.252	0.195	0.704	0.186	0.491	19
Yunnan	0.584	0.823	0.851	0.866	0.855	0.854	0.838	0.810	6
Shanxi	0.286	0.305	0.281	0.271	0.302	0.317	0.300	0.295	24
Gansu	0.565	0.649	0.590	0.489	0.535	0.652	0.589	0.581	18
Ningxia	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1.000	1
Western Region	0.644	0.615	0.564	0.572	0.506	0.577	0.501	0.568	
Liaoning	0.446	0.509	0.476	0.391	0.440	0.480	0.464	0.458	20
Jilin	0.691	0.668	0.662	0.641	0.652	0.653	0.674	0.663	15
Heilongjiang	0.250	0.271	0.234	0.208	0.226	0.238	0.247	0.239	26
North-east area	0.462	0.483	0.457	0.413	0.439	0.457	0.462	0.453	
Nationwide	0.657	0.661	0.638	0.624	0.608	0.635	0.613	0.634	

Source: The original data comes from the "China Science and Technology Statistical Yearbook" (2012-2020), calculated by dea-solver pro 13 software, and finally compiled according to the calculation results.

**4.4. Comparative analysis of national two-stage and comprehensive technological innovation efficiency**

It can be seen from Figure4 that the development of technological innovation efficiency at different stages is unbalanced. Compared with the technological research and development stage, the efficiency value of the technological achievement transformation stage is higher, and the efficiency of the technological research and development stage shows a downward trend as a whole. The difference between the efficiency values of technology transformation stage and technology research and development stage is 0.170 from the first stage (2011-2013) to 0.204 from the seventh stage (2017-2019), showing an expanding trend. Affected by the efficiency value of the technology research and development stage, the comprehensive technological innovation efficiency value is also relatively low. The overall efficiency and the change trend of the transformation efficiency of technological achievements are basically the same. It shows that in the joint effect of technology research and development efficiency and achievement transformation efficiency on overall efficiency, technology transformation efficiency is dominant. Therefore, if comprehensive efficiency is to be improved, achievement transformation efficiency must be improved, but the improvement of efficiency value in technology research and development stage cannot be ignored.

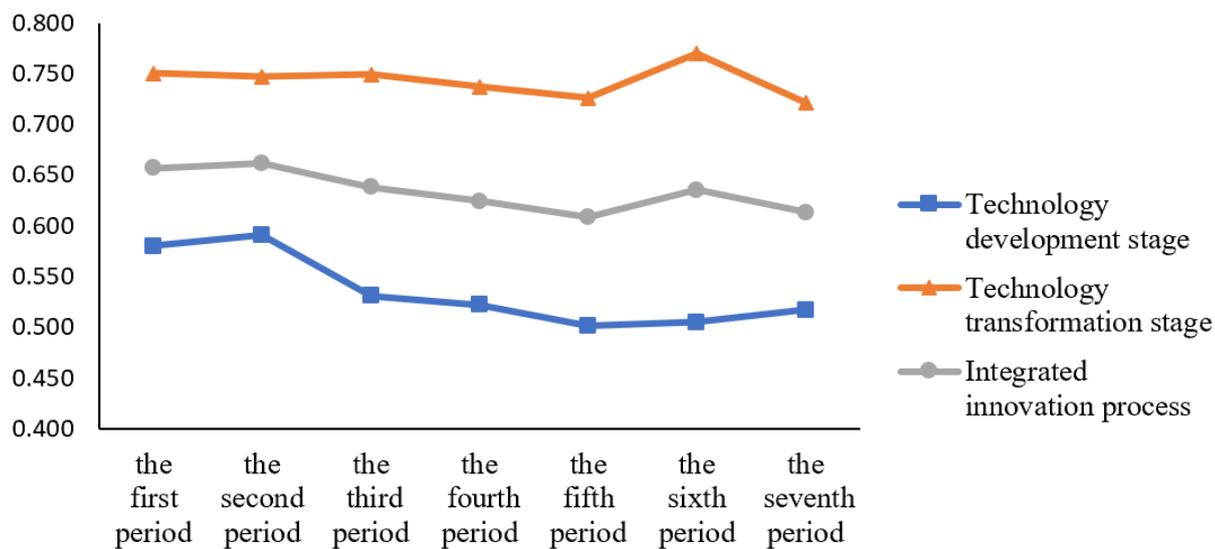


Figure 4 Two-stage and comprehensive technological innovation efficiency value of Chinese industrial enterprises

5. SPATIAL CORRELATION ANALYSIS

The above has carried out calculation and analysis on the technological innovation efficiency of industrial enterprises. This part will use the spatial statistical methods of global autocorrelation and local autocorrelation to study its spatial correlation characteristics in depth. The global space autocorrelation reflects the characteristics of a certain attribute in the global space, which is generally represented by the global Moran index (Golbal Moran, s I). The range of Golbal Moran,s I is [-1,1]. The closer to 1 at a given significance level, the higher the degree of agglomeration; the closer to -1, the greater the degree of dispersion and the more obvious the difference; When it is 0, it indicates that there is no spatial correlation.

Local spatial autocorrelation is usually used to study the similarity between a certain area and its surrounding areas. In this paper, local Moran index is used to analyze local spatial autocorrelation. LISA aggregation graph is a visual expression of Local Moran,s I, which can clearly express the local aggregation characteristics of technological innovation efficiency. The spatial weight matrix used in this part of the analysis is based on Queen's first-order spatial weight matrix, and the software used is ArcGIS 10.4 and GeoDa. The specific analysis is as follows:

5.1. Global spatial autocorrelation analysis

Golbal Moran,s I of comprehensive technological innovation efficiency of inter-provincial industrial enterprises is calculated. As shown in Figure 5,Moran,s I are both positive, and each period has passed 1% or 5% significance test, indicating that the spatial distribution of comprehensive technological innovation efficiency is not random, and there is obvious spatial agglomeration and spatial dependence. High efficiency provinces are adjacent to high efficiency provinces, while low efficiency provinces are adjacent to low efficiency provinces. From the trend of change, Moran,s I showed an "M"-shaped fluctuation, rising from 0.195 in the first period (2011-2013) to 0.336 in the third period (2013-2015), then falling to 0.242 in the fourth period (2014-2016) , Then rose to 0.355 in the sixth period (2016-2018), and finally fell to 0.311 in the seventh period (2017-2019), showing a volatile upward trend as a whole. It shows that although the spatial agglomeration of comprehensive technological innovation efficiency has certain volatility, it shows a trend of strengthening as a whole.

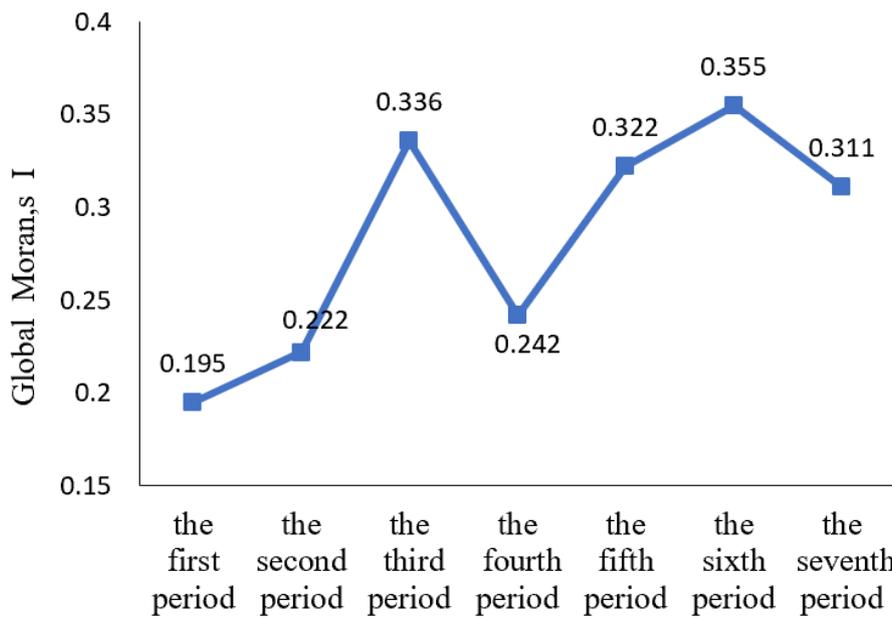


Fig. 5 Global Moran index change chart of comprehensive technological innovation efficiency of China's inter-provincial industrial enterprises

### 5.2. Local spatial autocorrelation analysis

In order to further analyze the local spatial characteristics, the first, third, fifth and seventh periods of LISA aggregation maps were made (Figure 6). There are four types of agglomeration States in LISA agglomeration diagram: ① high-high: agglomeration area with high efficiency value; ② High-low: the high-efficiency area is surrounded by the low-value area; ③ Low-high: the low efficiency area is surrounded by the high efficiency area; ④ Low-low: low-value agglomeration area. The spatial agglomeration feature shown in Figure 7 passed the significance test of 1% or 5%.

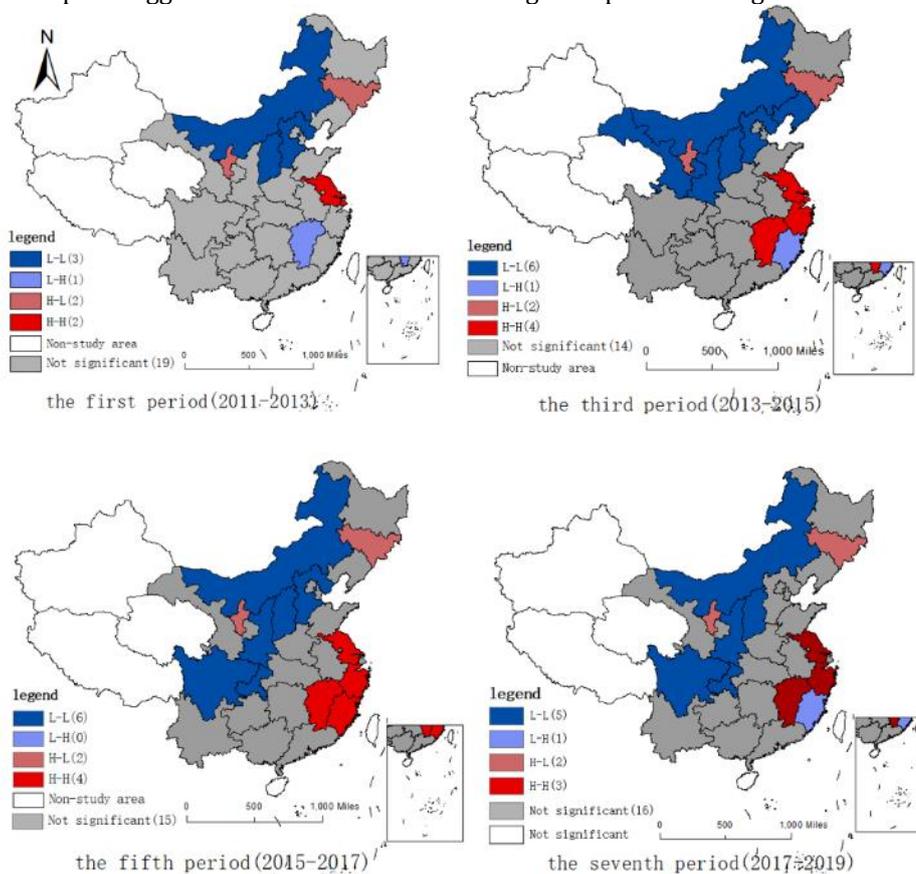


Figure 6 LISA cluster diagram of comprehensive technological innovation efficiency of Chinese industrial enterprises

It can be seen from Figure 6 that the high-growth agglomeration mainly consists of Jiangsu, Shanghai, Zhejiang and other provinces. Among them, Jiangsu Province has always been the high-growth agglomeration area. These provinces are mainly located in the eastern coastal area. This area has a developed economy, convenient transportation, and agglomeration of innovative resources. Provides certain advantages for innovation and development; low and low agglomerations are mainly located in the remote inland areas of the central and western regions. These provinces have relatively weak economic foundations, relatively scarce high-quality innovation elements such as R&D funds, technology, and talents, and the level of technological innovation efficiency of industrial enterprises Lower. Jilin and Ningxia have been high-low agglomeration during the entire study period. The efficiency values of these two regions are higher than the surrounding areas, but the spatial diffusion effect is limited and the radiation driving ability is weak, which cannot effectively promote the improvement of the efficiency value of the surrounding areas.

From an overall point of view, the agglomeration mode is mainly high-high agglomeration and low-low agglomeration, and the number of provinces belonging to these two agglomeration states is on the rise, indicating that the inter-provincial inter-regional linkage correlation is obviously strengthened. Provinces located in the middle of low-low agglomeration and high-high agglomeration regions performed insignificantly.

## 6. ANALYSIS THE INFLUENCING FACTORS

According to the previous evaluation and analysis of efficiency, it can be seen that there are obvious differences in different regions. In order to clearly understand the factors that affect the efficiency of technological innovation in each region, this section will regress the 27 provinces across the country as a whole, and then regress the four regions separately.

### 6.1. Construction of indicators

#### 6.1.1. Dependent variable

Select the inter-provincial comprehensive technological innovation efficiency as the dependent variable and record it as *inn*.

#### 6.1.2. Independent variables

Technological innovation efficiency is affected by many factors. This paper selects relevant indicators from the internal and external aspects of the enterprise. Within the enterprise, we mainly select three indicators: the input of R&D funds, the input of R&D personnel and the scale of industrial enterprises; the external selection of high-speed rail density, government support for innovation, the degree of government intervention in the economy and the level of regional economic development.

##### 6.1.2.1. Investment of R & D funds

R & D funding is an important part of R & D activities and the basis for the smooth development of technological innovation activities. In this paper, the R & D internal expenditure divided by the sales revenue of new products is used to express the R & D investment, which is recorded as *cap*.

##### 6.1.2.2. Investment of R & D personnel

R & D personnel are the human input of enterprises in R & D activities and the main participants in technological innovation activities (Liu Chunjiao, 2019: 147-149), which is of great significance to the development of technological innovation activities. The number of R & D personnel of industrial enterprises in various regions is selected to measure the index. In order to reduce the impact of heteroscedasticity, the logarithm is taken and recorded as *lnper*.

##### 6.1.2.3. Scale of industrial enterprises

The influence of enterprise scale on enterprise innovation efficiency has always been the research focus of domestic and foreign scholars. Different enterprise scales have different effects on enterprise innovation efficiency. This article refers to the research of Li Peng (2013), and uses the ratio of the total assets of industrial enterprises to the number of industrial enterprises in each region to represent the average size of industrial enterprises in each region, which is recorded as *sca*.

##### 6.1.2.4. High-speed rail density

The construction of transportation infrastructure is an important driving force for regional economic growth (Zhang Xueliang, 2012:60-77). As a new type of transportation, high-speed rail has greatly shortened the railway operation time between cities, promoted the flow of resources, and expanded the scope of knowledge spillover. As an important market entity, any changes in the macro environment will have an important impact on enterprises. The opening and construction of high-speed rail will also affect the behavior of enterprises to a certain extent. This article divides the number of high-speed rail mileage in each region by the total population of each region at the end of the year to express the density of high-speed rail in each region, denoted as *hsr*.

##### 6.1.2.5. The government's support for innovation

Although enterprises are the mainstay of innovation, the government can influence the innovation activities of industrial enterprises through fiscal and tax policies. With reference to the research of Zhang Hong and Wang Yulei (2016:118-189), the proportion of government funds in the internal expenditure of R&D expenditures of industrial enterprises in each region is used to express the funding of various regions' governments for innovation, which is recorded as gov.

6.1.2.6. *The degree of government intervention in the economy*

Economic development requires moderate government intervention, but if the government intervenes too much, it will affect the effective play of the market mechanism. The increase in fiscal expenditure will squeeze enterprises to use their own resources to invest, and have a negative impact on the improvement of technological innovation efficiency. This article uses the proportion of regional public fiscal expenditures in each region's GDP to express the degree of regional government intervention in the economy, denoted as *inter*.

6.1.2.7. *Regional economic development level*

The development of innovative activities requires certain financial support, and needs to rely on the good economic development level of the region. The per capita GDP of each region is used to express the regional economic development level. In order to reduce the impact of heteroscedasticity, the logarithm is taken and recorded as *lngdp*.

6.1.3. *Data source and processing*

Since this paper sets a two-year lag period, the overall efficiency of each period is affected by the combined effect of the influencing factors of the first two years of each period, and is the sum of the influencing factors of the first two years of each period. The influencing factors use data from 2011-2018, and the statistical caliber is industrial enterprises above designated size. The mileage of high-speed rail comes from online searches, and the rest of the data comes from the "China Statistical Yearbook" and "China Science and Technology Statistical Yearbook" (2012-2019) of the corresponding year. The missing part of the data is filled in according to the method mentioned above. In order to eliminate the impact of prices, the regional GDP per capita index is used as the base period to deflate the regional per capita GDP, the number of R&D personnel input is the actual variable, and other indicators are proportional data, and no deflation will be carried out.

6.1.4. *Selection of regression model*

When performing regression analysis in this part, the dependent variable is the comprehensive technological innovation efficiency value, and its efficiency value cannot be greater than 1, and all values greater than 1 are compressed at the point 1. In this case, using OLS regression directly, the results obtained are biased. This is because after the dependent variable is blocked, its probability density will also change accordingly. When the dependent variable is intercepted data, although there are all observation data, some observation data are compressed at one point. At this time, the probability distribution of the dependent variable is a "joint distribution" composed of a discrete point and a continuous distribution. Constitute. In this case, no matter whether the entire sample is used or the sub-samples of discrete points are eliminated, it is impossible to obtain a consistent estimate for the OLS estimation, and the Tobit model can overcome this problem. The Tobit model is also called a restricted dependent variable model, which is a model that takes values when the dependent variable satisfies certain constraints. It is applicable when the value of the dependent variable is partly continuous and partly discretely distributed data. The Tobit model is divided into three forms: left limited, right limited and bilateral limited according to the setting of the interception point. The comprehensive technical efficiency value of this article belongs to the right limited situation. The specific form of the Tobit model used in this article for:

$$Y_{it}^* = \alpha + \beta X_{it} + \varepsilon_{it} \tag{1}$$

$$Y_{it} = \begin{cases} Y_{it}^*, & Y_{it}^* < 1 \\ 1, & Y_{it}^* \geq 1 \end{cases} \tag{2}$$

Among them,  $Y_{it}^*$  is the latent variable,  $Y_{it}$  is the actual dependent variable,  $\beta$  is the parameter to be estimated,  $\varepsilon_{it}$  is the random error term,  $\alpha$  is the constant term. The dependent variables and independent variables are substituted into the Tobit model. This article constructs the measurement model as shown below:

$$inn_{it}^* = \alpha_i + \beta_1 cap_{it} + \beta_2 ln per_{it} + \beta_3 sca_{it} + \beta_4 sr_{it} + \beta_5 int er_{it} + \beta_6 gov_{it} + \beta_7 ln g dp_{it} + \varepsilon_{it} \tag{3}$$

In this paper, we first establish the individual random effect model, and then conduct LR test to determine whether to use the mixed panel model or the individual random effect model.

Table 4 Tobit regression results of influencing factors of technological innovation efficiency of industrial enterprises in China as a whole and in various regions

	The whole country	Eastern region	Central region	Western region	Northeast region
R&D capital investment (cap)	-0.869*** (-0.296)	1.225* (-0.713)	-0.995 (-0.688)	-0.934* (-0.545)	-0.624 -0.563
R&D personnel investment(lnper)	0.094* (-0.056)	0.009 (-0.071)	0.458** (-0.206)	-0.270** (-0.108)	-0.104 -0.15
Enterprise Scale (sca)	-0.012* (-0.006)	-0.003 (-0.005)	-0.047** (-0.020)	-0.0265 (-0.018)	-0.022*** -0.002
High-speed rail density(hsr)	-0.071 (-0.105)	0.232 (-0.241)	0.627** (-0.299)	-0.197 (-0.177)	0.883*** -0.064
Government intervention in the economy(inter)	0.968*** (-0.290)	0.401 (-0.394)	1.076 (-1.087)	1.120* (-0.648)	-0.416 -0.789
Government support for innovation(gov)	0.047 (-0.143)	0.164 (-0.167)	0.089 (-0.229)	0.07 (-0.255)	-0.057 -0.221
Regional economic development level (lngdp)	-0.096 (-0.103)	-0.248** (-0.113)	-0.484** (-0.242)	0.279 (-0.220)	-0.599** -0.236
constant	0.429	3.254**	0.406	0.224	8.707***
(C)	(-0.932)	(-1.364)	(-1.431)	(-2.544)	-0.79

Note: The values in parentheses are standard errors,\*\*\*,\*\*, and \* are significant at the levels of 1%,5% and 10% respectively.

Source:According to the calculation results of stata16 software.

6.1.5. Regression results

The software used in this section is stata16, which estimates five individual random effect models. According to the models established in the whole country and the eastern, central and western regions, the LR tests are respectively "Prob >= chibar2 = 0.000, Prob >= chibar2 = 0.000, Prob >= chibar2 = 0.000, Prob >= chibar2 = 0.000", both rejected the null hypothesis that there is no individual effect at the 1% significance level; according to the model established in the Northeast region, the LR test is "Prob >= chibar2 = 1.000", does not reject the null hypothesis that there is no individual effect. Therefore, the country as a whole and the eastern, central and western regions established the individual random effect Tobit model, and the northeastern region established the mixed Tobit model. These five models have passed the test and are all valid as a whole. The regression results are shown in Table 4:

- (1) The technological innovation efficiency of national industrial enterprises is significantly positively correlated with the investment of R&D personnel and government intervention in the economy; there is also a positive correlation with government support for innovation, but the effect is not obvious; the size of the enterprise has a significant effect on the improvement of technological innovation efficiency. Significant negative impact.

- (2) The technological innovation efficiency of industrial enterprises in the eastern region is significantly positively correlated with R&D capital investment, and there is also a positive correlation with the investment of R&D personnel, high-speed rail density, government intervention in the economy, and government support for innovation, but the effect is not significant; and The level of regional economic development is significantly negatively correlated.
- (3) The technological innovation efficiency of industrial enterprises in the central region is significantly positively correlated with the investment of R&D personnel and the density of high-speed rail. It is also positively correlated with government intervention in the economy and government support for innovation, but the effect is not obvious; it is related to the scale of the company significantly negatively correlated with the level of regional economic development.
- (4) The technological innovation efficiency of industrial enterprises in the western region is significantly positively correlated with government intervention in the economy, and is also positively correlated with government support for innovation and the level of regional economic development, but the effect is not significant. It is related to R&D capital investment and R&D personnel. Significantly negatively related to investment.
- (5) The technological innovation efficiency of industrial enterprises in Northeast China is significantly positively correlated with high-speed rail density, and significantly negatively correlated with the scale of enterprises and the level of regional economic development.

## 7. SUMMARY

### 7.1. Conclusion

This paper measures and analyzes the technological innovation efficiency of Chinese industrial enterprises, and tests their spatial relevance, and finally empirically analyzes the factors that affect technological innovation efficiency. The main conclusions are as follows:

#### **7.1.1 From the perspective of technological innovation efficiency of industrial enterprises**

In terms of the two-stage efficiency value: the average efficiency of the technology research and development stage is 0.535, the average efficiency of the technology transformation stage is 0.743, the average efficiency of the technology transformation stage during the research period is always higher than the average efficiency of the technology research and development stage, and the two-stage efficiency value exists Gap, and the gap is expanding. The efficiency value of the technology research and development stage shows a downward trend as a whole; there are gaps in different regions. The average efficiency of the eastern region is the highest, the northeast region is the lowest, and the central region has the fastest rise; only Anhui and Ningxia are effective in each period; from the average value It can be seen that the provinces that are distributed in the middle and low levels are the most, and the average value of 17 provinces is below the national average. The overall level of efficiency in the transformation stage of technological achievements is relatively high, but it shows a slight downward trend; there are 9 provinces where the efficiency values in each stage have reached the effective state, more than in the R&D stage.

In terms of comprehensive technological innovation efficiency: the national average is 0.634, the overall level is not high; from the perspective of different regions, the eastern region has the highest efficiency value, and the northeast region has the lowest efficiency value; from the provincial level, only the two provinces of Anhui and Ningxia Periods are in the state of DEA effective. From the average of the provinces, 15 provinces are above the overall level of the country, and most of these provinces are from the eastern and central regions. In short, the overall level of comprehensive technological innovation efficiency of Chinese industrial enterprises is not high, the gap between regions and provinces is obvious, and there is obvious incoordination in the efficiency of two-stage technological innovation. Compared with the efficiency value of the technological research and development stage, the efficiency value of the technological achievement transformation stage Higher, the comprehensive technological innovation efficiency value and the change trend of the efficiency value in the transformation stage of technological achievements are basically the same, that is, the comprehensive technological innovation efficiency is mainly affected by the efficiency of the technological transformation stage.

#### **7.1.2. From the perspective of the spatial relevance of technological innovation of industrial enterprises**

The technological innovation efficiency of Chinese industrial enterprises has obvious characteristics of spatial agglomeration. High-high agglomerations are mainly distributed in the eastern coastal areas, and low-low agglomerations are mainly distributed in the central and western inland areas. Although the spatial agglomeration of technological innovation efficiency has certain fluctuations, The overall trend is increasing.

#### **7.1.3 From the perspective of influencing factors of technological innovation efficiency of industrial enterprises**

Due to the different development stages and development methods of industrial enterprises in various regions, there are also differences in the factors affecting the efficiency of technological innovation in various regions.

The technological innovation efficiency of national industrial enterprises is significantly positively correlated with the investment of R&D personnel and government intervention in the economy; it is significantly negatively correlated with the investment of R&D capital and the size of the company, indicating that the overall R&D investment in the country is redundant and the R&D expenditure has increased extensively. It has not effectively promoted the improvement of

efficiency. The size of the enterprise has a significant negative impact on the improvement of technological innovation efficiency. It may be because the larger the enterprise, the less conducive to the effective allocation of resources and the improvement of efficiency.

The eastern region is mainly affected by the investment in research and development funds, which has significantly promoted the efficiency of industrial enterprises in the eastern region.

The central region is mainly affected by the investment of R&D personnel, the density of high-speed rail, the scale of enterprises and the level of economic development.

The western region has a significant positive correlation with government intervention in the economy, and a significant negative correlation with R&D capital investment and R&D personnel investment; it shows that moderate government intervention in the economy has effectively promoted efficiency improvement, but government investment in enterprise innovation funds inhibited innovation. The improvement of efficiency may be due to the "crowding out effect" of the government's excessive capital investment on the technological innovation input of industrial enterprises (Liu Ruiyu, 2016:277-283).

Northeast China is mainly affected by the density of high-speed rail, the scale of enterprises and the level of regional economic development. The construction of high-speed rail has effectively promoted the increase in efficiency in the Northeast; the unreasonable enterprise scale has inhibited the increase in efficiency.

## 7.2. Policy recommendations

### 7.2.1. Different regions should adopt different policies according to local conditions

The eastern region should give full play to its capital advantages, increase investment in research and development, increase research and development efforts, cultivate independent brands of enterprises, and improve core competitiveness; the central region should appropriately increase the investment of research and development personnel, enhance the independent research and development capabilities of enterprises, and increase the transportation infrastructure such as high-speed rail. The construction of facilities, speed up the flow of various resources and elements, and improve efficiency; the western region should give full play to the government's role in economic regulation, create a good innovation environment, and appropriately control the input of R&D elements to avoid waste of resources and improve R&D resources. Utilization efficiency: The Northeast region should increase the construction of high-speed rail and other transportation infrastructure, promote the rapid flow of various elements, improve efficiency, and appropriately adjust the scale of enterprises, control the scale of production within a reasonable range, and give full play to the positive role of economies of scale.

### 7.2.2. Promote the coordinated development of two-stage technological innovation efficiency

The low level of efficiency in the current technology research and development stage hinders the further improvement of the overall technological innovation efficiency level. All regions should focus on increasing investment in technology research and development, increasing research and development efforts, and promoting both on the basis of maintaining relatively high efficiency in the technology transformation stage. Stage the coordinated development of technological innovation efficiency, thereby improving the level of comprehensive technological innovation efficiency.

### 7.2.3. Strengthen regional cooperation and promote coordinated development of various regions

There are obvious regional differences and spatial correlations in the technological innovation efficiency of industrial enterprises. Each region should make full use of its spatial correlation, strengthen regional cooperation, and promote the coordinated development of various regions, so as to promote the improvement of comprehensive technological innovation efficiency. The eastern region should actively play the leading role of innovation on the basis of maintaining its own relatively high level of efficiency; the central region, linking the east to the west, must give full play to its location advantages, and actively take over the eastern region under the strategic background of "the rise of the central region." The industrial transfer of China should absorb its advanced technology to promote its own efficiency. At the same time, it should also play a radiating role to drive the efficiency of the western region. The western region should strengthen communication and exchanges with the eastern and central regions in terms of technology and talents, and introduce advanced technology and management experience improve innovation efficiency; as an old industrial base, the Northeast region is in the transitional stage of industrial transformation and upgrading. System reform and structural adjustment should be accelerated, exchanges and cooperation with other regions should be strengthened, and independent innovation capabilities should be comprehensively improved.

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## **Regular Session: RS02.3 - Infrastructure, transportation and accessibility**

**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/84223142845>**

**Chair Eko Wicaksono**

## DOES SOCIAL-DISTANCING SAVE LIVES?: THE IMPACT OF SOCIAL DISTANCING MEASURES ON PEOPLE MOBILITY AND COVID-19 CASES IN INDONESIA

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### ABSTRACT

As unprecedented event, Covid-19 pandemic has forced government across the world to rely more on non-pharmaceutical intervention since no specific medication nor vaccine were ready to counter the spread of this particular disease. Both social and mobility restriction were among the chosen policies implemented. Indonesian government took two substantial interventions at the onset of Covid-19 pandemic. Those interventions are school closure and voluntary social distancing which then was followed by Large Scale Social Restriction (PSBB). Voluntary social distancing encourages businesses and worship places to implement health protocol and there were legal punishment given to those who neglected the advice. On the other hand, PSBB had stricter measures in its implementation since only essential businesses could remain open during its period. It also required worship places closure and limited activities on public facilities as well as transportation. In addition, the government provided the legal basis in its implementation so that any disobedience would lead to legal consequences.

We evaluated the impact of these interventions on people mobility and the growth rate of confirmed COVID-19 cases. People mobility data were obtained from Google Mobility Report. Meanwhile, the cases growth rate data were obtained from official case counts which cover 34 provinces across Indonesia in between February 16, 2020 and May 7, 2020. We employ both synthetic control design and an event-study design adapted for continuous treatment to determine the impact of these non-pharmaceutical intervention on people mobility and cases growth rate.

We find that both interventions could reduce 30 % of average workplace mobility, and on the other hand, increased 15 % of average residential mobility. Using synthetic control method, we found that PSBB alone in DKI Jakarta decrease further its workplace mobility by 10%, but the impacts are more subtle in both West Sumatera and Gorontalo. Both school closure-voluntary social distancing and PSBB interventions have significant impact towards the growth of positive COVID-19 cases. During school closure-voluntary social distancing period, 1% increase in residential activity leads to decrease of COVID-19 cases growth by 1.03 percentage point in the first week and stagnant at 1.48 percentage point for the following periods. Holding residential mobility at pre-COVID-19 period, COVID-19 positive cases in Indonesia would have reached 17.450 cases instead of the actual observed cases at 12.754 or correspond to 37% higher on May 7, 2020. Furthermore, with a stricter social distancing that is PSBB, our simulation displays that the observed cases could further be reduced. These findings imply that containment policy at the early onset of Covid-19 outbreak is very important to flatten the curve and save more lives.

## NEGATIVE EXTERNALITIES FROM PORT DEVELOPMENT: EVIDENCE FROM MARINE POLLUTION IN INDONESIA

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### ABSTRACT

Developing transport infrastructure must involve a comprehensive cost-benefit analysis, and accounting for environmental quality changes associated with such infrastructure is one important aspect that can help complete this picture. In this study, we used difference-in-difference to estimate the marine pollution changes related to port development in Indonesia over the last decade. Using unique MODIS-derived monthly data of marine pollution, we found that local port presence causes a 1.7% increase in chlorophyll-a in coastal areas within 6 kilometers of the port. The effects are concentrated in the first two months of operation, and there is evidence for anticipation effects associated with the construction period. We found a greater effect in Indonesia's eastern regions, which rely on small ports for their local activities. Nevertheless, we argue that the effect can be substantial and potentially capable of creating an algal bloom in a larger port.

## **Regular Session: RS11.1 - Rural development**

**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/87822655076>**

**Chair Charles Kofi Owusu**

## RENEWABLE MINIGRIDS FOR RURAL ELECTRIFICATION IN GHANA: ANALYSIS OF HOUSEHOLDS' WILLINGNESS TO PAY

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### ABSTRACT

Renewable energy minigrids hold enormous prospects for the African energy sector in terms of enhancing clean energy access, while fostering sustainable low carbon development. The government of Ghana has established pilot renewable minigrids in 5 rural offgrid communities to provide mastery and learning for the electrification of over 600 existing rural communities that cannot be electrified via the national grid. Although, there is evidence on willingness to pay (WTP) for renewable-generated electricity in some developing countries, little is known about households' WTP for renewable-based electricity in Ghana and in particular renewable minigrids for rural electrification. The study sought to provide one of the first WTP estimates for renewable-based electricity for rural electrification in a developing economy context such as Ghana, setting the stage on how to de-carbonize the rural energy sector and spur low-carbon rural development. A Contingent Valuation (CV) survey was undertaken using structured questionnaires in all 5 pilot renewable minigrid project communities in Ghana, located in 3 of the 16 regions of Ghana. Two hundred households were interviewed adopting a combination of cluster and simple random sampling approaches.

We established that rural households are willing to pay an average of GHC29 (≈\$5)/month for renewable-powered electricity services, which is twice the amount they are currently paying based on the Uniform National Tariffs. Households in the rural areas are willing to pay between 9% and 11% of their discretionary incomes to cover the cost of accessing renewable-powered electricity in the rural, offgrid communities in Ghana. The findings suggest a positive attitude by households regarding their preparedness to pay for the cost of renewable-powered electricity services in the hope of contributing to a sustainable electricity service delivery and enhanced access in the communities. We call for a closer view at these estimates in the development of tariff regulations and frameworks by the government for renewable minigrid development in the rural areas.

## LIVELIHOOD RESILIENCE AND COPING STRATEGIES OF SELECTED RURAL HOUSEHOLDS IN BANGLADESH DURING THE COVID-19 PANDEMIC

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### ABSTRACT

The paper intends to explore the impact of COVID-19 on the livelihood of different types of rural households in Bangladesh and their livelihood resilience by employing the Resilience Index Measurement and Analysis II (RIMA-II) model. It has also explored the coping strategies that are adapted by the rural households during the pandemic. Data were collected through telephone surveys using the structured questionnaire and checklist. Convenience sampling was used to select 157 rural households from 102 sub-districts in eight divisions of Bangladesh. The study reveals that mixed (having both agricultural and non-agricultural livelihood capitals) households are the most resilient, and non-agricultural households are the least resilient during the pandemic. This study also reveals that COVID-19 has not affected employment status that much in rural areas. However, business activities have been affected the most compared to farming and service activities. In general, all rural households have low livelihood resilience, which indicates that rural households are not capable enough to cope with the adverse effects of the COVID-19 pandemic. To minimize livelihood risk agricultural households mostly rely on external coping strategies, whereas non-agricultural and mixed households depend on internal coping strategies. The main drivers of resilience capacity include having basic education and skills to shift livelihood strategy, a stable income source, and access to financial help when needed.

### KEYWORDS

Bangladesh, Coping Strategies, COVID-19 Pandemic, Livelihood Resilience, Rural Households.

### 1. INTRODUCTION

The unprecedented COVID-19 pandemic has led to a worldwide disruption of lives and livelihoods “Rashid et al. (2020); Walsh (2020); Zabaniotou (2020)”. Being an impoverished and densely populated country, Bangladesh is highly vulnerable to the COVID-19 pandemic “Genoni et al. (2020); Sakamoto et al. (2020)”. In March 2020, the government of Bangladesh declared a countrywide lockdown to limit community transmission of COVID-19 “Sakamoto et al. (2020)”. However, this lockdown has reduced the income opportunities of rural people, which makes the livelihood of rural people more stressful and vulnerable “Hasnin (2020); Rashid et al. (2020)”.

A livelihood comprises capabilities, assets, and activities that are needed to sustain a living “Rudiarto et al. (2019)”. Sudden exposure to shocks and stress that creates adverse effects on livelihood makes people vulnerable “Sarker et al. (2020); Endris et al. (2017)”. COVID-19 pandemic is a systemic shock as it affects the broader community at the same time or same place “Endris et al. (2017)”. To assess the vulnerability and to cope with unforeseen external disruptions and shocks, the concept of resilience has emerged “Steenbergen et al. (2020); Alam et al. (2018)”. Households will be resilient if they could anticipate, resist, cope with, and recover from shocks “Alam et al. (2018); Barua et al. (2014); Fan et al. (2014)”. Resilience is a multidimensional concept which refers to the ability of the individuals, households, communities, group, or organizations to cope with and adapt to shocks “Sarkar et al. (2020); Convertino & Valverde (2019); Roberts et al. (2019); Rudiarto et al. (2019); Alam et al. (2018); Tanner et al. (2015)”. Livelihood resilience is “the capacity of all people across generations to sustain and improve their livelihood opportunities and well-being despite environmental, economic, social, and political disturbances” “Tanner et al. (2015: 1)” Resilience capacity is the combination of three interrelated capacities: adaptive capacity, absorptive capacity, and transformative capacity “TANGO International (2018); Vaughan (2018)”. Coping strategies increase livelihood resilience and decrease vulnerability to shocks “Farzana et al. (2017)”. These are the strategies or mechanisms that vulnerable people adapt in times of sudden shock to minimize risks such as selling assets, borrowing money, reducing household food consumption, and migrating to other areas “Sultana & Rayhan (2012)”. Several studies have focused on the livelihood resilience of rural people in Bangladesh. However, only a few of them have measured livelihood resilience. Moreover, the livelihood resilience of

various occupational households during the COVID-19 pandemic has not been addressed yet. Therefore, this study addresses this gap and intends to answer the following research questions:

- Based on the occupational status of the households, which household is more resilient during the COVID-19 pandemic in rural areas of Bangladesh? What factors influence the resilience capacity of these households in Bangladesh during the COVID-19 pandemic?
- What is the impact of COVID-19 on the employment status of earning members in rural households of Bangladesh?
- What are the coping strategies of different types of rural households during the COVID-19 pandemic?

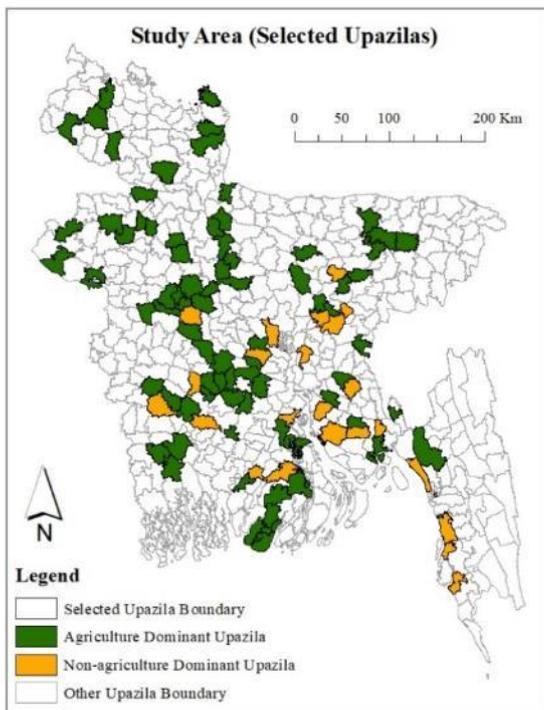
It is expected that this study will help the policymakers and planners to address the factors that expose people to vulnerability and the factors which make the rural household more resilient during any systemic shocks.

## 2. RELEVANT RESEARCH

Several studies have been found on the resilience of rural people in Bangladesh during natural shocks such as disasters, for example, livelihood resilience of riverine island dwellers “Sarker et al. (2020)”, community resilience to cyclone and storm “Uddin et al. (2020)”, climate change resilience “Alam et al. (2018)”. Many studies have explored the coping strategies of rural people in times of natural disasters “Islam et al. (2018); Fakhruddin & Rahman (2015); Masud-All-Kamal (2013); Sultana & Rayhan (2012)”. As natural disasters and pandemics both are systemic shocks, these studies are also helpful for the livelihood resilience study of rural people during the pandemic “Endris et al. (2017)”. Few recent research studies have addressed the vulnerability issue of Bangladesh during pandemic “Rahman et al. (2020); Sakamoto et al. (2020)”. However, the livelihood resilience of rural households in Bangladesh during the pandemic has not been explored yet. Few previous studies have measured the livelihood resilience of rural people during natural disasters. Measuring livelihood resilience is a very challenging task “Sarker et al. (2020); Quandt (2018)”. Among the measurement approach, composite indicator-based assessment is widely used to measure resilience “Sarker et al. (2020); Alam et al. (2018); Weldegebriel & Amphune (2017); Béné et al. (2016); FAO (2016); Alfani et al. (2015). So, this approach is followed in the study to measure the livelihood resilience of rural households, and to identify the factors that influence their resilience capacity during the COVID-19 pandemic.

## 3. STUDY AREA AND SAMPLE HOUSEHOLDS

As whole Bangladesh has been going through widespread community transmission of COVID-19 pandemic and is largely affected by it, 157 villages from 102 upazilas, from 48 different districts under all 8 divisions are selected as study area to represent the complete COVID-19 situation of rural areas. A telephone survey with a structured questionnaire was done in the period of October and November 2020. Information regarding 157 households and their villages was collected. Based on the responses, it has been found that from March to August 2020, when the transmission of COVID-19 was at its peak in Bangladesh, lockdown was declared in about 90% of these studied upazilas by the government. It was also found that lockdown was declared either by local administration or national government. Among the selected upazilas 82% are agriculture dominant, and 18% are non-agriculture dominant “BBS (2015)”. Studied households are divided into three categories: Agricultural households, Non-agricultural households, and mixed households. “A household is considered to be an agricultural household when at least one member of the household is operating a holding (farming household) or when the household head or main income earner is economically active in agriculture” “DESA (1984: 157)” Rural households that do not engage in agricultural activities are non-agricultural, and the households whose members are engaged in both agricultural and non-agricultural activities are mixed households “Videnovic & Arandjelovic (2020)”.



**Figure 1: Map of the study areas**

Source: Authors' own construction from "Bangladesh—Subnational Administrative Boundaries (2020)" & "BBS (2015)".

#### 4. MEASURING LIVELIHOOD RESILIENCE

Several studies used the composite indicator-based assessment to measure the livelihood resilience of vulnerable people during shocks "Sarker et al. (2020); Alam et al. (2018); Weldegebriel & Amphune (2017); Béné et al. (2016); FAO (2016); Alfani et al. (2015)". COVID-19 pandemic is a systemic shock that has disrupted rural people's livelihood to a great extent "Hasnin (2020); Rashid et al. (2020); Endris et al. (2017)". Resilience Index Measurement and Analysis II (RIMA-II) developed by "FAO (2016)" was followed in this study to measure the livelihood resilience of rural households during the COVID-19 pandemic. RIMA-II has been chosen as it covers all the livelihood aspects of households "Sarker et al. (2020); Weldegebriel & Amphune (2017)". The model and the selected indicators have been customized in this study following relevant research "Sarker et al. (2020); Alam et al. (2018); Weldegebriel & Amphune (2017); FAO (2016); Qasim et al. (2016); Hahn et al. (2009)".

Resilience is a function of three interrelated capacities: adaptive, absorptive, and transformative capacity "Sarker et al. (2020); Rudiarto et al. (2019); FAO (2016)".

$$\text{Resilience} = f(\text{Adaptive, Absorptive, Transformative}) \quad (1)$$

These capacities are comprising some indicators. Five major indicators of the capacities were selected from "FAO (2016)". Equal weights were applied to the indicators and then aggregated to obtain a multidimensional livelihood resilience index (LRI) for agricultural, non-agricultural, and mixed households of the study area.

Thus, LRI measurement is expressed as:

$$LRI_b = f(AC_b, ABC_b, TC_b) \quad (2)$$

Where,  $LRI_b$  is the livelihood resilience index for b-type households;  $AC_b$  is the adaptive capacity for b-type households;  $ABC_b$  is the absorptive capacity for b-type households;  $TC_b$  is the transformative capacity for b-type households.

Adaptive capacity is the ability of a household to cope with the risks, stresses, and shocks of livelihood "Sarker et al. (2020)". Absorptive capacity is the ability of a household to absorb the harmful effects of shocks "Sarker et al. (2020)". Transformative capacity is the ability of a household to transform livelihood from the adverse effects of shocks "Sarker et al. (2020)". Considering the major three components, FAO's RIMA model is contextualized in this study. Therefore, households' livelihood resilience index can be expressed as:

$$LRI_i = f(IFA_i, NA_i, AC_i, SSN_i, S_i) \quad (3)$$

Where, LRI = livelihood resilience index; IFA = household's income and food access; NA = household's non-agricultural assets; AC = household's adaptive capacity; SSN = household's social safety nets availing facility; S = household's sensitivity. Household's adaptive capacity, non-agricultural assets, income and food access are the main elements of adaptive capacity "Sarker et al. (2020)". Sensitivity is one of the major components of absorptive capacity, which indicates the extent to which shocks affect a household's livelihood "FAO (2016)". The social safety net is taken as a part of transformative capacity "Sarker et al. (2020)".

Each major indicators are comprising some sub-indicators. The sub-indicators were selected and customized from different literature based on the research topic. Each of the sub-indicators contributes equally to the corresponding major indicator's index value. A score ranges from 0.00 to 1.00 was applied to the indicators. The highest score of 1.00 indicates the most resilient, and the lowest score of 0.00 indicates the least resilient.

At first, the index value of each sub-indicator was calculated using the following equation:

$$Index_{S_b} = \frac{\sum_{i=1}^n SS_{bi}}{n} \tag{4}$$

Where,  $S_b$  is one of the sub-indicators for b-type households;  $\sum_{i=1}^n SS_{bi}$  represents the total score of that sub-indicator, indexed by  $i$ , for b-type households. This can be obtained by adding all the b-type household's scores for that sub-indicator;  $n$  indicates the total number of b-type households.

After that, the index value of each major indicator was calculated using the following equation:

$$M_{bj} = \frac{\sum_{i=1}^n Index_{S_b}}{n} \tag{5}$$

Where,  $M_{bj}$  is the value of major indicator  $j$  for b-type households;  $\sum_{i=1}^n Index_{S_b}$  indicates the total score of all sub-indicators of major indicator  $j$ , indexed by  $i$  for b-type households. This can be obtained by adding scores of all the sub-indicators of major indicator  $j$  for b-type households;  $n$  represents the number of sub-indicators in major indicator  $j$ .

After calculating the index value of five major indicators, the values were directly used in Eq. (3) to obtain the livelihood resilience of b-type household:

$$LRI_b = \frac{w_{IFA}IFA_b + w_{NA}NA_b + w_{AC}AC_b + w_{SSN}SSN_b + w_S S_b}{w_{IFA} + w_{NA} + w_{AC} + w_{SSN} + w_S} \tag{6}$$

Where,  $LRI_b$  is the livelihood resilience index for b-type households which is equal to the weighted average of five major components.  $w_{IFA}, w_{NA}, w_{AC}, w_{SSN}, w_S$  indicates the weightage of household's income and food access, household's non-agricultural assets, household's adaptive capacity, household's social safety nets, household's sensitivity respectively. The number of sub-indicators that comprise each major indicator is the weight of that major indicator. Thus all sub-indicators have equal contribution to the total LRI "Weldegebriel & Amphune (2017); Hahn et al. (2009)".  $IFA_b, NA_b, AC_b, SSN_b, S_b$  is the index value of household's income and food access, household's non-agricultural assets, household's adaptive capacity, household's social safety nets, and household's sensitivity respectively. The interpretation of the calculated value of LRI is shown in table 1.

**Table 1: The Interpretation of Livelihood Resilience Index**

Index Score	Interpretation of Livelihood Resilience
0.81 - 1.00	Very high
0.61 - 0.80	High
0.41 - 0.60	Medium
0.21 - 0.40	Low
0.00 - 0.20	Very low

Source: "Rudiarto et al. (2019)".

## 5. Results and Discussion

### 5.1 Socio-Economic Profile

In this study, around 53% are nuclear families having less than five members. Majority households (53%) has semi-pucca house (brick/concrete-walled house with a tin roof), 34% has pucca houses (brick/concrete house), and 13% has kutcha houses (mud/bamboo walled house with tin or thatched roof). Only a few household heads are illiterate (7%) in the study area, and 39% are graduates. Illiterate household heads are relatively higher in agricultural households, whereas graduate household heads are comparatively higher in non-agricultural and mixed households. Farming, service, and business activity are the major occupation of the respondents. Most households (69%) are engaged in non-agricultural activities. About 22% of households are engaged in agricultural activity, whereas only 10% of households are engaged in both agricultural and non-agricultural activities. Most of the households' (47%) monthly income are within 20001 to 40000 BDT, 34% within 10001-20000 BDT, 3% up to 10000 BDT, and only 16% of households' income are above 40000 BDT.

### 5.2 Livelihood Resilience Index

LRI of agricultural (0.326), non-agricultural (0.287), and mixed households (0.373) are low (Table 2). The LRI value of mixed households is slightly higher, which infers that mixed households are more resilient than agricultural and non-agricultural households during the COVID-19 pandemic (Table 2). The low LRI value of the households indicates that the households are not capable to cope with the adverse impacts of the pandemic which disrupts their livelihood to a large extent. Household's adaptive capacity, income and food access, and social safety net are the major factors that help the households to be more resilient during the pandemic (Table 2).

**Table 2: The index value of major indicators comprising the livelihood resilience index**

Major indicators of livelihood resilience	Index value of each indicator		
	Agricultural Household	Non-agricultural Household	Mixed Household
Household's adaptive capacity	0.616	0.638	0.704
Income and food access	0.372	0.332	0.402
Social safety net	0.324	0.166	0.253
Non-agricultural asset	0.151	0.129	0.226
Sensitivity	0.030	0.084	0.241
Livelihood Resilience Index (LRI)	0.326	0.287	0.373

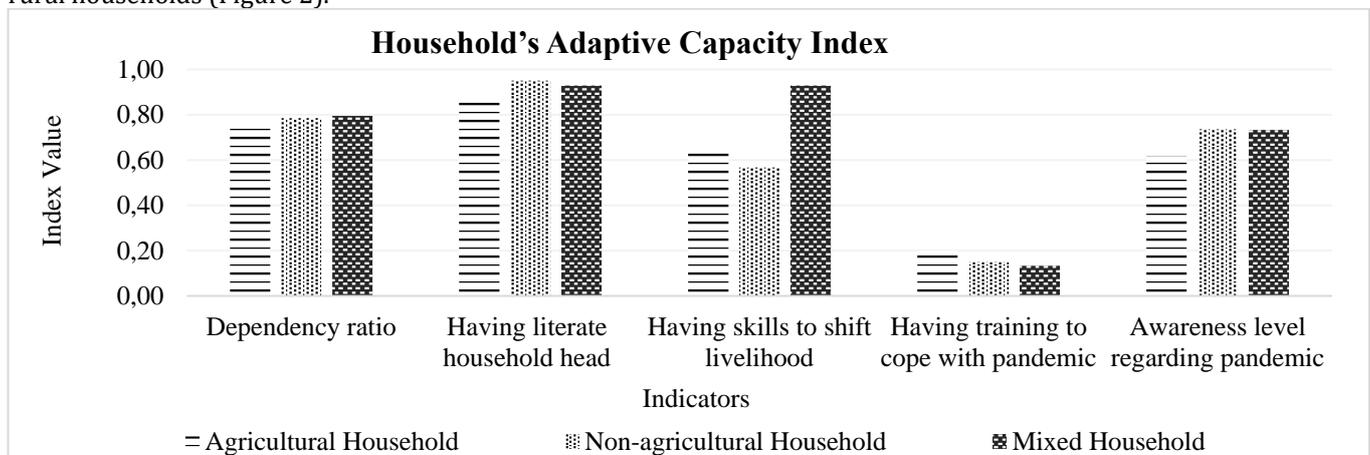
Source: Authors' own construction from telephone survey, 2020.

**5.3 Major Indicators of Livelihood Resilience**

The livelihood resilience index (LRI) is a function of adaptive, absorptive, and transformative capacity “Sarker et al. (2020); Rudiarto et al. (2019)”. The combination of these three capacities represents the resilience capacity of the households “TANGO International (2018); Vaughan (2018)”. All the households of the study area have low LRI scores. The study also finds some variation between the index values of major indicators, which indicates that the resilience capacity of rural households varies both at an overall level and in particular indicators.

**5.3.1. Household’s Adaptive Capacity**

The major components of household’s adaptive capacity are household’s dependency ratio, education level of household head, having skills to shift livelihood, having training to cope with pandemic and household’s awareness level regarding pandemic “Sarker et al. (2020); Alam et al. (2018); Weldegebriel & Amphune (2017); FAO (2016); Qasim et al. (2016); Hahn et al. (2009)”. Mixed households have a very high score (0.704) in household’s adaptive capacity than agricultural (0.616) and non-agricultural households (0.638), which is the major reason behind their higher resilience during the pandemic (Table 2). The index value for skills to shift livelihood is also very high for mixed households than the other two households (Figure 2). Thus mixed households have a high capacity to cope with the sudden livelihood shocks during the pandemic. The education level of the household head also contributes highly to enhance the resilience capacity of rural households (Figure 2).

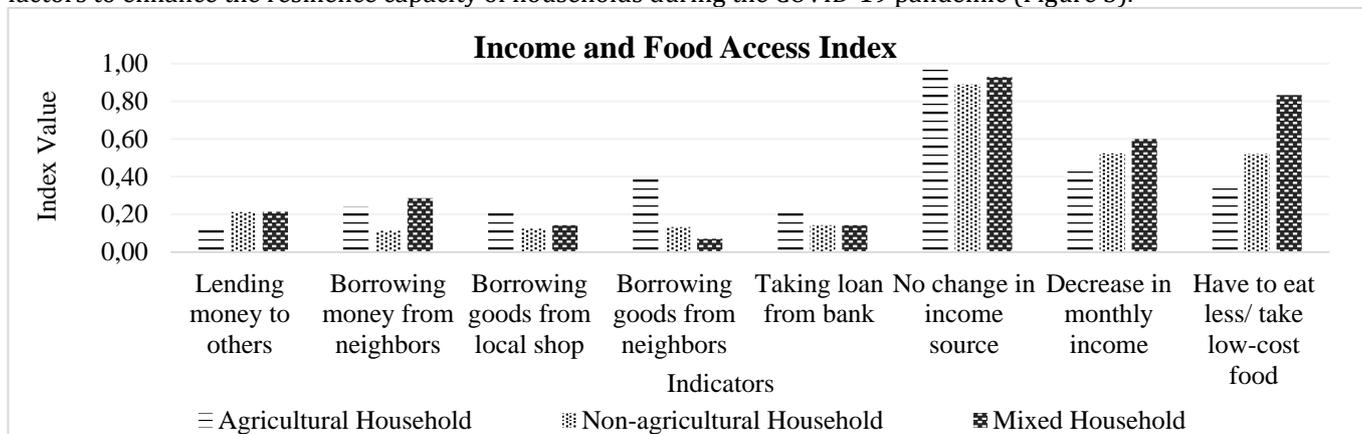


**Figure 2: Indicators of household’s adaptive capacity index**

Source: Authors’ own construction from telephone survey, 2020.

**5.3.2. Income and Food Access**

The components of income and food access include lending money to other people, borrowing money from neighbors, borrowing goods from local shops and neighbors, taking loans from the bank, no change in income source, decrease in monthly income, and having less food or low-cost food during pandemic “Sarker et al. (2020); Alam et al. (2018); FAO (2016)”. The overall index value for income and food access is much higher for mixed households (0.402) compare to agricultural (0.372) and non-agricultural households (0.332) (Table 2). The index value of “No change in income source” is comparatively higher than other factors, which indicates that a stable income source is one of the most significant factors to enhance the resilience capacity of households during the COVID-19 pandemic (Figure 3).



**Figure 3: Indicators of income and food access index**

Source: Authors’ own construction from telephone survey, 2020.

5.3.3. Social Safety Net

The major components of the social safety net include help or support from samiti or social welfare organizations, NGOs, government, cooperatives, and wealthy relatives or neighbors from the village “Sarker et al. (2020); Hahn et al. (2009)”. Several studies have found that the social safety net has a significant influence to increase the livelihood resilience of rural people during shocks “Awal et al. (2013); Davies et al. (2013)”. In this study, agricultural households have comparatively a high index value (0.324) for the social safety net, which indicates that these households receive the highest help and support from the community, government, and other organizations than the other two households (Figure 4). However, non-agricultural households have a very low index value (0.166) of the social safety net, which makes them less resilient during the COVID-19 pandemic (Table 2).

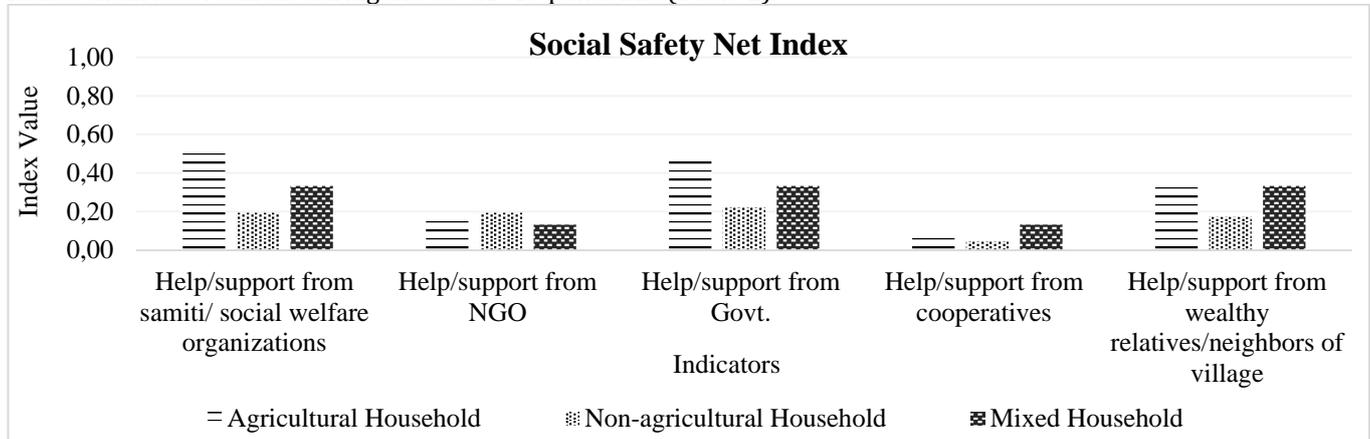


Figure 4: Indicators of social safety net index

Source: Authors’ own construction from telephone survey, 2020.

5.3.4. Non-agricultural Asset

Ownership of durable assets indicates resilience to COVID-19, as these items can be sold when necessary to cope with the adverse situation “Sarker et al. (2020)”. In this study, ownership of motorbike, van, bicycle, CNG, rickshaw, boat, sewing machine are considered as some major components of non-agricultural assets “Sarker et al. (2020); Alam et al. (2018); FAO (2016)”. The score of non-agricultural asset availability is very low for agricultural (0.151) and non-agricultural (0.129) households, which is comparatively higher for mixed households (0.226) (Table 2). Therefore, non-agricultural asset availability also makes mixed households more resilient than the other two households to some extent (Figure 5).

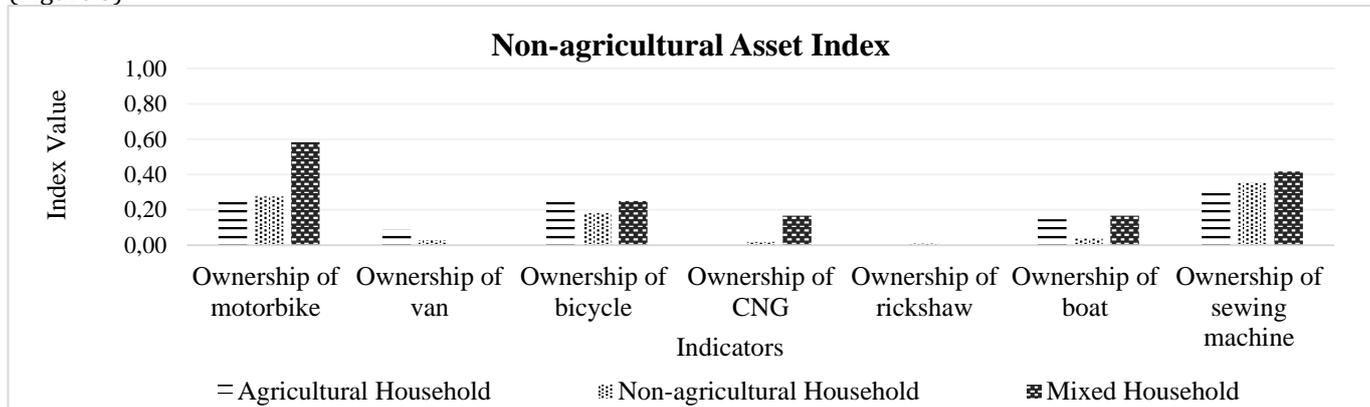


Figure 5: Indicators of non-agricultural asset index

Source: Authors’ own construction from telephone survey, 2020.

5.3.5. Sensitivity

The term sensitivity indicates the extent to which shocks affect a household’s livelihood (FAO, 2016). The components of sensitivity include being infected by COVID 19 pandemic and became unemployed due to losing jobs during the pandemic “Sarker et al. (2020); Alam et al. (2018); FAO (2016)”. Households’ sensitivity score is much higher for mixed households (0.241) compare to agricultural (0.030) and non-agricultural households (0.084) (Table 2). The study findings show that no respondent from agricultural households was infected by the COVID-19 pandemic, whereas mixed households were infected most by the COVID-19 pandemic in the study area (Figure 6). Again, the number of people who became unemployed during the pandemic was least in the agricultural households and most in the mixed households (Figure 6). Although the mixed household has a higher sensitivity score, in this study mixed household is most resilient (Table 2).

As mixed households have comparatively a high score in household’s adaptive capacity (0.704) and income and food access (0.402), they can cope with shocks (Table 2).

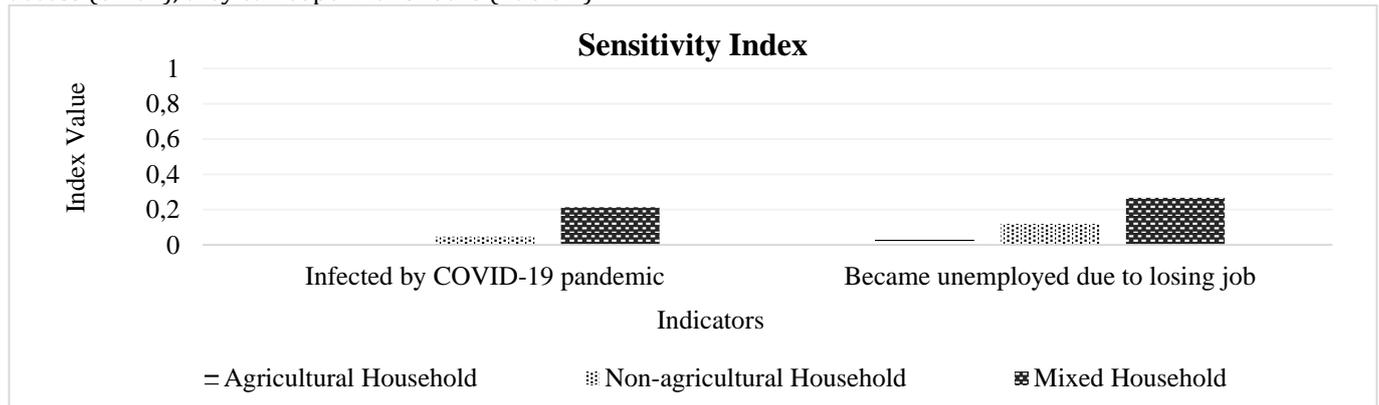


Figure 6: Indicators of sensitivity index

Source: Authors’ own construction from telephone survey, 2020.

### 5.3 Impact of COVID-19 on Employment Status

Major employment activities of these villages are farming, business, and service activities. In general, the COVID-19 pandemic has not affected employment status that much in rural areas. However, business activities have been affected the most compared to farming and service activities (Figure 7).

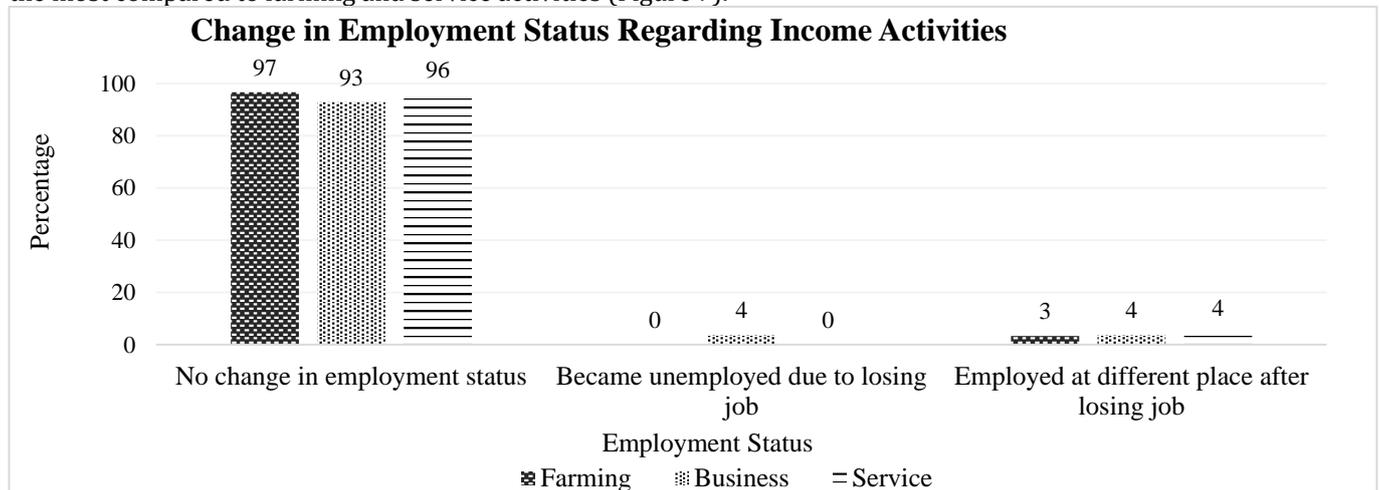


Figure 7: Impact of COVID-19 on employment status in rural area

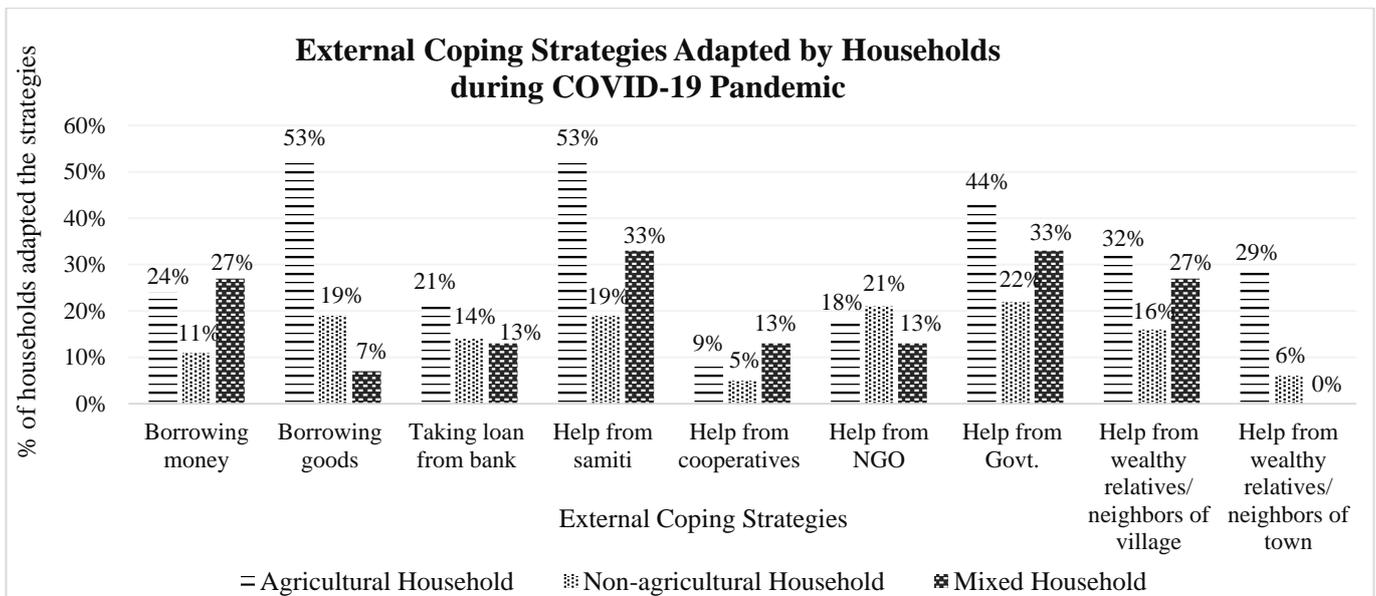
Source: Authors’ own construction from telephone survey, 2020.

### 5.5 Coping Strategies

Several studies found that household’s spending reduction, migration, savings, asset depletion, borrowing money from family/ community, taking loans from the bank, borrowing food items from shops/ community, taking help and support from government and NGO are some strategies that vulnerable people adapt in times of sudden shocks to minimize risks “Paumgarten et al. (2020); Endris et al. (2017); Farzana et al. (2017); FAO (2016); Sultana & Rayhan (2012)”. According to “Paumgarten et al. (2020)”, these strategies can be categorized as external and internal strategies. Households seeking help and assistance from family, community, government, and other non-government organizations (NGOs) are external coping strategies while household’s internal adjustments, such as household spending reduction, migration, savings, and asset depletion are internal coping strategies “Paumgarten et al. (2020)”.

#### 5.5.1. External Coping Strategies

The finding of this research shows that most of the agricultural households (31%) of the study area adapt external coping strategies during the pandemic, which indicates that agricultural households mostly rely on external help or assistance to cope with the adverse impacts of the COVID-19 pandemic. This finding is also consistent with the score of the major indicators of livelihood resilience. Agricultural households have a low score in household adaptive capacity and a high score in social safety net than the other two households (Table 2). For this reason, the percentage of agricultural households that depend on external support is also higher, which is comparatively lower for non-agricultural (15%) and mixed households (18%).



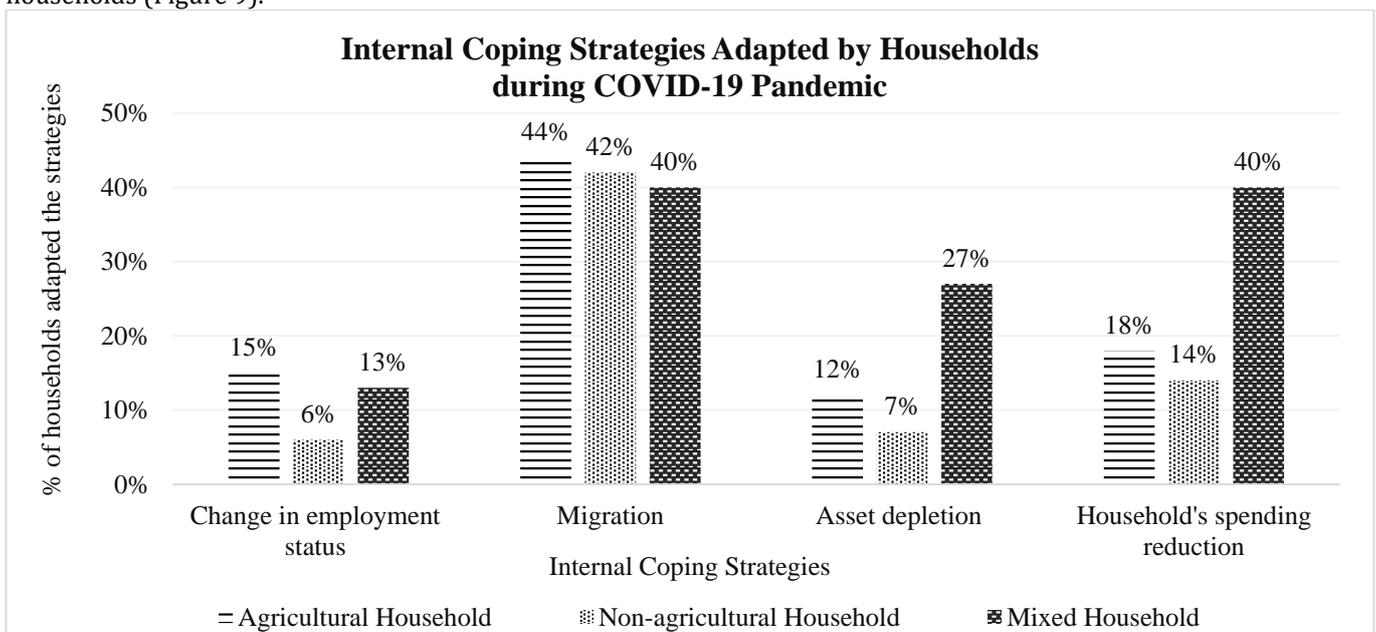
**Figure 8: Percentage of households of the study area adapt external coping strategies**

Source: Authors’ own construction from telephone survey, 2020.

The external strategies which are mostly adapted by the households of the study area are borrowing goods, taking help & support from samiti, government, and wealthy relatives/ neighbors of the village during the pandemic (Figure 8). Help from samiti and the government are found as top external coping strategies in all households of the study area (Figure 8). A notable percentage of agricultural (53%) and non-agricultural households (19%) borrow goods during the pandemic, whereas a small percentage of mixed households (7%) borrow goods during the pandemic (Figure 8).

**5.5.2. Internal Coping Strategies**

Most of the mixed households (30%) rely on internal adjustment during the COVID-19 pandemic. The percentage of households that adapt internal coping strategies is lower for agricultural (22%) and non-agricultural households (17%) than mixed households. Among the top internal coping strategies adapted by the households, migration and spending reduction are common for all types of households in the study area (Figure 9). All the migration was temporary except for one permanent migration. Asset depletion is the third important internal coping strategy for mixed and non-agricultural households, whereas the change in employment status is the third important coping strategy for agricultural households (Figure 9).



**Figure 9: Percentage of households of the study area adapt internal coping strategies**

Source: Authors’ own construction from telephone survey, 2020.

## 6. CONCLUSION

This study measured the livelihood resilience of different occupational rural households in Bangladesh and explored the factors affecting their resilience capacity during the COVID-19 pandemic by developing a composite indicator-based index. All these households of the study area have low LRI values, which indicates that the rural households are not resilient during the COVID-19 pandemic. Among the rural households whose members are engaged with both agricultural and non-agricultural activity are more resilient than agricultural and non-agricultural households. Mixed households have a high score in adaptive capacity, which makes them more resilient during the pandemic. The key factors that enhance the resilience capacity of rural households include having basic education, having skills to shift livelihood strategy, a stable income source, and access to financial help when needed. More improvement and interventions are needed in these sectors to make vulnerable rural households more resilient. At present, most agricultural households rely on external coping strategies, while non-agricultural and mixed households mostly adapt internal strategies to minimize livelihood risk during the COVID-19 pandemic. All the findings of the study will assist in better planning of resources and will guide resilience-building projects and programs in rural areas during any systemic shocks.

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## A STUDY OF PROMOTING MOBILE BROADBAND ADOPTION IN AFRICAN DEVELOPING COUNTRIES FOR ACHIEVING SDGS.

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### ABSTRACT

#### Objective

This paper makes a study for achieving SDGs in promoting mobile broadband (=3G+4G+5G) adoption, by employing the granger causality test in African Developing Countries.

#### Motivation

United Nations advocates the SDGs, which categorizes 17 Goals such as “No Poverty (Goal 1),” “Quality Education (Goal 4),” and “Partnerships (Goal 17)” by 2030 (United Nations, 2019). The 17 Goals are all interconnected and particularly “Partnership (Goals 17)” directly describes the importance of “information and communications technologies (ICTs).” United Nations also pointed out that The Internet is important for Goal 17 but “Almost half of the world’s population is not connected to the internet, particularly in poor countries” (United Nations, 2019). We must find out the ways to promote The Internet adoption especially for those countries.

The Internet consists of fixed broadband and mobile broadband, and this paper focuses on the latter.

#### Previous studies

Shinohara, Morikawa and Tsuji (2015) examined factors promoting mobile broadband adoption by OECD 34 countries data, and obtained the following factors: (i) the launch of Android and iPhone handsets; (ii) network externality; (iii) availability of trunk lines between mobile base stations; and (iv) competition of mobile carriers. Policy cannot directly handle (i) and (ii), and regarding (iii) policy does not either provide enough budget to build up trunk lines between mobile base stations. But policy can handle “(iv) competition of mobile carriers,” by allowing licenses to new entrants, for example, implying it is important to study the role of competition.

#### Methodologies and Expected Results

This paper estimates mobile broadband adoption in African countries and more than 200 countries. The dataset of this study contains the following characteristics: (i) quarterly data from 2000 to 2018; (ii) more than 200 countries; (iii) adoption ratios of mobile broadband; and (iv) market shares of mobile carriers.

This paper tests Granger causality between mobile broadband adoption and HHI. HHI is the reverse proxy of the competition of mobile broadband, calculated by the market shares of mobile carriers. The tentative result obtained is such that the null hypothesis “low HHI has no Granger causality for mobile broadband adoption ratio” is rejected (the number of countries: 219, the number of observations: 6705, F-Statistic: 5.428, Prob: 0.03%). In other words, this result indicates “low HHI promotes mobile broadband adoption.”

This paper will attempt to conduct the same estimation, focusing on developing countries in Africa.

The results of this paper suggest important theoretical basis of national broadband policy in each country for Achieving SDGs.

#### KEYWORDS

SDGs, Mobile Broadband, Diffusion of Innovation, HHI, Granger Causality Test

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## USE OF TECHNOLOGY IN THE RURAL HOUSEHOLDS OF BANGLADESH HAVING MIGRANT MEMBERS

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### ABSTRACT

A good number of rural households in Bangladesh have at least one migrant family member – either in the cities of Bangladesh or abroad. These migrants contribute to the technology diffusion in rural households. The remittance sent by these migrants increases the household income, thus increases the affordability of rural households to buy modern technological items. Based on the survey of 276 rural households of 8 sub-districts, this study finds that though the indirect impact of migration by sending remittance on technologies is quite significant, the direct flow of technology in the country is lagging behind. Almost 60-80% of the technological instruments are self-purchased rather than sent by migrant members. However, the presence of migrant members in a family has statistically significant impact on the family income. Thus, this study shows that the effect of migration is low on the technological advancement of rural households in Bangladesh.

### KEYWORDS

Migration, Technology, Rural

### 1. INTRODUCTION

Bangladesh is a developing country with almost 62.8% of the total of population belonging to rural area “Worldometers (2019)”. Given this large rural region, technological advancement in rural areas is very important for achieving overall development in Bangladesh. A popular speculation of technological advancement in origin countries is through migration “Global Economic Prospects (2006)”. This paper explores the effects of technological progression in Bangladesh by the migrant members of the rural households.

Migration is the movement of people either across international border (International migration) or within the state (Internal migration) for different purposes like employment, education, family reunification etc. “IOM (2019)”. Both international and internal migrants may contribute in transferring technology and related information back to their families living in rural areas as discussed in this paper “Global Economic Prospects (2006)”. Though technology is a vast term, this paper considers mainly money transfer technologies and information communication-based technologies like TV, mobile, internet and computer etc.

Migrants can directly send technology and technological information from developed destination countries or big cities to the rural areas. The remittance they send to their families in the rural areas can also increase the affordability of technologies “Global Economic Prospects (2006)”. This paper analyses the migration and technology related data collected from field survey from different rural areas of Bangladesh to understand the technological effect of migration on rural households. The overall the migration situation in the surveyed rural areas of Bangladesh has been explored, followed by whether the presence of migrant family members positively influences technological advancement, both directly by sending technology and indirectly by sending remittances to buy technology in the rural areas of Bangladesh. 276 respondents from 276 households in 24 villages of seven upazilas (sub districts) of Bangladesh were selected for structured questionnaire survey (Figure 1). Different variables such as socio-economic background, presence of migrant member, sources of different technological gadgets, use of money transfer technology etc. were tested for each respondent. six (07) Focus Group Discussions (FGDs) were also arranged in five upazilas, out of the seven upazilas (Annex Table 1).

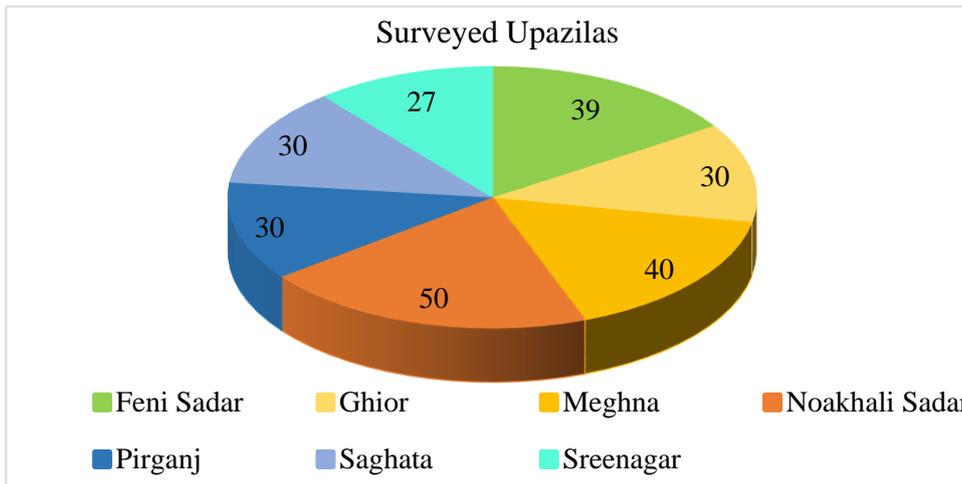


Figure 1: Number of respondents from each upazila

Source: Field Survey, 2018.

2. LITERATURE REVIEW

It is stated that migrants from technologically developed countries can transfer various technological goods and knowledge in developing countries “Ivus & Naghavi (2014)”. Diasporas are known to connect high technology countries with low ones promoting the local acceptance of new technologies “Valette (2016)”. One study indicated that a one percent increase in migration to the developed countries from developing countries quickens the growth rate of technology usage of the origin country by 0.3% “Lebesmuehlbacher (2015)”. When migrants return to their home countries, they bring technologies and knowledge about adaptation with them. Even if they do not return, they may send those stuff in other ways which contribute to the development of the origin countries “Linard (2006)”.

Other than the physical transfer of technologies, money sent back to home helps to buy new technologies or fund related projects. A study on Mexico found remittance sent by migrants had significant effect on flourishing the technology in agriculture sector “Quinn (2009)”.

Though comparatively well-off families can migrate abroad and the poorer are more engaged in domestic migration, both phenomena have positive impact on the adaptation of technology in rural households of Bangladesh “Mendola (2004).” As the rural to urban migrations cause local development of villages by remittance and knowledge flow, there are policies to promote such migrations in China to ensure equal development in all parts of the country “Ping & Shaohua (2005)”

3. MIGRATION SITUATION OF STUDIED RURAL AREAS

About 6.1% of total households of Bangladesh have migrant family members, among which about 81% are from rural area according to the Population and Household Census 2011 of Bangladesh “BBS (2015)”.

Figure 2 shows that there is considerable variation in number of migrants (to different destinations –upazila sadar/headquarter, zila sadar/district headquarter, big city, abroad from studied villages in each upazila.

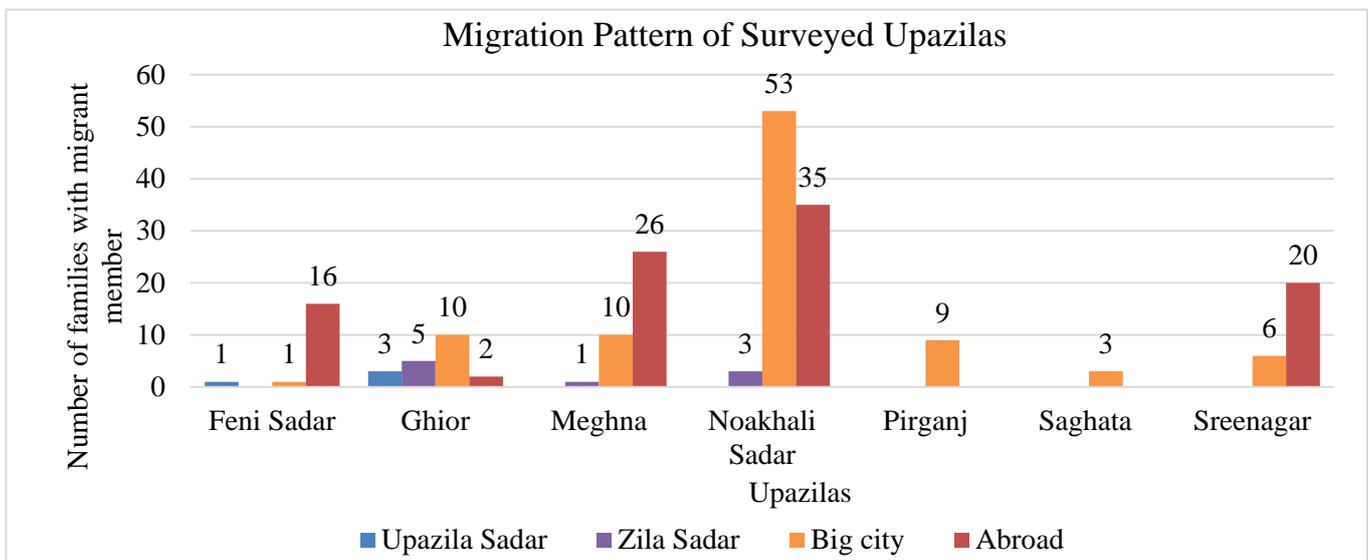


Figure 2: Destination and distribution of migrants from studied upazilas

Source: Field Survey, 2018.

Migration is extremely low from Pirganj and Shaghata area (Figure 2). From Focus Group Discussion (FGD) it is found that there is only seasonal migration to big cities like Dhaka from Pirganj. It has also been revealed that ever since the river erosion problems of Shaghata upazila have been resolved, migration has reduced drastically. From FGDs, it is found that almost every family in Meghna and Sreenagar have migrant members who choose to migrate abroad rather than completing their education (FGD number 1 and 6 in Annex Table 1).

According to the Population and Household Census 2011, Feni and Noakhali Sadar districts are supposed to have the highest migration rate “BBS (2015)”. Though this data matches for Noakhali Sadar (Figure 2), FGD in Noakhali revealed that migration rate has reduced significantly from before as people are now keener to complete proper education and settle in the country rather migrating abroad (FGD number 4 in Annex Table 1).

#### 4. IMPACT OF MIGRATION ON TECHNOLOGY DIFFUSION IN RURAL BANGLADESH

“Lebesmuehlbacher (2015)” suggests that the destination of migration is more important than the skill level of the migrants in technology diffusion. So, this study only focuses on the destination places of migrants.

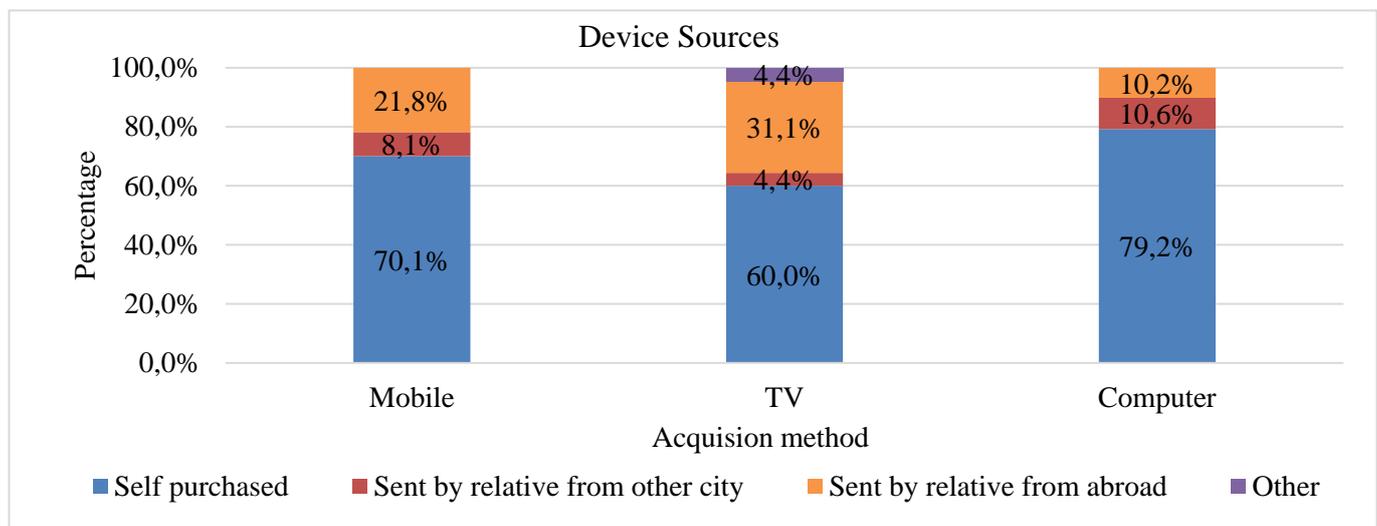
Studies “Docquier & Marfouk (2004)”, “Clemens & Pritchett (2016)” and “Gelb (2016)” show that migrants transfer technology and information mainly in 3 ways: (1) Directly by technological and knowledge transfers; (2) Investment and remittances contribute to the economic growth and transformation of migrants’ place of origin; and (3) Supporting entrepreneurship development in origin. This paper addresses the impact of first two ways and categorize them as direct impact and indirect impact.

##### 4.1 Direct Impact

Migrants can induce technology use directly by either sending them to villages or by communicating using technologies with families at home.

##### 4.1.1 Technology Inflow

The most basic way migrants contribute to the technology diffusion is by transferring technology to their home country directly. This is also reported in FGD 7 (Annex Table 1). During survey, it has been found that ICT gadgets and devices such as phone, computer, laptop and TV were sent by migrants to their families in the villages. Migrants from abroad seem to send more technologies than the migrants of big cities within the country. As phones, computers and laptops are smaller than TV, they are more often sent from abroad. However, figure 3 shows that most technological devices are self-purchased by the respondents.



**Figure 3: Percentage of different ICT from different sources**

Source: Field Survey, 2018.

As migration rate is highest in Noakhali, Feni and Sreenagar, transfer of phones from abroad is also high in these areas. Transfer of phones from big cities in the country is low except in Noakhali (Figure 4).

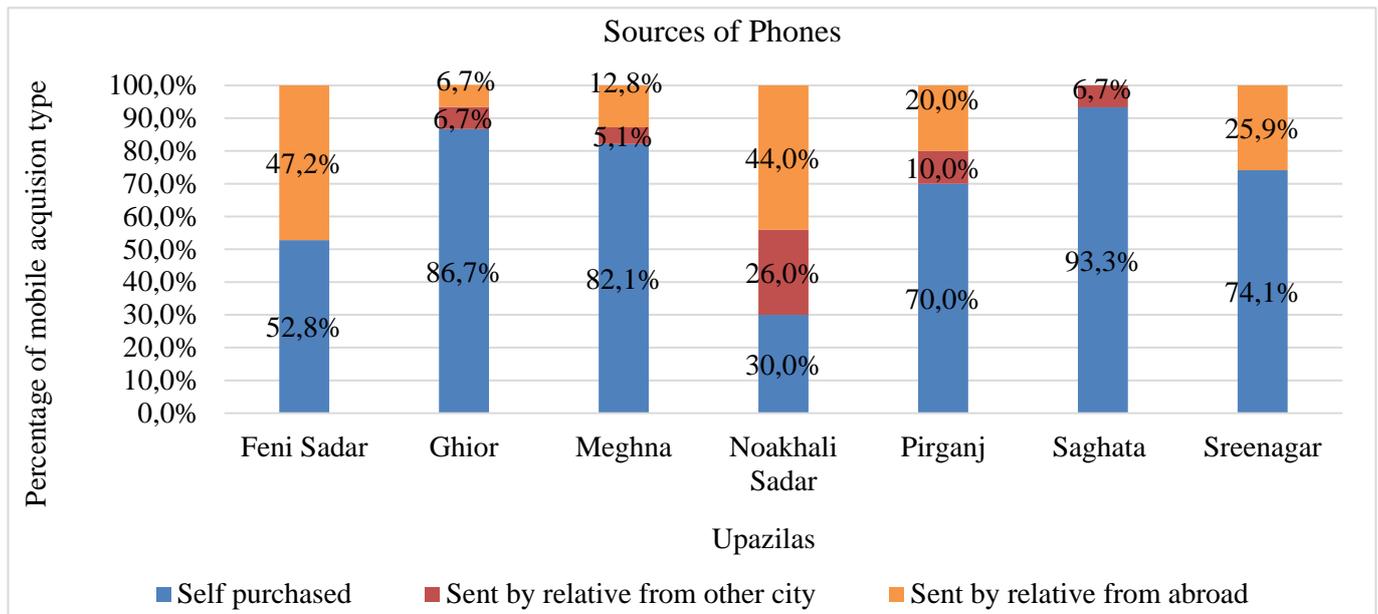


Figure 4: Percentage of sources of phones from different upazilas

Source: Field survey, 2018.

Computer is one of the least popular technologies used in the rural areas of Bangladesh. From figure 5 it is seen that among the very few computers in these areas, transfer from abroad is high in high migration areas like Noakhali, Sreenagar and Feni. Though migration is not high in Ghior, relatives in abroad are the major source of computers there. Some computers are sent from cities to Pirganj as internal migration is dominating there. A good portion of computers are transferred from cities to Meghna too as it is located quite close to Dhaka.

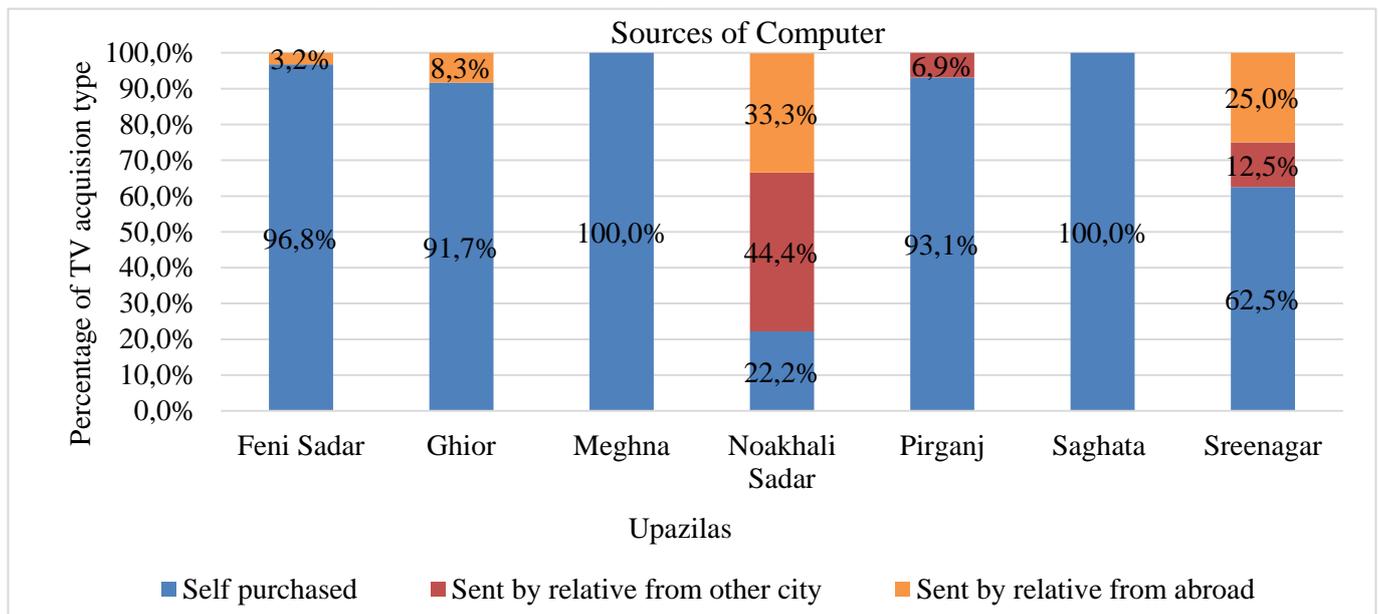


Figure 5: Percentage of sources of computers from different upazilas

Source: Field survey, 2018.

Overall transfer of TV from abroad is lower than other technologies except in Noakhali and Sreenagar. There is also some transfer of TV from big cities of the country to Noakhali as internal migration is also quite significant there (Figure 6). However, there is no inflow of televisions in Saghata as the rate of migration is extremely low there.

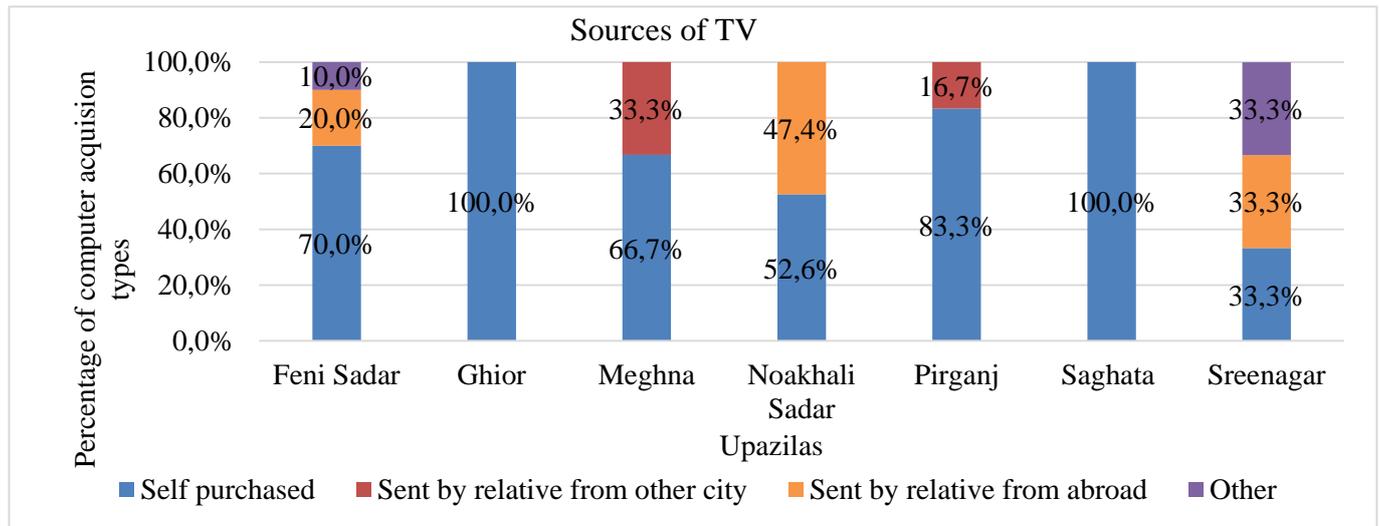


Figure 6: Percentage of sources of TV from different upazilas

Source: Field survey, 2018.

4.1.2 Technologies for Communication

In high migration areas, different technologies like mobile phone, computers and internet can be used to communicate with the migrant family members. During FGD (FGD number 6 in Annex, Table 1) in Munshiganj it has been found that the migrants of different countries communicate with their families living here using internet, especially the app "Imo". Besides people also communicate with family members living in abroad, via apps like Skype, if better internet connection is available via mobile phone. Lots of rural respondents informed that communication is one of the key reasons for using phones, computers and internet. This way, technology is bringing the migrants closer to their home and families.

4.2 Indirect Impact

Bangladesh is one of the top 10 remittance receiving countries in the world. In 2013, share of remittance was 9.24% in the total GDP of Bangladesh "BBS (2015)." Remittance and investments sent by migrants can affect technology diffusion in two ways- by increasing income and thus increasing the affordability of families to buy technologies or by using money transfer technologies.

4.2.1 Impact on Income

A significant relation between income and presence of migrant family member is seen in Chi-square test. Here Pearson chi-square= 40.896 (df=4) and p= 0.000. As the creamers V value is 0.387(>3), the impact is quite strong.

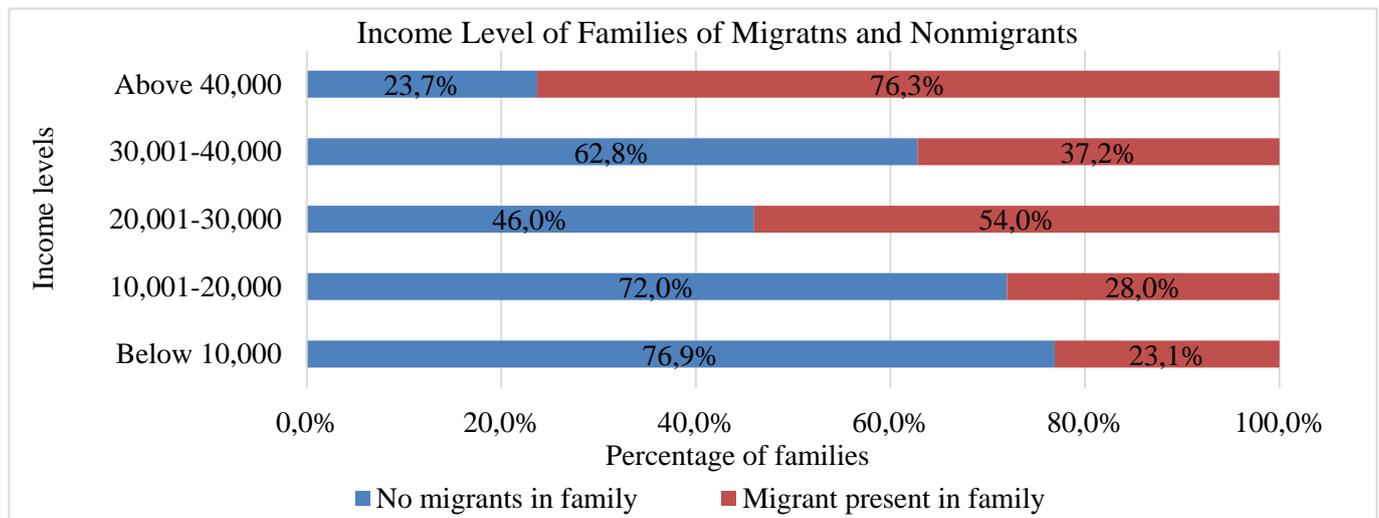


Figure 7: Impact of migrant family member on household income

Source: Filed Survey, 2018.

Figure 7 indicates that relation is quite positive as the presence of migrants increases in the higher income families. So, it can be assumed that migrants of these families send remittance which increase the household income. Another Chi-square test shows a significant relation between income and the number of migrants present in a family. Here the Pearson chi-square= 89.480 (df=20) and p= 0.000. As the creamers value is 0.287(2<0.287<3), the impact is moderate.

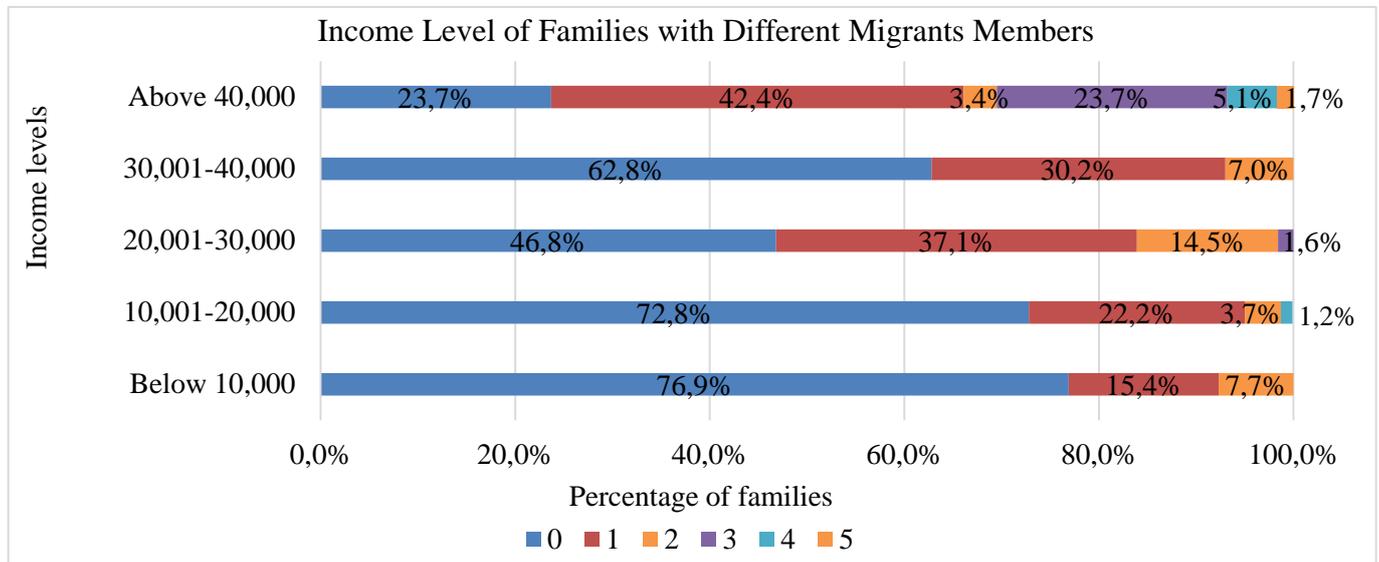


Figure 8: Effect of number of migrant members on family income

Source: Filed Survey, 2018.

Figure 8 shows that families with multiple migrant members generally belong to higher income groups indicating that the higher migrant numbers in a family may yield higher the amount of remittance and income. FGD in Sreenagar revealed that, new technologies are mostly used by the solvent people (about 80% of total users) of the area. Higher income increases the possibility of buying different technologies to upgrade the living standards of households.

4.2.2 Technologies Used in Money Transfer

For receiving foreign remittance, banks are the main channel. However, different local money transfer technologies are being used by the internal migrants as they are cheaper, quick and user friendly. A money transfer app named Bkash is more popular in every upazila (Figure 9).

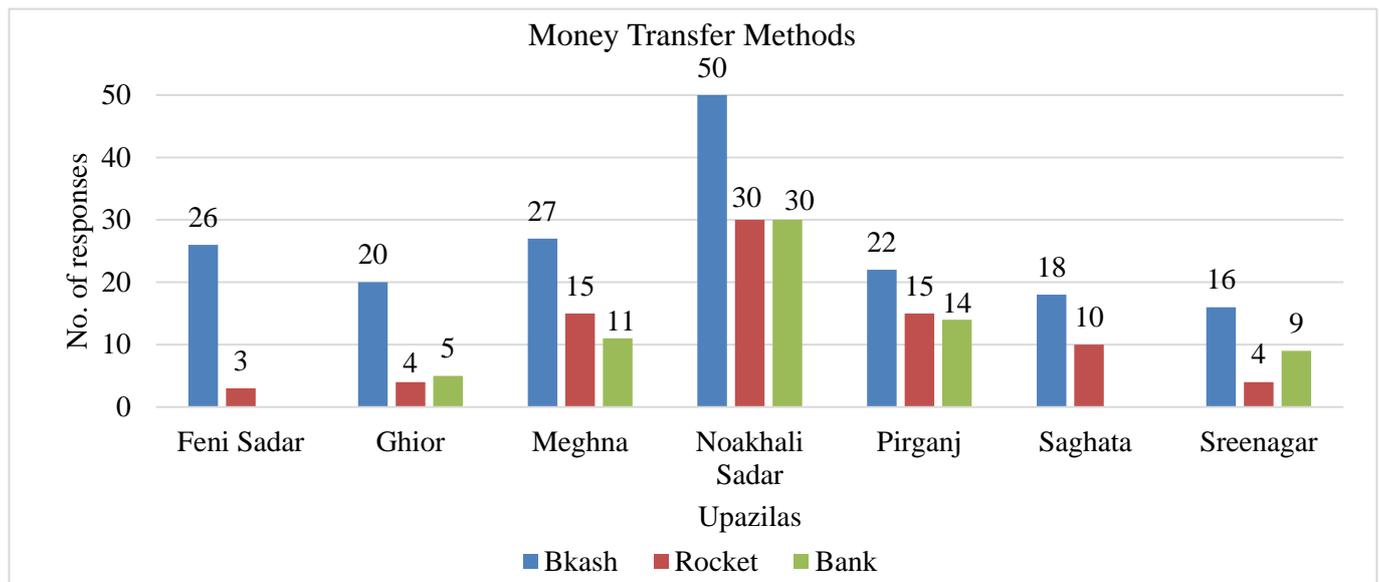


Figure 9: Use of money transfer technologies in different upazilas

Source: Filed Survey, 2018.

## 5. CONCLUSION

Though different studies show high impact of migration on technology diffusion, this study concludes that effect is not so big in Bangladesh. Specially in the case of technology transfer, only some of the high migration areas have some inflow. Indirect impact of remittance and investment on technologies and communication technologies are more dominant than the direct technology flow in the country. As the migration rate is quite high in different rural areas of this country, there is ample potential to use that to enhance the technology use in rural areas. Different policies can be taken to encourage technology inflow in the country.

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ANNEX

Table 1: Information from Focus Group Discussions (FGDs) of the study

FGD No.	Upazila	Place	No. of participants	Age & gender of participants	Occupation of participants	Relevant information
1	Meghna	Local tea stall, Chandanpur	Six	Two elderly (70+ years) and four middle aged (34-45 years). All male	One was the owner of the tea stall and rest were local farmers	<ul style="list-style-type: none"> <li>• High international migration rate</li> <li>• Most male members migrate abroad passing secondary school</li> <li>• Migrants send high remittance.</li> <li>• Every house has TV, Fridges and phones, mostly bought from remittance money.</li> </ul>
2	Shaghata, Gaibandha	Local tea stall, Bharatkhalai bazar	Six	25- 90 years, All male	Worker at rice mill, a businessman, a teacher, a van driver and two unemployed	<ul style="list-style-type: none"> <li>• High internal migration rate due to severe river erosion problem in the past</li> <li>• Migrated for better living conditions and job</li> <li>• Drastically reduced migration rate for past few years due to reduced river erosion problem.</li> </ul>
3	Pirganj, Rangpur	House of the village head, Panial village	Six	Five male (25-60 years), one female (38 years)	One ward member, two farmers, a lecturer, a housewife and the village head	<ul style="list-style-type: none"> <li>• No international migration</li> <li>• All seasonal migrants to Dhaka city</li> <li>• Many male villagers stay at home only during cultivation season and migrate to Dhaka for rest of the year to work at garments</li> </ul>
4	Feni	Shorishadi Bazar	Four	30-60 years, three male, one female	Two assistant teachers at Shorishadi High School and two business men	<ul style="list-style-type: none"> <li>• Very high international migration rate in the past, when people favored working abroad over completing school</li> <li>• Recent decrease in migration as villagers are keener to complete their education and settle in the country</li> <li>• Yet, most of the well-off families in the village have at least one earning member working abroad</li> </ul>
5	Sreenagar, Munshiganj	Crockery shop, Birata Village	Four	(26-50 years), all male	Two shopkeepers and two local businessmen	<ul style="list-style-type: none"> <li>• Reduced migration rate due to several incidents of human trafficking</li> <li>• People are more careful and only migrate abroad through reliable sources</li> <li>• Low rates of internal migration</li> </ul>
6	Sreenagar, Munshiganj	Tea stall, Hashara Village	Eight	25-65+ years, all male	Two van driver, three local businessmen, one fish-selling businessman and one unemployed elderly person	<ul style="list-style-type: none"> <li>• International migrant member in almost every family of the village</li> <li>• Usual destination are Singapore and UAE</li> <li>• Preference of migrating before completing education is the cause of low literacy rate</li> <li>• People having family members living in abroad easily communicate via apps like Skype, Imo due to availability of internet</li> </ul>
7	Sreenagar, Munshiganj	Tea stall, Hashara Village	Seven	Two were 60+ years, four were 30-50 years and one was 20, all male	Tea stall owner, one van driver, two businessmen, one carpenter and two farmers	<ul style="list-style-type: none"> <li>• High international migration rate, though less than before</li> <li>• Migrants send both technologies and high amount of remittance</li> <li>• Many of the household technologies are sent from abroad to families having migrant members</li> </ul>

Source: Field survey, 2018.

## **Regular Session: RS19.1 - Green economy and complexity of socio-ecosystems**

**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/83755733224>**

## COMMUNITY GARDENS AND URBAN RESIDENTS' QUALITY OF LIFE (QOL): A CASE STUDY FROM SHANGHAI, CHINA

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### ABSTRACT

In general, a high productivity due to the effect of agglomeration and economic growth has been realized along with urbanization in China. However, the accelerated urbanization has brought about environmental problems due to human activities, such as the reduction of green spaces, air and water pollution, noise and waste disposal problems in the country. Moreover, as urbanization progresses, the resources of available land in megacities are becoming more and more scarce, the lifestyles of residents have been influenced by a less communication among each other and the problems of community dilution are emerging (Zhang, 2017). On the other hand, in China, the middle class has been expanding in recent years, and they are increasingly concerned about the quality of life (World Bank & PRC, 2013). Therefore, to provide its local residents with a "better city, better life" (SHANGHAI MASTER PLAN, 2017-2035) has become an urgent challenge for urban planning.

On the other hand, existing studies have shown that urban residents' participation in community gardens can improve public health in cities (Armstrong, 2010). It is also pointed out that there is a positive correlation between the social capital of local residents and their interactions in community gardens (Alaimo et al. 2010). Furthermore, a study on community gardens and social sustainability showed that trust and stewardship contributed significantly to social sustainability through community gardens (Rogge et al. 2018).

Therefore, the purpose of this study is to explore the role of community gardens in improving the quality of life (QOL) of urban residents through multi-functionality of community gardens in Shanghai, China. We conduct a web-based questionnaire survey on Shanghai residents (including users and non-users of community gardens) and introduce structural equation modeling to clarify the following hypotheses: "The multi-functionality of community gardens can enhance the utility and life satisfaction of urban residents (H1)", "People with higher levels of social capital also have higher levels of community gardens participation and evaluation (H1-1)", and "People with higher community gardens participation and evaluation are more satisfied with local life (H1-2). Based on the analytical results, it concluded that a development strategy for urban agriculture is required in line with the vision of sustainable development of the city that meets the diverse needs of the residents.

### KEYWORDS

Quality of life (QOL), Community gardens, urban agriculture, Multi-functionality, Life satisfaction

### 1. INTRODUCTION

After reforming and opening up for the decades, the economy in China has grown rapidly and its level of urbanization has also highly progressed. According to a survey by the National Bureau of Statistics, China, in 2016, China's urbanization rate has already reached 57.35%, with a urban resident population of 792.98 million. And by 2030, the urbanization rate is expected to reach 70% (World Bank and PRC 2014).

In general, a high productivity due to the effect of agglomeration and economic growth has been realized along with urbanization in China. However, the accelerated urbanization has brought about environmental problems due to human activities, such as the reduction of green spaces, air and water pollution, noise and waste disposal problems in the country. Moreover, as urbanization progresses, the resources of available land in megacities are becoming more and more scarce, the lifestyles of residents have been influenced by a less communication among each other and the problems of community dilution are emerging (Zhang, 2017). On the other hand, in China, the middle class has been expanding in recent years, and they are increasingly concerned about the quality of life (World Bank & PRC, 2013). Therefore, to provide its local residents with a "better city, better life" (SHANGHAI MASTER PLAN, 2017-2035) has become an urgent challenge for urban planning.

On the other hand, existing studies have shown that urban residents' participation in community gardens (CGs) can improve public health in cities (Armstrong, 2010). It is also pointed out that there is a positive correlation between the social capital of local residents and their interactions in CGs (Katherine et al. 2010). Furthermore, a study on CGs and social sustainability showed that trust and stewardship contributed significantly to social sustainability through CGs (Rogge et al. 2018). On the other hand, according to a study that evaluated the external economic effects of parks, playgrounds, etc. and woodlands using a land value function, it is known that parks with green spaces have a positive external effect on land value (Kobayashi et al. 2009). Therefore, it is also supposed that CGs have a positive external effect on land value.

Therefore, the purpose of this study is to clarify the role that CGs in meeting the needs of urban residents for “better city, better life” in Shanghai, China, one of the largest cities of the country and the earliest beginning of community garden projects.

## 2. LITERATURE REVIEW

### 2.1. Urban residents' Quality of life (QOL) and the Role of Urban Agriculture

#### 2.1.1 Urban residents' Quality of life (QOL)

In recent years, the seriousness of the problems caused by the traditional approach to urban development has been recognized, and the need has arisen to seek sustainable development that can reconcile the natural environment with social development. The concept of “development that meets the needs of the present without compromising the ability of future generations to meet their own needs” (“Our Common Future”) was proposed in 1987. And in 2015, the United Nations published the internationally agreed 17 Sustainable Development Goals (SDGs), in which the sustainable developments of cities and communities (Make cities and human settlements inclusive, safe, resilient, and sustainable) are included.

In addition, sustainable urbanization in China is defined as providing people with the required quality of urban life, while making it compatible with the environment (land, air and water) and natural resources (World Bank & PRC, 2014). It is characterized by a greater focus on the quality of life of urban residents or urban amenities. And the quality of life of urban residents is a composite indicator about people’s mental and physical health (Marans 2015). On the other hand, the development of urban green infrastructure in cities to re-establish the relationship between nature and the built environment (Building Green Cities) helps to create attractive urban landscapes and a better quality of life (Breuste 2020). By providing blue and green infrastructure in the city, cultural ecosystem services can also be provided to the city, creating a multidimensional connection between people and their living environment (Andersson et al., 2015). In addition, some researchers have pointed out that urban agriculture can contribute to improving the quality of urban life by performing multi-functionality and providing local public goods (Kiminami & Kiminami, 2007).

#### 2.1.2 Urban Agriculture and its role

Urban agriculture is an important part of sustainable urban development (Zeeuw & Dubbeling 2011). The growing of plants and the raising of animals within and around cities. According to the Food and Agriculture Organization of the United Nations (FAO), urban and peri-urban agriculture (UPA) is defined as the growing of plants and the raising of animals within and around cities. And according to the Ministry of Agriculture and Rural Affairs of the China (2012), urban agriculture is modern agriculture that has developed along with urban modernization in, near and within large cities. These are the most straightforward definitions of urban agriculture geographically, limiting it to cities and their surroundings, while China’s definition of urban agriculture, in its own context, emphasizes the modernization of agriculture. However, these definitions of urban agriculture do not explicitly refer to the multi-functionality of urban agriculture.

On the other hand, regarding the multi-functionality of agriculture, the WTO (glossary) defines agriculture has many functions in addition to producing food and fiber, e.g. environmental protection, landscape preservation, rural employment, food security, etc. It has also been pointed out that urban agriculture, in addition to its obvious locational characteristics (in and around cities), has a variety of functions such as providing environmental services and social services in addition to food production, and supports the local economy through direct access to urban markets (Sanyé-Mengual 2015). Kiminami et al. (2018) mention that urban agriculture has multi-functionality such as promoting communication, welfare, education, recycling, environmental protection, forming beauty, disaster prevention, and experiencing agriculture, in addition to its production function. The multi-functionality of urban agriculture can therefore be divided into three categories: environmental, social and economic functions.

Firstly, in terms of environmental protection functions, according to Artmann & Sartison (2018), urban agriculture has the function of providing ecosystem services and the function of conserving biodiversity. And civic farms in cities can have the same importance as parks by providing ecosystem services, among other roles, (Breuste & Artmann, 2014). In addition, it has been argued that urban agriculture can contribute to low carbon cities and sustainable urban development by reducing greenhouse gases through lower food miles (mainly vegetables) (Lee et al., 2015).

In terms of social functions, urban agriculture can make use of various areas in the city, such as open spaces, residential areas and rooftops, to farm and supply the city with fresh produce produced (Saha & Eckelman, 2017). Urban agriculture has also been found to improve dietary diversity by providing calories (Zezza & Tasciotti, 2010). In addition, urban agriculture can re-establish the relationship between those involved and nature, increase awareness of environmental protection and satisfy participants’ own need to belong (Chan et al. 2016), and it also plays a more important role for socially disadvantaged groups such as the unemployed and the poor (Cabannes & Raposo 2013).

Regarding the economic functions of urban agriculture, Kiminami & Kiminami (2007) use Tokyo as a case study to point out that urban agriculture also has high economic functions through the production of high quality, high value agricultural products. On the other hand, they argue that the multi-functionality of urban agriculture can attract the creative class, which is a source of urban creativity, and that these people can contribute to the sustainable development of cities by actively participating in social business that address urban social problems (Kiminami et al. 2019). On the other hand, urban horticulture has many other uses besides food production and there are some differences between

urban horticulture and urban agriculture (Appendix 1), but urban horticulture and urban agriculture cannot be separated, especially at the small-scale production level (Breuste 2020).

## 2.2. Urban Agriculture and Community Gardens

### 2.2.1 Definition of Community and Community Gardens

CGs can be found in many parts of the world, but it is not easy to find a strict definition for them, and According to Guittart et al. (2012), around 63% or more of the papers on CGs do not define them strictly. The reason for this is that it is difficult to identify a fitting and uniform community garden based on different national or regional circumstances. In the United States, for example, attention has been paid to the ability of CGs to meet the diverse needs of the people who use them (McKelvey 2015), and to the social function of CGs in providing needed support to vulnerable groups, especially young people among them (e.g. drug users) (Ferris et al. 2002). On the other hand, China also emphasizes the multi-functionality of CGs, particularly the function of facilitating communication between residents, but the functions and roles of CGs differ between China and America due to the differences in their national circumstances.

In addition, the definition of community is closely related to society and culture, which means that CGs have different meanings in different countries and regions, which makes it difficult to define them. In general, a community is socially constructed through collaboration for a common purpose (Firth et al., 2011). In contrast, traditional Chinese communities (Shequ or Xiaoqu) are places where residents live (blocks are similar to Chinese streets or sub-district), with a greater focus on local and neighborhood relationships. However, since the reforming and opening up, communities have become fragmented (fragmentation of the socio-spatial structure, fragmentation of the profit structure, fragmentation of the power structure) with the transformation of traditional institutions (Li & Ge 2013). Therefore, nurturing communities through grassroots social organizations (Residents committee, Owners committees, Property management committee) can help build a harmonious society and develop civil society (Qiu, 2018).

In the case of China, CGs are gardening areas within residential areas that are operated collaboratively by residents and provide a place and opportunity for local residents to interact (Liu & Wei, 2018). Therefore, when discussing CGs in China, it is necessary to take into account the characteristics that each area has. Therefore in this study, CGs can be defined as a horticultural area closely related to urban agriculture that fulfils multi-functionality, including environmental, social and economic functions, through the active participation and management of the local residents, and can meet the diverse needs of them.

### 2.2.2 Multi-functionality of Community Gardens

CGs can be divided into three categories: environmental and ecological functions, social functions and economic functions. A case study conducted by Clarke & Jenerette (2015) in America found that CGs contribute to urban ecosystems and biodiversity and also provide valuable ecosystem services to communities with food security issues. Whereas allotment gardens and CGs, while providing important ecosystem services to urban communities, such as local climate and water regulation and habitat for diverse organisms, their contribution depends largely on the intensity of management and to some extent on their location in the city, and it has also been noted that CGs, in contrast to allotment gardens, are characterized by the cultivation of native plant species (Cabral et al., 2017). In addition, the trend in urban redevelopment policy is to increasingly include community participatory green space planning (Ferris et al., 2002). On the other hand, CGs provide environmental or ecological benefits as well as social functions. For example, CGs have been found to help promote public health and civic pride in cities (Armstrong 2000, Twiss et al. 2003). In addition, the trust among community residents is largely due to the high level of interaction and close relationships, and the cultural activities of community residents enhance the sense of community and indirectly contribute to the autonomy of the community (Qiu 2018). In addition, increasing the interaction and closeness of local residents to nature through the construction and management of CGs can promote neighbourhood harmony, community cohesion and the psychological well-being of residents, as well as increase residents' enthusiasm for public affairs and enhance their sense of community (Kou et al. 2019). These studies suggest that when local residents use CGs for communication, and cooperation, trust is deepened through the formation of networks among residents, which may enhance social capital (e.g. Firth et al., 2011; Alaimo et al., 2010). On the other hand, Glover et al. (2005) show that residents' activities in CGs promote citizenship and play a role in the democratic governance of the city.

And many researchers in Europe and America have pointed out that the construction of CGs contributes to food security in cities (e.g. Ferris et al., 2002). Specifically, CGs can provide cities with fresh or organic produce. However, the role of CGs in promoting food security and food safety is currently not much talked about in China. Therefore, the food security function of CGs may become one of the future research topics in China.

## 2.3 History of the building of Community Gardens in China (Shanghai)

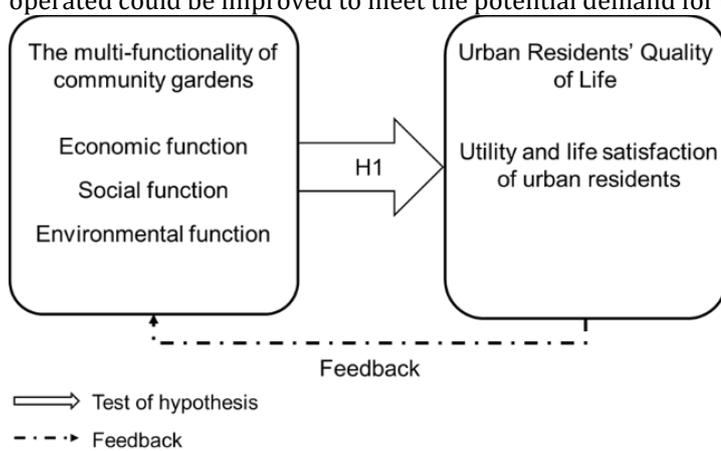
In developed countries or regions such as Europe, America and Japan, CGs have a relatively long history of development and construction (Liu & Wei, 2018). On the other hand, in China, CGs are still in their infancy and are being built on an experimental work in megacities such as Beijing and Shanghai. In 2008, the concept of CSA was first introduced, with Renmin University of China and the Haidian District Government as the main builders, to build the "XiaoMaoLú" civic farm in Haidian District, Beijing (Fan 2013).

Previously, urban agriculture in Shanghai gradually moved from the city center to the suburbs due to urban development plans (Kiminami et al., 2006). On the other hand, with the development of the city, in 2015 the Shanghai government

launched “Shanghai Urban Renewal Implementation Measures”, which introduced the concepts of “organic urban renewal” and “people first reconfiguration of space and activation of communities”. In addition, the Shanghai Greening Bureau advocates “residents’ greening autonomy”. In this context, between 2014 and early 2018, four green autonomous patterns had been formed in Shanghai, with more than 340 CGs of different sizes built (Shanghai Manual 2018). participation by urban residents (Liu 2020). On the other hand, despite they have temporality and short-term issues, current CGs provide a better living environment for local residents by overcoming urban social problems and providing nature education sites for children through cooperation between stakeholders, among other functions (Yin 2017). Furthermore, the World Bank and PRC (2014) report that as China’s urbanization grows, urban density is increasing, making urban land and space resources increasingly valuable. Therefore, there will be scope for further development of community gardens that can make effective use of urban micro land and space. However, there is a lack of research that discusses the role of CGs as a form of urban agriculture in terms of understanding the relationship between the quality of life of urban residents, as well as sustainable urban development.

**3. ANALYSIS FRAMEWORK AND HYPOTHESES**

Based on the above survey of existing studies, Figure 1 shows the analytical framework of this study. In other words, we argue that urban residents’ utility is enhanced and their quality of life is also improved through participation in CGs. We also believe that the multi-functionality of community gardens would be further enhanced if the way in which they are operated could be improved to meet the potential demand for community gardens (feedback).



**Figure 1: Analytical framework**

Therefore, in order to achieve the objectives of this study, the following hypotheses have been formulated.

*Hypothesis 1:* The multi-functionality of CGs can enhance the utility and life satisfaction of urban residents.

*1-1:* People with higher levels of social capital also have higher levels of CGs participation and evaluation.

*1-2:* People with higher CGs participation and evaluation are more satisfied with their local life.

**4. ANALYSIS METHODS**

Structural equation modeling (SEM) is a statistical analysis method that reveals the relationships between elements with complex structures. To clarify hypothesis 1, this study will conduct a web-based questionnaire survey of Shanghai residents (including users of CGs). In addition, the results of the web-based questionnaire will be used to introduce SEM analysis to clarify urban residents’ participation in CGs and their evaluation of social capital.

Figure 2 shows the conceptual model for the structural equation modeling in this study. A study by Zhang et al. (2017) explored the importance of social relationship capital in building online communities. For this reason, it is assumed that the social relationship capital of local residents positively influences their participation in the construction and operation of the CGs (H1-1). Furthermore, it can be assumed that through participation in the CGs, can meet the diverse needs of local residents and their satisfaction with local life will increase (H1-2).

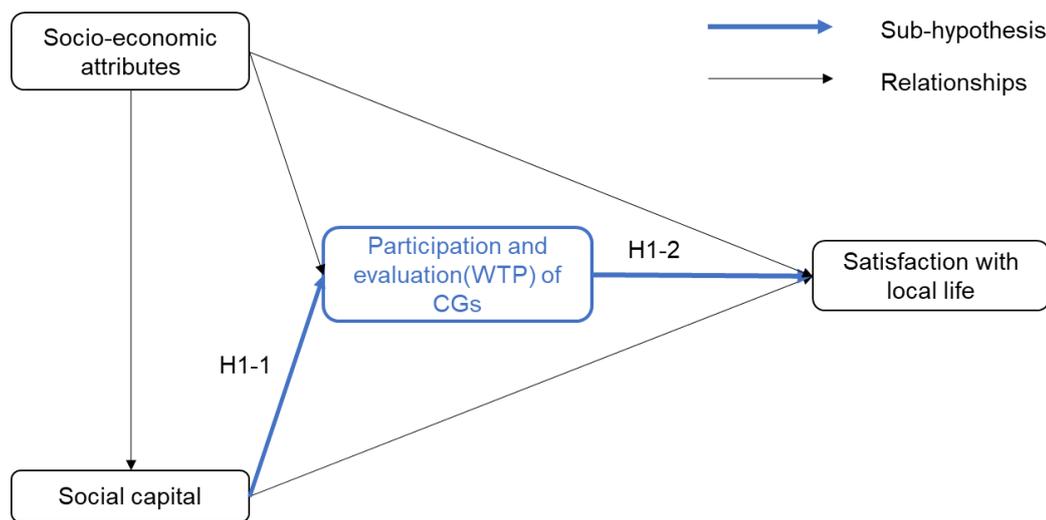


Figure 2: Conceptual model of SEM

## 5. ANALYSIS RESULTS

### 5.1. An overview of Shanghai and the reality of CGs operation

Located at the mouth of the Yangtze River in eastern China and facing the Pacific Ocean, Shanghai covers an area of 6,340.5 km<sup>2</sup> and consists of 16 districts with a resident population of 24.18 million at the end of 2017. In addition, the regional GDP reached RMB 306,329 million in 2017, with a per capita regional GDP of 18,450 Dollars.

In order to preserve Shanghai’s urban environment, create a beautiful landscape and build a harmonious society, the Shanghai government is promoting the construction of CGs. According to the “Shanghai Manual 2017”, there were 28 CGs distributed in the central area with high population density and house price and its adjacent areas by 2017.

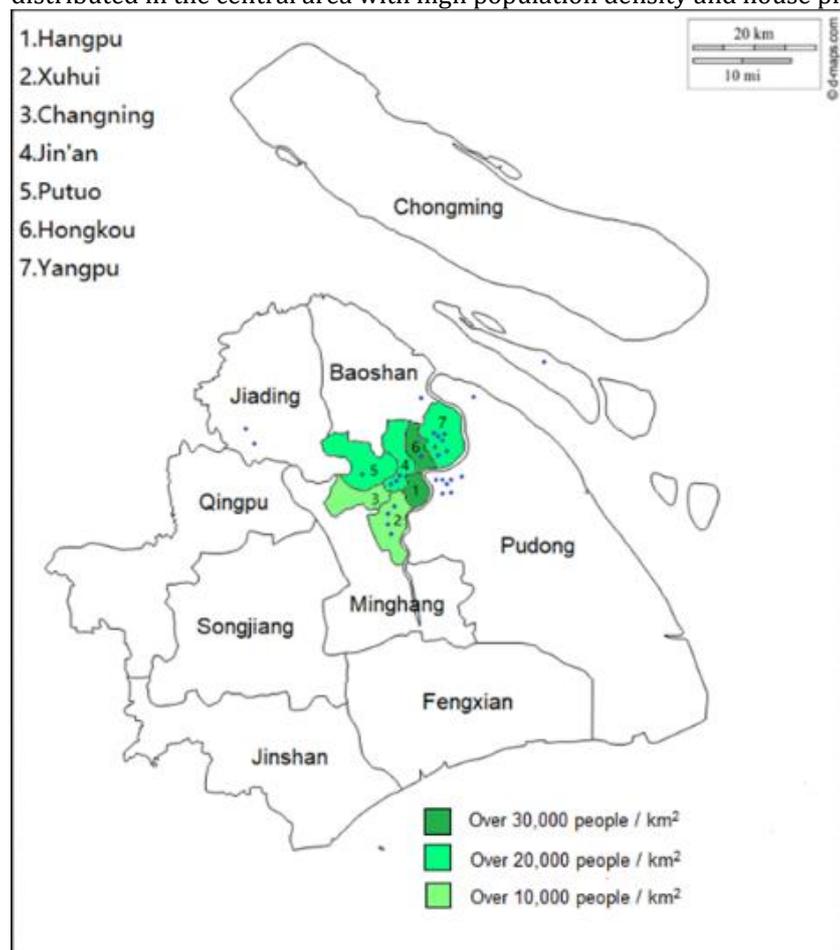
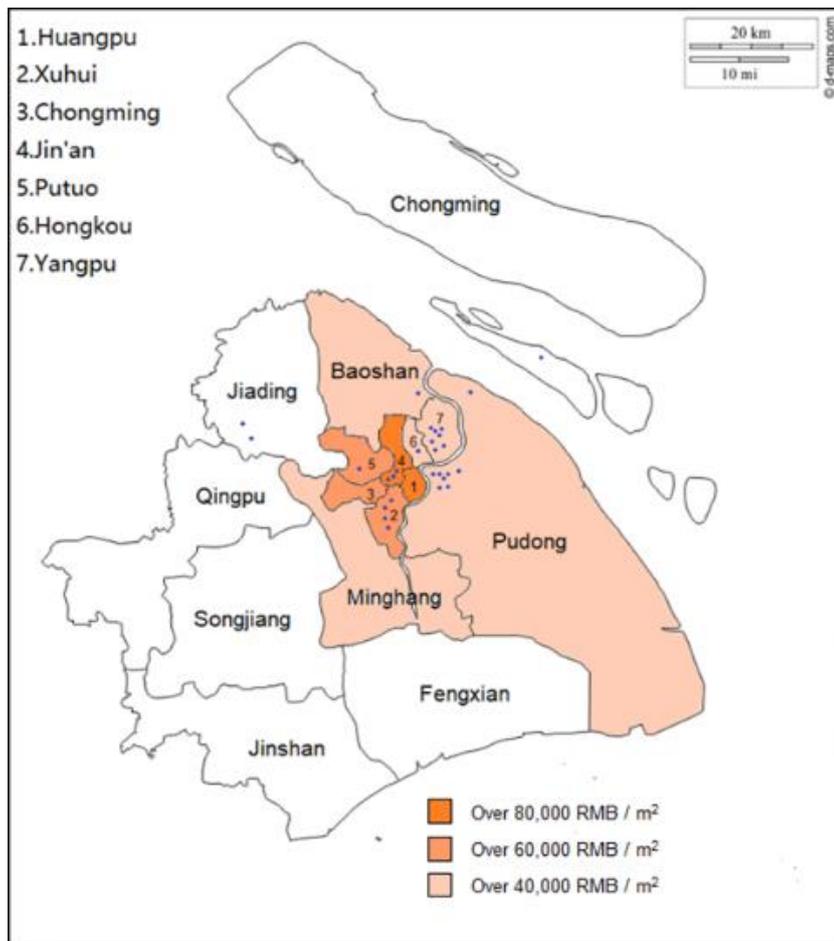


Figure 3: Community gardens and population density

Shanghai Statistical Yearbook 2018, Shanghai Manual 2017



**Figure 4: Community gardens and Community gardens and house price**

Shanghai Statistical Yearbook 2018, Shanghai Manual 2017

And according to Kou et al. (2019), as the management system of the CGs (including the construction and management entities), local residents are actively participated in all stages of the construction of the CGs. The CGs project is supported by companies or the government (funding, materials, etc.), and a team of experts designs and implements the CGs. NPOs, NGOs and other civil society organizations, as well as local community organizations and street residents' committees are also participated in the project. The construction and operation of CGs can therefore be found to be characterized by a large number of stakeholders. On the other hand, based on practical experience in the construction and management of CGs, the researchers make the suggestion that, as residents are likely to lack awareness and capacity in the early stages of community participation, external interventions are to be initiated, with capacity training by experts.

## 5.2. Basic overview of the web-based questionnaire

We commissioned NTT Com-Online Marketing Solutions to conduct a web-based questionnaire of local residents, including users of CGs in Shanghai. The survey was run from 25 August 2020 to 28 August 2020. The valid sample size is 536. In addition to examining the socio-economic attributes and social capital of residents, and how their participate in CGs affects how they evaluate CGs (satisfaction with CGs and willingness to pay (WTP)) and their satisfaction with local life. To examine whether this was the case, respondents were assigned a proportion of "Still in use or Used to use", "knew but never use" and "did not know".

Table 1 shows the profile of the respondents to the questionnaire. In terms of the sex of the survey respondents, males (45.9%) are slightly lower than females (54.1%). In terms of where respondents live, no one lives outside of Shanghai, with over 90% of respondents living in the central of Shanghai (Old Town) or Pudong New Area. In terms of having children, over 60% of respondents answered that they have children. In terms of monthly household income, over 60% of respondents had a monthly income between "RMB10,000 and RMB30,000", 25% of less than "RMB10,000" and 13.81% of more than "RMB30,000". And more than half of the respondents were aware of the existence of farmland (urban agriculture) around their homes. On the other hand, in terms of the age structure of the respondents, "30-39 years old" was the most represented age group (46.9%), followed by "19-29 years old" (35.8%).

**Table 1: Summary of respondents to the questionnaire**

	Rate						
Sex <sup>1</sup>	Male 45.9%	Female 54.1%	Total 100%				
Residential areas	central district <sup>2</sup> 61.8%	Pudong New Area 29.9%	Other districts in Shanghai 8.4%	Outside of Shanghai 0%	Total 100%		
Children	With children 61.6%	No children 38.4%	Total 100%				
Monthly household income	RMB10,000 25%	RMB10,000~30,000 61.2%	RMB30,000 13.8%	Total 100%			
Farmland (urban agriculture)	There is a lot 19.8%	There is a little 47.2%	here is not much 21.1%	There is not any 11.9%	Total 100%		
Age <sup>1</sup>	Below 18 1.5%	19~29 35.8%	30~39 46.8%	40~49 9.5%	50~59 4.1%	Over 60 2.2%	Total 100%

1: According to the 2019 Shanghai Statistical Yearbook, by the end of 2018, Shanghai’s registered population (14.623 million) consisted of 7.241 million males (49.5%) and 7.382 million females (50.5%). In terms of the age structure of Shanghai’s registered population, 1,765,000 (12.1%) are aged 17 and below, 2,474,300 (16.9%) are aged 18-34, 5,364,200 (36.9%) are aged 35-59, and 5,502,300 (34.3%) are aged 60 and over. 2: Central District means Huangpu District, Xuhui District, Changning District, Jing’an District, Putuo District, Hongkou District and Yangpu District in the center of Shanghai.

Table 2 shows the social capital of the respondents and their level of participation in the community garden and their evaluation of the CGs. And more than half of these respondents are involved in civil society organizations and social groups. And among the organizations and groups involved, residential community organizations (e.g. owners’ committees) had the highest proportion (17.7%), followed by charitable organizations (16.2%) and social service organizations (e.g. environmental protection organizations) in third place (16%). In addition, over 70% of respondents said that they had a very good relationship with their community. Regarding participation in CGs, about 60% of the respondents have been participated in CGs and 32.7% were still participating in CGs. On the other hand, using WTP as an evaluation of CGs, more than 80% of the respondents were willing to pay for the maintenance of CGs, while about 20% are not willing to pay.

**Table 2: Social capital, and community garden participation and evaluation**

	Rate							
Relationships with the community	Very good 20.9%	Good 55.6%	Cannot be sure 20.7%	Not very good 2.6%	Very bad 0.2%	Total 100%		
Participation in social organizations	Trade organizations 9.7%	Charitable organizations 16.2%	Academic groups 12.1%	political organizations 11%	Community organizations 17.7%	Social service organizations 16%	civic mutual aid organizations 8.2%	Peer organizations 14.7%
	Religious groups 2.4%	Regional activity groups 3%	Other NPO organizations 0.2%	Not involved 43.3%				
Participation in CGs	Still in use 32.7%	Used to use 26.3%	Knew but never used 24.8%	Did not know 16.2%	Total 100%			
Satisfaction with CGs	Very satisfied 24.4%	Satisfied 58.9%	Cannot be sure 12.9%	Not very satisfied 4.4%	Very dissatisfied 0.3%	Total 100%		
Evaluation (WTP) of CGs	Below 50 RMB/month 9%	51~100 RMB/month 19.4%	101~150 RMB/month 19.2%	151~200 RMB/month 21.1%	201~250 RMB/month 9.3%	Over 251 RMB/month 4.3%	Don not want to pay 17.5%	Total 100%

Table 3 shows the suggestions for CGs. The most popular concern was “rational planning of land layout” (42.9%), followed by “location of CGs” (37.1%), “openness of the range of users” (36.6%) and “greater participation in management” (36.4%).

**Table 3: Suggestions for CGs**

	Number	Rate
Openness for users of CGs	196	36.6%
Standard size of land available for use	134	25.0%
Rational planning of land layout	230	42.9%
Increasing participation in the operation of CGs	195	36.4%
Set reasonable fees and rules	187	34.9%
Matching with the city’s development plan	161	30.0%
Location of CGs	199	37.1%
Increase the proportion of edible plants cultivated	174	32.5%
Improve the facilities and equipment attached to the CGs	150	28.0%
Other	0	0%
Cannot be sure	39	7.3%
Total	536	100%

Regarding the reasons for using CGs (multiple choice question), only a small proportion (2.2%) of respondents indicated that they were invited by others, indicating that most community garden users participate in the gardens voluntarily. The most common reason was “love plants and want to be close to nature” (56.0%), followed by “to experience farming activities” (39.6%) and “to exercise the body” (33.9%) (Table 4).

**Table 4: Reasons for using CGs**

	Number	Rate
For mental health	82	26.0%
To exercise the body	107	33.9%
Love plants and want to be close to nature	177	56.0%
To experience farming activities	125	39.6%
To make use of the produce obtained through farming	67	21.2%
Want to participate in activities held in the community garden	76	24.1%
To interact with other users	68	21.5%
To use the community garden as a place to rest	100	31.7%
To have a view of the neighborhood	70	22.6%
To improve the natural environment of the neighborhood	76	24.1%
To increase the vitality of the community	56	17.7%
To be invited by others	7	2.2%
Other	0	0%
Total	316	100%

In contrast, the most common reason for not using CGs was “ don’t have a lot of free time “, followed by “don’t know about community gardens” and “No community gardens near home” (Table 5 (collated from responses to free-response questions)). This implies that at this stage there is not enough publicity about CGs, residents do not have a comprehensive understanding of CGs, the range of services that existing CGs can provide does not fully meet the needs of residents, and there is room for the development and evolution of CGs.

**Table 5: Reasons for not using CGs**

	Number
Don’t have a lot of free time	68
Don’t know anything about Community gardens	46
No community gardens near home	56
Too many people or consider it ineffective for socializing	6
Not interested in CGs	36
Community gardens are not well run	7
Other	12
Total	220

This is a free-response question from the respondent. We have collated and summarized the answers. On the other hand, as shown in Table 6, when community garden users were asked how satisfied they were with their local life (“Are you satisfied or dissatisfied with the local you currently live in?”) Approximately 80% of the respondents answered that they were satisfied with their local life. Also, in response to the question “Please select the city that best fits your vision of the future of the city you currently live in from the following city types”. “Sustainable city, eco-city or green city” had the highest response rate of over 50% (Table 7).

**Table 6: Users' satisfaction with local life**

	Number	Rate
Very satisfied	107	20.0%
Satisfied	315	58.8%
Cannot be sure	78	14.6%
Not very satisfied	32	6.0%
Very dissatisfied	4	0.8%
Total	536	100%

**Table 7: Users' vision of the city future**

	Number	Rate
Sustainable cities, eco-cities, green cities	277	51.7%
Global cities	61	11.4%
Smart Cities	106	19.8%
Creative Cities	60	11.2%
Megacities	18	3.4%
Inclusive Cities	14	2.6%
Other	0	0%
Total	536	100%

In addition, Table 8 shows the respondents' perception of the role of urban agriculture (multiple choice question). As can be seen from the results, only 1.9% of the respondents did not consider urban agriculture to play an important role. And among the roles considered important, the most chosen were the roles of "conservation of the green and environment" (58.6%) and "supply of fresh and safe agricultural and livestock products" (42.2%). This was followed by the role of "formation of good scenery" (38.2%), "education functions such as farming experience and food education" (35.3%) and "making a life tasteful and peaceful" (32.3%).

**Table 8: Awareness of the role of urban agriculture**

	Number	Rate
Supply of fresh and safe agricultural and livestock products	226	42.2%
Providing the employment	146	27.2%
Conservation of the green and environment	314	58.6%
Education functions such as farming experience and food education	189	35.3%
Revitalization of regional industry	148	27.6%
Disaster prevention function such as evacuation place in case of disaster	105	19.6%
Making a life tasteful and peaceful	173	32.3%
Succession of local tradition and culture	121	22.6%
Formation of good scenery	205	38.2%
Place for local community	121	22.6%
Medical and welfare functions such as horticulture therapy	122	22.8%
Place of familiar recreation	83	15.5%
Other	0	0.0%
Not considered important	10	1.9%
Total	536	100.0%

### 5.3 Results of the SEM analysis

The SEM analysis is introduced for the results obtained from the above questionnaire. Tables 9 and 10 summaries' the variable settings and basic statistics used in the SEM analysis.

**Table 9: Variable settings**

Classification	Variable	Setting
Socio-economic attributes	Sex	Male (1); Female (0)
	Monthly household income	Over RMB30,000 (2); RMB10,000~30,000 (1); Less than RMB10,000 (0)
	Children	With children (1); No children (0)
	Residential areas	Huangpu District, etc. (3); Pudong New Area (2); Other districts in Shanghai (1); Outside of Shanghai (0)
	Farmland (urban agriculture)	There is a lot (3); There is a little (2); There is not much (1); There is not any (0)
Social capital	Participation in social organizations	It was set up with 12 steps, such as 0 for no participation, 1 for participation in one organization, and 2 for participation in two organizations.
	Relationships with the community	Very good (4); Good (3); Cannot be sure (2); Not very good (1); Very bad (0)
Participation and evaluation(WTP) of CGs	Participation in CGs	Still in use (3); Used to use (2); Knew but never used (1); Did not know (0)
	Evaluation (WTP) of CGs	Below \$50 (6); 51-100 RMB/month (5); 101-150/month (4); 151-200 RMB/month (3); 201-250/month (2); Over \$251 (1); Don not want to pay (0)
Satisfaction with local life	Satisfaction with local life	Very satisfied (4); satisfied (3); Cannot be sure (2); Not very satisfied (1); Very dissatisfied (0)

**Table 10: Statistics of SEM variables**

Variables	No.	Mean.	SD.	Min.	Max.	
Socio-economic attributes	Sex	536	0.46	0.50	0	1
	Monthly household income	536	0.89	0.61	0	2
	Children	536	0.62	0.49	0	1
	Residential areas	536	2.53	0.65	0	1
	Farmland (urban agriculture)	536	1.75	0.91	0	3
Social capital	Participation in social organizations	536	1.11	1.37	0	11
	Relationships with the community	536	2.94	0.74	0	4
Participation and evaluation(WTP) of CGs	Participation in CGs	536	1.75	1.08	0	3
	Evaluation (WTP) of CGs	536	2.62	1.72	0	6
Satisfaction with local life	536	2.91	0.80	0	4	

And the path coefficients and path diagrams obtained from the SEM analysis using Stata/SE software are shown in Figure 4 and Table 11. The goodness-of-fit index was RMSEA = 0.051 and CFI = 0.991, which was a good result. The results of the analysis revealed the following.

Firstly, the presence or absence of children and the farmland around the homes had a strong positive effect on the relationship with the community, and the presence or absence of children, residential areas and farmland around the homes had a strong positive effect on participation in social organizations. The socio-economic attributes that are particularly effective for participation in CGs are residential areas, farmland and social capital (participation in social organizations and relationships with the community). On the other hand, the socio-economic attributes that are particularly effective in evaluating (with WTP) CGs are monthly household income, farmland and social capital. This suggests that people with higher levels of social capital are more enthusiastic about participating in CGs and evaluate it more positively. Furthermore, there was a positive relationship between participation in CGs and evaluation of CGs (WTP). In other words, it is clear that people with high engagement rate CGs highly, because they enjoy the utility it brings. In addition, satisfaction with local life was positively correlated with the evaluation of the CGs (WTP) and its relationship with the community. This suggests that residents who are often participated in social organizations and have good relationships with their communities are more likely to be participated in CGs, and that the utility they derive from CGs increases their satisfaction with local life.

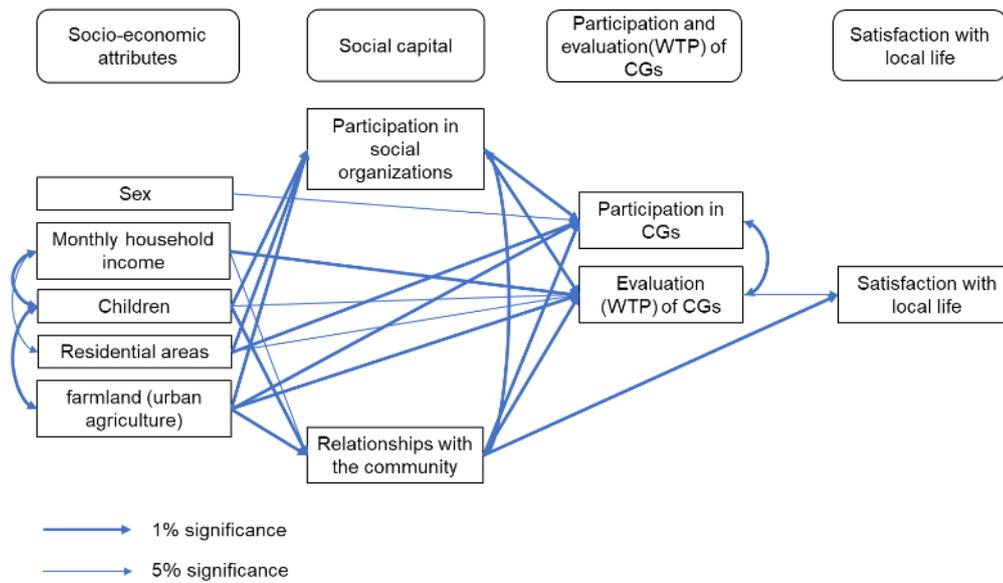


Figure 3: Path diagram of the results of the SEM

Table 11: Path coefficients for SEM results

		Coef.	p >  z
Satisfaction with local life	Relationships with the community	0.471	0.000***
	Evaluation (WTP) of CGs	0.049	0.022**
Evaluation (WTP) of CGs	Participation in CGs	0.777	0.000***
	Participation in social organizations	0.266	0.000***
	Relationships with the community	0.585	0.000***
	Monthly household income	0.332	0.001***
	Children	0.324	0.016**
	Residential areas	0.217	0.022**
	Farmland (urban agriculture)	0.527	0.000***
	Participation in CGs	Participation in social organizations	0.169
Relationships with the community		0.245	0.000***
Sex		0.154	0.045**
Residential areas		0.247	0.000***
Farmland (urban agriculture)		0.425	0.000***
Relationships with the community	Participation in social organizations	0.143	0.000***
	Monthly household income	0.102	0.049**
	Children	0.309	0.000***
	Farmland (urban agriculture)	0.101	0.003***
Participation in social organizations	Children	0.331	0.006***
	Residential areas	0.248	0.004***
	Farmland (urban agriculture)	0.393	0.000***
Residential areas	Monthly household income	0.034	0.050**
Children	Monthly household income	0.078	0.000***
	Farmland (urban agriculture)	0.077	0.000***

\*\*\*, \*\* statistical significance at 1% and 5% levels respectively.

6. CONCLUSION

The results of the above analysis support out hypothesis “The multi-functionality of CGs can enhance the utility and life satisfaction of urban residents” (H1). In other words, people with higher levels of social capital are more actively participate in CGs and also enjoy the benefits of CGs more, and are more satisfied with their local life. As traditional urbanization in China has left many challenges, so Chinese policy makers are seeking “people first” sustainable urbanization (OECD, 2015). In this context, CGs, as one of the means of urban renovation, not only beautify the environment, but also play an important role in promoting neighborhood relationships and building a harmonious society (Kou et al., 2019). This study considers CGs as a form of urban agriculture and clarifies their role in improving the quality of life (QOL) of urban residents through their multi-functionality. This means that there is room for further development of CGs, because they make effective use of fragmented urban land and space, improve the social capital of residents and increase their satisfaction with local life. In addition, CGs are not the only urban agriculture form that makes use of the small amount of land and space available in a large city; rooftop agriculture is also attracting attention. The development strategy of urban agriculture must therefore be in line with the current situation and development vision of each city, which is one of the challenges for sustainable urban development in the future.

On the other hand, CGs are still in their infancy in China, and even in Shanghai they are still in the pilot stage. As this questionnaire is biased towards people who know or participate in CGs, further research is needed to reach out to urban residents who are not yet aware of CGs, and this will be an issue for our future research agenda.

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## DEVELOPING RENEWABLE ELECTRICITY WITH CARBON TAX RECYCLING MECHANISMS IN THE EAST ASIA REGION

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### ABSTRACT

The East Asia region has become more important in terms of economy and population. Nonetheless, the region also has a significant increase in carbon emissions. One way to reduce carbon emission while ensuring economic development in the region is to develop more renewable electricity by using a carbon tax recycling mechanism. Nonetheless, there has been limited study on the impacts of the carbon tax recycling mechanism on renewable electricity development. Therefore, this paper analyses the socioeconomic and environmental impacts of the carbon tax recycling mechanisms to develop renewable electricity in the East Asia region. To achieve the objectives of this paper, this paper uses a multi-country computable general equilibrium for East Asia to conduct the analysis. There are three specific recycling mechanisms in this paper through additional investment in renewable electricity, indirect tax reduction for renewable electricity sectors, and subsidies for renewable electricity consumption by households. This paper finds that depending on the type of recycling mechanism and economy structure, a country could achieve double dividend or environmental benefits only. Regarding the best policy to develop renewable electricity, this paper finds that in terms of the economic objective, investing in renewable electricity to renewable electricity development would mostly benefit all East Asian countries except for Singapore. Providing indirect tax reduction is only economically beneficial for China. Further, subsidizing renewable electricity prices for households would mostly benefit India and South Korea. Regarding environment objectives, this paper finds that investing in renewable electricity or providing indirect subsidies for renewable electricity is beneficial for all East Asian countries while subsidizing renewable electricity prices for households would not benefit Australia, Indonesia, and rest of ASEAN. This paper also finds that recycling mechanisms could alter the distribution pattern across countries in the East Asia region and some countries could reduce poverty incidences. Also, only a few countries have a reduction in poverty incidence. Investing in renewable electricity or providing indirect subsidies to renewable electricity reduces poverty incidence in Indonesia and the rest of ASEAN. On the other hand, China and India could achieve a reduction in poverty incidence by subsidizing renewable electricity prices for households.

## THE ROLE OF NGO'S IN SHAPING INDONESIA'S CLIMATE CHANGE POLICIES

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### ABSTRACT

This paper explores the involvement of Non-Government Organisations (NGOs) in the development of Indonesia's climate mitigation policies. It analyses how NGOs both domestic and international influence and shape the national climate change landscape. Further, it also analyses the influence of international institutions and international norms in Indonesia's climate change policies. This paper uses grounded theory method as a research approach, based on in-depth interviews with 29 Indonesia's key stakeholders between August 2016-July 2018. This paper finds that both domestic and international NGOs play a significant role in shaping Indonesia's climate change policies. It also finds that international organisations are influential in the development of climate policies in Indonesia. Overall, this paper contributes to academic knowledge especially the influence of NGOs in the policy process in Indonesia.

### 1. INTRODUCTION

Indonesia is one of the top 10 largest greenhouse gas (GHG) emissions producers in the world. The data from the World Resource Institute Climate Analysis Interactive Tool (CAIT)<sup>66</sup> shows that Indonesia ranks 6<sup>th</sup> with 1.98 gigatons of GHG emissions in total (China is 1<sup>st</sup> and the US is 2<sup>nd</sup>) (WRI, 2015). This contributes 4.16% of total global GHG emissions. With an average emissions growth rate of 3.7% a year for the decade from 2001 to 2012 (WRI, 2015), and a population of close to 260 million, reducing GHG emissions in Indonesia will have a significant impact on slowing global emissions growth. Indonesia is determined to reduce its GHG emissions through a significant reductions target. To achieve such a target, Indonesia needs to maintain economic growth for the prosperity of the population. Efforts to reduce nationwide GHG emissions requires significant funding. Indonesia is the largest archipelagic country worldwide, with extensive tropical rainforests. It also has significant energy and mineral resources such as coal, oil, and gas. With major GHG emissions arising from forestry and energy sectors, climate mitigation policies will be very costly because of the need to reduce activity in major economic sectors. Therefore, policymakers need to formulate an effective carbon mitigation policy at the lowest cost.

The policy process in Indonesia involves multiple stakeholders and the government which are not necessarily steering in the same direction. A wide range of organisations engage in the policy process such as government agencies, business stakeholders, politicians, and non-government organisations. All of the stakeholders play an important role in shaping the policy making process.

This paper explores the involvement of Non-Government Organisations (NGOs) in the development of Indonesia's climate mitigation policies. It analyses how NGOs, both domestic and international, influence and shape the national climate change landscape. Further, it also analyses the influence of international institutions and international norms in Indonesia's climate change policies. It aims to understand how NGOs involve in the policy making process in terms of Indonesia's climate change governance. This paper contributes to the literature by giving new insights of the roles of NGOs in the climate change policy making in Indonesia by exploring the perspectives of Indonesian key stakeholders. This contribution is significant given the fact that the study about the role of NGOs in the climate policy process in Indonesia is still limited.

### 2. REVIEW OF LITERATURE

Domestic non-government organisations and international organisations play an important role in the policy process in some policy sectors. Through the formulation process of regulatory frameworks, laws, and other implementing regulations, donor agencies have had an influence on public policy development (Pramusinto, 2016, p. 125). For example, recent research by Datta et al (2018) showed the influence of the World Bank on higher education policy development (Datta et al., 2018, p. 11). According to this study, the World Bank has been the most dominant actor in shaping and involving higher education policy. For example, the World Bank has promoted the enhancement of higher education autonomy; promoted greater competition between higher education institutions; and promoted the improvement of accountability and transparency of higher education institutions in the use of public funding (p. 11). Rosser (2015) also pointed out that NGOs, parents, and teachers have been engaged in demonstration, lobbying, and strategic use of the court system to influence the education policymaking process (Rosser, 2015, p. 72).

Since the fall of Soeharto in 1998, a large number of civil society organisations, environmental advocates, female activists, and human rights activists, have also influenced the policy development process by entering politics (Mietzner, 2013, p.

<sup>66</sup> <http://cait.wri.org>

29). For example, NGO leaders have official positions in political parties, journalists enter parliamentary commissions, and labour activists join the bureaucracy. This enables NGOs provide policy insights to control environmental policies. NGOs play a significant role in addressing environmental issues. For example, World Wildlife Fund-Indonesia involved in establishing a transboundary agreement to promote sustainable forest management in Kalimantan Island among Indonesia, Malaysia and Brunei (Nugraha, 2016, p. 3). According to Nugraha, in 2007, WWF-Indonesia reached a large-scale conservation agreement with Malaysia and Brunei to protect forests of Borneo and put the whole of Borneo as an internationally significant conservation area. To follow up this commitment, in collaboration with international agencies such as UNESCO, UNICEF, and UNEP, WWF developed partnerships and coalitions with Indigenous People's Alliance (AMAN) to support its advocacy efforts.

NGOs also play an important role in framing environmental problems. Framing process is an effort to convince various targets and general public to support a policy change (Benford & Snow, 2000, p. 615). For example, in 2009 Greenpeace succeeded to frame forest fires as a problem in Indonesia caused by large palm oil companies (Ardhian, Adiwibowo, & Wahyuni, 2016, p. 214). They used public campaigns to accuse the Sinar Mas group of burning forests to expand their palm oil plantations. Greenpeace prevailed to stop supply chains, where large companies such as Nestle and Unilever ceased purchase contracts of palm oil products with the Sinar Mas (Ardhian et al., 2016, p. 214; Greenpeace South East Asia, 2010, p. 10). In the case of forest fires in 2015/2016, issue framings were more broadened and various. While WALHI and WWF-Indonesia developed their framings that forest fires were corporate crimes by palm oil industries, some Indonesian NGOs established an advocacy network (*ResponsiBank*) which framed that banks involved in Indonesia's forest fires by providing financial assistance to palm oil industries (Herlan, 2017, p. 125).

### 3. METHODOLOGY

This study uses grounded theory as the research strategy to address the research questions. Grounded theory enables an in-depth analysis of a social phenomenon based on dialogue with the participants to obtain data from their experiences (Charmaz, 2014; Francis, Chapman & Whitehead, 2016). This approach has been used to analyse the data from 29 Indonesian key stakeholders from interviews conducted between August 2016 and July 2018, along with a number of relevant documents. Grounded theory was selected because it allows for the exploration of the perspectives of Indonesian key stakeholders regarding the roles of NGOs in shaping Indonesia's climate change policies. This paper is a part of my doctoral thesis which addresses the opportunities and challenges of introduction a carbon tax in Indonesia.

Interviews have been chosen as the data collection method in this research to achieve in-depth insights and responses about the roles of NGOs in influencing the climate change governance in Indonesia. The interviews involved civil society groups or NGOs. In the current Indonesian context, NGOs play a significant role in addressing political issues, including environmental issues. There are at least three influential civil society groups or NGOs related to climate change issues in Indonesia: Greenpeace, *Wahana Lingkungan Hidup Indonesia (WALHI)*, and World Wildlife Fund (WWF) Indonesia. These organisations are actively involved in determining Indonesian positions in both domestic and international climate change negotiations. For example, they were part of the Indonesian negotiation team at COP 24 in Katowice, Poland 2018. They were also actively involved in the creation of the First Nationally Determined Contributions (NDCs) document submitted to the UNFCCC in 2016. Therefore, they have an influential position in lobbying the government and the private sector in response to cross-cutting agendas. Their focus is on efforts to shift government policy towards a low-carbon development path. Therefore, in this study, these NGOs are key stakeholders that have an important influence on government programs, systems, and policies. However, during the data collection process, the researcher could not contact the participant from World Wildlife Fund Indonesia. The reason for their refusal was that their schedule was very tight, so they did not have time to be interviewed. As a replacement, a participant from Friends of the Earth Indonesia was interviewed.

### 4. RESULTS AND DISCUSSIONS

#### 4.1. The importance of stakeholders engagement

The interviews with the key Indonesian stakeholders revealed that one of the most influential factors in achieving an effective policymaking process for introducing a carbon tax is for the government to engage with all stakeholders in the policymaking process. The literature shows that the importance of integrating multiple stakeholders with different perspectives and interests into the environmental policymaking process is increasingly being recognised at all levels of government (se e.g. Koontz, 2005, p. 459; Mangun et al., 2007, p. 157; Watson & Foster-Fishman, 2013, p. 151). The absence of engagement between policymakers and stakeholders is a key factor in policy failure. Conversely, stakeholder collaboration mechanisms could facilitate the policy process and improve policy outcomes (Marsh & McConnell, 2010, p. 572).

All relevant stakeholders should be involved by the government since the beginning of the policymaking process. A good communication must be established among the executives, legislatives, and civil society to introduce a carbon tax (NGO-02).

The participants mentioned that it is important to engage all stakeholders from the beginning of the policymaking process. As stated by Marsh and McConnell (2010, p. 572), bringing together all the stakeholders with their different interests in the policy process can lead to an understanding being reached, and ultimately, to a successful policy process. A successful policymaking process can lead to successful policy implementation. Therefore, to produce a successful multi-stakeholder initiative, dialogue between stakeholders is required (Bartley 2007, p. 300; Mena & Palazzo 2012, p. 536).

The regulation is comprised of rewards and punishment which will be effective if all the stakeholders have a shared commitment to the goals. Therefore, a common perspective among all the stakeholders will play a crucial role in the effectiveness of the introduction of a carbon tax. The goal is to achieve carbon emissions reduction target with this policy (NGO-04).

A policy succeeds when it can manage a complex and multi-stakeholder approval process to create an implementable policy (Howlett 2012, pp. 545-546). Engaging policy participants with diverse interests and opinions is the key element in developing a legitimate sustainable initiative (Balzarova & Castka 2012, p. 266), especially in relation to a complex issue such as climate change (Tompkins, Few, & Brown 2008, p. 1583). On the contrary, failure to involve stakeholders in an effective way can lead to failure to achieve the ultimate objectives of a policy (Hoque, Clarke, & Huang 2016, p. 369). Close collaboration between government and stakeholders from the beginning of the policymaking process is important. This is because in order to start the policy process, the policy participants inside and outside of government need a *problem* to become a policy issue in order for it to be addressed. According to Kingdon's theory of the policymaking process, whether a problem is recognised by the government as an important issue to be addressed also depends on the stakeholders outside of government that make the government pay attention to a problem and bring it onto the policy agenda (Herweg et al., 2018, p. 19). Therefore, framing an issue as a problem that reaches the attention of government is important. This implies that the role of the stakeholders in framing a problem in a particular way to gain the attention of the government is significant. As part of Kingdon's multiple streams approach, in the *problem stream*, policy participants inside of government and stakeholders outside of government are almost equally important in bringing a problem onto the policy agenda (Kingdon, 2011, p. 21).

## 4.2. The importance of stakeholders engagement

An example of the important role of stakeholders in framing an issue to become a problem which reaches the attention of government is the policy process of the ratification of the Paris Agreement. Stakeholders from Non-Government Organisations explained that NGOs played a crucial role in the process of ratifying the Paris Climate Agreement. Collective action by NGOs and other environmental activists in Indonesia, such as Greenpeace and Friends of the Earth became a major consideration for Indonesian policymakers in the ratification of the Paris Climate Agreement. Pressure applied to government by NGOs and the Indigenous communities reflected their awareness of environmental sustainability.

The NGOs and environmental activists started to frame the issue of Indonesian tropical forests and the role of the Indigenous communities to protect the forests to mitigate climate change. As many as 32 environmental and civil society organisations gathered before the signing of the Paris Agreement on 22 April 2016 in New York. They formed the *Climate Justice Now!* network and intensified their actions to urge the government to ratify the Paris Agreement. Meetings and negotiations between the network and the government occurred to discuss the importance of the ratification of the Paris Agreement for Indonesia as a commitment to protect Indonesian people from the adverse impacts of climate change.

NGOs play an important role in advocating environmental issues in Indonesia. For example, in 2007 World Wildlife Fund (WWF) initiated the establishment of declaration of the Heart of Borneo (HoB), a forest conservation and sustainable development program in Indonesia-Malaysia-Brunei Darussalam border (Nugraha, 2016). The objective of the HoB is to manage primary forests and cross-border area, manage sustainable natural resources, develop eco-tourism, and increase human resource capacity under sustainable development (Nugraha, 2016, p. 5). The HoB is a commitment by three countries (Indonesia, Malaysia, and Brunei Darussalam) to protect Kalimantan forests for the benefit of next generations based on the mutual respect of each country.

NGOs also play an important role in the development process of Indonesia's timber legality verification system. This is a government-rule standard to address illegal loggings as the most significant problems in the forestry sector in Indonesia. The policy process of timber legality verification has heavily involved environmental non-government organisations (NGOs) led by the Nature Conservancy (Maryudi, 2016, p. 103). In the earlier process, NGOs worked with government agencies to create and develop legality rules. The process took place between 2006 and 2008 involving broader stakeholders such as the government agencies, timber industries, universities, and research organisations (Maryudi, 2016, p. 103).

WALHI is a leading NGO in Indonesia that promotes environmental protection activities. While they urge the government to mainstream climate change in the national development plan, in the field they create a system of forest management system together with indigenous people. This concept is a counter activity for extractive industries which create deforestation and forest degradation through land use change activities. Together with indigenous people, WALHI has created a coalition which protect primary forest are from converting to oil palm plantations ([www.walhi.co.id](http://www.walhi.co.id), accessed 2 April 2020).

The actions of the NGOs and civil society organisations in framing the issue succeeded in reaching the attention of the government in their considerations of the ratification of the Paris Agreement. They used citizen's *perceptions* to frame the issue as a problem to be brought to the attention of the government (Kingdon, 2011, p. 110). Their perceptions were that the Paris Agreement was important for demonstrating the government's commitment to protecting Indonesian people from the impacts of climate change.

The role of NGOs and environmental activists is not only to frame and bring a problem to government attention (*problem broker*). They move further beyond the problem stream and find solutions in the *policy stream*. In the multiple streams approach, NGOs and other activists are known as *policy entrepreneurs*. The difference between the two is that problem brokers only frame a problem and argue that action must be taken to address the problem without offering policy solutions, while policy entrepreneurs suggest solutions to problems.

The NGOs also played an important role as *policy entrepreneurs* because they facilitated the government process by drafting an academic paper and the Law. The academic paper, which is a prerequisite of the policy process, was prepared by the government and brought to the parliament with a draft of the bill. In *the policy stream*, the government and the NGOs worked together to prepare the academic paper. Focus group discussions and a consultative process with the policy community consisting of experts, analysts, bureaucrats, and academics, were then undertaken. In the *political stream*, the stakeholders influenced the political dynamics of the political process through advocacy campaigns. In this process, the problem, policy, and political streams were coupled, and thus converged to open the policy window of opportunity for policy change (Kingdon, 2011, p. 202). This coupling resulted in the Law of the Ratification of the Paris Agreement. In this case, the role of government in bringing a problem onto the policy agenda is crucial. As Kingdon said, in the problem stream, when a problem is not perceived by the policymaker as an issue that requires attention, it will not go onto the policy agenda. In such a situation, stakeholders need to frame the issue as one that requires government attention. For example, researchers and/or academics could create focus group discussions with government agencies throughout Indonesia to discuss the research findings and the potential for bringing it onto the government agenda, while NGOs could frame the importance of introducing a carbon tax in Indonesia through mass media campaigns. For example, WALHI-Friends of the earth Indonesia engaged in the global March for Climate, urging global leaders to rise an awareness of addressing climate change impacts. WALHI also established the School of Ecology in Malang, East Java as one of their initiatives to raise people awareness of climate change and environment.

### 4.3. The role of NGOs in the climate change policy process

The role of NGOs (both domestic and international) is important in the formulation of climate mitigation policy in Indonesia. In Kingdon's multiple streams framework (in the *problem stream*), these stakeholders have framed the issues as a problem which then enabled them to bring the problem onto the government agenda. They framed the importance of the forestry sector in Indonesia as the major source of emissions. To do so, they leveraged international organisations, international NGO networks, transnational alliances, and Indonesia's foreign policy goals. Framing a particular situation and bringing it to the government's attention is important because the government only has limited time to pay attention to all the problems they have to deal with (Herweg et al., 2015, p. 437; Kingdon, 2011, p. 184). In the aforementioned example, the NGOs and CSOs in the policy process of the ratification of the Paris Agreement in Indonesia became *policy entrepreneurs*. Policy entrepreneurs play an important role in framing problems to generate attention, prepare solutions, and create opportunities to act (Cairney, 2018, p. 202). According to Kingdon (2011), they are stakeholders of policy change who have the skills and knowledge to be able to exploit opportunities (Kingdon, 2011).

The Indonesian policy to ratify the Paris Agreement is a continuation of the Indonesian commitment to international laws and treaties to address global climate change issues. As the stakeholders explained in the interviews, *image building* for Indonesia is important in the global political arena. Having a good international reputation will help Indonesia gain international assistance for achieving its emissions reduction target (Wuryandari, 2015, p. 125). Beyond this, Indonesia will lead developing countries in combatting global climate change problems. The ratification of the Paris Agreement also showed that Indonesia complies with international principles and responsibilities as part of the global community to preserve the quality of life (Windyswara, 2018, p. 1433). Through the ratification of the Paris Agreement, Indonesia has gained a number of advantages such as access to international funding, human resource development, environmental protection technology, and the necessary cooperation and coordination to assist with the implementation of the Paris Agreement. Nevertheless, the most important objective of the ratification of the Paris Agreement is for the international community to have a positive impression about the awareness of the Indonesian government towards environmental protection at both the national and global levels.

The results of this paper show that most Indonesian stakeholders agree with government efforts to reduce GHG emissions according to global norms and international organisations. However, there is also a growing influence of the business stakeholder coalition in the parliament. The ACF is a useful framework to explain this. Jenkins-Smith et al. (2014) has argued that according to the ACF, organisations which aim to influence the policy-making process form competing advocacy coalitions based on shared core beliefs, including value priorities, elemental causes, and preferred solutions (Jenkins-Smith et al., 2014, p. 189).

This is useful to mention here because there is a strong coalition that connects climate goals to foreign policy goals, but there is also a growing domestic coalition of business stakeholders and corrupt officials. Transnational NGOs have formed a strong coalition with domestic NGOs. They believe that it is important for the Indonesian government to produce climate policies to reduce GHG emissions that are connected to global norms and international organisations. However, the economic coalition represented by business stakeholders believes that climate policies could harm the economy. They propagate the idea to the government that a carbon tax will create additional costs which will harm their business activities.

The findings of this paper also show that there is no clear indication of opposition in these coalitions to global norms and international organisations. All the stakeholders (except for the business stakeholders) are in agreement about the global norms on anthropogenic climate change and about the adverse impacts of global climate change and agree that there is a need for collective action to address global climate change problems. There is also a much less polarised debate between stakeholders regarding the global norms and the influence of international organisations in Indonesia's climate change policy-making process. This is important because less opposition motivates the government to create domestic policy change.

The lower level of opposition from Indonesian stakeholders to global climate change norms and international organisations can probably be understood through two factors. First, international organisations have provided financial assistance for the government of Indonesia in relation to climate change mitigation programs. According to data from the Ministry of Finance, in 2011, 22 international donors contributed an estimated US\$3.851 billion to public finance flows in Indonesia in the form of climate change program loans and grants (Ministry of Finance, 2012). Most climate change program loans flow to state-owned enterprises as a form of low-cost project debt. Grants flow to private consultancies, NGOs, and other organisations involved in capacity building. Even though the funding disbursements are significantly lower than the commitments, international financial assistance helps the government of Indonesia achieve its ambitious emissions reduction goals. Second, it seems that global norms are less demanding for lower-income countries (non-annex 1) in terms of emissions reduction targets. According to the Paris Agreement, even though each country needs to submit their Nationally Determined Contributions (NDCs) to the UNFCCC after ratifying the Paris Agreement, there is still less opposition from lower-income countries, including Indonesia, because the emissions reduction targets are voluntary and there are no penalties if Indonesia does not achieve its emissions reduction target. Nevertheless, Indonesian stakeholders perceive that aligning with global climate change norms and international organisations provides strategic political advantages and aligns with the government's foreign policy goals (based on the interviews for this project).

## 5. CONCLUSION

The lofty international ambitions to reduce GHG emissions have motivated the government to produce domestic climate mitigation efforts that are linked to global norms. For example, a transnational advocacy coalition represented by international NGOs has created a transboundary climate network with domestic NGOs, which has motivated the Indonesian government to make an international commitment, and this has created pressure for domestic policy change. The ratification of the Paris Agreement followed by the submission of Indonesia's First Nationally Determined Contributions exemplifies this, showing that Indonesia has committed to serious efforts to combat global climate change under international principles and norms. However, this has also created internal and external pressure to align with domestic policy commitments. As one of the biggest GHG emitters in the world, Indonesia has a commitment to reduce its GHG emissions while at the same time, as a developing country, Indonesia has to maintain its economic growth. In practice, the commitments to reduce GHG emissions to the international community are in conflict with current domestic policy goals. Current economic development policy goals are focused on sectors and activities that are contrary to the GHGs reduction target. Instead of transforming carbon-intensive development towards a low-carbon trajectory, the Indonesian government has promoted sectoral policies which will produce more emissions. Domestic commitment to these policies has been significantly influenced by business stakeholders working in favour of their own interests.

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## **Regular Session: RS09.2 - Regional and urban policy**

**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/81342024716>**

**Chair Noriko Horie**

## CONTRIBUTION OF URBAN FACILITIES FOR REGIONAL SUSTAINABILITY THROUGH MUSEUM-LIKE FUNCTIONS

**[Noriko Horie](#)<sup>1</sup>, [Kiyoko Hagihara](#)<sup>2</sup>, [Fumiko Kimura](#)<sup>3</sup>, [Chisato Asahi](#)<sup>2</sup>**

<sup>1</sup>Bukkyo University, Japan. <sup>2</sup>Tokyo Metropolitan University, Japan. <sup>3</sup>Soka University, Japan

### ABSTRACT

Regional sustainability is an urgent issue in Japan, where population decline is rapidly progressing. An area cannot be maintained without urban facilities that support various activities. It is very difficult for an area with a population decline to maintain urban facilities because of the insufficient budget. However, needless to say, a budget is required to maintain urban facilities, but citizens' understanding and cooperation are also important. For example, in order to maintain a waste disposal system, it is necessary for people to properly separate garbage and make efforts to reduce waste. Furthermore, it is necessary to provide a budget for maintaining the system from waste collection to the final disposal. These are maintained by the understanding and cooperation of citizens who are the waste generators, taxpayers, voters involved in decision-making, and finally as residents accepting facility locations that are often regarded as so-called nuisance facilities. Urban facilities have multi-functions. They have not only their original functions but also wider functions, which are significantly important for the community, such as symbolizing the wisdom and hardship of the ancestors, cultural assets and local characteristic features. They make up the local landscape and convey the local memories. We think that urban facilities have museum-like functions. And we have been working on grasping the current situation through questionnaire surveys of water treatment facilities and waste treatment facilities. As a result, it was shown that many urban facilities have museum-like functions centering on exhibition education and they play an educational role in the area. There is a significant correlation between these functions and the amount of effort and the number of collaborations. The sustainability of the region, including population migration, population composition, and socio-economic activities, depends on "people". Urban facilities contribute to the sustainability of the community through efforts to work on "people" in addition to their original functions. Urban facilities serve as a base for raising interest in the region. And can nurture human resources which can deal with regional issues and contribute to improving the sustainability of the region. The significance of the museum-like functions of city facilities is as follows. The first is the role of disaster prevention education and environmental education for a wide range of citizens. The second is to convey local memories and lessons learned from ancestors and history. The third role is to provide a place for communication between citizens and city facility managers. For sustainability assessment, indicators such as the SDGs are presented. Education is emphasized in the SDGs, but the evaluation index is based only on school education. The contribution of urban facilities to local sustainability should be appropriately assessed by sustainability indicators. We need to consider assessing the contribution of urban facilities to local sustainability through museum-like functions.

## ON THE WORKING OF THE SOULFULIAN ON RISK SOCIETY: AN EMPIRICAL ANALYSIS OF THE KARAHORIAN, OSAKA, JAPAN

Kazuyoshi Hayama

Japan

### ABSTRACT

“SOULFULIAN” means people who survived the predicament. In this case, the predicament is about COVID-19. Because the current crisis is unprecedented. According to WHO(2020), On 31 December 2019, the WHO China Country Office was informed of cases of pneumonia unknown etiology (unknown cause) detected in Wuhan City, Hubei Province of China, and on May 3, 2020, The United States suspected that the source of the COVID-19 is China. However, the initial source of 2019-nCoV still remains unknown. So (first) wave and (first) silent wave and after first silent wave of COVID-19 is an academic area that is not well, completely, understood even among experts.

Digitization of information in all of its forms is one of the most developed things of the twentieth century.

This paper is about the COVID-19 for a sustainable clean region.

In the midst of the birth, after billions of years, the planet called Earth was formed. At the end of the twenty-first century, it will have been only a quarter of a millennium since computation emerged on Earth, which is a blink of an eye on an evolutionary scale—it's not even very long on the scale of human history.

But KARAHORIAN values human connections and the KARAHORI area continues to evolve sustainably from the end of the at least Muromachi (between 1336–1573) era period to this day of KARAHORIAN as the “SOULFULIAN” at the time of Corona (COVID-19) crisis.

For that reason, this paper investigated two things based on the historical perspective from the end of the Muromachi era period to the current of KARAHORIAN as the “SOULFULIAN” at the time of Corona (COVID-19) crisis, One is behavioral characteristics, and the others are about not masks-wearing people. The purpose is to discuss for the sustainable clean region, so discuss the effects of the first wave, first silent wave, second wave, second silent wave, third wave, third silent wave, and after these of COVID-19 in KARAHORI streets, Osaka, in Japan. This paper presents indicative the after Covid-19 data. The significance of this paper is the study of improves the environment and based to makes it a clean environment by preventing in the future and prevention.

This paper presents the transport data and not wear face masks data in times of crisis and concludes that there are no major prospects for an environmentally friendly recovery from the COVID-19 crisis unless there are adequate policies. The order of life takes place amid great chaos. It is significant to study the possibility of the future of a sustainable region based on the current data. It will become the assets to be studied in the future.

**PLACE-BASED SME FINANCE POLICY AND LOCAL INDUSTRIAL REVIVALS: AN EMPIRICAL ANALYSIS OF A DIRECTED CREDIT PROGRAM AFTER WW2**

**Keisuke Takano<sup>1</sup>, Hiroyuki Okamuro<sup>2</sup>**

<sup>1</sup>University of Tsukuba, Japan. <sup>2</sup>Hitotsubashi University, Japan

**ABSTRACT**

This paper examined the effects on the performance of local SMEs of a modernization fund program for small business enterprises implemented by Osaka Prefecture in the early 1950s. Utilizing firm-level panel data based on business credit reports, we empirically evaluated the effects of the program. We found an improvement in production levels among the recipients. In addition, recipients in sectors related to munitions production or in industrial agglomerations specialized in these sectors achieved additional or larger improvements in their production levels.

## **Special Session: SS18.3 - Urban Future in the Global South**

**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/84114610826>**

**Chair Abdul Shaban**

## 'JUGAAD' AND SOCIAL NETWORK OF BENGALI-SPEAKING MUSLIM MIGRANT WORKERS IN MUMBAI

Debangana Baruah

Tata Institute of Social Sciences, Mumbai, India

### ABSTRACT

The paper explores how a poor-landless Muslim community of Bengali-speaking migrant workers, who are originally from the state of Assam, migrate to the financial capital city of Mumbai. At home, they face hostility and communal persecution from the mainstream Assamese-speaking Hindu community based on the suspicion that this poor landless Bengali-speaking Muslim community is of Bangladeshi origin, and that they are illegal immigrants in the state of Assam. In reality, this community lives near the riverine areas of Brahmaputra. In Mumbai, most of these migrant workers' work in the informal sector as contractual labourers.

The paper investigates how the network mediates via the use of technology with the private/public agents to provide jobs by determining the demand and supply of information in the labour market. This information, which is provided via mobile phones, helps migrants to make alternative arrangements—jugaad—for themselves and their kin, thus making it possible for other potential labourers to also migrate. The peculiar kind of jugaad is embedded in the network, and it creates social capital for the members within it.

This new form of technology mediation has further their mobility by lending these urban spaces for them to practice the everyday urban experiences of the marginalized migrant workers who make efforts to claim the city amidst their precarious existence at its fringes. The network functions as the reservoir of their cultural identity and memory and compensates for the loss of social capital in the present climate of heightened xenophobia. Based on Bourdieu's social capital theory, the significance of social capital shapes migrants' agency to use, maintain, and reproduce their network. The essence of jugaad is to manifest their bargaining power to resist the powerful bureaucratic institutions and reclaim their right to the city.

Borrowing insights from the African context, De Sardan's idea of 'corruption complex' fits in the study. Engaging with the context of brokerage among Dalits in North India, the concept of technological mediation into state falls in the purview of my study, and it is important to look at how the moral economy of corruption takes place due to the struggle over state's resources.

Methodologically, the paper will adopt a bottom-up framework to understand the hierarchies within the migrant networks located in two Muslim neighbourhoods in South Mumbai, namely- Crawford Market and Masjid Bandar.

An ethnographic analysis will be conducted to understand the process of mobility in the city. These methods will be helpful in exploring migrant networks how they have been seen to expand over the years.

To this end, the paper investigates how the city creates a space for them, wherein the reproduction of networks is symbolic of their identity and is vital for the existence of their community.

## THE TRAJECTORY OF PLANNED URBAN DEVELOPMENT: A CASE STUDY ON RAJARHAT- NEWTOWN, KOLKATA

Angana Banerjee

India

### ABSTRACT

This article tries to figure out the how the co production of formal and informal place within the planned boundary of a metropolis has stimulated a mixed kind of place. Rajarhat-Newtown, a planned township located at the periphery of Kolkata, is an outcome of unwitting plan by the government of West Bengal in mind 1990s. The west Bengal government has denied its status of being a 'smart' city and declared it as a planned green city. Interestingly the place fragmented into formal city places with contradiction of unplanned village pockets within its planned boundary. This research will try to find out what factor has prompted the existence of village pocket within the planned area and the interaction between them. To understand the dilemma related to the existing village pockets urban ethnography was used as a method. To unfold about the existence of village pockets; historical narratives from the villagers, interview from the HIDCO officials, and the published secondary documents analyzed. This analysis helps to understand about whether those existing village pockets are example of neglect of planning or it is a legacy of planning? It also tries to answer "informality from the very heart of state and as an integral part of territorial practice of state power" (Roy, 2009). Therefore, this paper tries to reflect about the place is neither "smart" nor "planned". The transformation of rural place due to declaration of a planned township and the associated consequences will help to figure out the tyranny of planning and the trajectories of urban governance. Is this kind of urban development expands the city, transform rural places and generates a kind of mixed places (both urban and rural character) along the periphery of metropolis? It raises question in terms of planning, governance and sustainability. Thus it will help to understand the irony of planning, mapping-unmapping of a region and will try to figure out the actors and its interaction between how planned illegalities have reshaped a region and it helps to understand urban planning for India should be understood with the help of management of resources.

## TRANSCULTURATION AND COLLECTIVE IDENTITY IN SUBALTERN SPACES: URBAN DYNAMICS OF THE ETHNIC ENCLAVES OF CHITPUR ROAD FORMED BY MULTI-ETHNIC DIASPORA.

**Pritam Dey<sup>1</sup>, Paridhi Kedia<sup>2</sup>**

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<sup>2</sup>Anthropologist (Pursuing Majors), Independent Researcher, [paridhi.arch@gmail.com](mailto:paridhi.arch@gmail.com)

### ABSTRACT

City's today are agglomeration of multi-ethnic communities. Heterogeneity of sociocultural attributes, activities and everyday life differentiates old city from the more contemporary quarters which possess a higher degree of homogeneity. Older neighbourhoods of the city display a complex special semiotics where people appropriate the social space through active participation and asserting their presence in the socio-spatial domain. Diaspora shift is not a contemporary phenomenon but happened extensively in the past, as a result *glocalised*<sup>1</sup> spaces are formed. Humans are territorial, through cultural and social attributes they define the practical limit of physical territory and social meanings of existence. It creates an important process of self-definition and by differentiating the sense of self and non self they tend to claim agency in the physical environment. Streets, shops, pavements, living quarters are often customized acquiring an informal expression and social meaning, due to assemblage of people from diverse ethnic background and exercising a plethora of socio-economic processes creating ethnographic neighbourhoods. Thus, we realise there is a simultaneous negotiation between human activities and space that creates the phenomenology of the urban environment. Globalization in an old city like Calcutta has brought in diverse communities from across the globe who migrated along with their culture and occupational choice and settled within a distinct political boundary, thereby creating a diverse spatial semiotics in the everyday life on streets, shops, public spaces. Dynamics of capitalistic and neo-liberal urban aspirations are potentially posing as threats to the old quarters of cities of Global South.

**India's extensive economic and demographic growth queries what the old city cores (foundation cities, pre-industrial cities, precolonial cities) can become in the future? These cores with their remarkable diversified urbanity are today under a double transformation: abandoned by the middle class and subject to brutal physical change by capitalist transformations.**

2 anthropological perceptions of city could be understood in this kind of situation:

The interactional role studies behaviour lines that tie the social setting to the city and determine its evolution within a larger society. It would also reveal the performers of socio-cultural roles within an overall social organization.

The ideological ties, eg. *pattern of values that bind this sub altern society to the city*. Here, rules would be studied, those composed the cultural roles of ethnic enclaves and its diffusion from the smaller cultural society to the city.

The paper tries to **analyse the transcultural effect of the subaltern communities, their collective identity and attempts of legitimising presence in the city**. The conative, expressive, and phatic (Jacobson, 1960) expressions of spatial semiotics will be read along one of oldest streets of Calcutta-chitpur road.

The research uses an ethnographic method through direct observation and participation observation method. (A)

The next step would be to understand the symbiotic relation between and space and communities through interview.

The next step would be to understand **how collective identity and a hybrid socio-cultural perspective played an important role in shaping up the urban environment embodying a localized set of everyday practices, social customs, interactional relationships, and cultural meanings?**

*Glocalised*<sup>1</sup> - *Glocalization, first appeared in a late 1980s publication of the Harvard Business Review* At a 1997 conference on "Globalization and Indigenous Culture", sociologist [Roland Robertson](#) stated that glocalization "means the simultaneity – the co-presence – of both universalizing and particularizing tendencies.

### 1. INTRODUCTION

People makes place. It is the multi-layered activity and manifestation of everyday life processes that create a phenomenology of an urban space.

Globalization in an old city like Calcutta has brought in diverse communities from across the globe who migrated along with their culture and occupational choice and settled within a distinct political boundary, thereby creating a diverse spatial semiotics in the everyday life on streets, shops, public spaces. Dynamics of capitalistic and neo-liberal urban aspirations are potentially posing as threats to the old quarters of cities of Global South.

**India's extensive economic and demographic growth queries what the old city cores (foundation cities, pre-industrial cities, precolonial cities) can become in the future? These cores with their remarkable diversified urbanity are today under a double transformation: abandoned by the middle class and subject to brutal physical change by capitalist transformations.**

Kolkata (Calcutta till 2001) is indeed not such an old city, It was relatively a newly built city, founded during the colonial time by the British Raj in the XVII century (1690), constituting three villages Sutanati, Kalikata, and Gobindapur on the East bank of the Hooghly river. Chitpur Road is part of the native settlement, which grew, around the colonial town, Fort William. This native town was majorly occupied and appropriated by **merchants and craftsmen** coming from East Bengal but also from other provinces and countries. These two towns also received names: the colonial city, the 'White Town', opposed to the native town, the 'Black Town'. Nevertheless, the Indians researchers have criticized this distinction reminding the number important of interrelationships existing between the two societies (business, constructions, weddings, etc.). It leads to another concept for naming this urban situation: the 'Grey Town'.

Chitpur Road has been for 3 centuries the place to be for the merchants, craftsmen (business, vocations), middle class Bengali residents.

## 2. DIVERSITY OF CHITPUR ROAD IN TERMS OF SPACE, AGENCY AND SOCIETY

Chitpur road is characterized by successive urban enclaves organised around distinguished vocations and different kinds of bazars: merchants (textile and others products), craftsmen (blacksmiths, sculptors of marble, sculptors of idols, woodworkers), fruits and vegetable sellers (markets), printers (theatre posters, books), etc. All these occupations (or vocations) were originally based on communities from the same region and similar caste. Thus numerous ethnically diverse, cultural enclaves were formed along the stretch of the street. These communities produced a specific urban fabric called 'para' in Bengali - conceptually like the 'pol' of Ahmedabad or 'mohalla' in Varanasi, but practically they seem to be quite different. These 'para' - and for the smaller neighbourhoods '-tuli-' or '-tola' were organised socially and culturally, but they have been changing with time since post-independence era. However, the physical structure of 'para' around massive mansions of the then urban elites and bourgeoisie upper middle class still struggles to exist reminding an eclectic past.

So, these two aspects, which are even two main dynamics, have been structuring the Chitpur Road since the foundation:

- **The occupation:** Chitpur has always been the place to be for merchants and craftsmen (business, vocations).

**The multi-ethnic diaspora:** various ethnic groups of merchants and craftsmen, traders from across the globe (China, Israel, Persia, Afghanistan, Bangladesh, England) migrated and settled in Chitpur road creating a socio-culturally hybrid urbanity.

## 3. TENTATIVE METHODOLOGY

A

**The First step:** learning from Chitpur Road by making drawings on 'occupations (vocations)' attempting to express the physical space (architecture) as well as the activities (people working, living, etc.).

Identifying 7 distinctive diverse (socio-culturally and occupation wise) neighbourhoods along chitpur road. Identify type of activities existing (occupations, vocations), expressions of identity and both of these are juxtaposed in which kind of space (architecture) in the following scales.

- **the doorstep of a shop (occupations and architecture)**

- **from the doorstep to the façade of the building**

- **from the doorstep to the section of the building.**

In other words:

- **from the shop to the road, from the shop to the back storage, from street to courtyard, from ground floor to roof top.**

**The Second step:** A critical ethnographic analysis of the data and inferences revealed from the **First step** through a cross cultural frame of reference.

## **Special Session: SS27 - Discontent, Hate & Intolerant Attitudes**

**09:30 - 10:45 Wednesday, 26th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88689482335>**

**Chair Alessandra Michelangeli**

## THE GEOGRAPHY OF DISCONTENT OR THE DISCONTENT OF THE PEOPLE. EVIDENCE FROM INDIVIDUAL DATA FOR SOME EUROPEAN COUNTRIES.

Enrique López-Bazo

AQR–University of Barcelona, Spain

### ABSTRACT

At present, the world is going through rapid urbanization, which greatly affects the climatic condition of a particular area and human life within this region. The rapid growth of the urban population of developing countries in south-east Asia like China, India, Pakistan, Bangladesh, Indonesia, Malaysia, etc., heading towards unplanned and haphazard growth of urbanization, which altered the urban microclimate greatly. Urban areas face intensified heatwave conditions due to the Urban Heat Island (UHI) effect, which results from anthropogenic changes on both surface and atmospheric temperature patterns relative to the natural environment. (Arnfield, A. J., 2003). Asansol, the second-largest city in West Bengal after Kolkata, is experiencing a rapid urban growth rate. This rapid urbanization is negatively affecting the environmental condition, especially on the microclimatic condition of the city. Urbanization, Industrialization, the growing transportation sector, and coal mining activities uniformly produce greenhouse gases like CO<sub>2</sub>, CO, SO<sub>2</sub>, NO<sub>2</sub>, CH<sub>4</sub>, and CFC, dust particles leading to the greenhouse effect and rising temperature. Built-up areas and industrialization have increased the impervious land surface and emit poisonous gases for the greenhouse effect, which changed the micro climatic condition. This present study will bring out the relationship and effect of Land Use Land Cover changes spatiotemporally and relationship with Land Surface Temperature change. Land Use Land Cover map is prepared through Landsat satellite images of 1990 and 2020, and corresponding Land Surface Temperature is also calculated using thermal bands. Correlation of Land Surface Temperature (LST) with various spatial indices like Normalized Difference Vegetation Index (NDVI), Normalized Difference Water Index (NDWI), Normalized Difference Built-up Index (NDBI) have been measured, and it shows there is a significant and strong correlation with each other. Temperature patterns indicate a direct association with changing LULC patterns of the study area. The maximum and minimum temperature of 1990 were 37.37°C, and 16.25 °C respectively, which increased to 39.27 °C and 26.05 °C in 2020. This change is indicating a continuous increase in LST.

On the other hand, the built-up area has also increased from 8.86 to 22.87 percent, respectively, from 1990 to 2020, signifying natural land conversion to the built-up area. The average temperature increased to 5.85 °C during this period, indicating a significant change in temperature in the city. Nearly 22 %, i.e., 71.84 km<sup>2</sup> was under green cover in 2000, which has reduced to 17.05 %, i.e., 55.66 km<sup>2</sup> in 2010; so green space has lost 4.5 % only in 10 years (Siddique et al., 2020) which validate the impact of human on environmental change.

## THE URBAN-RURAL DIVIDE IN ANTI-EU VOTE: SOCIAL, DEMOGRAPHIC AND ECONOMIC FACTORS AFFECTING THE VOTE FOR PARTIES OPPOSED TO EUROPEAN INTEGRATION

[Laura de Dominicis](#)<sup>1</sup>, [Lewis Dijkstra](#)<sup>1</sup>, [Nicola Pontarollo](#)<sup>2</sup>

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### ABSTRACT

In recent years, protest voting, voting for populist parties and, specifically for Europe, votes for parties opposed to European integration, have increased substantially. This has focussed the attention of researchers and policy makers on the causes behind this trend. Most of the existing research looked at voters' characteristics, mainly values, education and age, or economic insecurity, such as rising unemployment or a declining economy more in general. This paper focuses instead on the urban-rural divide in anti-EU sentiment, and tries to explain why cities – and urban areas in general - in Europe tend to vote less for Eurosceptic parties. Using electoral data for national elections at the electoral district level for the years 2013-2018 and political parties' orientation as assessed by the Chapel Hill Expert Survey, we find robust statistical evidence of a lower anti-EU vote in cities, towns and suburbs than in rural areas. We also find that drivers of voting for anti-EU parties differ significantly between urban and rural areas in the EU and UK, despite some similarities. We show that three factors are associated to a higher anti-EU vote in all areas: growth in unemployment, a low turnout and a higher share of people born outside the EU. A sluggish economy is associated to a higher anti-EU sentiment in rural areas, but not in cities and towns and suburbs. Higher shares of university graduates, people aged 20-64, and of people born in a different EU country reduce anti-EU voting in rural areas and towns and suburbs, but have no impact in cities.

### KEYWORDS

Euroscepticism; anti-system voting; urban-rural divide; economic insecurity; voters' socio-demographic characteristics

### 1. INTRODUCTION

In recent years, anti-EU voting has emerged as an electoral force in Europe. Lack of trust in the European Union (EU) passed from around 25% in the mid-2000s, to around 45% in the late 2010s (source: Eurobarometer Survey; see also Dijkstra et al., 2020). This growing lack of trust in the EU can also be seen in the growing votes for parties that were against EU integration. Between 2013 and 2018, around 13% of voters in EU national elections cast their votes for parties strongly opposed or opposed to European integration. This figures increased to around 27% if we consider also parties moderately opposed to European integration (Dijkstra et al., 2020). Against this background, a large body of research has rapidly emerged in Europe trying to explain this phenomenon, whether analysing country specific voting, as in the case of the Brexit referendum to leave the EU (Alabrese et al., 2019; Abreu and Öner, 2020) or looking at the EU as whole (Lechler, 2019; Dijkstra et al., 2020). In particular, we can distinguish between two approaches. A first approach highlights that individual characteristics, such as income, education and age, or cultural factors such as political orientation and tolerance towards immigrants, drive anti-EU sentiment (Schoene, 2019; Schraff, 2019). A more recent strand of the literature, initiated by Dijkstra et al. (2020), extends previous research by including geography as an additional driver of anti-EU sentiment, originating what is well-known as the Geography of EU discontent.

In the present work, we go one step further by trying to explain the causes behind a potential urban-rural divide in anti-EU voting in Europe, a phenomena widely studied in the context of rising populism in the United States (see for example Rodden, 2019), but which received little attention so far in Europe.<sup>67</sup> Recent studies, mainly in the field of political science, and often based on country-specific analyses, have suggested that rural, suburban and peripheral areas are more likely to be influenced by populist parties (Scoones *et al.* 2018; Mamonova and Franquesa, 2020). Particularly after the great crisis, the socio-economic urban-rural divide in the EU became a focus of debate. The 2019 Eurostat Statistical Yearbook (European Commission, 2019), for instance, reports that rural areas, as well as towns and suburbs, if compared to cities, show a considerable digital skills divide. An urban-rural split is observable also in population trends, with the majority of urban regions reporting population growth, and many peripheral, rural and post-industrial regions a decline. A gap is noticeable also on health perception, with a higher proportion of people living in cities that perceive their own health as good or very good. Finally, in at least half of EU Member States self-employed persons in rural areas are not satisfied with their job, possibly because they are self-employed due to lack of other options. For the case of the United States, research has focussed on the concept of “great inversion”, referring to once prosperous rural regions and middle-to-small

<sup>67</sup> See for instance Schoene (2019) for the EU, and Marcinwiewicz (2018) for Poland.

metropolitan areas that suffered a (relative) economic and/or employment decline, (see Moretti 2012; Rodden, 2019). It has also been linked to a “populist explosion” (Judis, 2016), with small towns in rural and peripheral regions becoming reservoirs of populist resentment (Cramer, 2016). For Europe, Dijkstra et al. (2020) show that rural areas and small towns are more Eurosceptic than bigger cities, while Gordon (2018) identifies a greater support for populist parties in non-urban areas (countryside or village). On the other hand, the results of Schoene (2019) support the position of Essletzbichler et al. (2018), who posit that the geographies of the electoral rise of anti-system parties are more complex than the rural-urban differences in populist vote shares.

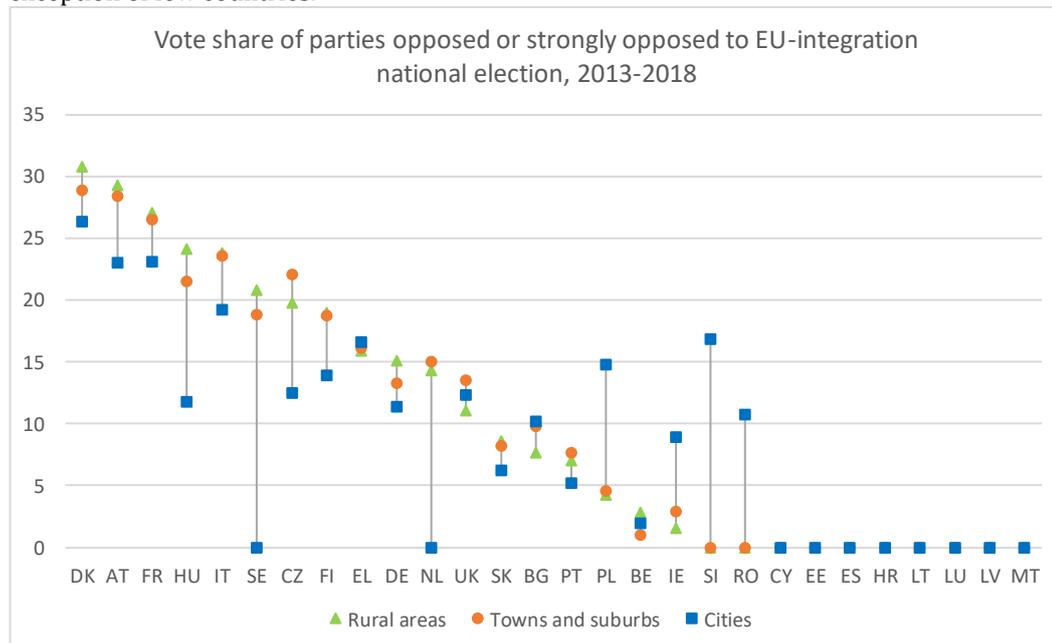
In what follows, we try to answer to three questions: [i] do urban areas in the EU and UK vote more or less than rural areas for parties that are opposed or strongly opposed to European integration? [ii] what are the territorial roots of anti-EU voting? and [iii] do they differ between urban and rural areas?

The paper is organized as follows. Section 2 shows that the vote share of anti-EU changes according to the place where people live, and tend to increase when we move from cities, to towns and suburbs, to rural areas. Section 3 explains the methodology and data used to analyses the drivers of anti-EU votes. Section 4 presents the econometric specification and describes the results. Section 5 concludes.

**2. ANTI-EU VOTING BY DEGREE OF URBANIZATION**

Firstly, we look at whether in Europe we can talk of an urban-rural divide when it comes to voting preferences for parties that are opposed to European integration. To do so, we first classify all 63,231 electoral districts in the EU and the UK into three categories (Dijkstra and Poelman, 2014): i) cities or large urban areas (for a total of 2,172 electoral districts), ii) towns and suburbs (9,452 electoral districts), and iii) rural areas (51,607 electoral districts).<sup>68</sup> When referring to urban areas, we refer to cities plus towns and suburbs. Voting data in our analyses cover all national elections that had taken place in the EU and UK between 2013 and 2018. Party positioning on European integration comes from the assessment made in 2014 and 2017 by the Chapel Hill Expert Survey. In the survey, political parties received a score between 0 (European integration not at all important) and 10 (European integration extremely important) with respect to their position with respect to European integration. Following Dijkstra et al. (2020), we consider as anti-EU vote the share of votes obtained by parties opposed and strongly opposed to European integration (i.e parties receiving a score below 2.5).

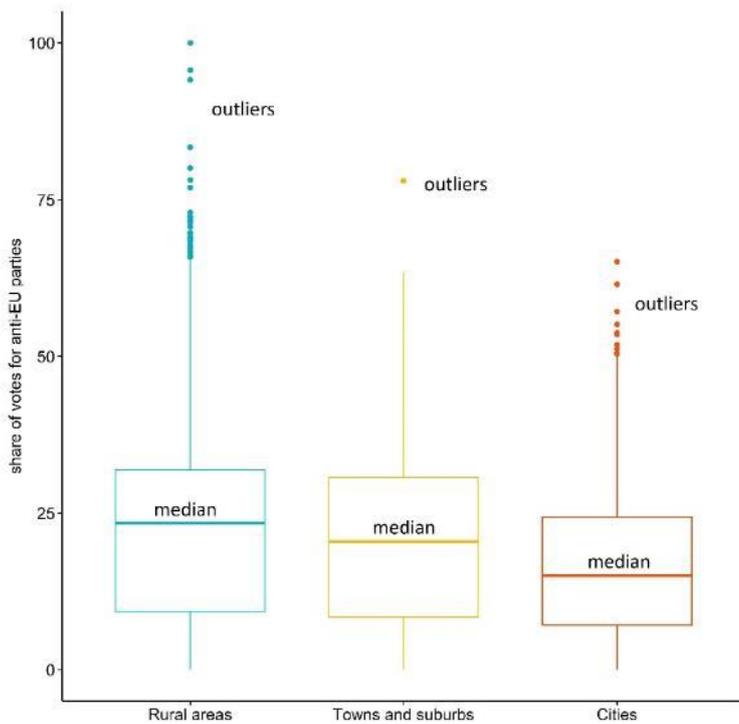
Figure 1 shows, for example, that votes for anti-EU parties in the EU and UK are consistently lower in cities, with the exception of few countries.



**Figure 1: Vote share of parties opposed or strongly opposed to EU-integration in national election, 2013-2018**

When considering all electoral districts, without referring to the country where the elections have taken place, we observe that in cities, and in towns and suburbs, people tend to vote less for anti-EU parties than in rural areas. The median vote for parties opposed and strongly opposed to the EU decreases with the degree of urbanization of the electoral district. The median vote for Eurosceptic parties is 23.4% in rural areas; it declines to 20.5% in towns and suburbs, and further decreases to 15% in cities (Figure 2).

<sup>68</sup> Cities or large urban areas if at least 50% of the population lives in high-density clusters. Towns and suburbs if less than 50% of the population lives in rural grid cells and less than 50% lives in high-density clusters. Rural areas, if more than 50% of the population lives in rural grid cells. The classification considers as basic units of classification 1 km<sup>2</sup> grid cells. Rural grid cells are the grid cells outside urban clusters. Urban clusters are those clusters of contiguous grid cells of 1 km<sup>2</sup> with a density of at least 300 inhabitants per km<sup>2</sup> and a minimum population of 5,000. High-density cluster are contiguous grid cells of 1 km<sup>2</sup> with a density of at least 1,500 inhabitants per km<sup>2</sup> and a minimum population of 50,000.



**Figure 2: Boxplot of the share of the vote for parties opposed or strongly opposed to European integration (2013-2018) by degree of urbanisation**

We also check whether there are statistically significant differences between the mean values of anti-EU votes in the three types of areas, using an Analysis of variance (ANOVA) methodology. Our (null) hypothesis is that the average vote for Eurosceptic parties is equal in urban and rural areas, meaning that there is no relationship between the type of territory (whether it is urban or rural) and the propensity of voters to support Eurosceptic parties. The alternative hypothesis is that not all the means for the three area types are equal, and that there is a relationship between the type of area and the propensity to vote for Eurosceptic parties. Results in Table 1 confirm that the variation of the share of votes for parties opposed and strongly opposed to European integration among different areas is much larger than the variation within each type of territory. This finding corroborates our initial hypothesis of a significant relationship between votes for Eurosceptic parties and whether an electoral district can be identified as rural or urban.

**Table 1: ANOVA for votes for parties opposing and strong opposing European integration and degree of urbanisation**

	Degrees of freedom	Sum of Squares	Mean Squares	F-test
Degree of Urbanisation	2	71,67	35,83	183***
Residuals	63,23	12,377,573	196	

Notes: \*\*\* p-value<0.01, \*\* p-value <0.05, p-value \*<0.10.

One limit of the previous analysis based on a standard ANOVA is that, however, it does not show which typologies of electoral districts are different from the others. To overcome this, a Tukey test is used (Table 2). The test performs multiple pairwise-comparisons between the means of the three groups and shows significant difference in Eurosceptic vote between each pair of type of areas. Results show that the vote for Eurosceptic parties is significantly higher in rural areas than in towns and suburbs and cities, and that in towns and suburbs it is higher than in cities. In cities, the support for anti-EU parties is around 5.5 percentage points lower than in rural areas. In towns and suburbs, the support for anti-EU parties is around 1.3 percentage points lower than in rural areas. The difference between cities and towns and suburbs corresponds to 4.1 percentage points.

**Table 2: Tukey test: votes for parties opposing and strong opposing European integration by Degree of Urbanisation**

	Percentage points difference	Lower	Upper
Towns and suburbs areas vs. Rural areas	-1.3	-1.7	-1.0***
Cities vs. Rural areas	-5.5	-6.2	-4.7***
Cities vs. Towns and suburbs	-4.1	-4.9	-3.4***

Notes: \*\*\* p-value<0.01, \*\* p-value <0.05, p-value \*<0.10.

### 3. DRIVERS OF ANTI\_EU VOTING: METHODOLOGY AND DATA

As a second step, we empirically investigate the drivers of anti-EU voting, with a focus on whether there are similarities or differences across cities, towns and suburbs, and rural areas. We correlate the share of votes for anti-EU parties, at the electoral district level, with a set of potential explanatory variables. We perform the analyses for the full sample, and by looking separately at cities, towns and suburbs and rural areas. Following Dijkstra et al. (2020), we estimate the following equation:

$$AEV_{r,2013-2018} = \alpha + \beta X_{r,t} + \nu_c + \varepsilon_{r,t} \quad (1)$$

where  $AEV_{r,2013-2018}$  is the share of the vote for parties opposed and strongly opposed to European integration in national legislative election that took place between 2013 and 2018. The terms  $r$  and  $t$  denote *constituency* (i.e. electoral district) and *time*, respectively. The vector  $X_{r,t}$  contains a set of explanatory variables identified by the literature as potential drivers of populist vote. Finally,  $\varepsilon_{r,t}$  denotes the error term.

Due to data limitation, our explanatory variables on the right-hand side of equation (1) are observed at different levels of territorial aggregation (i.e. electoral districts, NUTS3 regions and for a few indicators NUTS2 regions<sup>69</sup>). We estimate our model via Ordinary Least Square (OLS), and we cluster the standard errors at the NUTS 3 level of territorial aggregation, to correct for the fact that variables are observed at different territorial scales.<sup>70</sup> In order to capture country dynamics, we include country specific effects,  $\nu_c$ . In addition, a Chow test is performed to check whether the coefficients calculated for each type of area (namely, cities, towns and suburbs, and rural areas) are significantly different from the estimates for the full sample.

Based on the existing empirical literature on anti-system and populist vote, we identify four groups of drivers of Euroscepticism: *Regional economic variables*, *regional socio-demographic variables*, *electoral district characteristics* and *electoral variables*.

Recent studies based either on microdata (Jennings et al., 2016; Ramiro, 2016) or data aggregated at electoral district or regional level (Algan et al., 2017; Nicoli, 2017; Gordon, 2018; Essletzbichler et al., 2018; Dijkstra et al. 2020, Lechler, 2019; Schraff, 2019; Guiso et al., 2018) show that economic and socio-demographic factors, such as age, education, unemployment and wealth drive anti-system and anti-EU voting. Therefore, we control for:

#### Regional economic variables

- *GDP per capita* and *GDP per capita growth*. These two variables approximate the local economic conditions and the dynamics over time, respectively. The role of GDP per capita has been highlighted by Schraff (2017) who, combining European Social Survey data (ESS) with regional level data, finds that disadvantaged poor regions and middle-income regions show significantly higher probabilities of Eurosceptic voting, a result confirmed more recently by Dijkstra et al. (2020). In addition, wealth can also be associated to a higher propensity to cast votes for anti-EU parties, in those countries or regions where voters, for instance, may believe they do not need the EU, as their national governments are able to provide them what they need (Dijkstra et al., 2020). Average GDP per capita and GDP per capita growth are calculated over the years 2002-2014 and are defined at NUTS3 territorial level (Source: Eurostat).
- *Unemployment rate* and *change in unemployment rate*. The inclusion of this variable finds justification on the fact that rising unemployment is one of the main factors behind recent populist votes in Europe (Emmenegger et al, 2015; Nicoli, 2017; Guiso et al., 2018 and 2020; Algan et al., 2019). Using data from the European Social Survey (ESS), Lechler (2019) finds that regional employment growth is a causal factor for forming attitudes towards the European Union and reduces voting for Eurosceptic parties.

The two variables are calculated as the average over the period 2002-2014 and are defined at NUTS2 level of territorial aggregation (Source: Eurostat).

#### Regional socio-demographic variables

- *Age structure* is proxied by including the share of the population by age group 20-39, 40-64 and 65 and over in the total population, observed in 2017, and is defined at NUTS3 level. In the empirical literature on factors driving populist vote, age is often used as a control variable, but not often by looking at different age-groups of the population. In our case, similarly to Jennings et al. (2016), we aim at checking not only for the Euroscepticism of the different cohorts, but also for the differences according to the degree of urbanisation. To avoid multicollinearity issues, as there is very strong correlation between age groups, we include each one at the time. This serves also as a robustness check with respect to the other variables.
- *Education* consists in the share of adults (25-64) with a tertiary education, observed in 2017, at the NUTS2 level. Following the recent literature (see Dijkstra et al. 2020; Lechler, 2019; Schraff, 2019, among others), highly educated voters are expected to support less anti-EU parties, as they have on average better jobs and a more

69 The nomenclature of territorial units for statistics (NUTS) is a classification for the EU and the UK providing a harmonised hierarchy of regions. The NUTS classification subdivides each Member State into regions at three different levels, covering NUTS 1, 2 and 3 from larger to smaller areas. For more details, see: <https://ec.europa.eu/eurostat/web/nuts/background>

70 As Moulton (1986) shows, when the nesting of observations within geographical units is not considered, the unobserved characteristics that individuals share within this unit are not accounted for, leading to an underestimation of the standard errors of the dependent variables, due to the within-group (intra-class) correlation across individual units.

cosmopolitan view, in opposition to lower educated voters that, according to Gordon (2018), are more likely to support more localist and anti-establishment parties.

- *Share of population born in a different EU Country and share of population born outside EU.* The two variables are defined at NUTS 3 level of territorial aggregation (reference year 2011). Barone et al. (2016) find that immigrants have a causal effect on increasing votes for the centre-right coalition and on the rising of protest votes in Italy, in particular in smaller municipalities. Hartevelde et al. (2018) demonstrate that the number of asylum applications in EU Member States did affect Euroscepticism in countries where it had increased. The relevant channels are cultural diversity, native-immigrant competition in the labour market and in the access to public services (Norris and Inglehart, 2019). Nicoli and Reinl (2020) confirm the result for European regions. In our empirical setting, instead of using a single variable regarding immigration, like in Barone et al. (2016), we distinguish migrants according to their place of origin. Population born in a different EU country has a different profile than those born outside the EU. For example, people born in another EU country are more likely to be employed than those born in that country, while people born outside the EU are less likely to be employed. Countries such as Portugal, Spain, France and Italy have seen an inflow of affluent retirees from colder Western European countries. The freedom of movement within the EU also means that people can easily move back to their country of birth or to another EU country, if the economic situation changes. This is much more complicated and costly for immigrants from more distant countries or countries experiencing conflict. Given the higher economic integration of the population born in another EU country, we expect that it will reduce voting for anti-EU parties. Compared to people born in another EU country, people born outside the EU may also stand out more because a higher share of them may have a different skin colour and may adhere to a religion with a distinct dress code. In several EU countries, Muslims and/or Jews have been cast in a negative light by populist parties. As a result, a high *share of population born outside EU* could be linked to a higher vote share for anti-EU parties.

## Electoral districts characteristics

We follow Rodríguez-Pose (2018) and Dijkstra et al. (2020) and control for:

- *Neighbourhood density*, calculated for each electoral district using the density (reference year 2011) of 1 km<sup>2</sup> grid cells. For each cell, density is multiplied by the population count. The products are summed by electoral district and divided by the total population of the district, providing a measure of spatial concentration. The advantage of using this methodology compared with the simple ratio between population and area is that this measure of density is not affected by the size of the geographic units for which it is calculated and approximates the average density of neighbourhood where residents live. Indeed, given the way in which population-weighted density is constructed, two constituencies with the same size and population where the first has very sparse population and the second very concentrated, will have very different population densities: very high the first, and very low the second. This also adds a differentiation within the three Degrees of Urbanisation. It will distinguish large from small cities, towns from suburbs, and villages from other rural areas. This variable has been rescaled (the original value has been divided by 100) to make the magnitude of the estimated coefficients interpretable.
- *Road performance* is measured using the indicator recently introduced by Dijkstra et al., (2019), which combines accessibility and proximity into an overall metrics of road performance. Thanks to the high spatial resolution at which it can be computed, this measure allows to analyse and compare road performance among different types of settlements (cities, rural areas and towns and suburbs). As for GDP, road performance can be a proxy of the stage of development of an economy. It may also contribute to a higher confidence in national than EU institutions, which has been shown to contribute to anti-EU votes (De Vries 2018).<sup>71</sup>

## Electoral variables

The last group of variables includes *turnout*, defined as the number of valid votes expressed as a percentage of the total number of eligible voters, and conceived as another way to express dismay or approval of the EU (Guiso et al. 2018) and the share of votes going to parties not included in the waves 2014 and 2017 of the Chapel Hill Expert Survey (CHES).

## 4. RESULTS

Results based on the full sample show that a combination of socio-demographic and economic factors are the main drivers of anti-EU votes in the EU and UK, which is in line with the literature (Goodwin et al. 2016). On average, electoral districts with a more educated workforce and a higher share of population aged 20 to 39 vote less for anti-EU parties in all three OLS regressions (see Table 3). In contrast, a higher share of population aged 40 to 64 increases the anti-EU vote, which suggests that the generational divide happens at an early age than retirement age. Growing unemployment rates has a highly significant link to a higher share of vote for anti-EU parties in all three regressions. A relative economic decline is also linked to a higher share of anti-EU voting, but it is not significant in one regression and less significant than changes in unemployment in the other two regressions. The level of unemployment and the level of GDP per capita both have no significant impact. Higher weighted population density (or neighbourhood density) reduces anti-EU voting and efficient, well-functioning road network increases it.

<sup>71</sup> For more details on the methodology, see Dijkstra et al. (2019)

A recent study finds that the inflow of asylum seekers into the EU has increased Euroscepticism (Harteveld et al., 2018), while a number of studies conclude that concerns about immigration are the main drivers of support for radical right parties, for which a common factor is a strong aversion toward the EU (Evans and Mellon, 2016 and 2019; Hobolt and Tilley, 2016). Our results show that the presence of migrants is associated to a higher anti-EU vote, but only for migrants from outside the EU. In contrast, the presence of migrants from other EU countries leads to a lower support for anti-EU parties.

Higher neighbourhood densities lead to lower anti-EU voting in all three regressions, which fits with the significant differences found between cities, towns and suburbs, and rural areas. Better road performance, on the other hand, is linked to more anti-EU voting in all three regressions. As in other studies, higher turnout leads to a lower share of anti-EU votes.

**Table 3: OLS Estimation results for the full sample**

	(1)		(2)		(3)	
Intercept	51.74 (4.70)	***	16.48 (12.37)		36.31 (5.93)	***
GDP per capita (2014)	0.01 (0.02)		-0.01 (0.02)		-0.00 (0.02)	
Change GDP per capita (2002-2014)	-1.09 (0.58)	*	-0.87 (0.58)		-1.29 (0.60)	**
Unemployment Rate (2015)	-0.07 (0.14)		-0.16 (0.14)		-0.16 (0.15)	
Change unemployment Rate (2002-2014)	0.72 (0.22)	***	0.71 (0.23)	***	0.72 (0.22)	***
Population born in a different EU country (share, 2011)	-0.75 (0.23)	***	-0.79 (0.25)	***	-0.73 (0.23)	***
Population born outside EU (share, 2011)	0.890 (0.15)	***	0.874 (0.18)	***	0.802 (0.16)	***
Population aged 20-39 (share, 2017)	-0.53 (0.17)	***				
Population aged 40-64 (share, 2017)			0.67 (0.31)	**		
Population aged 65+ (share, 2017)					0.20 (0.14)	
Population with tertiary educated (share, 2017)	-0.22 (0.10)	**	-0.20 (0.10)	**	-0.195 (0.10)	**
Neighbourhood density (2011)	-0.05 (0.01)	***	-0.06 (0.01)	***	-0.06 (0.01)	***
Road performance	0.04 (0.01)	***	0.03 (0.01)	***	0.04 (0.01)	***
Turnout	-0.08 (0.03)	***	-0.08 (0.03)	***	-0.08 (0.03)	***
Share of vote no CHES	-0.22 (0.03)	***	-0.30 (0.04)	***	-0.22 (0.03)	***
Observations	62,900		62,900		62,900	
Country dummies	yes		yes		yes	
R-squared (Adjusted)	0.65		0.65		0.64	
Chow test	4084.51		4087.37		4046.99	
(p-value)	(<0.001)		(<0.001)		(<0.001)	

Notes: \*p<0.10; \*\*p<0.05; \*\*\*p<0.01. Standard errors clustered at NUTS3 level in parenthesis.

The Chow-White test rejects the joint null hypothesis of structural stability among areas, further corroborating our initial hypothesis that it is meaningful to analyse drivers of anti-EU voting separately for urban (cities, towns and suburbs) and rural areas. Table 4 examines how differences in the degree of urbanisation across European territories shape the level of anti-European voting at electoral district level in national elections.<sup>72</sup> It shows that, among the economic factors, GDP per capita level has no effects on anti-EU vote, while its growth decreases anti-EU vote in rural areas. As expected, unemployment growth is positively and significantly correlated to the share of Eurosceptic vote, and this happens regardless of the type of area. On the other hand, high unemployment levels are significantly linked to lower anti-EU voting in cities and in towns and suburbs. This puzzling result is not new in literature and the possible causes are well-explained by Nicoli (2017). The author observes that “*although several northern countries have enjoyed low levels of*

<sup>72</sup> Our data has a hierarchical structure, due to data availability, with variables measured at different levels of territorial aggregation. To check for the robustness of our results, we performed additional estimates using a multilevel model (Hox, 2001). We estimated three alternative specifications of a multilevel model: [i] the first model includes country random effects, [ii] the second model is estimated at the NUTS3 level of territorial aggregation (i.e. electoral districts are aggregated at a larger territorial scale, the NUTS3) and country random effects, and [iii] a third model has NUTS3 nested within NUTS2 and controls for country random effects. Independently from the estimation technique used, the coefficients are found to be robust both in term of sign, magnitude and significance. For a discussion, see McNeish et al. (2017) and Primo et al. (2007). Results are available upon request.

unemployment, they have nonetheless developed strong Eurosceptic parties in opposition to bailout programmes for southern states (for example, the case of Finland's True Finns). In contrast, Southern European countries with very high levels of unemployment have seen the electoral emergence of Eurosceptic forces only some years after the beginning of the crisis (Italy after 2013; Spain in 2014). The results seem to suggest that voters attribute the responsibility in failing to address the crisis to the EU rather than blaming it for the crisis itself." (Nicoli, 2017: page 324). Furthermore, given that he finds a positive correlation between the unemployment rate and non-zero net contributions to the financial support measures, he hypothesizes the existence of a domestic effect of economic governance.

Lechler (2019) shows that the share of EU migrants significantly and positively shapes individuals' attitudes toward the EU, while the share of non-EU migrants does not have any significant effects. Our results show that the presence of immigrants has a significant impact in towns and suburbs and in rural areas, but not in cities. The impact in those areas is in line with our expectations. Areas with a higher share of population born in a different EU country have lower votes for Eurosceptic parties, which may be because they are more likely to have a job than the native born and tend to stand out less. Areas with a higher share of people born outside EU have higher share of anti-EU votes, which may be related to their lower employment rates and/or their visible differences.

Cities have a much higher share of people born in another country (17% of the population of 15 and older in 2019 in the EU28) than other areas do (12% in towns and suburbs, and 6% in rural areas). As a result, people in cities may be more accustomed to living with people born in other countries. This may explain why the share of population born in another EU country has no significant impact and the share of population born outside the EU has a weak and less significant impact. If the link between the share of people born outside the EU and anti-EU voting is primarily driven by economic concerns, then boosting employment growth and increasing the economic integration of people born outside the EU could lead to less anti-EU voting both directly, by reducing unemployment, and indirectly, by addressing economic concerns linked to immigration. If this link is primarily driven by a discomfort with visibly different populations, a purely economic policy will not address this problem.

As is the case in other research, we also found that a higher share of younger people (20-39 years old) implies a lower vote share for anti-EU parties, but only in town and suburbs and in rural areas. On the other side, the share of people aged 40-64 has significant and positive impact at 5% level in towns and suburbs, and at 10% in rural areas. Only in cities does the share of people 65 and older have a significant positive affect on anti-EU voting. We draw from these results that in cities what matters is the share of older people, while in town and suburbs and in rural areas it is the share of younger and the middle aged. In the first case, it is possible that older age people feel uncomfortable with the rapid changes in cities and react by voting against further EU integration. On the other hand, in town and suburbs and in rural areas, youngers tend to vote pro EU, as they may perceive more directly the advantages of EU integration (for instance, in terms of travel opportunities, and study exchange programs). Population aged 40 to 64 in town and suburbs may be concerned about their income and employment prospects as technological change and trade affects some areas and industries more than others.

Following the same logic, tertiary education reduces Euroscepticism in such areas by increasing people's chances to secure a good job or find a new one. Cities have the highest share of tertiary educated (42% in 2019 as a share of people aged 25-64), compared to towns and suburbs (29%) and rural areas (24%). Since 2012, the share of tertiary educated has been increasing in all three areas, but faster in cities. This lower growth in tertiary educated outside cities may lead to a wider gap in the perceived benefits of the EU or in the capacity to benefit from the opportunities offered by EU membership. This may explain why education has not impact on anti-EU voting in cities, but reduces it in towns, suburbs and rural areas. Significance levels are slightly lower than for other variables, but this may due to low spatial resolution of that data (NUTS-2).

High population-weighted or neighbourhood density reduces anti-EU voting for all three types of areas, except in cities when controlling for the share of population aged 65 and over. This means that villages are less likely to vote anti-EU than other rural areas, that towns are less anti-EU than suburbs and that large cities are less anti-EU than smaller cities. It is striking that not only does anti-EU voting in general decreases as densities rise, but this pattern is also found within each type of area.

Road performance is also positively and highly significantly linked to anti-EU voting. This road performance indicator compares the population that can be reached in a 90 minute drive to the population within a 120 km radius. The combination of a concentrated population with a dense road network including highways will the higher the road performance. The positive impact of the road performance on anti-EU voting shows that it is not the lack of road infrastructure that leads to anti-EU voting. On the contrary, within each degree of urbanisation the lack of a performant road network is linked to less anti-EU voting. People in areas with a poor road performance may think that their area needs more public investment, which may make them more supportive to the EU and the transport investments it funds. It may also be related to a pattern found in recent papers where higher GDP is associated to higher anti-EU sentiment (see Dijkstra et al., 2020). As for GDP, road performance can be a proxy of the stage of development of an economy and may contribute to a higher confidence in national than EU institutions, which has been shown to contribute to anti-EU votes (De Vries 2018).

Finally, in contrast with Lecher (2019), turnout has a significant and negative impact on anti-EU vote shares. In other words, the higher the turnout, the lower the vote for anti-EU parties. Our finding is more in line with but in line with Guiso et al. (2018), who find that a higher turnout translates into less votes for populist parties.

Table 4 reports the complete set of results, while Table 5 summarises the main findings.

Table 4: OLS Estimation results by type of area (for reference years of the variables, see Table 3)

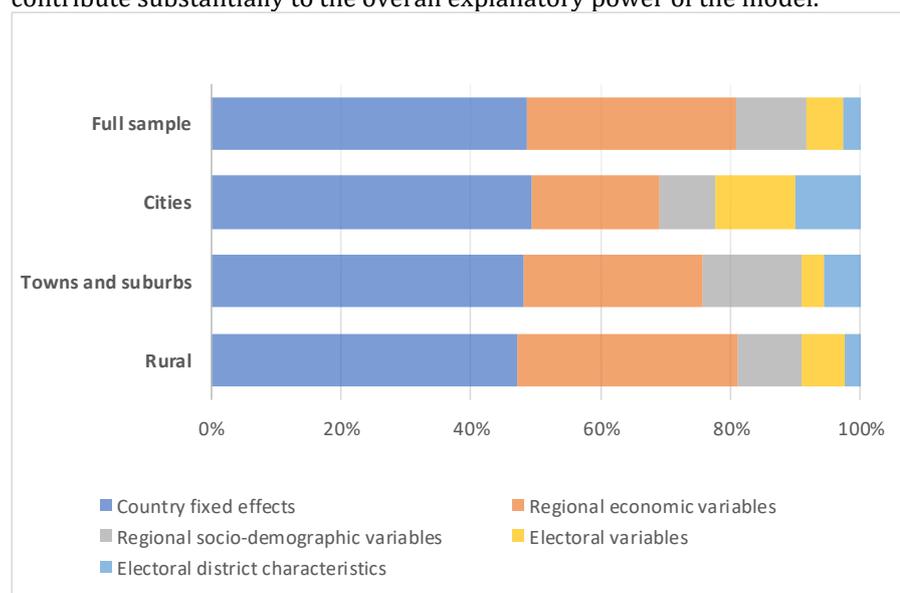
	Cities			Towns and suburbs			Rural areas		
	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)
Intercept	52.19 ** (5.67)	45.56 * (13.05)	35.46 * (8.63)	60.92 * (6.29)	13.29 (17.47)	44.43 * (8.73)	50.88 * (5.21)	18.75 (13.52)	34.36 * (6.54)
GDP per capita	-0.02 (0.02)	-0.02 (0.02)	-0.00 (0.03)	0.00 (0.02)	-0.01 (0.02)	-0.01 (0.03)	0.02 (0.03)	-0.01 (0.02)	0.00 (0.03)
Change GDP per capita	-0.23 (0.52)	-0.34 (0.53)	-0.37 (0.52)	-0.13 (0.66)	0.12 (0.63)	-0.25 (0.69)	-1.25 (0.64)	-1.07 (0.66)	-1.48 (0.64)
Unemployment Rate	0.661 * (0.16)	-0.716 * (0.16)	0.449 * (0.17)	-0.534 * (0.18)	-0.623 * (0.17)	0.723 * (0.20)	0.107 (0.15)	-0.018 (0.14)	0.021 (0.16)
Change unemployment rate	0.676 ** (0.28)	0.666 ** (0.28)	0.794 * (0.26)	0.700 * (0.27)	0.627 ** (0.28)	0.653 ** (0.28)	0.700 * (0.23)	0.688 * (0.24)	0.704 * (0.23)
Born in different EU country	0.021 (0.23)	-0.070 (0.22)	0.147 (0.21)	-0.688 (0.29)	-0.746 ** (0.30)	0.646 ** (0.28)	-0.806 * (0.24)	-0.808 * (0.28)	-0.772 * (0.24)
Born outside EU	0.21 * (0.12)	0.18 (0.13)	0.27 ** (0.12)	0.76 * (0.21)	0.79 * (0.23)	0.66 * (0.22)	1.00 * (0.17)	0.94 * (0.19)	0.92 * (0.18)
Population aged 20-39	-0.20 (0.14)			-0.66 (0.2324)			-0.56 (0.19)		
Population aged 40-64		0.10 (0.27)			0.91 ** (0.42)			0.58 * (0.34)	
Population aged 65+			0.48 ** (0.19)			0.12 (0.20)			0.23 (0.14)
Tertiary education	-0.10 (0.09)	-0.12 (0.09)	-0.09 (0.09)	-0.26 (0.11)	-0.26 ** (0.11)	-0.24 ** (0.12)	-0.21 ** (0.10)	-0.18 * (0.10)	-0.18 * (0.10)
Neighbourhood density	-0.04 * (0.01)	-0.04 * (0.01)	0.04 * (0.01)	-0.06 * (0.01)	-0.05 * (0.01)	-0.06 * (0.01)	-0.08 ** (0.03)	-0.09 ** (0.03)	-0.09 ** (0.03)
Road performance	0.07 * (0.02)	0.07 * (0.03)	0.07 * (0.02)	0.06 ** (0.02)	0.05 ** (0.03)	0.06 ** (0.02)	0.04 * (0.01)	0.03 * (0.01)	0.04 * (0.01)
Turnout	-0.32 * (0.07)	-0.33 * (0.07)	-0.34 * (0.07)	-0.15 ** (0.07)	-0.15 ** (0.07)	-0.14 ** (0.07)	-0.08 * (0.02)	-0.07 * (0.03)	-0.08 * (0.02)
Share no CHES	-0.11 ** (0.05)	-0.11 ** (0.05)	-0.12 ** (0.05)	-0.20 * (0.06)	-0.20 * (0.06)	-0.19 * (0.06)	-0.22 * (0.03)	-0.24 * (0.03)	-0.23 * (0.03)
Observations	2,135	2,135	2,135	9,351	9,351	9,351	51,413	51,413	51,413
Country dummies	yes	yes	yes	yes	yes	yes	yes	yes	yes
R-squared (adj)	0.66	0.66	0.67	0.68	0.68	0.68	0.65	0.64	0.64

Notes: \*p<0.10; \*\*p<0.05; \*\*\*p<0.01. Standard errors clustered at NUTS3 level (in parenthesis).

Table 5: What drives Euroscepticism in cities, towns and suburbs and urban areas?

	Regional economic variables		Regional socio-demographic variables						Electoral district characteristics		Electoral variables
	Declining GDP	Increasing unemployment	Higher share of tertiary educated	Higher share of migrants		Higher share of population aged			Better road performance	Higher neighbourhood density	Higher turnout
				Born in the EU	Born outside the EU	20-39	40-64	65+			
Cities		↑			↑			↑	↑	↓	↓
Towns and suburbs		↑	↓	↓	↑	↓	↑		↑	↓	↓
Rural areas	↑	↑	↓	↓	↑	↓	↑		↑	↓	↓
	↑	Increases	Anti-EU vote								
	↓	Decreases									

Variable importance is a useful concept in econometric modelling. After estimating a linear regression model, quantifying the importance of each variable is often looked-for, not only for academic purposes but also to design the most effective interventions. This normally involves decomposing the variance, or, equivalently, its R-squared (Grömping, 2006 and 2015). Consequently, as a final step, we look at the relative contribution of each variable in the right hand side of equation (1) to the model's total explanatory power (that is on the total R-squared).<sup>73</sup> See Figure 3. Overall, we observe that the highest contribution (around 50%) derives from country fixed effects, meaning that a large share of the variability is due to country-specific characteristics. Economic variables (*GDP per capita level and growth*, and *unemployment share level and growth*) have the second highest contribution, corroborating previous findings on the drivers of anti-EU voting (Dijkstra et al., 2020), followed by socio-demographic characteristics (*age, education, migrants born within and outside the EU*). Without considering country fixed effects, economic variables seem to explain most of the variability in towns and suburbs and rural areas, due to significant impact of *GDP change* and *unemployment change* in rural areas and *unemployment levels* and *change* in towns and suburbs. Socio-demographic variables (*education, age, share of migrants*) have a significant impact in towns and suburb and rural areas, and especially in towns and suburbs, they explain a relevant share of variability. In cities only, electoral variables (*turnout and share of no-CHES votes*), in particular *turnout*, contribute substantially to the overall explanatory power of the model.



**Figure 3: Relative contribution of the explanatory variables, based on results in columns (1), (4), (7), and (10)**

### 5. CONCLUSIONS

This work shows that the people in rural areas are significantly more likely to vote for anti-EU parties, also after taking into account many economic, socio-demographic and local characteristics.

The issues linked to higher anti-EU voting also differ by degree of urbanisation. Economic decline leads to more anti-EU voting in rural areas, but not elsewhere. More tertiary educated reduces anti-EU voting in rural areas, towns and suburbs, but not in cities. This underlines the importance of promoting economic growth in rural areas. Increasing the share of tertiary educated outside cities depends not only on access to this type of education, but also on the employment opportunities for people with more qualifications. More remote education and employment opportunities could help to reduce this gap. The current pandemic is likely to accelerate the trend to more online learning and working remotely.

The impact of the age structure also depends on the degree of urbanisation. In rural areas, towns and suburbs a low share of people aged 20-39 and a high share of people aged 40-64 are both linked to more anti-EU voting, but not in cities. In cities, a high share of population aged 65 and over is linked to more anti-EU voting, but not elsewhere. Most studies have focussed on the elderly and the young, while this study highlights that Euroscepticism starts at middle age. More research is needed to understand how the perception of the EU changes across different age groups in the three different types of areas.

The impact of migrants depends on their country of birth and on the type of area. Migrants born outside the EU increase anti-EU voting, but not in cities. Migrants born in other EU countries reduce anti-EU voting, but this impact is smaller and less significant in cities. The right to free movement of people within the Union is an important achievement and tends to make people more supportive of the EU as well. The economic integration of people born outside the EU would benefit these migrants and the communities they live in. It may also reduce EU discontent especially in rural areas, towns and suburbs.

<sup>73</sup> See Annex I for more details on the methodology and a full description of the results, broken down by variable. Note that the relative importance of the regressors is independent from the statistical significance of the explanatory variables. This means that we could have some regressors that explain a high share of the overall R<sup>2</sup> in spite being not-significant, and the *vice-versa*. Therefore, in commenting the contribution of each variable to overall R<sup>2</sup>, we stress the results only for variables that are found statistically different from zero.

The biggest impact on anti-EU voting, after the country effect, comes from the regional economic and socio-demographic variables. This implies that boosting economic growth, reducing unemployment, increasing education and supporting the economic integration of migrants born outside the EU have the most potential to reduce EU discontent, especially in rural areas.

The key challenge is to understand what is driving this rural EU discontent. This paper provides a first indication of which factors contribute to anti-EU voting, but more research both quantitative and qualitative is needed. The public consultation launched by the European Commission in the context of the long-term vision for rural areas may provide additional insights into rural EU discontent.

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## ELECTORAL EARTHQUAKE: NATURAL DISASTERS AND THE GEOGRAPHY OF DISCONTENT

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### ABSTRACT

The recent literature on the determinants of populism has highlighted the role of long-term gradual trends of progressive isolation and prolonged economic stagnation in engendering discontent and, in turn, demand for radical political change. We investigate, instead, the potential of unanticipated local shocks in shaping the 'geography of discontent'. Using comprehensive data at a fine spatial scale and a quasi-experimental method, we document that the occurrence of two destructive earthquakes in Italy resulted in sharply diverging electoral outcomes: while the Emilia 2012 seism did not alter voting behaviour, L'Aquila 2009 earthquake paved the way for an impressive and persistent surge in right-wing populism in the most affected areas. Such heterogeneous patterns mainly originate from a stark contrast in the post-disaster reconstruction process. Our findings are consistent with the idea that not just "places that don't matter", but also "places that don't recover", can become populist hotbeds. This makes the evolution of the geography of discontent more unstable and, thus, unpredictable, and places an additional burden on the role played by institutions in managing local recovery and ensuring territorial resilience.

## INCLUSIVE ATTITUDES TOWARDS IMMIGRANTS IN EUROPE: THE ROLE OF PREFERENCES, SPACE, AND ECONOMIC OUTCOMES

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### ABSTRACT

In this paper, we analyze the extent of inclusive attitudes towards immigrants within European countries. To this purpose, we use data from the European Social Survey Round 1 and 7, collected in 2002 and 2014, respectively. The two waves contain a module of questions exploring different aspects of public opinion about immigration. We distinguish between variables identifying the kind of migrants Europeans wish from those variables providing information about the extent of contact with members of migrant communities and the perceived costs and benefits of immigrants on the economy, cultural context, welfare system of host countries. The survey data are merged with data from Eurostat providing information on socio-economic conditions.

Natives’ attitudes are measured by an index reflecting the overall level of support for immigration. The advantage of such a measure is that it can be broken down into specific areas of investigation reflecting people’s perceptions of the effects of migration on the economic, cultural and welfare system. This allows to identify the role and the importance of different issues in determining the level of inclusive attitudes towards migrants. A similar measure is developed to cardinalize natives’ preferences for the kind of immigrants they wish. We explore the correlation between our measure of natives’ attitudes and the measure of natives’ preferences plus an array of aggregate economic and social indicators.

We obtain a comprehensive picture of natives’ attitudes towards immigrants that is broken down into specific areas such as rural/urban locations, as well as into groups identified, for example, by gender or country. We also show that different patterns of inclusive attitudes across European countries are in general positively related to economic activity and social capital while are negatively related to inequality.

### KEYWORDS

Immigration; European Social Survey; multidimensional index; economic outcomes

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# PARALLEL SESSIONS (7)

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## **National Session: SS16.2 - Smart, sustainable, resilient regions: Responses to pandemic challenges**



**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/86856640416>**

**Chair Romeo Ionescu**

## THE ROMANIAN RESPONSE TO THE COVID-19 CRISIS: LOCAL, COUNTY OR REGIONAL EFFORT? A PERSPECTIVE ON VACCINATION CAMPAIGN

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### ABSTRACT

Against the backdrop of a continuously changing situation, Romania, as many other countries, has adapted on the go to the pandemic situation. On 27 December, 2020, the national vaccination campaign started. The existing literature shows that such an effort requires coordination and a clear strategy that must include all the administrative levels. But in this Covid-19 situation it is still unclear what role can be played by the territorial units (local, county and regional level) in unitary states. To address this gap in the literature this article tries to analyse the Romania's strategy in managing a national vaccination campaign and what is the involvement of local, county and regional authorities in pursuing this aspect. From the methodological point of view, this research is based on a comparative approach, by using also quantitative (statistics) and qualitative data. The analysis is done through primary data, obtained from government official websites, public declarations and other official documents issued by national and county authorities. The documents analysed were selected on the basis that they represent the official vaccination programmes and campaign materials published on the most widely-used platforms. This filtering of the material was based on the initial research, which showed that such terminological association on vaccination campaign was a common and important feature of the official programmes. According to the procedures, each hospital within which a vaccination centre is organized establishes its vaccine requirement for three days, based on the schedules made, and sends it to the county public health directorates. They, in turn, centralize the vaccine requirements from all the rounded vaccination centres and send it, by 1 pm the day before the actual vaccination, to the Regional Storage Centre where they are rounded up. The regional storage centre prepares, for distribution, the necessary quantity of vaccines, according to the requests / schedules received and distributes them, accordingly, to the public health directorates, respectively the vaccination centres. Therefore, the Regional Centres are not independent entities, they are based on the national structure, on units subordinated to the Ministry of Defence or the Ministry of Health. However, the preliminary findings of our study show that the use of existing regional structures might increase the efficiency and the level of coordination between the national and local authorities.

### KEYWORDS

Administrative levels, COVID-19, vaccination campaign, regional authorities, territorial units

### 1. INTRODUCTION

Vaccine hesitancy is an old story which happened multiple times in different contexts. But this time, due to the Covid-19 pandemic, with the widespread mortality and economic disruption, a well-informed campaign should be organized in order to improve the trust of the people.

The new global context of this pandemic saw governments and health authorities in the way to develop new laws and public communication strategies to inform people about their actions. From the beginning of this pandemic, along with official messages from the authorities, an unusually wide range of disinformation and conspiracy theories about the origins and severity of Covid-19 spread online and on personal messaging platforms (Freeman et al., 2020; Chadwick et al., 2021). This may have been also influenced by official authorities' missteps, delays, and mixed messages, along with an unknown virus and unknown ways how to deal with it.

The same pattern happened when the first available vaccine was approved. We might agree that vaccine hesitancy, in this context, is also a social information situation. If people decide to get the vaccine or not depends on the level of information about the safety and efficacy. When official authorities develop a well-organized strategy and provide access to the vaccines, the success is easier to be achieved.

Previous vaccination campaigns have shown that multiple factors might influence the success of this. For example, not only sociodemographic factors have played a role in adult vaccination acceptance (Head et al., 2020), but also the way in which the vaccination strategy was organized – controlled only by the centre or with a regional or local initiative. In a pandemic time, in order to deliver efficient immunization services, it takes a proactive approach of all political, economic or health bodies from national, regional or subregional / local levels (WHO Regional Office for Africa, 2015). Thus, the development of the vaccination campaign will need to be managed by experts of local, regional and national bodies and this also determines the strengthening of national capacity and regional infrastructure.

Also, as a vehicle of promotion and communication, mobilizing leaders or public figures to be a voice for immunization might increase the number of people who will accept the vaccine. But this requires continuous updating of their

knowledge through highly condensed, relevant briefings with talking points (WHO Regional Office for Africa, 2015). In conclusion, country and regional communication, research and development innovations maximize the benefits of immunization campaigns.

## 1.1. How are vaccination campaigns going in other European countries?

The United Kingdom was one of the most affected countries by the COVID-19 pandemic. So, excepting the fact that their national specialists were involved in developing a proper vaccine, when the first one was developed, this was seen as an opportunity to limit the impact of the disease and to reduce the number of deaths in any third wave.

The vaccination campaign in the UK involved from the beginning the Local Clinical Commissioning Groups who supported and coordinated the arrival of vaccines to practices. The government also developed mass vaccination centres in local hospitals, pharmacies and community centres (Harnden, Earnshaw, 2021). Thus the UK government approved three types of vaccination site:

- vaccination centres, using large-scale venues, such as football stadiums and accessed by a national booking service;
- hospital hubs, using NHS trusts across the country;
- local vaccination services, made up of sites led by general practice teams working together in already established primary care networks and pharmacy teams through community pharmacies<sup>74</sup>.

Italy, the country with the oldest population in Europe and the first one severely affected by the COVID-19 pandemic, planned its vaccination campaign including cooperation between the national and regional health agencies. The vaccination plan in Italy was centred around 8 axes. The sixth axis concerns the governance of the vaccination plan, which will be ensured through a constant coordination between the Ministry of Health, the Extraordinary Commissioner, the Regions and Autonomous Provinces<sup>75</sup>. This partnership between the national and regional health authorities speaks to the unified and centralized response to the country's vaccination strategy<sup>76</sup>.

Spain, another European country with a high percentage of old people, was strongly affected by the current pandemic. The Ministry of Health in Spain worked at the creation of a COVID-19 State Vaccination Register in collaboration with the autonomous communities and cities, which were fed with information from the vaccine registers and information systems, or any other system with information of interest on the autonomous communities and cities<sup>77</sup>. In developing a vaccination campaign, Spain's regions prepared mass vaccination sites, as a complement to, and aimed at avoiding congestions of, health centres, which are also a key part of the immunization campaign (El País, 2021).

Sweden, known from its different perspective in considering a lockdown during the pandemic, developed a well-organised vaccination strategy. There was approved a national coordinator, but, specifically, certain responsibilities have been assigned to the regions for carrying out COVID-19 vaccinations. This included:

- Distributing vaccines within the respective region;
- Making plans for staffing, premises and successfully carrying out vaccinations;
- Offering COVID-19 vaccination to residents, as decided in the region on the basis of the Public Health Agency of Sweden's recommendation<sup>78</sup>.

Also, the county administrative boards continue to be responsible and involved in coordinating regional crisis and supporting regions, municipalities and civil society in their vaccination process.

## 1.2. Methodological approach

In this article, we mainly focus on the “where”—the vaccination campaign was coordinated from the Romania's perspective. The “how”—the specific thematic messages—is crucial as well but is not our main focus here.

H1. Enhancing local, county and regional structures in the vaccination strategy will create mutual benefits for all the actors involved (authorities in managing the campaign and people as beneficiaries of the vaccines as soon as possible).

In demonstrating this hypothesis, the actual research is based on a comparative approach, by using also quantitative (statistics) and qualitative data. The main research question of our study is: are regional centres individual entities in developing a strategy and implementing a strategy?

In order to assess the role and contribution of each Romanian region in implementing the vaccination strategy, our study employs document analysis from the national, regional and local authorities involved in this regard. The analysis is done through primary data, obtained from government official websites, public declarations and other official documents issued by national and county authorities. The documents analysed were selected on the basis that they represent the official vaccination programmes and campaign materials published on the most widely-used platforms.

74 The Government of United Kingdom, *Department of Health & Social Care, UK COVID-19 vaccines delivery plan. Places*, 2021, available at <https://www.gov.uk/government/publications/uk-covid-19-vaccines-delivery-plan/uk-covid-19-vaccines-delivery-plan>.

75 The Government of Italy, Ministry of Health, *Guidelines of the Strategic Plan on COVID-19 vaccines approved by Parliament*, 2020, available at [http://www.salute.gov.it/portale/news/p3\\_2\\_1\\_1\\_1.jsp?lingua=italiano&menu=notizie&p=dalministero&id=5208](http://www.salute.gov.it/portale/news/p3_2_1_1_1.jsp?lingua=italiano&menu=notizie&p=dalministero&id=5208).

76 Thing Global Health, *Italy's Vaccination Strategy: Careful Planning and Building Trust*, 2021, available at <https://www.thinkglobalhealth.org/article/italys-vaccination-strategy-careful-planning-and-building-trust>.

77 The Government of Spain, Ministry of Health, *Covid-19 vaccination strategy in Spain. Key points*, 2020, available at <https://www.mscbs.gob.es/gabinetePrensa/notaPrensa/pdf/24.11241120144436287.pdf>.

78 Emergency Information for Swedish Authorities, *Allocation of responsibility for vaccinations*, 2021, available at <https://www.krisinformation.se/en/hazards-and-risks/disasters-and-incidents/2020/official-information-on-the-new-coronavirus/vaccination-against-covid-19/allocation-of-responsibility-for-vaccinations>.

## 2. ROMANIA'S STRATEGY OF COVID-19 VACCINATION

The main document for the vaccination campaign against COVID-19 in Romania is the Government's strategy which establishes the vision, principles and way of action for the administration of the vaccines authorized by the European Medicines Agency. The document is formulated in accordance with the European legislation and medical protocols. The strategy, called *Vaccination Strategy of 27 November 2020 against COVID-19 in Romania*, was published in the Official Gazette no. 1171 of 3 December, 2020, Strategy of November 27, 2020, Issuer - The Government of Romania.

Through this strategy, Romania aims to ensure access to vaccination against COVID 19 in terms of safety, efficacy and equity to prevent infection and to limit the spread of COVID-19 pandemic in the country.

The strategy includes information about the entire process and national chain of vaccination, as: storage of vaccines, maintenance of the cold chain, monitoring safety and efficiency and waste management. In the context in which other local and regional key actors will be involved in the process, the strategy proposes the underlying guidelines of the vaccination campaign against COVID-19 in Romania.

At the time of elaboration of this strategy, 19 November 2020, 393,851 cases of infection with the new Coronavirus were confirmed; of those infected - 269,590 were declared cured. At the same time, the number of deaths caused by the virus infection was amount to 9,596 people<sup>79</sup>.

The general purpose of the vaccination strategy is to ensure access to vaccination against COVID-19 under conditions of safety, efficacy and equity for the prevention of SARSCoV-2 infection and the limitation of the COVID-19 pandemic in Romania.

To achieve this goal, a management structure of the vaccination campaign was established. The organization and coordination of activities is carried out by a National Committee for the Coordination of Activities on Vaccination against COVID 19, which is an inter-ministerial body, without legal personality, subordinated to the General Secretariat of the Government and in coordination of the Prime Minister.

To this national level, other central structures were involved with responsibilities in ensuring the proper functioning of the vaccination program against COVID-19. Those were and are still functioning by this time:

- The Ministry of Health with all subordinated institutions, in coordination and under the authority of the Ministry, with a role in public health;
- The Ministry of National Defence with its subordinate institutions;
- The Ministry of Internal Affairs with the subordinate and coordinated institutions;
- Special Telecommunications Service;
- Other ministries and institutions with their own health networks;
- Other ministries.

After presenting the responsibilities of each of these national institution, the Romanian Vaccination Strategy continues with the presentation of the local structures with responsibilities in ensuring the proper functioning of the vaccination campaign against COVID-19. As we can see, the regional level is left beside.

So the local structures involved were:

- The institution of the prefect;
- County Centre for Coordination and Management of Intervention (CJCCI);
- The Public Health Directorate of the Municipality of Bucharest and the county public health directorates;
- Territorial administrative units - county, municipality, city and commune;
- Other governmental and non-governmental institutions and organizations;
- Public and private providers of medical services;

As we can see, at the local level are mentioned and involved in the vaccination strategy only institutions and authorities from the county, municipality, city and commune structures. Again, the regional level is not mentioned at the national structures, neither at the local ones.

Chapter eleven of the *Strategy* is dedicated to the organization and conduct of vaccination against COVID 19 campaign, being focused on the following pillars:

- How to implement the vaccination campaign;
- Description of population groups for vaccination against COVID 19;
- Vaccination stages;
- Storage and distribution network: cold chain;
- Stock and loss management;

Thus, at national level a module dedicated to vaccination will be developed against COVID 19 within the National Electronic Vaccination Register (NEVR), which will constitute electronic vaccination database. Each person will receive a certificate of vaccination from the NERV with specific vaccination data.

For the description of population groups for vaccination against COVID 19, one important criterion made reference to *epidemiological criteria* to allow flexibility in vaccine allocation at the regional level and local - depending on the evolution of the infection in the territory, such as: the rapid, exponential growth of the number of cases above a certain threshold value (definition of an incidence threshold) at the level of a region will allow, depending on the characteristics of the population, the priority distribution of vaccines in that population to limit the spread of the virus.

<sup>79</sup> The Government of Romania, *Vaccination Strategy against COVID-19 in Romania*, available at [https://vaccinare-covid.gov.ro/wp-content/uploads/2020/12/Strategia-vaccinare-02-12-2020-CL-FINAL-cu-COVID-19-tabel-2\\_CUPRINS-UPDATE-1.pdf](https://vaccinare-covid.gov.ro/wp-content/uploads/2020/12/Strategia-vaccinare-02-12-2020-CL-FINAL-cu-COVID-19-tabel-2_CUPRINS-UPDATE-1.pdf)

The document also exemplifies the population categories (stage I - health and social workers - public and private system, stage II - population at risk, workers carrying out activities in key areas and stage III - all the population).

As for the vaccination stages, these are assumed as follows: for stage I, vaccination will be organized at the workplace and through fixed and mobile vaccination centres and for stages II and III vaccination will be made through fixed and mobile vaccination centres, mobile teams, family medicine network and drive-through centres.

The storage and distribution network bring into discussion the existence of a central storage and regional storages. The number or the location of regional storages are not mentioned in the Strategy. It is stipulated that all have to fulfill the requirements of storage according to the vaccines (for vaccines with long-term storage at -80-degree Celsius, for vaccines with long-term storage at -20 - degree Celsius, for vaccines with long-term storage at 2-8 degree Celsius). The distribution to the local, fixed and mobile vaccination centers will be made from the central and regional storages.

As for the stock and loss management, all vaccination centers should monitor the use and loss of vaccine doses on a monthly basis. This activity is extremely important being a way of scheduling and self-control.

*The National Institute of Public Health*<sup>80</sup> based on the Ministry of Health distribution order, will upload to NEVR the vaccine stocks distributed to regional storage centers, and the centers, based on the record of the number of people, will distribute the vaccine to users in the territory at the level of local vaccination centers and at the level of family medicine practitioners. The vaccine coverage will be available at county and national level.

Because the health of the population is very important, the Strategy, in the last chapter makes also reference to the possible side-effects reactions after the vaccination which will be monitor for a period of 30 days through an individual electronic reporting system and to the vaccination waste management.

### 3. REGIONAL INVOLVMENT

The regional implication of the regional centers, in terms of receiving and storing the vaccines, was presented by the coordinator of the vaccination campaign in Romania, dr. Valeriu Gheorghiuță. In November 2020, before the starting of the campaign, he declared that : *In addition to the Cantacuzino Institute, which will be the main storage center for the anti-COVID-19 vaccine, 6 regional centers will be organized in military hospitals, which have the capacity to keep the vaccine at a temperature of minus 80 degree Celsius*<sup>81</sup>.

Accordingly, 6 military hospitals have the role of Regional Storage Centers, as it is mentioned on the site of Ministry of Defense, as follows:

- Military Emergency Clinical Hospital "Dr. Iacob Czihac" Iași;
- Military Emergency Clinical Hospital "Dr. Constantin Papilian Cluj-Napoca;
- Military Emergency Hospital "Dr. Alexandru Gafencu" Constanța;
- Military Emergency Clinical Hospital "Dr. Ștefan Odobleja" Craiova;
- Military Emergency Hospital "Regina Maria" Brașov;
- Military Emergency Clinical Hospital "Dr. Victor Popescu" Timișoara<sup>82</sup>.

<sup>80</sup> National Institute of Public Health, *Organizational Structure*, available at <https://insp.gov.ro/>.

The activity of the Institute at territorial level is realized through 4 national centers and 6 regional centers of public health, organized in its structure, without legal personality.

The national centers, which ensure the specific professional coordination at national level of the Institute, are:

- a) The National Center for Surveillance and Control of Communicable Diseases (NCSCCD);
- b) The National Center for Monitoring the Risks in the Community Environment (NCMRCE);
- c) National Center for Health Assessment and Promotion (NCHAP).
- d) National Center for Statistics and Informatics in Public Health (NCSIPH)

The regional centers of public health, which ensure the coordination and professional execution at regional level of the Institute, are:

- a) Bucharest Regional Center for Public Health (BRCPH);
- b) Cluj Regional Center for Public Health (CRCPH);
- c) Iasi Regional Center for Public Health (IRCPH);
- d) Timisoara Regional Public Health Center (CRSPT);
- e) Targu Mures Regional Public Health Center (TGRPHC);
- f) Sibiu Regional Public Health Center (SRPHC).

<sup>81</sup> Hotnews.ro, *Vor fi 6 centre regionale în spitale militare pentru depozitarea vaccinului anti-COVID în România / Medici școlari și studenți, în echipele care vor vaccina populația - coordonatorul campaniei de vaccinare*, available at <https://m.hotnews.ro/stire/24435238>.

<sup>82</sup> Ministry of National Defense, The Medical Directorate of the Ministry of National Defense, available at <https://directiamedicala.mapn.ro/pages/view/191>.

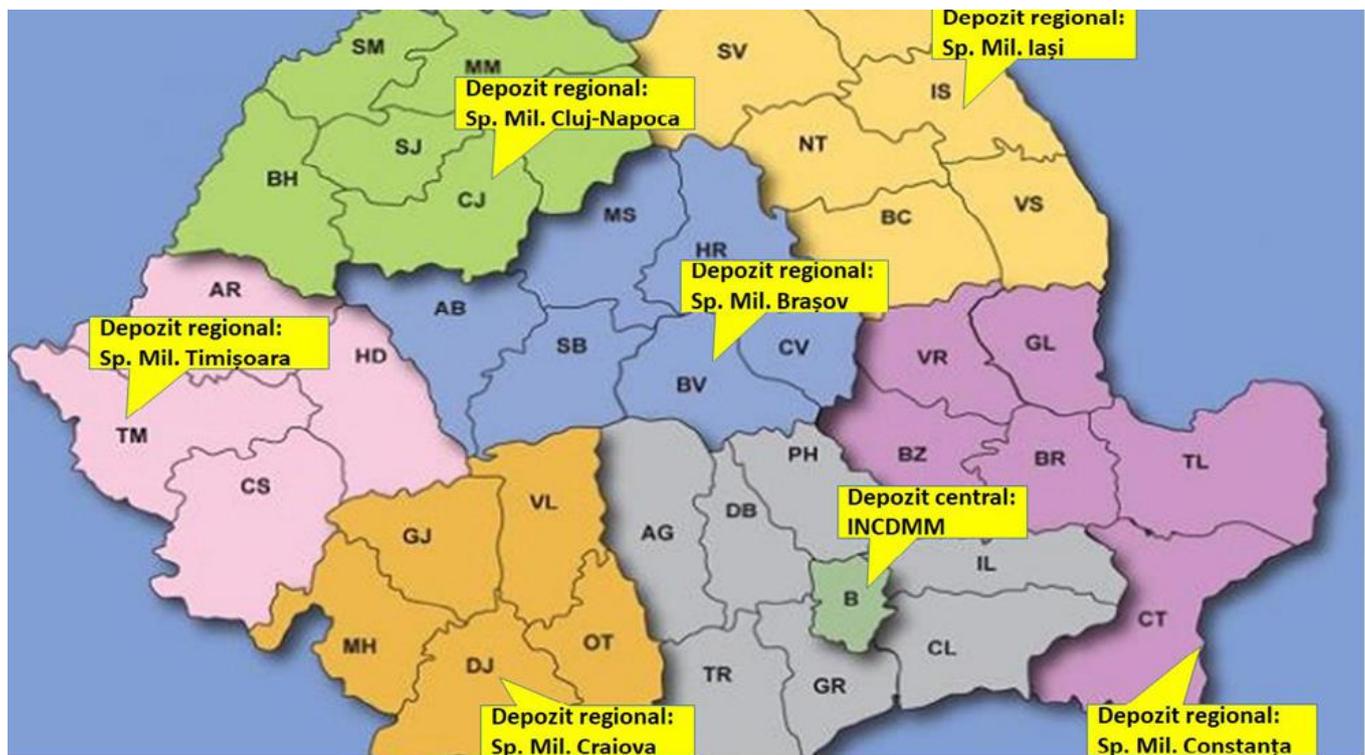


Figure 1. Regional Storage Centers<sup>83</sup>

In fact, they overlap with the Romanian development regions, excepting South Muntenia which is also served by the *Cantacuzino Institute* (including Bucharest and Ilfov county, too).

Due to its involvement in ensuring the transport of vaccine doses by land and air, from their arrival in the country to the regional storage centers and by supporting the distribution to the vaccination centers in the country and the vaccination teams with qualified human resources, the Ministry of National Defense has a very important role in supporting the inter-institutional effort in the anti-COVID-19 vaccination campaign.

In Romania, as concern the regional development, there are eight regions related to NUTS 2 level in the European Union. The law no. 315/2004 establishes the institutional framework, objectives, competencies and instruments specific to the regional development policy in Romania<sup>84</sup> and is considered to be the fundamental law of regional development in Romania. For each region was also constituted eight different Councils for Regional Development, which analyse and decide the regional development strategy and programs. Coordinated by the Councils, were also established eight Regional Development Agencies, non-governmental bodies, of public utility, with legal personality and not seeking to make a profit.

In what concern the regional approach for the COVID-19 vaccination campaign, these regional entities were not involved in any particular aspect and did not have any responsibilities.

At the county level, only the public health directorates were involved in reporting on the incidence of illness per thousand inhabitants. Depending on this report, vaccine doses are distributed to the vaccination centers. Also, the public health directorates offer authorizations for vaccination centres and involved personnel in the county were they are functioning. The evidence from quarantine / decarantine of the people is also in their role. In this regard, it is important to mention that the county public health directorates in Romania are deconcentrated public services under the authority of the Ministry of Health<sup>85</sup>.

#### 4. CONCLUSION

In conclusion, the general purpose of the vaccination strategy in Romania was to ensure access to vaccination against COVID-19 under conditions of safety, efficacy and equity for the prevention of SARSCoV-2 infection and the limitation of the COVID-19 pandemic in the country. To achieve this goal, national and local authorities and institutions were involved and as concerns the regional level, the existing entities like the regional as Regional Councils or Regional Development Agencies from each one of the eight regions had no responsibility.

The regional approach is missing and the only implications were developed through the regional centers, in terms of receiving and storing the vaccines. Those regional centers are also military hospitals, one for each region, excepting South-Muntenia which was grouped with Bucharest-Ilfov regions to one single hospital. To conclude, were established

83 Source. Ministry of National Defense, available at <https://directiamedicala.mapn.ro/pages/view/191>.

84 Lau no. 315 of June 28, 2004 (\* updated \*) on regional development in Romania, available at <http://legislatie.just.ro/Public/DetaliiDocument/53040>.

85 Ministry of Health, List comprising the units with legal personality subordinated, under the authority or under the coordination of the Ministry of Health, available at <http://old.ms.ro/?pag=8>.

only seven regions to implement the vaccination strategy in Romania. In these regions were functioning military hospitals used for receiving and storing vaccines. In the same time, at the county level, the public health directorates were involved in reporting on the incidence of illness per thousand inhabitants. Through this reporting, the doses were sent to the vaccination centers.

We can observe that the regional approach in Romania is still in an incipient phase, and it was ignored in the writing and implementation of the vaccination strategy, differently that it was in other European countries where the regions and regional authorities had a stronger voice and implications.

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## REMOTE WORKING AS DRIVER FOR INDIVIDUAL AND ORGANIZATIONAL RESILIENCE IN PANDEMIC CONTEXT

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### ABSTRACT

Global pandemic is exerting extreme pressure on the economy, and on our view of life by bringing to the fore goals that we did not choose but simply we had to adhere to. An important change was felt at the labor market, at the individual and organizational level. Resilience and work adaptability are increasingly relevant for employees and employers, in the context in which the working frame has moved from a clearly defined place and with a specific structure, as a program and as a set of actions, to working from home, remote, (teleworking).

In this paper, we analyzed the ability of employees to adapt to pandemic context, by identifying the drivers of individual resiliency. We explored their capacity of coping with adversity or opportunity through the condition of remote working. In addition, part of research is focus on shocks and risks as disrupts the proper functioning of certain production processes in labor market.

The study was conducted using the quantitative research method. The research method consist in questioner based survey for collecting empirical data. The questionnaire was applied online among employees with full-time jobs in private and public organizations, using a non-probabilistic sample.

A more resilient employees and organization have to shift to sustainable practices and to adapt to the context. We argued that remote working process helps achieving goals, prioritizing activities, get the target results, cope with change, maintain a work-life balance, and ensure individual and organizational resilience.

### ACKNOWLEDGEMENT

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**MAKING COMMUNITIES RESILIENT DURING THE COVID-19 PANDEMIC. WHO COMPLIES WITH SOCIAL-DISTANCING RULES? AN ANALYSIS ON THE METROPOLITAN AREA OF CLUJ-NAPOCA**

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**ABSTRACT**

During the COVID-19 pandemic authorities have relied on the adherence of citizens to the social-distancing and mask wearing rules in order to limit the spread of the virus. Nevertheless, it was soon evident that not all citizens are willing to comply with the rules imposed by authorities. It is highly important to identify the factors that influence the extent to which people adhere to the social-distancing rules, as it can make the difference between resilient and non-resilient communities during the pandemic. However, only a limited number of studies examined these factors. As such, the present paper seeks to identify the factors that predict the extent to which people comply with the social-distancing rules in the metropolitan area of Cluj-Napoca. In doing so we make use of a representative survey conducted in December 2019 on a sample of 705. More specifically, we investigate the extent to which the following factors predict the declared level of compliance with the social-distancing rules: trust in authorities, perception regarding the way authorities communicated with the public, the media sources individuals used to keep informed, and other socio-demographic variables.

## THE INTRIGUING CONNECTIONS BETWEEN REGIONAL TOURISM AND ECONOMIC RESILIENCE

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### ABSTRACT

Tourism is an important key sector in regional and national economies which appears to have often a favorable recovery potential after a shock, leading to the notion of resilience capacity of regions. In the context of a tourism-led growth mechanism, the concept of tourism-led resilience capacity is introduced (constituted of sustained tourism resilience and speed of recovery). The analytical framework is tested for the 2008-2012 financial crisis in European Union by examining relevant data from European NUTS 2 regions. The research is unfolded on two complementary axes: a) assessing the resilience of the tourism sector, and b) estimating the weight of tourism in the overall resilience performance of EU regions. Finally, several implications for regional and European policies are addressed as well, particularly related to the role of innovation and diversification in increasing the recovery speed following a disruption.

## SMART CITIES FROM LOW COST TO EXPENSIVE SOLUTIONS. AN OPTIMAL ANALYSIS

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### ABSTRACT

Each region contains at least one urban agglomeration which becomes a growth pole over time. During pandemics, such as COVID-19, the negative effects on growth poles are exacerbated by the accumulation of aggravating health and economic factors. In this context, the concept of smart city has acquired a new nuance and has aroused both theoretically and practically the interest of the researchers.

The objective of this scientific approach is represented by a critical analysis starting from the current state of scientific knowledge in the area, the development of the smart city / smart community concept in order to objectively evaluate the progress of these organization forms in relation to other classical / traditional forms of the cities' organization.

The empirical approaches are supplemented by a pertinent statistical analysis of the socio-demographic and economic indicators reported through the Eurostat platform by the first 10 European smart cities, to which is added the city of Bucharest, as an anti-pole of smart city development.

The statistical data processed in dynamics allowed the consolidation of smart indicators at the level of the selected sample (local GDP, internet users, R&D&I, Internet of Things, internet banking, general motor rate, green vehicle motor rate and polluting vehicle motor rate).

The elaborated model allowed the construction of the dashboard of the access actions in the smart city / smart community category on two levels of financial effort correlated with the impact on the sustainable development of the smart cities. We have to specify that this model is absolutely new. It is not a copy or an adaptation of another existing model. This model was transposed by pivoting the hypotheses into a minimal and extended dashboard with pivoting links on each branch of the table in order to facilitate the step by step implementation of this form of superior organization of urban populations. We started from simple solutions, implementable on short term, but we arrived at extensive solutions with high efficiency and high added value on the inhabitants' life of the applicant cities.

The statistical analysis covers 2009-2020, the period representative as duration and which includes the impact of COVID-19 on the urban society.

The validity of the proposed model and our approach are supported by the complex statistical analysis performed in this scientific article.

The results of the study are useful for all administrations ready for change which want the rapid implementation of the measures with beneficial effects on the community or which through a strategic vision aim to connect to the European objectives of sustainable growth and social welfare for citizens.

The entire analysis is based on the latest official statistics, which are processed in the form of diagrams, tables and relevant mathematical equations and functions.

### KEYWORDS

IoT, smart city, smart economy, sustainability, urban development.

### 1. INTRODUCTION

The urban overpopulation and urban growth poles impose significant differences in social and economic development for these communities' members compared to other forms of population aggregation and bring direct benefits to the residents by sustainably increasing of the life quality and adaptability of the population to permanent societal challenges. On the contrary, this urban agglomeration produces amplified effects during the pandemic period through the accumulation of aggravating health and economic factors, but also during general periods, through the environment pollution. In relation to the European strategic development objectives, the limitation in time of these effects is seen as a side of the sustainable development, the practices of limiting the adverse effects being supported by long-term financing by the European and global organisms.

In this context, the concept of smart city has acquired a nuance and has aroused the interest of researchers both theoretically and practically, currently existing top cities on all indicators that have approached the concepts of smart city or smart community in order to manage the negative aspects of the growth urban agglomeration.

In this sense, a combination of scientific approaches have shown that the smart management's implementation in communities can generate viable solutions to specific problems, but an integrated approach is needed to achieve the status of smart city or smart community.

The objective of this scientific approach is represented by a critical analysis starting from the current state of the scientific knowledge in the field, the development of the smart city / smart community concept, in order to objectively evaluate the progress of these forms of organization in relation to other classical / traditional forms of towns' organization. The transposition of this model by pivoting the hypotheses into a minimal and extended dashboard with pivoting links on each branch of the table facilitates the step by step implementation of this form of superior organization of the urban populations, starting from simple solutions, implementable on the short term, to extensive solutions with high efficiency and high value-added contribution on the life of the applicant cities' inhabitants.

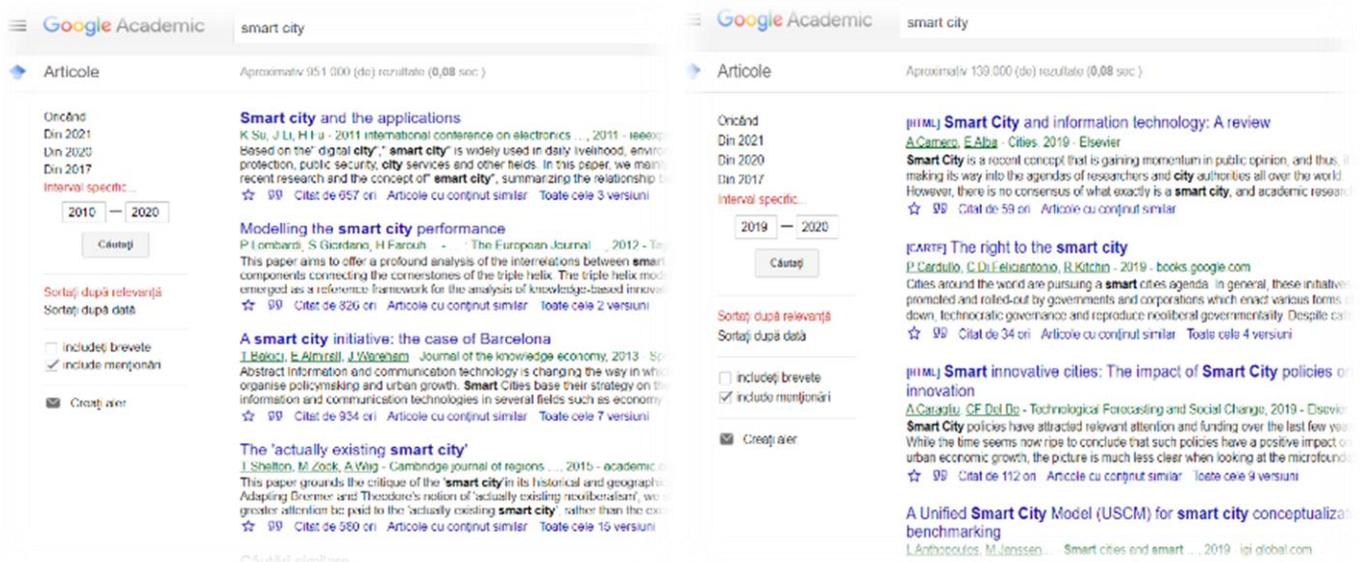
The methods used in carrying out this scientific approach are prospective for analysing the achievements in the smart city field for urban localities included in the top of the European smart cities and around the world, as they have been transposed in the literature by the international experts. The empirical approaches are supplemented by a pertinent statistical analysis of the socio-demographic and economic indicators reported through the Eurostat platform by the first 10 European smart cities, to which is added the city of Bucharest, as an anti- pole of the smart city development.

The statistical data processed in dynamics allowed the consolidation of the smart indicators at the level of the selected sample (local GDP, internet users, R & D & I, Internet of Things, internet banking, general motor rate, green vehicle motor rate and polluting vehicle motor rate). These indicators were structured according to the average evolutions on the selected sample during 2009-2020. The main observations of the core of indicators allowed the elaboration of a smart economic model, which analyses the impact at the sample level of the adaptation of the smart city / smart community policies.

The elaborated model allowed the construction of the dashboard of the access actions in the smart city / smart community category on two levels of financial effort correlated with the impact on the smart cities' sustainable development. The results of the study are useful to all administrations ready for change which want the rapid implementation of the measures with beneficial effects on the community or which through a strategic vision aim to connect to the European objectives of sustainable growth and social welfare for citizens.

## 2. LITERATURE REVIEW

The interest for the scientific research related to the smart urban development is huge. According to an analysis conducted by Google Scholar, were published a number of over 930,000 scientific articles, some with over 800 to 2400 citations, during 2010-2020. In the last year, 2019-2020, approximately 140,000 articles have been published, some of them with over 150 citations. The Figure 1 below shows these.



**Figure 1: Literature focused on smart city concept**

Source Google Scholar platform.

In order to quantify smart city capacity, different models were developed. One of them, a quadruple-helix model for smart city capacity measurement, directly connects the city and the innovation capacity of the companies based in it. As a result, the concept of smart city is defined and analysed using relevant phrases such as: smart governance, smart economy, smart living, smart environment, smart mobility and smart human capital. These concepts are derived from the smart use of: strategy and planning, marketing, quality management, technological processes, logistics and human resources (Lombardi, Giordano, Farouh, & Yousef, 2012).

The smart urban development must be carried out in conditions of environmental protection and reduction of energy consumption. The urban demographic dynamics is another important element. In this sense, there is already a European regulatory framework (directives and technical norms). The concrete way of applying these regulations in the case of the large Mediterranean city in Italy (Palermo) is analysed in detail in the case of this research. The entire analysis is supported by The Urban and Environmental Building Code as Implementation Tool. This Code covers 4 Areas and 20

Articles. The Areas are: Environmental sustainability and context appraisal; Energy performance of building envelope; Energy performance of technical systems; and Renewable energy systems. The result of this approach was a smart planning protocol able to create an instrument between cloud governance and smart tools for local urban administration (Riva Sanseverino, Riva Sanseverino, R., Vaccaro, & Zizzo, 2014).

The smart city services are treated in an aggregate manner and cover: “Initiatives for communities with special needs like jobless, elderly, female and disabled; Vocational training services; Heritage provision and protection services and economic support (e.g., loan provision for settlement); Several types of consulting services (e.g., training and new business registration); Volunteer and cultural activities; Metro-WiFi infrastructure and pet related services since they both are consider to be related with local quality of life (L. G. Anthopoulos & Reddick, 2016).

From the economic and the quality of urban life point of views, another paper is focused on the costs of implementing the smart city concept, on their efficiency seen from the perspective of energy savings, production value, ease of implementation, improving quality of life, etc. The authors of this paper discuss complex concepts such as improving urban economic development and social acceptance (L. Anthopoulos & Giannakidis, 2017).

An interesting concept of smart development is the energy dimension of a smart city. It allows a new understanding of the urban systems and progress towards a new style of urban management. The new urban management is based on energy and technology (Lai, Leone, & Zoppi, 2016).

The engine able to move the urban system in its spatial and temporal development is the technological dimension of the smart city. It must be completed by energy, because the cities represent the greatest energy consumers. As a result, a new approach in the planning of a smart city has to be based on the energy dimension. This approach was implemented in Italy, where the concern about cities’ energy is real. The international researchers used three dimensions in order to analyse the smart city concept: ECOware: natural capital; Water/energy; and SMART environment. The concept of ECOware: natural capital covers: hand-made capital, economic and financial capital, institutional capital, human capital and social capital. Water/energy is focused on: transport, business, city services, citizens and communications. Finally, SMART environment deals with: SMART mobility, SMART economy, SMART governance, Smart people and SMART living (Lai et al., 2016).

An interesting analysis is that which connects the accessibility by collective transit and the availability of space for parking vehicles under a smart approach. This accessibility takes into account two elements: the individual motorized transport accessibility and the collective and non-motorized transport accessibility (Gerundo, Fasolino, & Grimaldi, 2016).

The concept of smart city was defined in connection to the urban innovation and e-government and human welfare. This connection represents the base of defining and implementing new planning and management principles and ideas for smart urban governance (L. Anthopoulos, 2017b).

The theoretical approach of the smart city concept and its evolution is made in a reference work that aims to find answers to questions related to the type of technologies used by the smart city, the types of services offered by the smart city approach, the solutions offered by the smart city approach and the differences between theory and practice in the case of smart cities. Moreover, the paper analyses the processes that synthesize a smart city project, how to mobilize resources and the life cycle of the smart project (L. Anthopoulos, 2017a).

The contemporary economic approach cannot be done without internet platforms. If we can talk about an Industry 4.0, we can also talk about the Internet of Things (IoT), which connects with digital productive capacities. The main global economic actors already have industrial platforms 4.0: Germany has the “Industry 4.0 Platform”, China the “Made in China 2025” and the USA the “Industrial Internet Consortium”. The Industry 4.0 platform is connected to industrial manufacturing and IoT applications for healthcare management, transportation, energy and smart cities (Sendler, 2017).

An interesting component of the smart city is education, respectively smart learning as a key element for the innovative and sustainable urban development. Education is able to promote creativity and innovation. Moreover, based on education, new concepts have been developed such as: smart technology, smart teaching, smart education, smart e-learning, smart classrooms, smart universities, and smart society. In this approach, the smart learning covers both traditional learning and informal learning, as well (Liu, Huang, & Wosinski, 2017).

The Netherlands is one of the main promoters of the smart approach. In this sense, the Netherlands has advantages compared to other states. At the urban level, there is a good collaboration between the local administration, the private sector and the academic environment. In addition, smart solutions are already being implemented in society on a large scale. This process is also supported by the presence of some important multinational companies in this country. The Netherlands also has an extremely high-performance physical and digital infrastructure, functional test stands and a strong civil society (Bamwesigye & Hlavackova, 2019)

In Romania, large companies such as ENEL, have launched smart programs at the level of urban communities. This company's smart approaches target multiple connections between underground infrastructure, energy and transportation infrastructure, urban energy flows, personal urban flows, buildings and green and public areas. The company's smart solutions, included in the ENEL X project, allow the urban administrations to use a single interface, to process interconnected and integrated services (EnelX-SRL, 2021).

An interesting approach is that starting from the impact of the urban development on the environment. This approach was able to support the building of the ISUT Model. The model defines a Composite Index able to quantify the sustainability of the urban development using a vector cartography the urban land and building an alpha-numerical database. This database prepares the model’s inputs regarding the green spaces and the built-up area (Gerundo et al., 2016).

Other interesting approach defines the smart city as a building based on 6 concepts like the following: smart city economy; smart people; smart mobility; smart environment; smart living; smart governance (Vinod Kumar & Dahiya, 2017).

The smart city development has to be realised under sustainability. This approach started from the idea that the smart city represents an application of IoT (Internet of Things). Moreover, the city development has to improve the environment, the citizen lifestyle and the governance's performance. The basic approach is that the development of the smart technologies has to be achieved with minimal human interaction (Silva, Khan, & Han, 2018).

A more optimistic approach considers the smart city as the solution for rapid urbanisation. The classic urban development is limited and face harder to the new challenges. As a result, the smart city development is able to face to all new challenges, including the pandemic (Okai, Feng, & Sant, 2018).

The real advantages of the smart city are related to the citizens' life standards, the local economy development, transport and traffic management, environment and better connection to the public administration. Under the new challenges, a smart city has to be analysed under its specific aspects: smart mobility, smart living, smart environment, smart citizens, smart government and smart architecture in their connections to technologies and concepts (Ismagilova, Hughes, Dwivedi, & Raman, 2019).

A new approach is interesting by introducing the concept of smart ecosystem as a complex connection between governance/administration, transportation, agriculture, logistics, maintenance, education and healthcare. Such a smart city has to be connected to the Information Communication Technology (ICT) which is able to improve even the traditional urban infrastructure (Ahad, Paiva, Tripathi, & Feroz, 2020).

The goals of the urban sustainable development are analysed in order to quantify the quality of life. In order to realise this, the authors combine public resources, human and social capital, information and communication technologies. The analysis is based on a survey implemented in Brazil and uses the application of the Structural Equation Modelling (SEM) methodology. The authors of the paper points out that they succeeded in improving the governance of the smart cities in order to increase the quality of urban life (De Guimarães, Severo, Felix Júnior, Da Costa, & Salmoria, 2020).

The Chinese experience in developing smart cities is presented in a study which covers 35 smart cities, using the principal component analysis and back propagation neural network techniques. Such a neural network takes into consideration six dimensional factors and 22 operating indices. According to the analysis' results, the main element in development of the smart cities is the development of a smart economy through sustainable productivity in innovative companies and in high-tech industries (Li, Fong, Dai, & Li, 2019).

A real link between the smart city's components seems to be the sustainable transport. Nowadays, almost all urban transport systems are unsustainable. As a result, the sustainable transport, including cycling, and the greater implication of the women in this industry are analysed starting from the good practices in Netherlands and Germany. The same analysis is implemented in Kenya and Uganda (Bamwesigye & Hlavackova, 2019)

A review of the literature on smart governance and its implication on supporting the active cooperation between citizen and public administrations in developing smart cities was realised in 2019. The authors considered that the smart development is more theoretical than practical. As a result, they propose new way of cooperation and an agenda able to improve the active partnership between citizens and public administration for smart development (Tomor, Meijer, Michels, & Geertman, 2019).

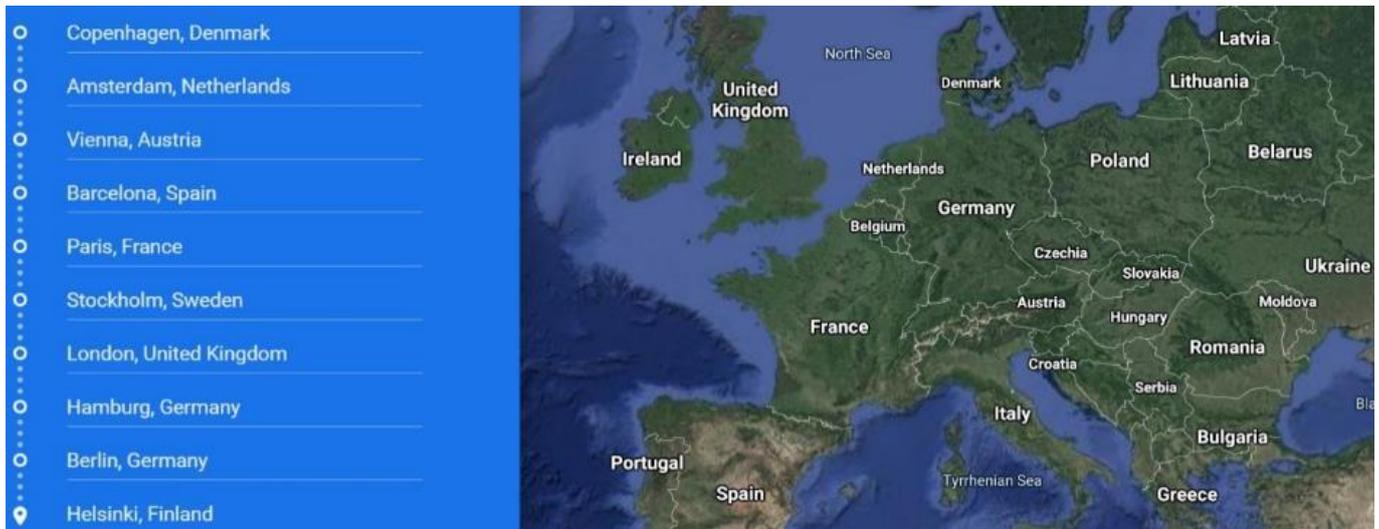
According to the above literature review, it results that, in dynamics, the concept of smart city has gained consistency since the '00s, when against the background of increasingly obvious climate change, complemented by changes in demographic trends (in the sense of their accentuation) and marked economic fluctuations deep crises, which destabilized the global economy) was the problem of organizing large cities in the sense of fruitful technological and digital development.

Thus, monitoring components of the main elements of the local economic development were created in accordance with the increasingly stringent objectives of the environment and resources' protecting. The core of monitoring of the smart city development is composed of capitals, energy and water resources and environment with applicative purpose at the level of local economic development on smart components. The synthesis of this desideratum is the increase in the urban population's quality of life and the normalization of the risk factors associated with the demographic growth at global, national and local level.

On this structure, the opportunity of the study proposed by the authors in this paper is demonstrated. It aims to create a tool for evaluation and gradual implementation of the smart concept starting from socio-economic indicators related to the monitoring core and the top 10 cities in Europe which have made significant progress in the smart city area.

### 3. METHODOLOGY

According to the Eurostat data, the top ten European smart cities are those in Figure 2.



**Figure 2: Top ten European smart cities in 2020**

Source Author`s contributions.

To these was added as an anti-pole the city of Bucharest, which stands out with similar demographic characteristics (2583460 inhabitants) in relation to the general average of the population of the 10 smart cities (2265876 inhabitants). Instead, the rest of the economic indicators are significantly lower than those of the evaluated smart cities in Bucharest. For example, GDP / capita is 0.02 million Euro / inhabitant in Bucharest compared to the average of smart cities of 0.04 million Euro / inhabitant.

In the analysis of this scientific approach, we sought to use atypical "new" indicators compared to dedicated classical studies, but with a significant impact on urban smart development. These indicators refer to:

- **local GDP** - reflects the economic development of cities classified in terms of smart development and certified by the international top rankings made by the Eden Strategy Institute and Ong & Ong (OXD)'s research report;
- **internet users** - the urban consumption of internet communications that attests the possibilities of implementing intelligent communications among the population and its opening up to the assimilation of new technologies in the field;
- **R & D & I** - the level of innovation reached / implemented at local level as a factor of economic development associated with the acceptance of new technologies and the integration of these technologies in daily activity. This indicator is in line with the European objectives promoted through the competitiveness axis, through technological R&D and innovation;
- **Internet of Things (IoT)** - smart city specific indicator that involves the use of the Internet to interconnect devices and services through network devices. In dynamics, the use of IoT started with the expansion of the logistics chains in order to make them more efficient (2000s), reaching in 2010 the interconnection of security networks and supervision of the food transports and administrative services. Currently, it has reached the stage of monitoring and control of remote objects through teleoperation and manipulation of services (tele school, tele work, tele health);
- **internet banking** - indicator of financial capacity of the local market that evaluates the flexibility of the financial system used by the inhabitants and its capacity to connect to the global financial flows in a safe and secure environment;
- **the general motorization rate** - seen from the point of view of the contribution to the local pollution. This indicator measures the urban transport capacity related to the sustainable dimension of this service. As the taxonomy of the ecological transport service is recent, this general indicator is able to measure the sustainable dynamics only in relation to the following two indicators;
- **motor vehicle rate of green vehicles** - calculated on the basis of registrations of new ecological vehicles less than two years old;
- **motorization rate of polluting vehicles** - calculated on the basis of registrations of polluting vehicles older than 10 years.

In order to test the homogeneity of the data series collected from the Eurostat platform, non-parametric Kolmogorov-Smirnov were used, which demonstrated, by rejecting the null hypothesis and rejecting the alternative hypothesis, the homogeneity of the sample as follows:

**Table 1: Statistical analysis of the Null Hypothesis**

Hypothesis Test Summary				
Null Hypothesis	Test		Sig.	Decision
The distribution of Official population is normal with mean 2.294.747 and standard deviation 2202215.786	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.029 <sup>1</sup>	Reject the null hypothesis.
The distribution of INTERNET - 2016 is normal with mean 87 and standard deviation 7.148.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.047 <sup>1</sup>	Reject the null hypothesis.
The distribution of INTERNET - 2018 is normal with mean 89 and standard deviation 5.047.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.041 <sup>1</sup>	Reject the null hypothesis.
The distribution of INTERNET - 2019 is normal with mean 91 and standard deviation 6.235.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.011 <sup>1</sup>	Reject the null hypothesis.
The distribution of IOT - 2013 is normal with mean 73 and standard deviation 15.312.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.047 <sup>1</sup>	Reject the null hypothesis.
The distribution of IOT - 2014 is normal with mean 74 and standard deviation 14.588.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.036 <sup>1</sup>	Reject the null hypothesis.
The distribution of Banking - 2020 is normal with mean 74 and standard deviation 20.323.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.035 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2009 is normal with mean 17.334.825 and standard deviation 16037305.994.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.021 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2010 is normal with mean 17.528.774 and standard deviation 16217332.357.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.022 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2011 is normal with mean 17.701.606 and standard deviation 16395452.280.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.023 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2012 is normal with mean 17.882.952 and standard deviation 16568308.953.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.023 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2013 is normal with mean 18.180.288 and standard deviation 16826907.303.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.020 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2014 is normal with mean 18.298.673 and standard deviation 16.926156.882.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.020 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2015 is normal with mean 18.488.342 and standard deviation 17074308.925.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.021 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2016 is normal with mean 18.771.165 and standard deviation 17276098.823.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.020 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2017 is normal with mean 19.063.598 and standard deviation 17446381.917.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.019 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2018 is normal with mean 19.337.658 and standard deviation 17616522.414.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.019 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2019 is normal with mean 19.588.177 and standard deviation 17792833.690.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.019 <sup>1</sup>	Reject the null hypothesis.
The distribution of CAR - 2020 is normal with mean 19.866.565 and standard deviation 17981294.029.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.019 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2009 is normal with mean 2.647.154 and standard deviation 2444367.156.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.004 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2010 is normal with mean 2.519.893 and standard deviation 2341374.842.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.005 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2011 is normal with mean 2.320.708 and standard deviation 2154252.829.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.024 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2012 is normal with mean 2.303.830 and standard deviation 2173046.909.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.031 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2014 is normal with mean 2.251.151 and standard deviation 2172256.564.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.018 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2019 is normal with mean 19.600.384 and standard deviation 17802107.469.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.019 <sup>1</sup>	Reject the null hypothesis.
The distribution of NEW CAR - 2020 is normal with mean 19.875.697 and standard deviation 17988234.697.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.019 <sup>1</sup>	Reject the null hypothesis.
The distribution of OLD CAR - 2009 is normal with mean 5891278.808 and standard deviation 5406678.465.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.011 <sup>1</sup>	Reject the null hypothesis.
The distribution of OLD CAR - 2010 is normal with mean 6022711.647 and standard deviation 5452717.427.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.012 <sup>1</sup>	Reject the null hypothesis.
The distribution of OLD CAR - 2011 is normal with mean 6072948.025 and standard deviation 5471075.665.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.013 <sup>1</sup>	Reject the null hypothesis.
The distribution of OLD CAR - 2012 is normal with mean 6240598.701 and standard deviation 5555250.104.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.030 <sup>1</sup>	Reject the null hypothesis.
The distribution of OLD CAR - 2013 is normal with mean 6.191.282 and standard deviation 5512597.718.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.014 <sup>1</sup>	Reject the null hypothesis.
The distribution of OLD CAR - 2014 is normal with mean 6.303.108 and standard deviation 5571509.819.	One-Sample Smirnov Test	Kolmogorov-Smirnov Test	.026 <sup>1</sup>	Reject the null hypothesis.

Notes: Asymptotic significances are displayed. The significance level is .05. <sup>1</sup>Lilliefors Corrected Source Author's contributions.

In order to elaborate the new proposed model, the following **working hypotheses** are used:

**H1:** The rate of urban economic development is significantly and directly proportionally influenced by the efforts to implement the R & D & I results and by the openness of the inhabitants in the use of the IT infrastructure for the management of financial flows.

**H2:** Urban economic development does not significantly influence the pro-ecological attitude of the inhabitants. In order to activate it, administrative steps are required in terms of infrastructure and service networks.

**H3:** The development of IoT is directly related to the openness of the inhabitants in the use of IT infrastructure for the management of financial flows.

**H4:** The smart maximization function is valid and adequate if and only if there is a minimum level  $\alpha_i$  of each of the above indicators for an urban population correctly dimensioned according to the urban endowments and the minimum level of economic capacity measured by the rate of the urban economic development.

Based on the above hypotheses, we developed a **smart economic model**, which analyses the impact at the sample level of adapting smart city / smart community policies. The model was developed using the least squares method (OLS), by simple linear regression and is of the form:

$$\begin{cases} \widehat{SMART}_{GDP} = \alpha_1 * NEW\_CAR + \alpha_2 * IoT + \alpha_3 * RDI + \alpha_4 * Banking \\ \forall i \in N, i \neq 0, \exists i, \text{ so that } \max_{i \rightarrow 1}(SMART_{GDP_i}) \gg GDP_i \cup \alpha_i > 0 \end{cases} \quad (1)$$

where:  $SMART_{GDP}$  - the smart function of the cities' economic development based on the transformation of the administrative flows into smart flows using IoT; NEW\_CAR, RDI, Banking.

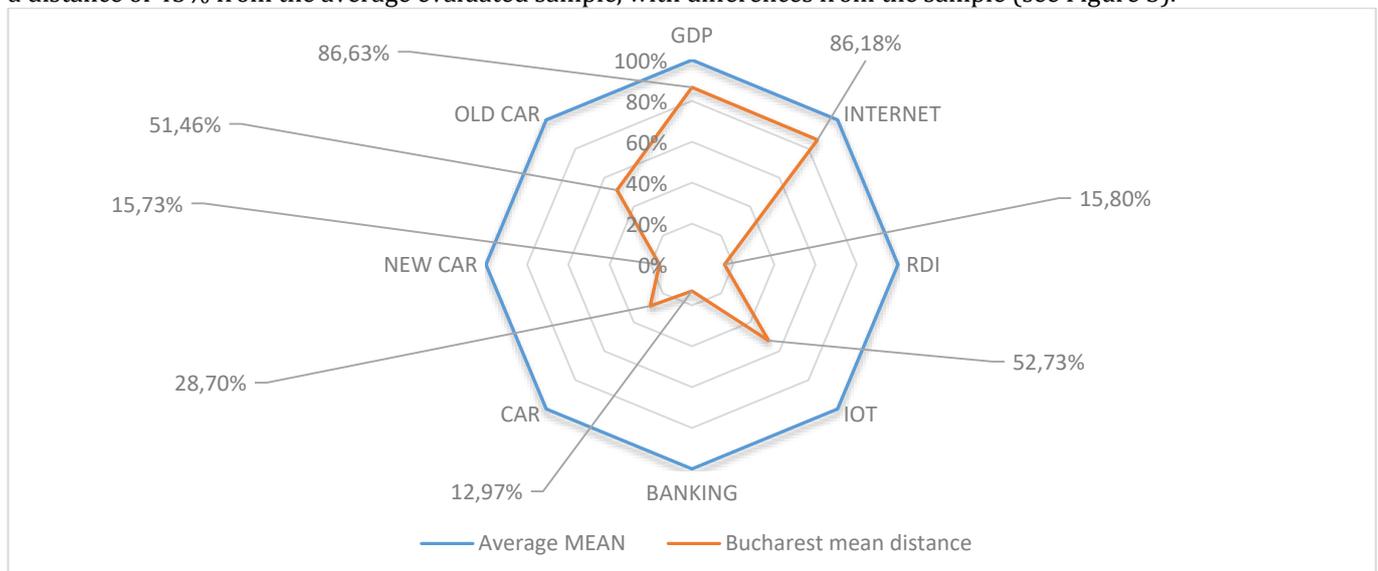
## 4. RESULTS AND DISCUSSIONS

The model ensures the evaluation of the smart policies' applicability / efficiency at the level of smart city / smart community, starting from the development core of the first 10 European smart cities published in the specialized tops in contrast to the smart development anti-poles. Following the modelling, the model equation becomes:

$$\begin{cases} SMART_{GDP} = -6,858E^{-6} * NEW_{CAR} - 127.897 * IoT + \\ + 53.74 * RDI - 75.988 * Banking \\ \max_{i \rightarrow 1}(SMART_{GDP_i}) \gg GDP_i \cup \alpha_i > 0 \end{cases} \quad (2)$$

The sample for which the model was applied concerns information related to the following smart cities: Copenhagen, Amsterdam, Vienna, Barcelona, Paris, Stockholm, London, Hamburg, Berlin, and Helsinki. The anti-pole of smart development Bucharest was used for comparison.

From the distribution averages point of view, after applying the evaluation procedure on the frequency series pivoted after each evaluated smart city, we found that the anti-pole (Bucharest) is from the smart development point of view at a distance of 43% from the average evaluated sample, with differences from the sample (see Figure 3).



**Figure 3: Presentation of the smart development at the evaluation date for the anti-pole of the model: the city of Bucharest**

Source Author's contributions.

It can be seen from Figure 3 that, in terms of the smart development's main components, the city of Bucharest is deficient in most key development points: RDI, IoT, banking, new cars, but well represented by the use of the Internet and the engine rate of polluting vehicles. This aspect demonstrates the model's usefulness and opportunity, which in the first step

allows the evaluation of the development in order to identify later the vulnerable points that need improvement strategies in order to maximize the smart function of the city.

From the Pearson correlation table, it results that, at the level of the analysed sample regarding the concept of smart city integrated on modelled components (GDP, Internet, RDI, IoT, internet banking, motorization rates), the weakest correlation is found at the level of motorization of green vehicles, which is an active component of the pollution reduction with a lower resilience to implementation, while the internet banking and the RDI component generate the most significant correlations on the Pearson correlation coefficient with sigma value tending to 0 (see Table 2).

**Table 2: Pearson Correlation**

Indicators		GDP mill. euros	RDI	IOT	Banking	NEW CAR
Pearson Correlation	GDP mill. euros	1.000	.994	.958	.990	.652
	RDI	.994	1.000	.973	.998	.656
	IOT	.958	.973	1.000	.975	.584
	Banking	.990	.998	.975	1.000	.663
	NEW CAR	.652	.656	.584	.663	1.000
Sig. (1-tailed)	GDP mill. euros	.	.000	.000	.000	.011
	RDI	.000	.	.000	.000	.010
	IOT	.000	.000	.	.000	.023
	Banking	.000	.000	.000	.	.009
	NEW CAR	.011	.010	.023	.009	.

Source Author`s contributions.

By using the Entered method in the linear regression model (using the least squares method), model in which the regression variable is local / regional GDP, as a implementation of the smart city concept's favouring factor, all regression variables were included (NEW CAR , IOT, RDI, Banking). As a result, no variables were excluded in the modelling.

The proposed model proved to have a coefficient of determination of over 98% and a standard estimator error of 384.96%. The model is valid, with a sigma value of the change factor tending to 0, according to the summary of the model presented in Table 3.

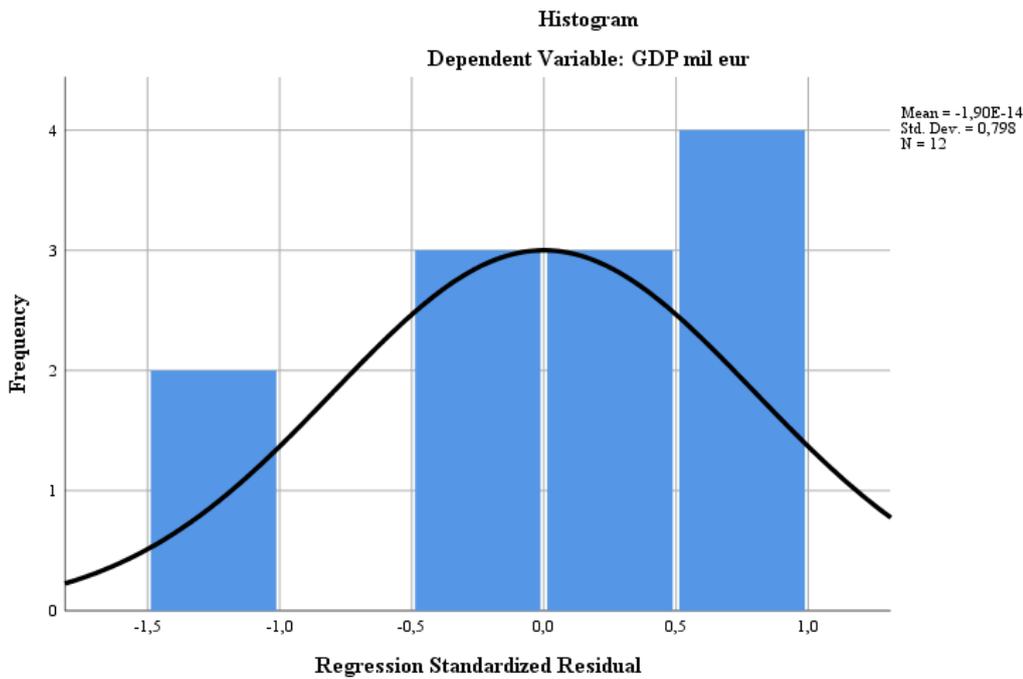
**Table 3: Model Summary**

Model <sup>b</sup>	R	R Square	Adjusted R Square	Std. Error of the Estimate	Change Statistics	
					R Square Change	F Change
1	.995 <sup>a</sup>	.989	.983	384.96550	.989	159.245
Model	Change Statistics					
	df1	df2	Sig. F Change		Durbin- Watson	
1	4	7	.000		1.665	

Note: b. Dependent Variable: GDP mill. Euros.

Source Author`s contributions.

From the normal distribution of the dependent variable's point of view, the histogram diagram reflects a homogeneous distribution with accumulation on the ascending slope (afferent to the anti-pole in the model) and on the descending slope. This demonstrates that there are significant differences between the distribution of the dependent variable for the analysed smart city core in relation to the Bucharest anti-pole, which demonstrates that the evaluation is relevant and captures the differentiated smart development dynamics of the anti-pole from the rest of the smart city core in the sample (see Figure 4).



**Figure 4: Normal distribution of the dependent variable**

Source Author`s contributions.

Following the ANOVA test, it is found that the dependent variable in relation to the regressor variables is mainly characterized (98.91%) by the regression function, the influence of the residual factor being only 1.09%. The number of degrees of freedom on the regression function is 4 and on the residual function is 7. The value of the F test is 159.24 with sigma tending to 0 (see Table 4).

**Table 4: ANOVA method**

Model <sup>a</sup>		Sum of Squares	df	Mean Square	F	Sig.
1	Regression	94399485.842	4	23599871.460	159.245	.000 <sup>b</sup>
	Residual	1037389.064	7	148198.438		
	Total	95436874.906	11			

Notes: a. Dependent Variable: GDP mill. Euros; b.Predictors: (Constant), NEW CAR, IOT, RDI, Banking.  
Source Author`s contributions.

P-P plot diagram for the presentation of the standardized residual regression for the dependent variable GDP reflects the fact that the years 2013, 2015 and 2011 are best represented for smart development according to the model, while the distance from the regression line that measures the average deviation of the observed values the probabilistic evolution is maximized for the years 2010, 2016 and 2012. The years 2019 and 2020 show an average deviation from the forecasted evolution, which means that the development over time (in dynamics) of the cities and their transformation into cities with smart management is variable, with sinusoidal development function and significant external influences induced by the macroeconomic context and the strategic development directions adopted by the EU associated with their financing (see Figure 5).

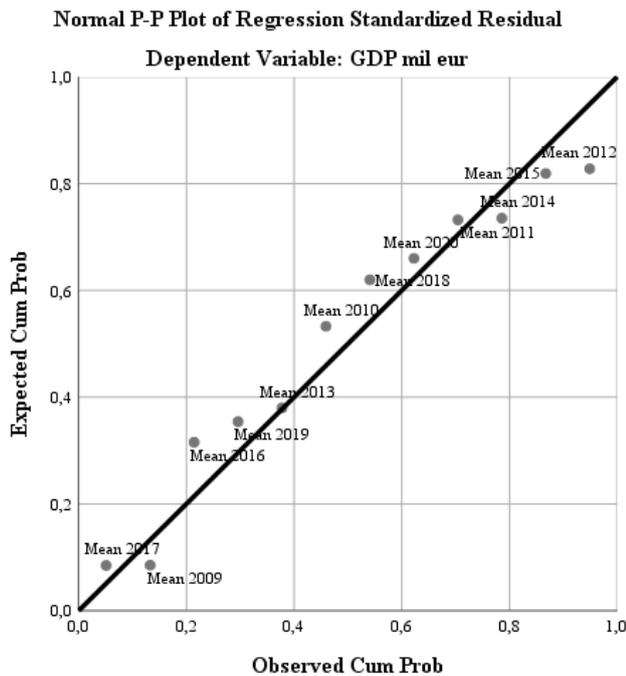


Figure 5: Normal P-P Plot of Regression Standardized Residual for Dependent Variable (GDP)

Source Author’s contributions.

It is found that in relation to the model variable, the R&D function plays a significant role and is in direct proportionality with the dependent variable of the model, which demonstrates the H1 hypothesis of the model, namely: **H1:** *The rate of urban economic development is significantly and directly proportionally influenced by the efforts to implement the R & D & I results and by the openness of the inhabitants in the use of the IT infrastructure for the management of financial flows.*

From the variable rate of motorization rate of green vehicles’ point of view, there is an inversely proportional evolution of the variable in relation to the dependent variable at the level of representation of non-standard beta coefficients (-6,858E-6) and at the level of correlation coefficients on the covariance matrix, which proves the H2 hypothesis of the model: **H2:** *Urban economic development does not significantly influence the pro-ecological attitude of the inhabitants. In order to activate it, administrative steps are required in terms of infrastructure and service networks.*

Regarding the use of IoT, it has an inversely proportional correlation with the dependent variable, which means that it is a managerial component with significant resource consumption, which has long-term performance in smart function and is dependent on openness to the use of non-polluting means and with the concept of R&D. According to the correlation of the coefficients, the IoT concept varies inversely with the internet banking flows, this aspect being a decelerator of the IoT development, which is demonstrated by the H3 hypothesis: **H3:** *The development of IoT is directly related to the openness of the inhabitants in the use of IT infrastructure for the management of financial flows.*

The proposed model is homogeneous, well represented and significant for evaluating the smart development of cities in relation to a core of development poles in Europe and demonstrates the H4 hypothesis by comparing it with the Bucharest anti-pole, as follows: **H4:** *The smart maximization function is valid and adequate if and only if there is a minimum level  $\alpha_i$  of each of the above indicators for an urban population correctly dimensioned according to the urban endowments and the minimum level of economic capacity measured by the rate of the urban economic development.*

The correlation coefficients used in the argumentation of the hypotheses and in their validation are presented in Table 5.

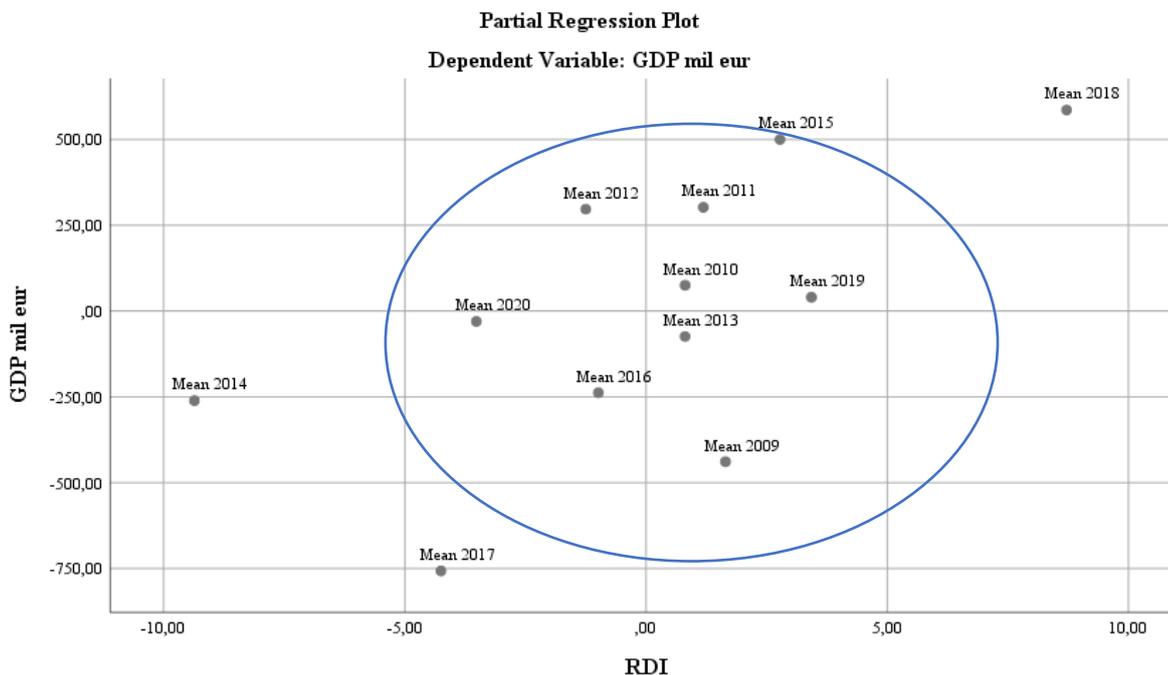
Table 5: Coefficient Correlations

Model <sup>a</sup>		NEW CAR	IOT	RDI	Banking	
1	Correlations	NEW CAR	1.000	.371	.117	-.262
		IOT	.371	1.000	.021	-.303
		RDI	.117	.021	1.000	-.956
		Banking	-.262	-.303	-.956	1.000
	Covariances	NEW CAR	6.219E-10	.001	7.558E-5	-.002
		IOT	.001	17293.651	71.962	-10640.291
		RDI	7.558E-5	71.962	669.097	-6604.536
		Banking	-.002	-10640.291	-6604.536	71294.709

Source Author’s contributions.

At the level of partial regression on the regressive variables of the model, the aim was to evaluate the development of these components as part of the smart policies in dynamics (by years) at the level of the study sample. Regarding RDI, it

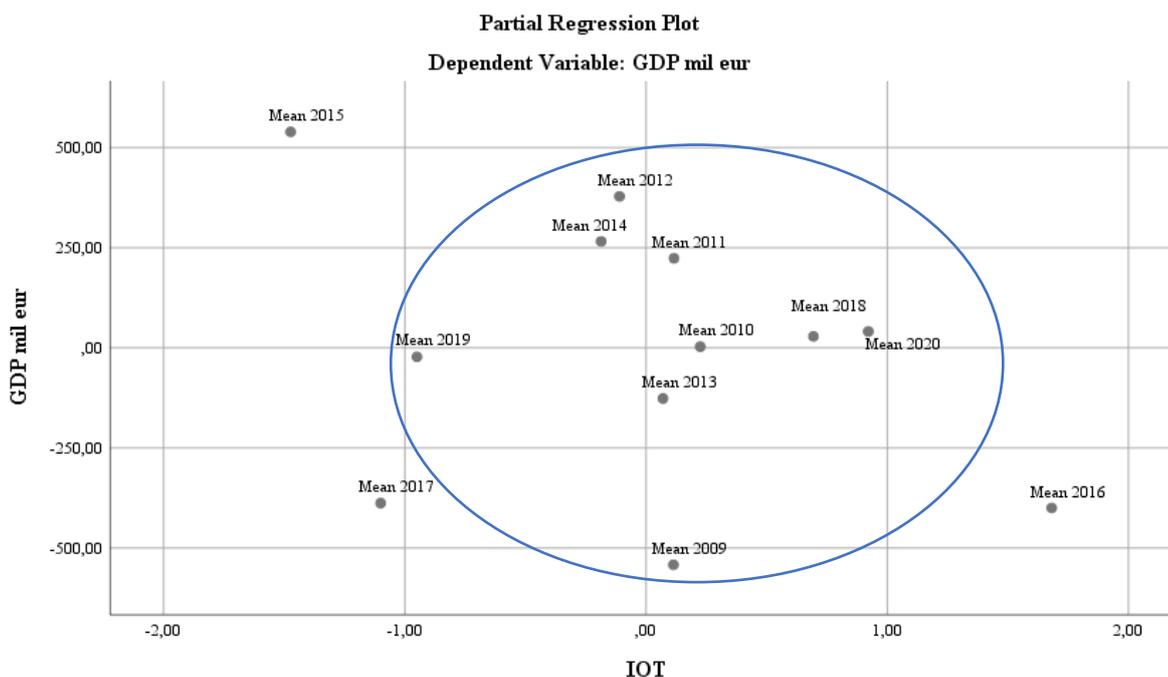
is found that there is a unified practice regarding the coherent application of policies to approximate RDI policies as a smart part, excepting 2014, 2017 and 2018. This evolution represents a logical consequence of the economic recovery processes at EU level after the global economic contractions due to the crisis. In addition, for 2017-2018, the initiation of Brexit was a difficult test for the European economy, a fact reflected in the table above by the presence of the city of London (see Figure 6).



**Figure 6: R&D&I regression analysis**

Source Author`s contributions.

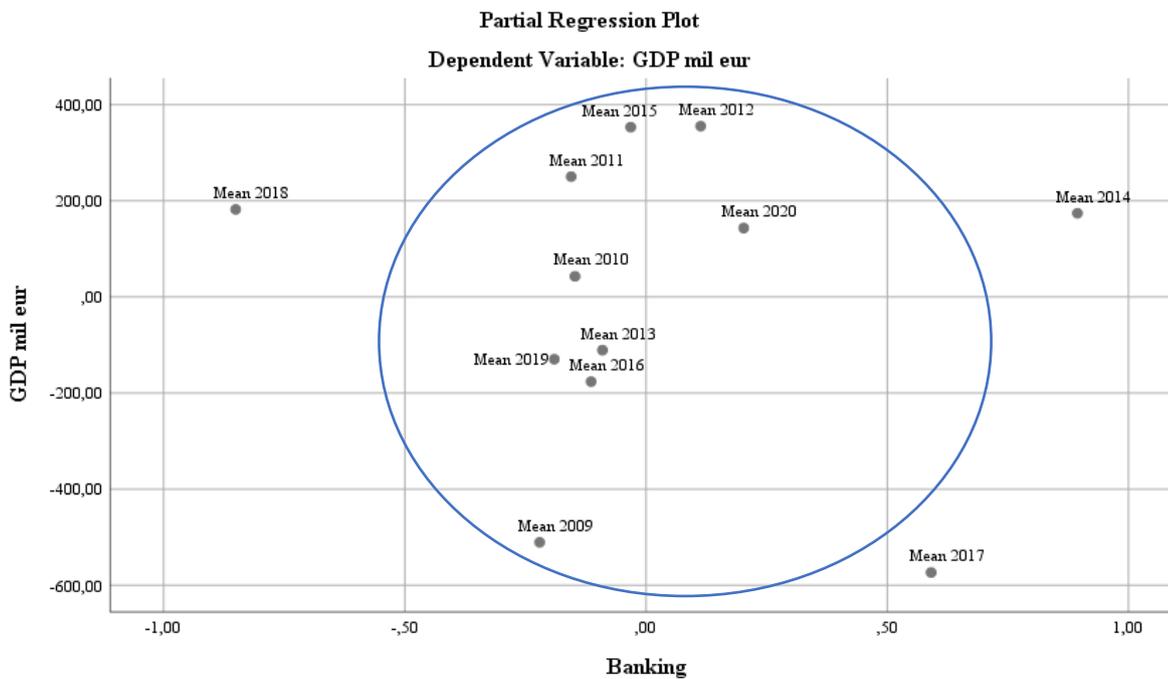
At the IoT development's level, there is a core focused on the entire period, excepting 2015-2017, years in which the incidents caused by the Mirai malware (Munro, 2021) caused infections of DVR devices, materialized in DDOS type attacks (in 2016, the KrebsOnSecurity block (Goodin, 2016) was attacked with a 600Gb stream, and in 2017, the Hajime worm infected many devices, blocking access to their ports), (see Figure 7).



**Figure 7: IoT regression analysis**

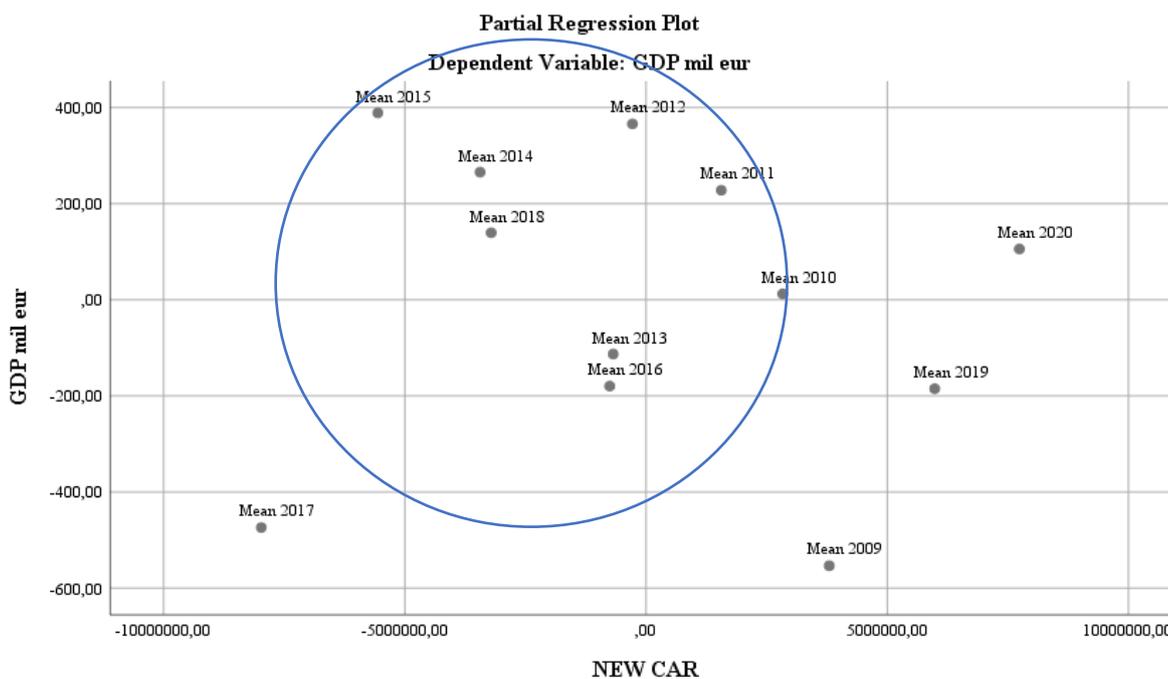
Source Author`s contributions.

As the financial crisis evolved into the euro area debt crisis it became clear that deeper integration of the banking system. Initially, mechanisms were introduced: single supervisory mechanism (SSM) (European Commission, 2021b) and single resolution mechanism (SRM) (European Commission, 2021a), which directly influenced the development of the internet banking. In October 2017, the above two mechanisms became fully operational, leading to a significant increase in the unionist banking architecture in the EU, including the explosion of banking operations (see Figure 8). The evolution of the demand for new vehicles at EU level was constantly high, but the coordinates of the new production of green cars were not felt in 2009. The demand for such vehicles has grown exponentially during 2017-2019. In 2020, the restrictions imposed by the COVID-19 pandemic changed the structure of transport options to personal ones, increasing the choice of consumers for green vehicles in accordance with the strategy of their promotion applied by all major car manufacturers (PricewaterhouseCoopers, 2020), (see Figure 9).



**Figure 8: Banking regression analysis**

Source Author's contributions.



**Figure 9: New car regression analysis**

Source Author's contributions.

From the presented analysis, the following smart development strategies applicable to cities whose goal is to reduce administrative costs and ensure integrated urban functionality by using alternative means generated by the implementation of new technologies and integrated financial flows are as follows (see Table 6):

**Table 6: Low cost vs expensive costs/solutions**

Indicator	Type	Solutions	Impact	Comments
Local GDP	Low cost Implementation	<ul style="list-style-type: none"> <li>- Differentiated charging system;</li> <li>- Progressive system of fines for environmental pollution applied to the local agents;</li> <li>- Differentiated taxation of the locations which promote R &amp; D &amp; I.</li> </ul>	<ul style="list-style-type: none"> <li>- Increasing the collection in the interest of the local community;</li> <li>- Financing subsequent smart city development projects;</li> <li>- Development of smart infrastructure projects.</li> </ul>	<ul style="list-style-type: none"> <li>- Both options are desirable and allow local / regional GDP growth;</li> <li>- Sustainable development;</li> <li>- Increasing the quality of life;</li> <li>- Smart city development.</li> </ul>
	Expensive solution	<ul style="list-style-type: none"> <li>- Implementation of new technologies in local administration;</li> <li>- Digitization;</li> <li>- Development of local research for the introduction of new technologies.</li> </ul>	<ul style="list-style-type: none"> <li>- Resource economy;</li> <li>- Increasing the income of the urban population;</li> <li>- Increasing the taxpayer satisfaction.</li> </ul>	
Internet users	Low cost implementation	<ul style="list-style-type: none"> <li>- Supporting the educational policies for access to the new technologies and communications in schools;</li> <li>- Creating an open society for the implementation of the new technologies.</li> </ul>	<ul style="list-style-type: none"> <li>- By increasing the number of users on long term;</li> <li>- Obtaining an educated local population, open to the new.</li> </ul>	<ul style="list-style-type: none"> <li>- Both options are desirable and allow the sustainability of the process, especially by inserting the new technologies in the school and give the process a high character of sustainable development.</li> </ul>
R&D&I	Expensive solution	<ul style="list-style-type: none"> <li>- Creation of urban networking centres;</li> <li>- Activation of counselling and guidance cells led by specialists / experts;</li> <li>- Creating IT clusters and developing solutions within them to local problems.</li> </ul>	<ul style="list-style-type: none"> <li>- Immediate accessibility on short and medium term;</li> <li>- Increasing the degree of adaptation to information technologies for the mature population;</li> <li>- High possibilities to reduce unemployment and increase the quality of life through information.</li> </ul>	<ul style="list-style-type: none"> <li>- Both options are desirable and allow the sustainability of the innovation process and the use of the solutions for the smart city development with an effect in reducing the development costs and immediate operationalization of the measures (also benefiting from the technical support of the specialists who produced the innovation).</li> </ul>
	Low cost implementation	<ul style="list-style-type: none"> <li>- Implementation of the 9 stages of technology readiness level in innovation; (Comes, Bunduchi, Vasile, &amp; Stefan, 2018)</li> <li>- Implementation of the benchmark in innovation.</li> </ul>	<ul style="list-style-type: none"> <li>- Increasing the applicability of innovation on medium term;</li> <li>- Connecting theory with practice.</li> </ul>	
Internet of Things (IoT)	Low cost implementation	<ul style="list-style-type: none"> <li>- Implementation of IoT at the level of surveillance processes (traffic, waste collection) in the second wave of applications;</li> <li>- Creating integrated and electronically coordinated flows;</li> <li>- Ensuring an integrated operational system at the level of local administration for the maintenance of the created flows.</li> </ul>	<ul style="list-style-type: none"> <li>- On the medium term, these flows will be operationalized, resulting in a saving of human and material resources at the level of local administration that will exceed the value of the investment during a time period assimilated to a discount rate of 8%.</li> </ul>	<ul style="list-style-type: none"> <li>- Both variants are desirable; they allow the sustainability of the monitoring process and the implementation of IoT, with effect on the consumption of resources and on the increase of the quality of the local administrative act. (Prince &amp; David, 2018)</li> </ul>
	Expensive solution	<ul style="list-style-type: none"> <li>- Introduction of teleoperation and telepresence systems with remote object monitoring and control;</li> <li>- Development of risk sensor detection agent software for IoT's efficiency and operationalization.</li> </ul>	<ul style="list-style-type: none"> <li>- On the medium and long term, it will be possible to manage with a very low cost and a maximum limitation of the risks the entire administrative flow at the locality level, which will lead to a maximization of the smart city rate.</li> </ul>	

Indicator	Type	Solutions	Impact	Comments
Internet banking	Low cost implementation	<ul style="list-style-type: none"> <li>- Multiplication of internet applications for accessing bank accounts and products;</li> <li>- Stimulating the use of internet banking through various incentives granted to the customers.</li> </ul>	<ul style="list-style-type: none"> <li>- The increase of internet banking activities on short term;</li> <li>- The increase of the number of banking internet users on medium and long term;</li> <li>- Increasing security of the banking operations on short, medium and long term.</li> </ul>	<ul style="list-style-type: none"> <li>- Both variants are desirable and allow the operational financing of the activities, current economic development, increasing the smart level of local development (smart city).</li> </ul>
	Expensive solution	<ul style="list-style-type: none"> <li>- Generalization of the internet banking access through single supervisory mechanism (SSM) and single resolution mechanism (SRM).</li> </ul>	<ul style="list-style-type: none"> <li>- Increasing the financial security on long term;</li> <li>- Increasing the speed of accessing funds by shortening the analysis time;</li> <li>- Supporting the sustainable development.</li> </ul>	
The overall rate of motorization	Low cost implementation	<ul style="list-style-type: none"> <li>- Creation of the networks for alternative traffic of cyclists and mopeds;</li> <li>- Expansion of parks and green spaces.</li> </ul>	<ul style="list-style-type: none"> <li>- Reducing pollution on short term;</li> <li>- Traffic reduction;</li> <li>- Increasing the quality of life.</li> </ul>	<ul style="list-style-type: none"> <li>- Both variants are desirable, they allow the decrease of pollution, achieving the objectives of sustainable development (environment component) and activating the urban quality indicators related to the smart city.</li> </ul>
	Expensive solution	<ul style="list-style-type: none"> <li>- Creation of an operational infrastructure and an adequate capacity related to the urban traffic, which should limit the general motorization rate applied in the locality;</li> <li>- Ensuring optimal power supplies for vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>- Reducing pollution on short term;</li> <li>- Traffic decongestion;</li> <li>- Reducing the carbon footprint of the locality;</li> <li>- Increasing the quality of life of smart city residents.</li> </ul>	
The rate of green motorized vehicles	Low cost implementation	<ul style="list-style-type: none"> <li>- Providing power supplies for green vehicles;</li> <li>- Application of the differentiated taxation system on the vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>- Increasing the motorization rate of the green vehicles on short term.</li> </ul>	<ul style="list-style-type: none"> <li>- Both variants are desirable; they allow the achievement of the sustainability objectives on the environment component;</li> <li>- Reduction of urban pollution, with long-term effect on increasing the quality of life;</li> <li>- Important pillar for smart city development.</li> </ul>
	Expensive solution	<ul style="list-style-type: none"> <li>- Offering facilities for the construction of services dedicated to green vehicles;</li> <li>- Replacement of the local transport fleet with green vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>- Increasing the motorization rate of the green vehicles on long term;</li> <li>- Reducing pollution;</li> <li>- Increasing the quality of life.</li> </ul>	
The rate of polluting vehicles	Low cost implementation	<ul style="list-style-type: none"> <li>- Application of the differentiated taxation system on the vehicles;</li> <li>- Establishment of areas with access restrictions for polluting vehicles.</li> </ul>	<ul style="list-style-type: none"> <li>- Decrease in the engine rate of polluting vehicles on short term;</li> <li>- Reducing pollution;</li> <li>- Increasing the quality of life.</li> </ul>	<ul style="list-style-type: none"> <li>- Both variants are desirable; they allow monitoring the city's fleet of polluting vehicles and limiting it in time;</li> <li>- Increasing sustainability;</li> <li>- Increasing the degree of smart city development.</li> </ul>
	Expensive solution	<ul style="list-style-type: none"> <li>- Establishment of pilot programs to stimulate the replacement of the polluting vehicles (providing facilities);</li> <li>- Establishment of a monitoring system of CO<sub>2</sub> emissions produced by polluting vehicles whose effect should be manifested in strict monitoring of the city's car fleet.</li> </ul>	<ul style="list-style-type: none"> <li>- Decrease in the engine rate of polluting vehicles on medium term;</li> <li>- Reducing pollution;</li> <li>- Increasing the quality of life.</li> </ul>	

Source Author's contributions.

According to the two-phase smart implementation table (Table 6) which covers the proposed objective of piloting a concept implementation tool from accessible to complete, from low cost to expensive solutions, it results that the concept is affordable and implementable not only by cities that know a top economic development, but also by cities that due to the large urban agglomeration should carefully monitor the core of indicators whose combined risk affects the quality of life and for which the smart solution is at least a desirable alternative.

## 5. CONCLUSIONS

The paper addresses a topic of maximum interest for the current economy, drawing attention to the need to monitor those indicators of vulnerability that trigger risks in large urban areas and the solution to reduce these risks by developing smart cities.

The components of the monitoring core were selected after careful monitoring of the literature, which presents a multitude of approaches to smart development, but which undoubtedly links this development to environmental issues, improving the quality of life and sustainable economic growth.

We drafted, based on a vector cluster of monitoring indicators studied at the level of European smart city cities (Top 10) and a smart development anti-pole (Bucharest), a model for evaluating the staging of smart city development in relation to the cluster average, highlighting, at the level of the selected indicators, the vulnerabilities which prevent the anti-pole from aligning with the smart development desideratum.

The main shortcoming of the model consists in the relatively limited number of indicators, the authors proposing to extend the model in a future study, including the implementing of questionnaires at the local administration level of this anti-pole of smart development.

The study can be extended to any other large urban agglomeration without translation problems of the model, based on known statistical methods and consolidation principles detailed in this study and valid demonstrated working hypotheses.

The second post-evaluation stage consists in identifying the possible smart development alternatives for each variable in the monitoring core by building a biphasic picture from accessible to complete, which would give the local administration the effective chance to implement the concept at the locality level.

The authors state that there are no conflicts of interest.

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## National Session: SS48B.2 - Regional Science in Russia



**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84728052596>**

**Chair Alexander Pelyasov**

## HOW DIFFERENT PATTERNS OF URBANIZATION AFFECT REGIONAL INNOVATION? EVIDENCE FROM RUSSIA

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### ABSTRACT

The present paper assesses the impact of general urbanization and urbanization patterns (the number of cities of a certain size in the region) on different phases of the regional innovation process: knowledge creation, implementation, and production of innovation production. Knowledge creation is measured by patent statistics, knowledge implementation – by the share of innovative organisations, innovation production – by the volume of innovation production produced by industrial organisations.

We apply the dynamic panel data model technique by using data from the period of 1998 to 2016. Our results suggest that general urbanization has a positive influence on every stage of the innovation process, while the impact of different urbanization patterns varies depending on its stage. Million plus cities affect knowledge creation in the region but have no considerable impact on knowledge implementation and innovation production. At the same time, the presence of cities with a population from 500 000 to 1 000 000 people in the region positively influences more mature stages of the innovation process: knowledge implementation and manufacturing of innovation production.

So far as the effective innovation development demands complete innovation cycle, not only million plus cities should be considered as the main drivers of innovation, but cities of lower size (at least with population from 5 000 000 to 1 000 000 people) as well should attend the innovation agenda.

**RADICAL INNOVATIONS AND INDUSTRIAL STRUCTURE OF REGIONS:  
INSIGHTS FROM RUSSIA**

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**ABSTRACT**

Radical innovations as a key driving force for long-term socio-economic progress are one of the vivid topics in regional science. The paper aims to shed light on the structure-specific factors of regional economies that favor the increase of a firm's radical innovations, considering the case of Russia. We use data from national innovation survey and measure radical innovations as the sales of new-to-the-market and new-to-the-firm innovative goods and services. The ordinal regression is applied to quantify the effects of independent variables on radical innovations. These indicators reflect how much the industrial structure of a firm's home region is diversified or specialized, and the shares of knowledge-intensive business services (KIBS) and creative & cultural industries (CCI) in a region's economy. We control regional market size, expenditures on technological innovations, and a firm's location in a region with a city of over 1 million population. The results show that, apart from expenditures, the industrial structure of regional economies affected the likelihood of higher sales of radical market novelties introduced by the firms located therein. More sales were detected in the firms, operating in the specialization industries of their home regions that were identified with cluster mapping of related industries. The shares of KIBS in the industrial structure of regions had greater impact on radical innovations, while the influence of CCI was not significant.

## THE IMPACT OF INTERNATIONAL SKILLED MIGRATION ON INNOVATION RESILIENCE OF RUSSIAN COASTAL REGIONS

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### ABSTRACT

The highly dynamic and progressive regions around the globe all share certain commonalities – competitive industries, advanced infrastructure, and the inflow of talents. Despite being somewhat elusive and implicit, the competencies, ideas and creativity are continuously regarded as the drivers of regional growth. The processes of knowledge spillovers, innovation diffusion, and regional learning are all related to interpersonal communication. The development of coastal regions is particularly defined by the coastalization phenomenon, which stands for the attraction of human resources, economic activity and financial capital to the coasts. The aim of the study is to test the interdependence of international skilled migration with innovation development in the coastal regions of Russia. The research design is based on quantitative statistical data of the Federal Service for Labor and Employment (Rostrud), the SPARK-Interfax database on industry performance, and the Scopus database on research output. The sourced dataset is geotagged and processed in QGIS for identifying the spatial patterns. The incoming flows of migrant workers from abroad analyzed in the article mainly represent countries with a visa regime for entry and are characterized by a high level of qualifications or a profession that is in short supply on the Russian labor market. Despite the numerical reduction of this cohort of workers in recent years, their concentration in the most economically developed coastal regions of Russia contributes to the human capital of the receiving territories. This effect is most noticeable at the level of individual regions, where the share of such workers in the labor market is most significant. At the same time, not only traditional centers of attraction in the most economically developed regions of the country (North-West and South of Russia) but also new local centers of attraction that have developed within the regions of population outflow (North and Far East of Russia) are attractive to international skilled migration. Highly educated migrants are concentrated in economically developed coastal regions with a high level of development of international relations (e.g. Kaliningrad region), while in the periphery, workers with secondary general, secondary, or primary vocational education are in demand. The study suggests that coastal regions attract skilled migrants giving an extra impulse for the regional innovation systems taking into consideration local specifics.

## **Regular Session: RS03.2 - Knowledge and innovation**

**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/84223142845>**

**Chair Roberto Antonietti**

## INNOVATION FOR SUSTAINABLE DEVELOPMENT IN POOR COUNTRIES- LESSONS FROM ETHIOPIA

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### ABSTRACT

Innovation is generally considered as knowledge creation (e.g., patents), R&D activities, and technological advancement. It typically benefits highly-developed regions, increasing their gaps with poorer regions. The integration of innovation in poorer countries can thus significantly contribute to their integration in the global economy. However, the common innovation policy concepts are inappropriate for poor countries.

We devise a conceptual approach for innovation in poor countries, design and test a simplified methodology for its implementation, and employ the case of Ethiopia for its demonstration. Our approach is summarized in four steps:

- Innovation is not a goal in itself, but rather an instrument for the achievement of distinct national development goals (e.g., economic growth, employment, improved wellbeing).
- Distinct types of innovation contribute to different development goals.
- The innovation ecosystem factors should be adapted to the specific innovation needs and conditions of poor countries.
- Innovation priorities should be adapted to the country's exogenous macro-economic conditions (development level, economic regime, economic structure, and development priorities).

The methodology employed to test the innovation needs and priorities of Ethiopia was as follows: key-informant interviews, focus group discussions, and questionnaires involving all ecosystem actors: government, academic and research institutions, business leaders (n= 49). Seven main ecosystem factors were tested (finance, human capital, infrastructures, information, academy, government services, culture) and evaluated through a total of 91 variables. Two aspects were evaluated for each variable, on a 1-5 scale: the variable's perceived importance for the advance of innovation, and the variable's current availability in the Ethiopian reality. The gap between the two scores indicates respondents' "frustration" level. The robustness of the findings is further corroborated by specific questionnaires for students (n=55), researchers (n=67), unemployed (n=53), and small enterprises (n=71). Secondary data on the national economy and the innovation situation in the country (drawing on the Global Innovation Index) complemented our primary data.

Findings indicate a gloomy economic situation and low innovation level, but at the same time high potential for growth based on a growing market, and considerable government commitment and efforts. The ecosystem analysis reveals frustration with the low availability of each of the factors, as well as their weak interaction within the ecosystem: lack of coordination between government, industry and academy; lack of coordination within government departments; and lack of interaction among businesses.

Several directions for innovation policy guidelines are derived from the analysis.

- *Adaptation.* At given exogenous conditions, innovation efforts should focus on a broad-base adaptation of existing technologies to more traditional activities.
- *Impact innovation.* Priority should be given to innovation types that can have major economic impacts and boost productivity and employment—e.g., in agriculture, industrialization, and SMEs.
- *Focus on market needs.* Rather than encouraging technology push, the innovation policy should focus on the market pull, respond to people's unmet needs, and support privatization.
- *A governmental coordination platform* is needed to set up the development priorities of innovation activities, strengthen coordination and collaboration among all ecosystem factors, and provide appropriate services and infrastructures.

## KEY ENABLING TECHNOLOGIES AND THE COMPLEXITY OF JOBS, TASKS, AND SKILLS IN EMILIA-ROMAGNA

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### ABSTRACT

During the last decade, the economic literature has depicted different scenarios with respect to the effects of the "fourth industrial revolution" on employment (Brynjolfsson and McAfee, 2014). Within this framework, one interesting field of investigation concerns the effects of Key Enabling Technologies (KETs) on regional occupational structures and the related implications for skills development. It is widely argued that KETs will lead to a major shift in skill demand due to both the change in the occupational composition of the labour force (between-occupation effect) and the need for new skills or a change in the relative skill composition in certain job categories (within-occupation effect).

Focusing on between-occupation effects, this paper investigates whether a more intense use of KETs corresponds to a higher demand for more complex jobs, tasks, and skills in the manufacturing industry of Emilia-Romagna region, Italy, between 2008 and 2017. The empirical analysis relies on three data sources. Employment data come from the Sistema Informativo Lavoro - Emilia-Romagna (SILER), consisting in administrative linked employers-employees microdata collected by Italian regions. Such a system encompasses all occurrences concerning a job position (hiring, firing, conversion and fixed-term contract prolonged duration) at the firm-level. These data are merged with information provided by the INAPP-ISTAT national survey on jobs, tasks, skills, and work attitudes for all the occupational profiles in Italy. With this information we compute two dependent variables: (i) following Autor et al. (2003), the routine task index (RTI), defined as the share of local employees accomplishing high-, or low-, routine tasks; (ii) following Hidalgo and Hausmann (2009), three indicators of complexity, based on the diversity and exclusivity of jobs, tasks, and skills respectively. While the former aims to measure routine-biased technological change at the intensive margin, the latter is more suited for measuring it at the extensive margin. Data on regional KETs endowment come from OECD-REGPAT. KETs-related patents are identified as those labelled with at least one International Patent Class (IPC) and/or Cooperative Patent Classification (CPC) identified by the European Commission feasibility study on KETs (EC, 2012). Specifically, we use NUTS-3 regional patent applications to the following six classes of patents that we redistribute to local labour market areas (LLMA) in the region: advanced manufacturing technology, advanced materials, industrial biotechnology, nanotechnology, micro-, and nanoelectronics, and photonics. Our fixed-effects estimates show that a higher share of KETs in an LLMA corresponds to a higher level of task and skill complexity, but not of job complexity. Using an instrumental variable approach, we find that this result is robust to endogeneity. The general-purpose, and enabling, nature of KETs stimulates a higher demand for a more diversified, and exclusive, portfolio of tasks and skills while keeping job profiles unchanged. We also find that such a relationship is particularly strong for advanced manufacturing technologies.

## THE FORMATION MECHANISM OF SPATIAL AGGLOMERATION OF URBAN CULTURAL INDUSTRY—CASE STUDY ON CHENGDU CITY

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### ABSTRACT

Based on the theory of professional division of labor, spatial location theory and Marshall externality theory, this paper studies the spatial agglomeration of cultural industry, and measures the location entropy of the spatial agglomeration of cultural industry in Chengdu. From three aspects of economic factors, cultural factors and location factors, combined with the policy factors of the government, this paper constructs a mathematical model of the influencing factors of cultural industry spatial agglomeration. The empirical test of spatial econometrics is carried out. Research practice has proved that the cultural industry spatial agglomeration is the result of the interaction of cultural factors, location factors and economic factors, and the government's policy support and financial investment play a direct role in promoting and stimulating the spatial agglomeration of cultural industry. Finally, based on the research results, the corresponding policy recommendations have been given.

### KEYWORD

Cultural industry spatial agglomeration; professional division of labor theory; spatial location theory; Marshall externality theory

### 1. INTRODUCTION

With the rapid development of cultural industry, there is a new trend of agglomeration in urban cultural space. More and more scholars pay attention to the level of cultural industry agglomeration, and increase the observation and research on the concentration trend of cultural economic activities. The first observation of cultural industry agglomeration in foreign countries is based on the research of "new geographical economics" (Krugman, 1998<sup>86</sup>; Fujita et al, 1999<sup>87</sup>), which defines the investigation of cultural industry agglomeration in the general spatial model of economic activities. Some scholars describe the cultural industry in the framework of industrial organization and regard it as "the spatial state of the combination of culture and economy" (Chris Gibson and Connell, 2004<sup>88</sup>). A large number of scholars have conducted theoretical research on the spatial agglomeration of cultural industry in special areas. Clark (1984), Davis (1990), Schorske (1980), Zukin (1995) and many other scholars have described the phenomenon of cultural industry agglomeration in various urban backgrounds (Alan J. Scott, 2010). Studies on the spatial agglomeration of cultural industries mainly focus on the following aspects:

#### (1) Research on the spatial agglomeration location of cultural industries.

Alan J. Scott is an earlier and more in-depth scholar on the spatial agglomeration of cultural industry. He believes that the emerging global cultural economy tends to be condensed into geographical landscapes in the form of scattered cities and regional production systems (Scott, 2000), and the spatial distribution of cultural industries tends to gather in the form of spatial agglomeration in major cultural cities around the world, such as New York, Paris, Shanghai, etc. Markusen and G. Schrock (Markusen & G. Schrock, 2006) explained the diffusion and transfer trend of the agglomeration places of cultural and creative industries. Moloch (1983) believes that the distinctive feature of cultural industry is that it tends to form dense specialized industrial areas in the structure of big cities. By investigating the locations of cultural producers in 109 small Canadian cities, Jonathan (2012) found the "anti-urbanization" tendency in cultural industry clusters, and artists were more willing to choose villages with lower living costs and beautiful natural environment rather than cities as new creative destinations. The agglomeration of urban groups also plays an important role in the spatial agglomeration of cultural industries. According to the study of Hall (2000), it is easier for different groups to develop into the location of urban cultural spatial agglomeration in the process of urban agglomeration, communication, integration and collision.

#### (2) Study on the relationship between spatial agglomeration of cultural industries and cities.

86 P. R. Krugman, A J. Venables. Globalization and the Inequality of Nation [J], *Quarter of Journal Economics*, 1995,110(4): 857-880.

87 M. Fujita, J.-F. Thisse, Does Geographical Agglomeration Foster Economic Growth? And Gains and Loses from It?[J]. *The Japanese Economic Review*, 2003,54:121-145.

88 Gibson, C. and Connell, J. 2004: Cultural industry production in remote places: indigenous popular music in Australia. In Power, D. and Scott, A. editors, *The cultural industries and the production of culture*, London and New York: Routledge, 243-58.

City is an important place for cultural industry spatial agglomeration. Sassen (1991) studied the agglomeration of cultural industries from the perspective of the internal spatial structure of big cities. In his opinion, old warehouses and urban fringe areas often play an important role in the agglomeration of urban cultural industries. Hutton (2000,2004) found that the "new production space" of the city could provide some architectural, cultural, environmental, learning and social convenience for the groups and enterprises concentrated in the creative industry. Some scholars have also studied the influence of cultural industry agglomeration on urban development. Mommaas (2004) analyzed the agglomeration strategy of Dutch cultural industries, and believed that the agglomeration of cultural industries could play a positive role in promoting a city's identity identification, innovation and creativity, and the reuse of old space. UNESCO believes that "arts, cultural resources and cultural clusters are engines of sustainable economic development... And urban regeneration policies can be adopted to regenerate cities "(OECD,2005). Montgomery J (2004) regards the construction of cultural industrial parks as a mode of urban regeneration and urban spatial transformation. Sharon Zukin believes that in a sense, the city first appears as a space, so the study of urban culture is also a kind of space research.

### **(3) Research on the internal organization of cultural industry spatial agglomeration.**

In addition to the study on the spatial agglomeration of cultural industries and the relationship between them and urban space, researchers also pay attention to the issue of how cultural industries organize production in aggregates. Scott (2006) attributed the aggregation of cultural and creative industries in urban space to the interaction of human relations, historical cultural precipitation, changes in production organization and institutional arrangement, and believed that producer network, local labor market and creative field were the main factors that promoted the cultural industry agglomeration in urban space. He argues that the increasing differentiation of the labor force, both in the cultural and economic fields of production, strongly demonstrates the aggregation of many specialized but complementary individuals and organizations, constantly changing each other, and thus forming an aggregation of functions and Spaces of interrelated activities. Negus (2002) found that because cultural consumption is concentrated in the region, producers must "closely act" to keep track of competitors in order to keep in touch with the current trend, so as to benefit from the work of cultural media at the same time by virtue of various new technologies. Molotch (1996) believes that with the specialization of the cultural industry, cultural production will lie more in various professionals, who gradually replace individual artists in the traditional sense in all aspects. This process forms a geographical "lock-in" phenomenon in the space of cultural industry agglomeration, and finally forms the identity of products in special places and serves as the exclusive cultural monopoly capital of the place. Harald Bathelt (2006) believes that the cultural industry in Leipzig is controlled by several large local companies. Due to the defect of being over-rooted, the cultural industry in Leipzig keeps loose contact with the outside world, which is detrimental to the development of cultural industry spatial agglomeration. In the research process, some scholars also found that the production activities of cultural industry agglomeration are more inclined to be carried out around projects rather than companies. They (Blair H, Grey S, Randle K) believe that the spatial agglomeration of cultural industry is more conducive to the development of the working mode of project team and project network. Grabher G. (2002, 2004) put forward the concept and research methods of project ecology. He believed that different levels, such as core team, company, cognitive community and individual network, constituted the project ecology of cultural and creative industries, and paid attention to the relationship between projects and the environment. Bassett et al. (2002) discussed the structure of natural history film production agglomeration in Bristol based on the theory of urban growth pole. This study focuses on the origin, stage, depth of regional industrial agglomeration, the relationship between local industrial agglomeration and the world economy, the policy system and support to agglomeration, and the current dynamic changes of agglomeration development. Through empirical tests, the researchers found that the formation of cultural industry agglomeration in Bristol also tends to be based on small and medium-sized enterprises and private individuals.

### **(4) Research on the main body of cultural industries spatial agglomeration.**

Zukin (1988) paid attention to the importance of various cultural producers represented by artists to the formation of cultural industry agglomeration. Richard Florida, puts forward the concept of the Creative Class (Creative Class), and the Creative Class is divided into to the core of the artist as the main body of the Super or Creative Class (Super Creative Class) and management, financial and legal services of professional Creative Class (Creative Professionals), in Richard's view, the Creative economy is different classes such as art, business and technology in the field of cultural and economic integration. At the same time, the contract of cultural and artistic producers, the decision factors of artists' location mobility and relocation, the role and political nature of artists themselves in cultural production, as well as the Life Path of the most creative artists and scientists, have all attracted varying degrees of attention. (Allen Scott Allen Scott) respectively from the Los Angeles apparel industry, furniture industry, and Hollywood animation industry empirical research, from the Angle of labor resources, probes into the cultural industry agglomeration form reason, he pointed out that the accumulation of the cultural professionals make labour market expands, the cultural industry of employees and enterprise benefit (Allen Scott. 2005, 2006). John Hawkins, known as the "father of creative industry", fully affirmed and attached importance to the role of creative talents in cultural industry agglomeration (Hawkins J., 2001). Lee (2001), Markoff (2005), Markusen (2003), Roberta (2012) and other scholars also conducted corresponding studies on cultural industry agglomeration groups.

### **(5) Research on the formulation of spatial agglomeration policies for cultural industries.**

Coe (2000) points out that the development of cultural industry agglomeration depends to some extent on the intervention and guidance of the public sector, and different levels of governments and different styles of management structures can bring different results to the creation and innovation of cultural industry agglomeration. Bauer and Scott (Power & Scott, 2004) especially believe that the establishment of spatial agglomeration of cultural industry has become an important symbol of the current cultural and economic policies. Hitters and Richard (Hitters E. & Richards G., 2002) found that the government's intervention mode in cultural industrial parks from complete non-interference to centralized management has a certain degree of management continuity. Researchers such as Gibbons et al. (Gibson et al., 2002) believe that the defined architectural scope is re-modelled and re-built as a cultural district, and cultural industry activities are used as a means to promote the development strategy of marketized cities and attract floating capital. They are under a strategy of localized manufacturing and urban image regeneration, yet cultural themes describe particular places in ways that enhance or counter the popularity of other places. Because of the recognition of the effect of cultural industry spatial agglomeration on urban economic development, some scholars have also made corresponding research on the relationship between cultural industry planning and urban spatial planning. They believe that urban economy is constantly dependent on the production and consumption of culture, so that cultural industry planning and urban planning are often closely linked or even inseparable (Landry, 2000). Freestone and Gibbons (Freestone & Gibson, 2004) believe that cultural projects are not subconsciously planned strategies, but the result of competition (Bianchini, 1993; Evans and Foord, 2003); Boyle (1997) observed that cultural agglomeration was linked to the civic driven agenda of urban elites in urban planning strategies. Power & Scott (2004) pointed out that when local governments seek to develop their cultural economy, policy makers need to pay attention to promote the collective competitive advantage and establish a modern theoretical cultural industrial district, the cultural economy is an integral part of the contemporary economy, and the state can plan for cultural industrial zones or cultural agglomeration spaces through planning for innovation and creativity centers, through mixed land use or tax incentives, and through recognition of work networks between companies.

On the basis of the original literature research, this paper makes a theoretical analysis of the formation process of cultural industry spatial agglomeration from the perspective of professional division of labor theory. Professional division of labor as a special culture of self-organizing network model, cultural industry agglomeration is not only a pure culture of professional role, but also affected by the economic level and geographic space location, is the cultural accumulation, the industrial agglomeration and spatial agglomeration in the cultural factor, economic factor and the inner mechanism of the locational factors, in the government, market and society three mechanisms of propulsion mechanism under the action of polymerization. The arrangement of this paper consists of five parts: part 1 is the introduction, part 2 the concept definition and feature classification, part 3 is the model construction, part 4 is the empirical test, and the fifth part is the countermeasures and suggestions.

## 2. CONCEPT DEFINITION AND TAXONOMY

### 2.1 Culture

#### (1) Culture concept definition

Culture, as an interdisciplinary concept with rich connotations, is an important part of interdisciplinary studies such as anthropology, sociology, economics, management and history. In the research framework of human sociology, culture refers to the values, beliefs and understanding of the world shared by members of the society. People use culture to explain experience and initiate behavior, and culture is also reflected in people's behavior. The first clear and comprehensive definition of culture comes from Edward Burnett Taylor: "the complex body that includes knowledge, belief, art, morality, law, custom, and any other talents and habits acquired by man as a member of society" (Taylor, 1992). In Taylor's view, the various parts of culture function as an integrated whole. American anthropologists Kroeber and Clark Hong (1952) summarized the cultural connotation into two levels: one is the level of values, the other is the level of science and technology. According to the Australian economic and cultural scientist Throsby, culture includes two meanings: one is the sum total of cultural activities-based, the other is social values and habits (Throsby, 2003). In his book *The Important Role of Culture: How Values Influence Human Progress*, Huntington defines "culture" as "the values, attitudes, beliefs, orientation, and generally held opinions within a society" (Samuel Huntington, Lawrence Harrison, 2002). It can be seen that Huntington defined the concept of culture mainly from the psychological aspects of values, attitudes and so on. According to Malinowski, a British anthropologist, and Fei Xiaotong, a Chinese scholar, culture can be divided into three aspects: the level of objects, the level of institutions, and the level of ideas. As the code of conduct and symbol externalization of values, institutions and implements are determined by cultural concepts in the final analysis. Therefore, the essence of culture is the spirit value concept, way of thinking and code of conduct of cultural subjects.

#### (2) The role of culture in economy growth

In *The Wealth of Nations* published in 1776, Smith argued that division of labor and specialization promoted economic development, and that human beings, as rational individuals, unconsciously contributed to the increase of social welfare and the prosperity of social economy when they pursued their own interests maximization. The invisible hand refers not only to the market behind a trade, but also to the cultural concepts and consciousness that drive people's trading decisions. Marshall (1890), the epitomizer of classical economics, noted that cultural factors (including religion, morality, ideas, and ideals) and economic motives also determine people's behavior. He thought that every man with a little merit

had a higher character when he was in business. Personal emotion, sense of responsibility and the worship of noble ideals are also fully reflected in business operation. At the same time, Marshall also proposed the famous cultural industry atmosphere theory, he believed that a set of social and cultural norms and practices centered on the production system are related first to an underlying, non-regional production structure, and second to the economic geography of a particular place. Even in a non-regional world, if such a thing were possible, it is entirely conceivable that different cultural expressions associated with particular economic activities would, however, be at present departmental rather than spatial (Alan J. Scott, 2010). Hayek (1976) believed that the unconscious cognition and behavior of individuals contributed to the growth of group and social economy. In other words, the positive promoting effect of system and order on economic development has become the root of path dependence. In conclusion, the classical economists, represented by Adam Smith in the origin and development of the economy, seemingly abstract away people's individual consciousness and the concept of cognition, the man as a rational person, but actually they are the sublimation in the cultural concept to individual behavior choice, inherent in the individual pursuit of economic interests, which is constituted of individual utility preference theory, just did not explicitly proposed the economic concept of the culture. The influence of culture on a single subject, the visible culture is through the cultural concepts, cultural system and cultural products for an individual to influence, different individuals, as the price of the same cultural preferences and choice between formed layers of a particular culture, and formed many different cultural spheres of economic spatial difference of regional culture characteristics.

## 2.2 Cultural industry

### (1) Definition by deferent countries and organization

Most countries in the world define the concept of cultural industry according to their own national emphasis on the development of cultural industry. At present, the general terms include "copyright industry", "cultural and creative industry", "content industry", "cultural and leisure industry" and so on. The following are some representative categories of cultural industry concepts: 1. Cultural Industry. UNESCO was the first organization to use the concept of cultural industry. Since 1986, cultural industry has been defined as "a series of activities in which cultural products and services are produced, reproduced, stored and distributed according to industrial standards". Since then, after two revisions in 2000 and 2009, the concept has continued. In terms of countries, Canada, South Korea, Finland and others also use the concept of "cultural industry". China adopts the definition of UNESCO and also uses the concept of "cultural industry". The cultural industry is defined as "the collection of production activities that provide cultural products and culture-related products for the public." 2. Creative Industry. The UK was the first country to use the concept of creative industries. It was first proposed in the "Creative Britain Action Plan" released by the British government in 1997. The UK specifically emphasizes creative industries in order to distinguish them from traditional industries, including popular design and fashion, crafts, music, design, performing arts, casual software and games. These industries include music, publishing, audiovisual, multimedia, performance, visual arts and crafts, etc. They cover fields such as design, industrial design, graphics, fashion and so on. They integrate the art industry and computer communication, and make them communicate with each other through digitization, making them the new power of the new economy. Other countries such as Singapore and New Zealand, as well as China's Hong Kong and Taiwan also use the concept of creative industries. 3. Copyright Industry. The United States is a typical country that uses the concept of copyright industry. As early as 1990, the copyright industry was included in the U.S. statistical indicator system and used to calculate its contribution to the U.S. economy. It was divided into core copyright industries, cross-copyright industries, partial copyright industries, and marginal industries.

The definitions of cultural industry various from worldwide countries and organizations, but there is no unified definition of cultural industry in the world. Therefore, in the following research of this article, the concept of "cultural industry" will be used uniformly to equate with Industrial concepts such as cultural creativity, cultural leisure, and content copyright. According to Throsby, the cultural industry is the aggregation of all art forms and related service providers within a region, which together constitute the entire art industry within the region, the country or any other region concerned by the research institute. He believed that the cultural industry is an economic group with the core of creative thought extending and expanding outward, and with "creation" as the core and combining with other inputs to form various cultural products. Scott (2001) summarized the cultural industry as "products and services that provide entertainment facilities, social communication, self-cultivation, decorations, social status, etc., which exist not only in elite culture such as movies and music, but also in the combination of more utilitarian functions such as furniture or clothing. Pratt (1997) defined a series of cultural industry production system components: performance, fine art and literature as well as their reproduction forms of expression -- books, periodicals, magazines, newspapers, films, radio, television, audio CD or tape; Art forms such as advertising (also known as print and radio) and the production, distribution and display processes of museums, libraries, theatres, nightclubs, and galleries are linked together. Chinese scholars Jin Yuan Pu will be a cultural industry is "the condition of globalization to people's spiritual and cultural entertainment consumption era demand as the foundation, supported by high-tech technology, dominated by Internet in new ways, with culture and arts and economic comprehensive union for its own characteristics, multinational cross-industry inter-departmental interdisciplinary restructuring or create a new industry cluster." From the above analysis, it can be seen that there is no unified definition and appellation for the cultural industry, whether it is the governments of many countries or the academic circles at home and abroad. Although the appellation concept is different, but the meaning is similar. No matter cultural economy, cultural industry or creative economy, they all express the same meaning: that is, the industrial form

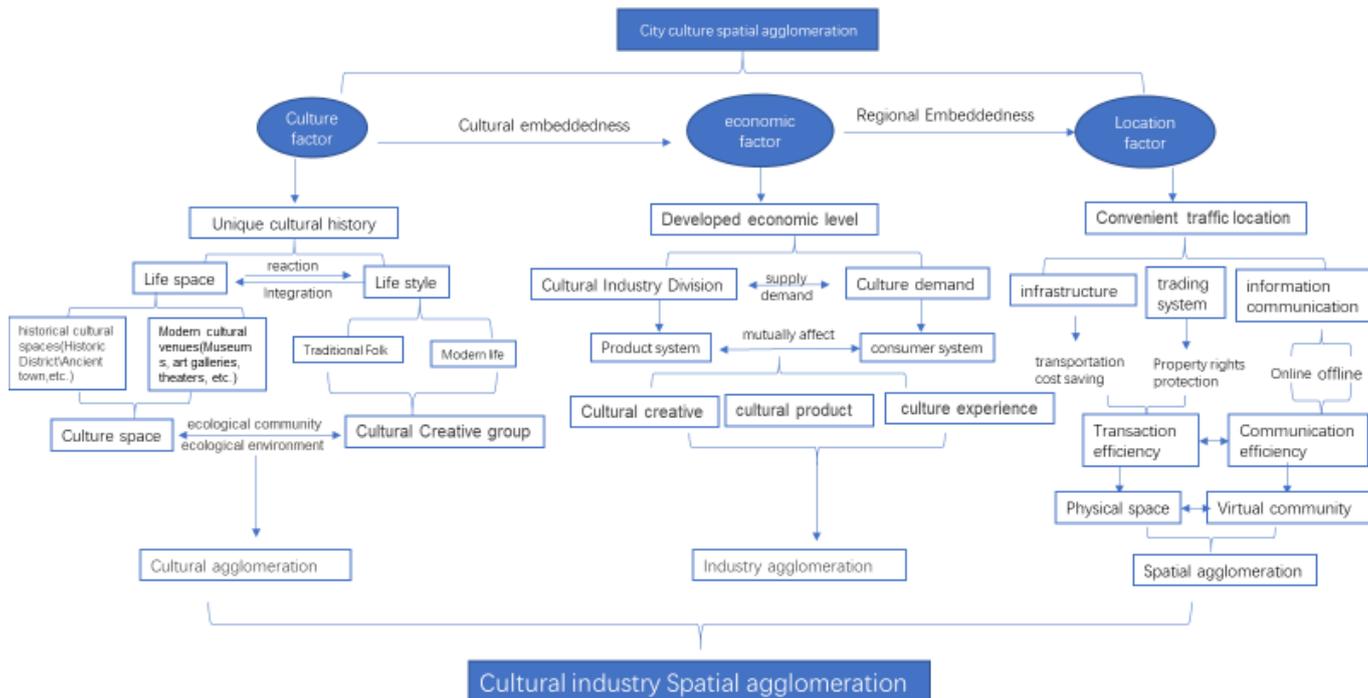
combining culture and economy. The above definitions of the concept of cultural industry respectively emphasize the creativity, spiritual production and service of cultural industry. Based on this, this paper holds that cultural industry is a specialized production and service activity of creative content production based on professional division of labor, taking cultural factors as its characteristics, and spreading and serving with the help of advanced scientific and technological means and information technology.

### 2.3 The concept of spatial agglomeration of cultural industries

According to the world intellectual property organization (WIPO), the definition of "cultural creative industry cluster" refers to the cultural industry, public welfare, movies, music, publishing, interactive software, design, etc.) in geographically concentrated, it will be voluntary cultural creativity industry together, make the creation of cultural products production, distribution and use of optimization. Scott (1996) believes that spatial agglomeration of cultural industry refers to the non-random concentration or agglomeration in space of independent cultural enterprises or institutions of different scales, mainly small and medium-sized enterprises. The above definition, the former is more of a resultant static description, ignoring the dynamic process of industrial agglomeration formation. The latter ignores the government and cultural practitioners, thus losing the comprehensiveness of the concept description of cultural industry agglomeration. Industrial spatial agglomeration, this paper argues that culture is based on all kinds of cultural professionals in the crowd, based on the established specialized division of labor and collaboration, mainly small and medium-sized enterprises of different sizes of independent cultural enterprises and related government, research institutes, in parks, on the space settlement or building as a carrier of the interpersonal network and space location of focus. The "agglomeration" here lays more emphasis on specific economic logic and industrial association, and is the dynamic response of cultural industry and its industrial chain in spatial agglomeration. A large number of studies by scholars at home and abroad show that the spatial agglomeration of cultural industries is mainly formed in the cultural industrial districts of international cities. Specific appellations are "cultural industry park", "cultural industry area", "cultural industry base" and so on, according to the specific formation of the agglomeration area and have different appellations.

### 2.4 Cultural industry agglomeration formation mechanism

The spatial agglomeration of cultural industry is not only the agglomeration of industry, enterprises or people, but also the interaction and interaction of economy, location and culture. (Figure 1)



**Figure 1. Mechanism of cultural industry spatial agglomeration**

Cultural factors form unique cultural concept characteristics through cultural resources, which are often directly reflected by the local traditional living space and lifestyle. Living space includes traditional cultural space such as historical and cultural blocks, ancient towns and ancient villages, as well as modern venues such as museums, art galleries and cinemas. As the representation of specific cultural concepts, lifestyle mainly includes traditional historical folk culture and modern lifestyle. As the excavators and promoters of these two lifestyles, cultural creative groups often choose to gather in specific cultural space to form cultural creative settlement.

The movement of economic factors mainly selects regions with more developed economic level. Under the condition of cultural industry division, through the implantation of cultural factors, the production and consumption system of cultural and creative industries with local characteristics is formed. Due to its own industrial characteristics, cultural industry often has the instantaneity, sharing and replicability of production and consumption. As a labor group in the production consumption system, cultural and creative groups gather together to produce cultural and creative industries driven by economic benefits, including the creation of cultural content, the development and production of cultural and creative products, and the development and operation of cultural experience base. Finally, under the promotion of the industrial chain, the cultural creativity will be gathered in the industry.

The movement of location factor is mainly driven by the convenient transportation and transportation cost. Enterprises often choose the location where the infrastructure is intact, the trading system is sound, and the information exchange is efficient. The construction of infrastructure mainly involves the construction of expressways and public transportation. The most important transaction system of cultural industry is the property right transaction system. Therefore, whether there is a complete property right protection system is an important part in the location selection of cultural industry enterprises. As a knowledge spillover enterprise, information exchange is a necessary way for creative people to improve their creative level and knowledge. The traditional information exchange is mainly face-to-face, but with the development of modern information technology, virtual network space communication is becoming more and more important. Under the joint promotion of transaction efficiency and exchange efficiency, the cultural industry in a specific location gathers in the entity space.

These three factors do not exist independently. The unique regional cultural resources in the cultural factors form the unique cultural embeddedness in the economic factors of cultural industry. At the same time, it benefits from the movement of location factors. The improvement of transaction efficiency and exchange efficiency promotes the regional embeddedness. As the carrier of cultural factors and location factors, economic factors are fixed in the form of industrial system, and finally form the formation of cultural industry spatial agglomeration.

Under the action of the three factors, the post Fort regional and cultural economy shows perfect individual identity. The environment in which all types of cultural production - whether in the form of commodities or not - is rooted in a unique community of practitioners anchored to specific locations. For example, the Brahman painters of Nathd-wara in Northeast India, and a large number of film and television production groups gathered in the film settlement of contemporary Paris or Hollywood<sup>89</sup>. the active centers of social reproduction are formed through these groups. In the process of social reproduction, the key cultural capabilities are maintained and recycled, and continue to play a role, eventually forming a cultural industry cluster with unique regional labels.

### 3. MEASUREMENT OF SPATIAL AGGLOMERATION OF CULTURAL INDUSTRY

#### 3.1 location quotient measurement

In the existing literature, market concentration index, Gini coefficient, Herfindahl index, Ellison Gleeser index are used to measure industrial concentration. However, these indicators are non-spatial and only rely on the industrial dimension, which can not provide information on where industries are concentrated. Location quotient (LQ) reflects the level of specialization in a region. It can be used to measure the degree of industrial agglomeration and its scale advantage in higher level regions. It has been widely used in the study of creative industries in European countries. The calculation formula of LQ is as follows:

$$LQ_{ij} = \frac{\frac{E_{ij}}{E_i}}{\frac{E_j}{E}} \quad (1)$$

Where in formula (1):  $E_{ij}$  is the total number of employees in industry  $i$  in region  $j$ ;  $E_i$  is the total number of employees in industry  $i$  in the region;  $E_j$  is the number of employees in region  $j$ ;  $E$  is the total number of employees in the region.  $LQ > 1$  means that the degree of specialization of  $i$  industry in region  $j$  is higher than the regional average, and its scale has a comparative advantage;  $LQ < 1$  means that the degree of specialization of  $i$  industry in region  $j$  is lower than the regional average, and its scale is relatively weak;  $LQ = 1$  means that the  $i$  industry in region  $j$  is at a general level. In the case of a given region and industry, location quotient can also be described as:

$$LQ = \frac{N_1/A_1}{N_0/A_0} \quad (2)$$

Where  $N_1$  is the output value of a certain department in the research area (or the number of employees);  $A_1$  is the output value of all departments in the research area (or the number of employees);  $N_0$  is the output value of a certain department in the background area (or the number of employees);  $A_0$  is the output value of all departments in the background area (Or the number of employees). Comparing the total output value of the cultural industry in each administrative region of Chengdu, we can get the location and degree of the cultural industry in Chengdu.

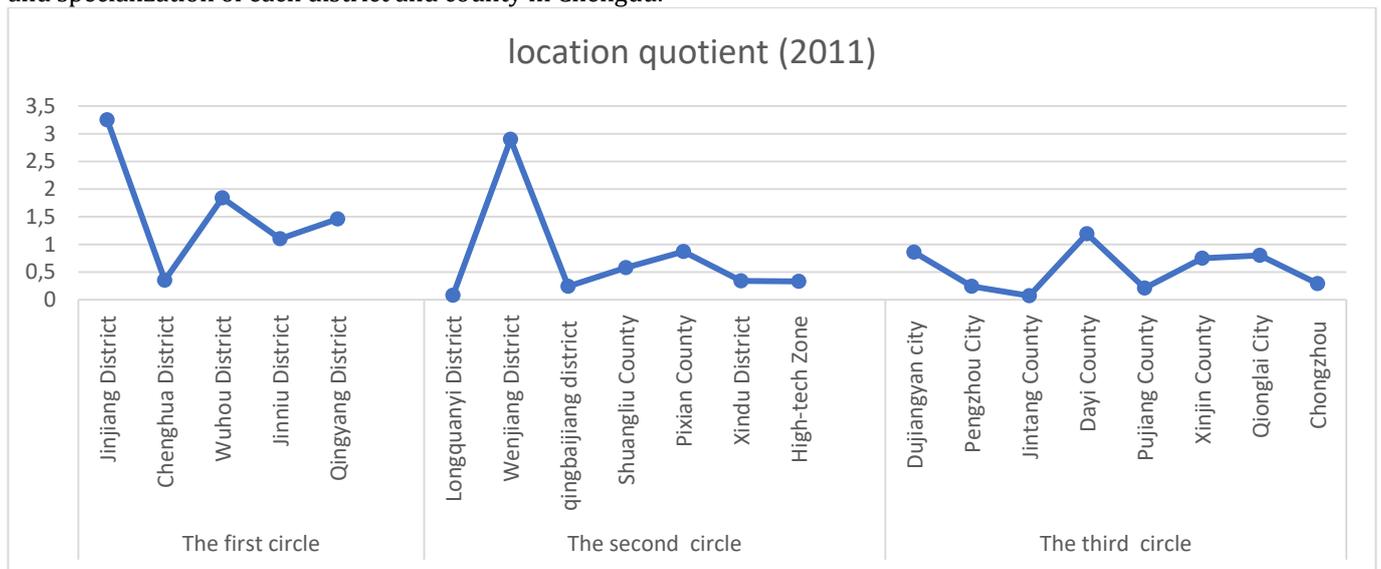
#### 3.2 location quotient of cultural industry in different regions of Chengdu

##### 3.2.1 Location quotient measurement of GDP added value

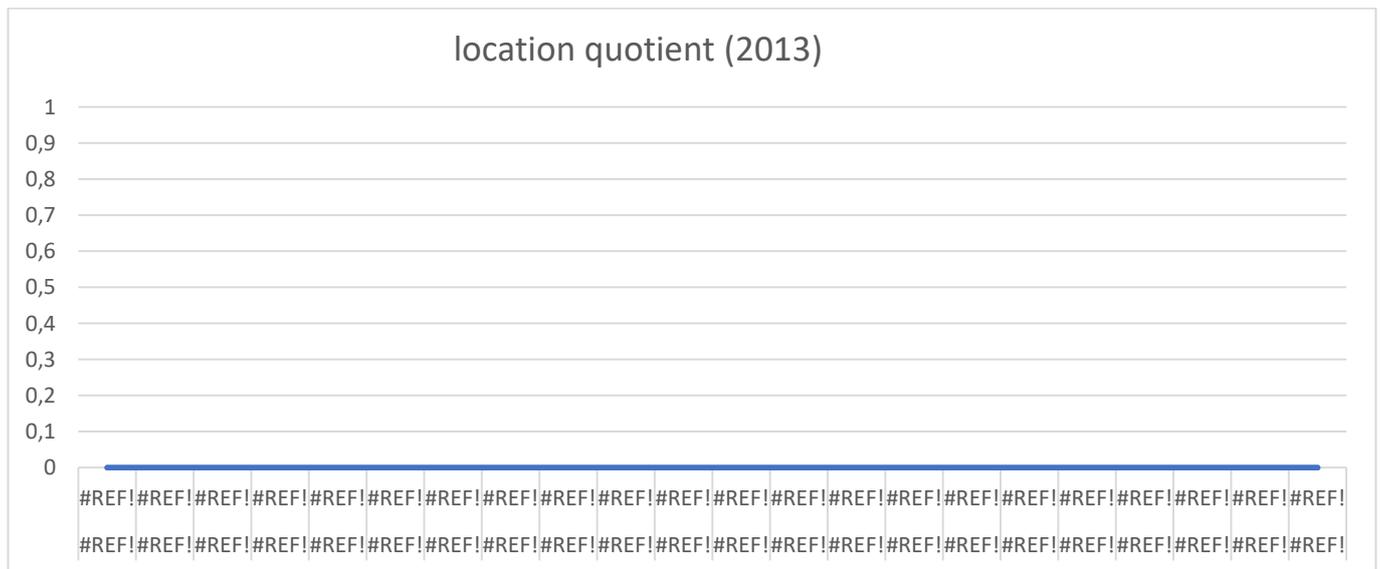
According to the cultural industry GDP added value and its proportion in GDP of Chengdu City and its administrative districts and counties in year 2011 and 2013, the location entropy of cultural industry GDP added value of each district

<sup>89</sup> Alan J. Scott. Translated by Dong Shu bao and Zhang Ning. Urban Cultural Economics [M]. Renmin University of China Press, 2010.

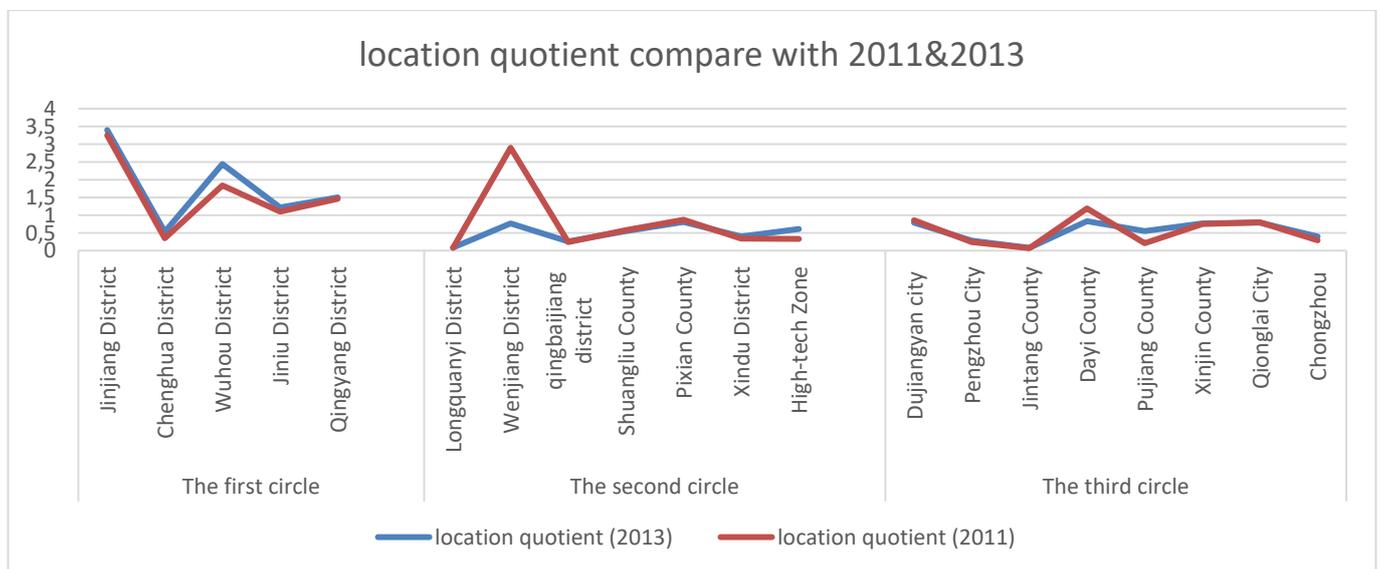
(city) and county is measured, which can investigate the proportion of cultural industry GDP added value in each region and whether there is obvious industrial agglomeration, so as to investigate the degree of cultural industry agglomeration and specialization of each district and county in Chengdu.



**Figure 1. location quotient of cultural industry in Chengdu in year 2011**



**Figure 2 location quotient of cultural industry in Chengdu in year 2013**



**Figure 3 location quotient of cultural industry in Chengdu in year 2011 and 2013**

Data source: Chengdu Municipal Bureau of Statistics

According to the trend chart of cultural industry agglomeration in each district (city) and county in Figure 1-3, whether in year 2011 or 2013, the location entropy of cultural industry in GDP present similar location distribution trend. The city center as the first circle take the obvious agglomeration advantage, and Jinjiang District got the highest location entropy, which further proves that Chengdu City has formed culture industrial agglomeration pattern with the city center as the leading area and Jinjiang District as the core.

### 3.3 Summary

According to the above measurement results of location entropy of cultural industry, the following conclusions can be drawn:

(1) It's clear that the dominant areas of cultural industry development are concentrated to the main urban area, Jinjiang District has the best industrial agglomeration effect, followed by Qingyang District, Wuhou District and Jinniu District, as well as Wenjiang District and Dayi County in the second circle, which is similar to that the development of cultural industry in Chengdu mainly relies on cultural and museum tourism coincide.

(2) Except for the above six districts and counties, the location entropy of other regions is less than 1, and the agglomeration effect of cultural industry is not very obvious. The development of cultural industry is relatively disadvantaged in the second and third circle, such as Jintang County, Longquanyi District, Pujiang County, Pengzhou City and so on.

(3) By comparing the location entropy of each district and county in Chengdu, we can see that the cultural industry specialization level of Jinjiang District is the highest, which is consistent with the actual situation. Jinjiang District is clearly positioned as the cultural creativity and industrial design concentration area among the 21 industrial concentration areas in the industrial planning layout of Chengdu. Therefore, the cultural industry of Jinjiang District is the most concentrated area of cultural industry development in Chengdu.

## 4. SPATIAL AUTOCORRELATION TEST

### 4.1 Moran I index test

In order to test the spatial agglomeration of cultural industry in Chengdu, spatial autocorrelation test is needed. Spatial autocorrelation test includes global spatial autocorrelation test and local spatial autocorrelation test. In spatial statistical analysis, Moran index and Geary are used to study the global spatial correlation, and there is a negative correlation between them. Among them, Moran I index reflects the similarity degree of attribute values of adjacent or adjacent regional units. Moran index is used for statistical analysis.

$$Moran'I = \frac{\sum_{i=1}^n \sum_{j=1}^n W_{ij} (Y_i - \bar{Y}) (Y_j - \bar{Y})}{S^2 \sum_{i=1}^n \sum_{j=1}^n W_{ij}} \quad (3)$$

Among them,  $Y_i$  are the observation values of the area  $i$ ,  $n$  is the number of observation areas, there are 20 observation areas in this paper.  $W_{ij}$  is the spatial weight matrix of 0-1 distribution

$$W_{ij} = \begin{cases} 1; & \text{area } i \text{ is adjacent with area } j \\ 0; & \text{area } i \text{ is unadjacent with area } j \end{cases}$$

Where  $i = 1, 2, 3 \dots n$ ;  $j = 1, 2, 3 \dots m$ . Moran' I index can be regarded as the sum of the product of the observed values, and the range of values is between [- 1,1].When the value is close to 1, it indicates that there is spatial positive correlation in the urban spatial scale, and when the value is close to - 1, it indicates that there is spatial negative correlation. According to the results of Moran' I index, the hypothesis test of normal distribution can be used to judge whether  $n$  observations have spatial autocorrelation

$$Z(d) = \frac{Moran'I - E(I)}{\sqrt{VAR(I)}} \quad (4)$$

The expected value and variance of Moran' I index were as follows:

$$E_n(I) = - \frac{1}{n - 1} \quad (5)$$

$$VAR_n(I) = \frac{n^2 w_1 + n w_2 + 3 w_0^2}{w_0^2 (n^2 - 1)} - E_n^2(I) \quad (6)$$

Among them,

$$W_o = \sum_{i=1}^n \sum_{j=1}^m W_{ij} \quad (7)$$

$$W_1 = \frac{1}{2} \sum_{i=1}^n \sum_{j=1}^m (W_{ij} + W_{ji})^2 \quad (8)$$

$$w_2 = \sum (w_{i.} + w_{.j})^2 \tag{9}$$

If the Z value of Moran’ I index is greater than the critical value of 0.05 confidence level of 1.96, it indicates that there is an obvious positive correlation between the spatial scale of cultural industry, and the cultural industry system formed by adjacent regions has spatial spillover effect and proximity effect.

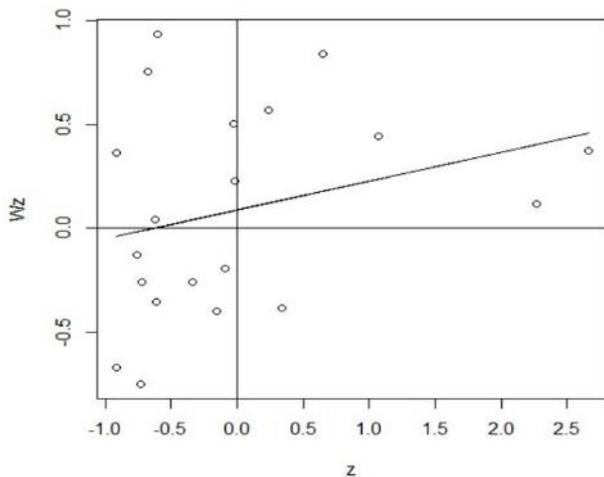
The Moran’ I index of Chengdu cultural industry agglomeration in 2011 is calculated by creating the spatial weight matrix of 20 districts and counties by Geoda9.5. By calculating the expected value and variance of I index, we can get the normal statistical value Z (as shown in Table 3). In 2011, the normal statistical value Z is 2.454108, which is greater than the critical value of 1.96 under the significance level of 0.05, which shows that the spatial agglomeration of cultural industry in Chengdu presents positive spatial correlation, that is, spatial dependence, and the spatial agglomeration of cultural industry in Chengdu presents a certain degree of agglomeration.

**TABLE 1. Moran’ I index and Z value**

Particular year	Moran’ I index	Moran’ I index expectations	Variance var (I)	Normal statistics Z	P value
2011	0.3334544	-0.0526	0.02474626	2.454108	0.003

Next, Chengdu cultural industry space Moran’ I is generated. The results show that there are four patterns of cultural industry spatial agglomeration in Chengdu: the first quadrant (H-H) high concentration area of cultural industry, showing positive spatial autocorrelation; the second quadrant (L-H) low concentration area of cultural industry is close to the high concentration area, showing a negative spatial autocorrelation relationship; the third quadrant (L-L) low concentration area of cultural industry is adjacent to the low concentration area, showing a positive spatial autocorrelation relationship Positive spatial autocorrelation; the fourth quadrant (H-L) high concentration areas of cultural industry are surrounded by low concentration areas, showing negative spatial autocorrelation.

Moran’s I scatter diagram



**Figure 4 Moran’ I index scatter chart of Chengdu cultural industry spatial agglomeration**

Through the statistics of the data of each district and county, it is found that the areas represented by the points in the four quadrants in the above figure are shown in the following table (Table 2).

**Table 2 four modes of spatial agglomeration of cultural industry in Chengdu**

	Spatial pattern	Region
Quadrant 1	H-H	Jinjiang District, Qingyang District, Chenghua District and Wuhou District
Quadrant 2	L-H	Jinniu District, Shuangliu County, Longquanyi District, Pixian County, Wenjiang District
Quadrant 3	L-L	Qingbaijiang District, Jintang County, Pujiang County
Quadrant 4	H-L	Dayi County, Chongzhou City, Qionglai City

The table-2 shows that the four regions in the first quadrant (H-H) (the shaded part in the upper right corner of Figure 3) are the intensive areas with high spatial concentration of cultural industry in Chengdu, mainly concentrated in the main urban areas with developed tertiary industry. The five regions in the second quadrant (L-H) (the shaded part in the upper left corner of Figure 3) are areas with low concentration of cultural industry, mainly concentrated in the main urban area with relatively low tertiary industry and the marginal area of the second circle. The five areas in the third quadrant (L-L) (the shadow part in the lower left corner of Figure 3) are low concentration areas, and they are adjacent to each other, that is, low concentration areas are surrounded by low concentration areas, mainly concentrated in Dayi County, Chongzhou city and Qionglai city. The three regions in the fourth quadrant (H-L) (the shaded part in the lower right corner of Figure 3) are high concentration areas. However, due to their geographical location close to the low

concentration areas shown in the third quadrant (L-L), they present a spatial pattern that high concentration areas are surrounded by low concentration areas, as shown in Figure 3.

Analysis shows that agglomeration phenomenon has been existed in Chengdu cultural industry, presenting a pattern of coexistence of spatial dependence and spatial heterogeneity, but mainly manifested as spatial dependence. Therefore, it is necessary to use spatial measurement to test the spatial structure of Chengdu's cultural industry to determine the factors affecting the spatial agglomeration of Chengdu's cultural industry.

## 4.2 Spatial influence factor test

### 4.2.1 Measurement model

The traditional economic geography school, the new economic geography school and the industrial policy theory school have their own emphasis on the influencing factors of cultural industry agglomeration. The traditional economic geography pays attention to the influence of geographical location and natural endowment; the new economic geography pays attention to the influence of economic externalities and spatial costs, which include financial externalities and technological externalities, while spatial costs focus on space transportation costs and transaction costs, which are mainly caused by infrastructure such as transportation, posts and telecommunications; industrial policy theory Mainly from the school of economic geography of cultural industry, cultural industry as a semi-public goods, to a large extent, needs the government policy, funds and other aspects to achieve industrial agglomeration in space. Based on the research results of the above three universities, combined with the professional division theory, Marshall externality theory and spatial location theory, this paper sets cultural factors (resource endowment), economic factors (economic agglomeration effect), location factors (spatial location conditions) and policy factors (government investment) to influence the spatial agglomeration of cultural industry in geography as the cultural products of this paper. According to the availability of data, a model framework of cultural industry spatial agglomeration is assumed

$$G=f(x) = Z_0 + \sum[\int(S(x)) + \int(D(x)) + \int(C(x))]$$

It can be seen from the model that the spatial agglomeration level of the cultural industry is a set of functions related to the sum of the three major factors of economic specialization, spatial location conditions and cultural resources, plus the external force of government-related policy actions. Where G represents the spatial agglomeration level of the cultural industry, among which, S(x) represents the level of economic specialization, D(x) represents the spatial location, C(x) represents the level of cultural resources and knowledge spillover, and Z0 represents the government policy behavior, which is the cultural industry Based on the external force of spatial accumulation, the following assumptions are made according to the model:

#### **(1) Cultural factors are positively related to the spatial agglomeration of cultural industries.**

The cultural factor here mainly refers to cultural resources and their spillover effects. According to Ohio Forest's natural resource endowment theory and Marshall's industrial location theory, this article believes that in the production process of cultural industries, the amount of cultural resources is a prerequisite for the development of cultural industries in a region. The development level of a region's cultural industry is positively related to the amount of cultural resources it owns. The more cultural resources, the better the development of cultural industries and the higher the spatial agglomeration of cultural industries.

#### **(2) Economic factors are positively correlated with the spatial agglomeration of cultural industries.**

The economic factors here mainly refer to the economic development environment and degree of economic agglomeration in a specific area. Here we mainly examine the impact of the development level of the tertiary industry and the per capita disposable income on the agglomeration of cultural industries in Chengdu. As an important part of the tertiary industry, the cultural industry has very high requirements for industrial relevance and needs a good foundation for the development of the service industry. The service industry can provide the necessary information, technology, and industrial cooperation support for the development of the cultural industry. Therefore, the development of the service industry level of the tertiary industry is an important consideration index for the new cultural industry enterprises in the region to choose the space area.

#### **(3) Location factor is positively correlated with the spatial agglomeration of cultural industries.**

The level of economic development is directly related to the location and traffic conditions. According to the classical location theory and the viewpoint of the emerging economic geography school, the spatial traffic cost of a region is directly related to the industrial development and economic level of the region. The better the location and traffic conditions, the better the economy. Level of development. Population density is an indicator that reflects the level of population agglomeration in a region. Generally speaking, population agglomeration is positively correlated with economic development. The higher the population density, the more developed the local economy. Therefore, the level of population density also affects the degree of cultural industry agglomeration; the number of employees and legal entities in the transportation sector directly determines the economic relationship between this area and the outside world, and can determine whether the area has an advantageous spatial location. Based on this, this article gives the third hypothesis of the factors affecting the level of cultural industry agglomeration, that is, location traffic conditions and cultural industry spatial agglomeration are positively correlated.

**(4) As independent external forces and three factors, policy factors are positively related to the spatial agglomeration of cultural industries.**

The development of the cultural industry has benefited to a large extent from the policy promotion and support of the local government, and promotes the spatial agglomeration of the cultural industry through a top-down policy mechanism. Based on the availability of data, this article uses the level of regional government fiscal expenditures to examine the local government's stimulus for the development of cultural industries, thereby examining the impact on the spatial agglomeration of cultural industries.

According to Ansenlin (1988) on the spatial econometric model, the spatial factors neglected by the classical regression analysis are introduced into the model, and the influence of spatial heterogeneity on the model is fully considered, including spatial lag model (SLM) and spatial Error model (SEM). The expression of the spatial lag model is:

$$G = \rho W_G + X\beta + \epsilon$$

$$G = C + \rho W_G + \beta_1 X_1 + \beta_2 X_2 + \beta_3 X_3 + \dots + \epsilon$$

G is the explained variable, X is the n×k exogenous explanatory variable matrix, W is the n×n-order spatial weight matrix, and ρ is the spatial regression coefficient, which reflects the degree of spatial dependence of the observations, that is, the adjacent regions. The degree and direction of the influence of the observation value WG on the observation value G in the region, ε is the random error term vector.

**4.2.2 Indicators identify**

In this paper, the explanatory variable is set as G to represent the output value of the cultural industry in each region. The explanatory variables are mainly inspected by economic factor indicators, cultural factor indicators, location factor indicators and government input indicators, which are represented by X1, X2, X3...Xi, among which economic factor indicators include per capita disposable income represented by X11, and the tertiary industry accounts for The proportion of total output value is represented by X12; cultural factor indicators are related to cultural resources, including the possession of ancient towns, museums, cultural venues, and intangible cultural heritage, respectively represented by X21, X22, X23, X24; location factor indicators mainly examine each district The population density of the county, the number of employees in transportation legal entities, and industries are represented by X31, X32, and X33, respectively. The government input indicators mainly examine the government's fiscal expenditures to various districts and counties in the year, denoted by X0; see Table 5 for the specific indicator system.

**Table 5 index system of cultural industry spatial agglomeration**

Research index system of cultural industry spatial agglomeration		
index		unit
Economic factor index X <sub>1</sub>	X <sub>11</sub> : Per capita disposable income	yuan
	X <sub>12</sub> : Proportion of tertiary industry in total output value	%
Cultural factor index X <sub>2</sub>	X <sub>21</sub> : ancient town	individual
	X <sub>22</sub> : museum	individual
	X <sub>23</sub> : Cultural Venues	individual
	X <sub>24</sub> : Intangible cultural heritage	term
Location factor index X <sub>3</sub>	X <sub>31</sub> : Population density	Person / km <sup>2</sup>
	X <sub>32</sub> : Employees in transportation and postal logistics departments	people
	X <sub>33</sub> : Number of legal entities in transportation and postal logistics departments	individual
Government input indicators X <sub>0</sub>	X <sub>0</sub> : Local public finance expenditure	Ten thousand yuan

**4.2.3 Data description**

The data used in this measurement model is the cross-sectional data of the 20 districts, cities and counties in Chengdu in 2011. In order to reduce the measurement error caused by the inconsistent indicators, this paper has carried out a dimensionless treatment on the explanatory variables. The cultural factor index of each region is mainly based on the cultural resources published by Chengdu City and the districts and counties. The economic factor index is mainly based on the economic annual report issued by the relevant statistical departments of Chengdu and the districts and counties, and the third national economic census. Obtained from the Chengdu Statistical Yearbook, the fiscal expenditure data of each district is mainly based on the annual fiscal budget and final accounts data of each district and county published on the Chengdu government website.

**4.3 Model analysis**

Using the spatial lag model, we found that except for the variables X22 (Museum), X23 (intangible cultural heritage) and X33 (number of transportation legal entities) on the cultural industry output value, the other variables have significant impact on the cultural industry output value.

**Table 6 estimation of influencing factors of cultural industry spatial agglomeration (SAR)**

	Coefficient $\beta$	Z value	P value
$X_{11}$	0. 004764	1.2	0.229
$X_{12}$	3. 321259**	1.98	0.048
$X_{21}$	3.786255*	1.66	0.096
$X_{22}$	0. 073205	0.1	0.920
$X_{23}$	3.014261***	4.25	0.000
$X_{24}$	1. 864454	0.3	0.768
$X_{31}$	0. 022555*	1.76	0.079
$X_{32}$	0. 003307***	4.68	0.000
$X_{33}$	0. 038796	1.08	0.281
$X_0$	0. 000143**	2.81	0.005
cons	15.22778	1.21	0.226
Wald test of rho=0:		chi2(1) = 5.424 (0.020)	
Likelihood ratio test of rho=0:		chi2(1) = 4.749 (0.029)	
Lagrange multiplier test of rho=0:		chi2(1) = 2.143 (0.143)	

Note: \*\*\*,\*\*, and \* indicate that they have passed the significance test at 1%, 5% and 10% levels respectively.

From the above analysis model, it can be seen that the per capita disposable income in economic factors has no significant impact on the output value of the cultural industry, which proves that the cultural consumption consciousness of residents in various districts and counties of Chengdu is not affected by income levels, which also proves Chengdu from the side. The living conditions that the people are comfortable with, the high-income class and the low-income class have their own suitable cultural consumption methods. The proportion of the tertiary industry in GDP has a significant impact on the output value of the cultural industry, indicating that the development level of the tertiary industry in a region has a significant impact on the output value of the cultural industry, which can also promote the regional spatial agglomeration of cultural industries. In the cultural factor system, ancient towns and cultural venues have passed the significance test, while museums and intangible cultural heritage failed to pass the significance test, proving that ancient towns as a resource element can well promote the development of cultural industries, which also reflects Chengdu Theoretical analysis of people's fun. As a cultural environment indicator, cultural venues can create a good cultural environment for local residents, thereby cultivating residents' cultural literacy and enhancing residents' spiritual consumption consciousness and consumption ability. The population density of the location factor system and the number of employment in transportation have a significant impact on the output value of the cultural industry, which proves that the cultural industry can get better results in areas with good population agglomeration conditions and areas with busy and developed transportation. development of. Government fiscal expenditure  $X_0$  has a positive effect on the spatial agglomeration of cultural industries. Its coefficient is 2.81, which has passed the test at the 5% significance level. It shows that government investment is an important force for the development of cultural industries and the promotion of cultural industry spatial agglomeration. The expansion of the industrial space scale plays an important guiding role. In summary, the degree of development of the tertiary industry, sufficient space for cultural resources, convenient location conditions, and active government investment have an important impact on the spatial agglomeration of cultural industries in Chengdu, which is consistent with the model assumptions.

**5. CONCLUSIONS AND SUGGESTIONS**

In the internal mechanism of the spatial agglomeration of cultural industries in Chengdu, cultural factors, location factors and economic factors constitute a three-dimensional industrial space system with urban cultural connotation. In this space system, culture is the soul, and it is the cohesion that links the cultural industry and the geographical position of Chengdu. The economy is the ecological main body of the spatial agglomeration of Chengdu's cultural industry. Through the operation of the economic unit with enterprises as the main body and a large number of freelancers, the vitality and benefits of Chengdu's cultural industry are realized. Location is the root, which is the basis for the origin of Chengdu's cultural characteristics, and also the soil for Chengdu's cultural industry to take root. The construction of a world famous cultural and creative city focuses on the promotion of cultural and creative industries and the construction of city brands. With the proposed status of Chengdu as a national central city, Chengdu government has set up the industrial goal of building the cultural and creative center in the west of China in the aspect of cultural industry. From the perspective of the theory of professional division of labor, the Western Cultural and Creative Center pays more attention to the establishment of the professional division of labor system of the cultural industry. Compared with the famous historical and cultural city which is solely based on historical and cultural resources, it needs to pay more attention to the establishment of the cultural industry network space system with Chengdu characteristics. The focus needs to start from the following three aspects:

**(1) Based on cultural factors, build the urban brand cultural atmosphere of Chengdu.**

To build an international city cultural brand supported by the world famous cultural and creative city, the first step is to build a unique urban brand cultural atmosphere of Chengdu. Urban brand cultural atmosphere is the branding of urban cultural atmosphere, which is based on the high integration of Chengdu cultural factors, economic factors and location

factors. Furthermore, it is the unification and abstraction of urban cultural concept, professional division of urban cultural industry and urban geographical location. Chengdu city culture atmosphere, is based on the appreciation of leisure inclusive culture trait and play the life interest, with tourism, animation games for advantage industries, traditional history culture resources superiority and the modern science and technology bring out the best in each other, through diversification by different cultural spheres of professional event and exhibition to promote. According to the action mechanism of cultural factors on the spatial agglomeration of cultural industries (see Figure 7-3), urban cultural factors with leisure and inclusion as the core penetrate through the expression layer, space layer and agglomeration layer of cultural industries, and finally manifest themselves through different spatial agglomeration bodies of cultural industries. Implementation of Chengdu city cultural atmosphere of the brand, first of all, to be closely related to the urban culture of leisure tolerance factor, refined abstract Chengdu culture life style and features of cultural products, image, video, audio, advertising for expression, to repackaging of city image and city space, and in film, TV, Internet and other ways for promotion. The advertising video directed by Zhang Yimou for Chengdu, with the slogan "Chengdu, a city you never want to leave once you come", shows the leisure of "never entering the river" in another more modern language, which deeply touches the hearts of every Chengdu person and sets up the urban cultural brand of Chengdu perfectly. Under the goal and mission of building the cultural and creative center in western China, Chengdu city brand cultural atmosphere needs to build more urban brand image of innovation, entrepreneurship and creativity center, so as to better adapt to the industrial characteristics of cultural industry. Second, to form the cultivation of the basic urban cultural environment. Through public cultural infrastructure construction, digital culture service platform construction, "elegant" Chengdu construction engineering for the urban cultural atmosphere to provide good public cultural environment, enhance the protection and inheritance of history and culture, pay attention to the material and cultural heritage and intangible cultural heritage of the industrialization, at the same time, support enterprises and related organizations and individuals to develop the media animation game, performing arts entertainment, creative design, original works of art, copyright services, publishing, etc. Activate urban cultural resources and urban cultural elements, enhance the brand image of Chengdu as a world famous cultural city and western cultural and creative center, and export the brand and image of Chengdu as an international city culture to the world with the help of international cultural exchanges and trade activities.

## **(2) Promote the integration of cultural factors and economic factors to form a network space for specialized cultural production.**

The core of the integration of cultural factors and economic factors lies in the specialized production of culture. Cultural industry in Chengdu in the operation of the inner mechanism of the spatial agglomeration, culture is specialized in the urban historical and cultural resources on the basis of the economic factor of cultural production system works - consumers, culture specialized production network space through the specialized production promotion network effects, formed the so-called "industrial agglomeration externalities" Marshall, promote cultural industry agglomeration spatial extension. Therefore, compared with the traditional definition of famous historical and cultural city or cultural capital, Chengdu municipal government puts more emphasis on the role of specialized division of labor in putting forward the western cultural and creative center. In order to construct Chengdu's cultural production network space, the first step is to construct the cultural production-consumer system exclusive to Chengdu, and form the microbiota of cultural industry specialized production. Specifically, is to build to the cultural industry projects, professional production team as the driving force, innovation to create more and better cultural content of products, such as games, anime, movies, novels, plane design, etc., at the same time extend the culture industry production chain, through theater, drama, dance, film, television, music and so on way to content the high-quality goods again creation again spread, on this basis, developed a series of experiential gen products, cultural content, the scene is rich in content and level consumer spending. Therefore, Chengdu cultural production network space should cover cultural content creation team, cultural product operation team, post-production team, communication and promotion team, etc. Under the specialized production and the Internet information technology support, the team's operation can be implemented on a global scale to mobilize resources and operational projects, by helping to develop more international vision and global height of the Chengdu local team, to bring more excellent international level of Chengdu cultural activities and cultural work, strengthening the construction of cultural infrastructure at the same time, promote the development of cultural industry park and characterization, differentiation, and will be built in Chengdu is more advantageous to the development of the regional culture characteristic, multicultural integration cultural and creative cities.

## **(3) Improve the trading efficiency of the cultural industry and optimize the agglomeration space of Chengdu's cultural industry.**

Under the framework of new classical economics, transaction efficiency is an important way to improve the economic performance of specialized organizations. As a self-organizing network, the spatial agglomeration of cultural industries, in addition to the network effect of specialization, whether the optimization of transaction efficiency can be achieved is an important indicator to measure the spatial agglomeration benefit of cultural industries in a region. This paper believes that the influencing factors of the transaction efficiency of cultural industry are composed of three aspects: concept system, infrastructure (including communication technology, public cultural buildings and road facilities) and humanistic quality, which is also the path and direction of the spatial agglomeration transaction efficiency improvement of cultural industry in Chengdu. First of all, in terms of concept system, with Chengdu becoming a national central city, under the guidance of the goal of building a world famous cultural and creative city, it is necessary to establish international cultural industry-related policies, systems and industry standards, especially the copyright protection law and related regulations

related to the production of cultural content. At the same time, through holding international cultural industry conferences, forums, exhibitions, etc., to promote Chengdu to become an international center of multicultural exchange. Secondly, strengthen the construction of cultural infrastructure, fully integrate the ancient Shu culture, water culture, Three Kingdoms culture and other traditional cultural elements, and build a number of historical and cultural blocks, architectural communities and cultural landscapes represented by "Chengdu Center" and bearing the memory of Chengdu's urban culture. Enhance the cultural and creative transformation of the abandoned buildings in the old city center, create more space carriers for cultural industry agglomeration, and effectively promote the further realization of the Renaissance and cultural prosperity in the old city center. At the same time, with the help of modern information technology, strengthen the construction of urban cultural public information platform network, Chengdu public culture to realize the omnipresent sense. Finally, to enhance the efficiency of urban cultural industry trade needs as consumer group Chengdu citizens cultural consumption cognitive ability, increase the public welfare culture construction, let more people have the opportunity to understand and into the cultural industry, promote the communication between the subject and public cultural industry, optimize the environment of culture industry communication, improve the humanities cultivated manners of the city and convenience of transaction efficiency, promote cultural industry so as to further promote the cultural industry agglomeration optimization in the center of the city.

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## **Regular Session: RS15.2 - Theoretical and empirical urban economics**

**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/87822655076>**

**Chair Daniela-Luminita Constantin**

## LONG-TERM ORGANIZATION OF URBAN GROWTH IN FRANCE (1800-2015). WHICH REALITY IN TIME AND SPACE OF STOCHASTIC PROCESSES "À LA" GIBRAT?

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### ABSTRACT

Globalization, migratory phenomena, and transformations of production systems reflect processes driving change and evolution in cities. However, despite these ongoing disturbances, urban hierarchies maintain a stable state over time (Duranton, 2007). This stable state of urban systems is studied through many works on a national scale (see among others: Davis and Weinstein, 2002, Bosker et al., 2008, Gonzalez-Val, 2010). These studies provide an interesting but reductive approach to the processes at work in these systems. Indeed, it is accepted that two laws summarizing their functioning govern national urban systems. Urban hierarchies converge towards a stable state in time (Zipf's Law) thanks to a stochastic process (Gibrat's Law) (Gabaix, 1999). Zipf's law assumes that the city size distribution (that is, the ranking of cities from largest to smallest) is linear and continuous<sup>[1]</sup>. Gibrat's Law seeks to explain the linear and continuous shape of the city size distribution by describing urban growth processes (Gibrat, 1931). Gibrat's law is a stochastic process that implies that growth rates depend on a number of factors and that the effect of each of these factors is marginal growth. Simon (1955) and Ijiri and Simon (1977) conclude that Gibrat's law is confirmed if the long-term growth rate of cities is the same and does not depend on the size of urban areas.

This paper explores the reality of the stochastic processes "à la" Gibrat thanks to long-term censuses data of French municipalities from 1800 to 2015. Several assumptions are tested in this paper to improve our knowledge of the stochastic urban growth processes. In the literature, Gibrat's law is tested independently of the effects of time and space, yet there is no reason why some periods or places are not more sensitive than others to stochastic dynamics. All these hypotheses will allow us to nuance and better apprehend the stochastic processes at work in a European country with a very long urban history.

In the first assumption, we will test the validity of Gibrat's law over the two centuries studied. More precisely, we question the possible convergence of this Gibrat's law from the industrial revolution onwards. We also test a second assumption on the relevance of stochastic growth processes as a function of urban size. Is Gibrat's law more valid for small or large cities? Finally, we wonder whether the dynamics observed at the national scale are also valid at the regional scale. For that purpose, we compare the national dynamics to the regional dynamics so as to reveal the diversity of growth processes depending territorial and regional specificities. The linearity depicted at aggregate national scales actually obscures variation observed in a multi-scale regional analysis (Bessey, 2002).

<sup>[1]</sup> Simply, it means that the size of the city of rank two is equal to half of the size of the city of rank one; the size of the city of rank three is equal to one-third of the size of the city of rank one, etc.

**SMART CITY – RESILIENT CITY: SYNERGIES AND TRADE-OFFS****Daniela-Luminita Constantin<sup>1</sup>, Cristina Serbanica<sup>2,1</sup>**<sup>1</sup>Bucharest University of Economic Studies, Romania. <sup>2</sup>Constantin Brancoveanu University of Pitesti, Romania**ABSTRACT**

According to the 2030 Agenda for Sustainable Development, making cities and human settlements „inclusive, safe, resilient and sustainable” (UN, 2015, p.26) represents one of the major goals, pointing out the close relationship between resilience and sustainability, which work together for the well-being of a system. City/urban resilience contributes to this paradigm „the capacity of individuals, communities, institutions, businesses, and systems within a city to survive, adapt, and grow no matter what kinds of chronic stresses and acute shocks they experience” (100 Resilient Cities, 2019, p.1). It is already considered an increasingly relevant topic for international development and urban studies, becoming a “framework for thinking” and a background for planning, development and management “with regard to life and assets protection and maintaining continuity of functions through ‘any plausible shock or stress’” (UN Habitat, 2017, p.6). The resilient city concept is relating to other concepts like ‘sustainable city’, ‘smart city’, ‘eco city’, ‘liveable city’, etc. and systematic explorations of these connections and their significance for urban development policy and practice are still required. This paper aims to examine the smart city - resilient city nexus, seeking answers to the following questions: How do ‘resilient cities’ relate to ‘smart cities’? How can ‘smart solution’ address ‘resilience challenges’? What are the synergies and trade-offs between smart and resilient cities? Based on a starting point that acknowledges the diversity of urban resilience challenges, the role played by the contextual factors and the emphasis on innovation and smart solutions when it comes to solutions to resilience challenges, the paper proposes a three-step research methodology, using the database of the 100 Resilient Cities (100RC), as follows: first, the most frequent resilience challenges are identified and a taxonomy is created by means of hierarchical cluster analysis; second, the smart solutions proposed within the framework of the “Urban Resilience Strategies” for 74 cities participating in the 100RC are pointed out using the content analysis with ‘smart’ and ‘digital’ as search queries; third, the ‘smart solutions’ are connected to ‘resilience challenges’. The results have made it feasible to integrate the city resilience framework with the smart city framework, highlighting the synergies between the two concepts. At the same time, the trade-offs are discussed, emphasizing additional resilience challenges that can be brought in by smart cities and the fact that smart technologies can improve outcomes before, during, and after shocks and stressors occur but “smart cities solutions are not a panacea for all urban sustainability and resilience issues” (Hurley, 2019).

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## **FARAWAY, SO CLOSE! THE INTERREGIONAL TRADE BETWEEN SPAIN AND MOROCCO**

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### **ABSTRACT**

For the first time, this paper analyzes the methodology and results of a new database on the region-to-region trade flows between Spain and Morocco. Following the experience of previous estimates of region-to-region flows within the EU, the new dataset combines the most updated statistics available in Spain about region -to-region (Nuts 3) freight flows (tons) by different transport modes (road, ship, air) between the two countries, and the official and solid information about the Spanish trade (tons and Euros), split at the province-to-country level (Nuts3-Nuts1), covering all transport modes and the period 2010-2018. Once the estimation of this database is completed, the flows are analyzed in the context of the gravity equation, studying the robustness of the figures obtained, exploring the spatial and sectoral dimension. Due to geographical proximity, Spain remains Morocco's main trading partner, and it is the top destination for Spanish exports in Africa and the Arabic world, with more than 20,000 Spanish companies operating in the country. In 2019, 45.5% of Spanish exports to Africa were destined to Morocco. In 2020, the rate increased to 47.5%. It is also interesting to look that Morocco has developed strong value chains linkages over last 20 years. The European Union is an important GVC partner of Morocco, in fact, this integration in the global value chain has become the dominant paradigm in the trade relations and strengthens the ability to compete in a global marketplace.

## **Regular Session: RS14.2 - The spatial dimension of sustainable development**

**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/83755733224>**

**Chair Ekaterina Kadochnikova**

## TECHNOLOGY DIFFUSION AND CONSUMPTION GROWTH: IDENTIFYING SPATIAL EFFECTS

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### ABSTRACT

In the context of a pandemic, consumer-controlled digital technologies are one of the key determinants of the sustainable development concept: they lead to the replacement of labor with capital, the growth of information and knowledges, reduce economic costs, expand consumer choice, take into account consumer preferences, and integrate the economic space. As we learned from the theory, the spread of technology leads to an equalization of growth rates in the long term for leaders and technological followers. Therefore, the aim of the study is to analyze the convergence of consumption, taking into account the spatial specifics and the impact of digital technologies on the average growth rate of consumption. *Research questions:* is there a spatial relationship in consumer spending per capita? Is there a  $\beta$ -convergence of the average consumption growth rate in the long term? *The hypothesis of the study:* Russian regions are not making full use of the households digitalization in achieving sustainable development. The data sample is obtained from the "Regions of Russia. Socio-economic indicators. 2019" material. Dependent variable: the average growth rate logarithm of consumer spending per capita in 2014 prices. Independent variables: income per capita, share of population using the Internet; number of active subscribers of mobile broadband access to the Internet per 100 inhabitants, the deposits of individuals, savings rate ((income per capita, consumer spending per capita)/monetary income per capita). We used the boundary weight matrix, global Moran and Geary spatial correlation indices, and local Moran indices. In a study in the R software environment (plm package, splm package), models of unconditional and conditional  $\beta$ -convergence are constructed on panel data without/with a spatial component (according to the SAR, SEM, SAC types) with fixed effects and with random effects (Barro R., 1992):

$$1/T \cdot \ln(Y_i(t_0+T)/Y_{it0}) = \alpha + \beta \cdot \ln Y_{it0} + \sum \gamma_j X_{jit} + \rho W \ln(Y_i(t_0+T)/Y_{it0}) + \epsilon_{it};$$

$$1/T \cdot \ln(Y_i(t_0+T)/Y_{it0}) = \alpha + \beta \cdot \ln Y_{it0} + \sum \gamma_j X_{jit} + \lambda W_{ui} + \epsilon_{it};$$

$$1/T \cdot \ln(Y_i(t_0+T)/Y_{it0}) = \alpha + \beta \cdot \ln Y_{it0} + \sum \gamma_j X_{jit} + \rho W \ln(Y_i(t_0+T)/Y_{it0}) + \lambda W_{ui} + \epsilon_{it}.$$

The analysis revealed a positive spatial dependence of consumer spending in the Russian regions, the impact of shocks in neighboring regions on the consumption growth rate in this region. Local Moran indices indicated the presence of local spatial clusters in consumer spending similar to neighbouring territories, regions, Moscow and Moscow region, Ural Federal district, Siberian Federal district, North Caucasus Federal district. All types of models predict beta-convergence of consumption in the long term, which corresponds to the concept of their sustainable development. No visible direct and indirect effects on the share of the population using the Internet and the number of mobile Internet subscribers on the growth of consumption predictably confirms the hypothesis of weak use of household digitalization in achieving sustainable development. Therefore, it is advisable for strategic management institutions to influence the demand and digitalization of households in neighboring regions, to develop online services in the practices of households. The measurement of the beta-convergence of consumption as an indicator of the sustainable development of regions, based on spatial-econometric models, provides *the novelty* of the work.

## TOWARDS A CIRCULAR DEVELOPMENT APPROACH TO INTEGRATE LES BIDONVILLES WITHIN CASABLANCA

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### ABSTRACT

Slums represent a global ethical challenge that affects the well-being of cities. The vast majority of these areas are located in and around cities of the Global South because of the fast urbanisation and globalisation trends that have been met with insufficient employment, infrastructure and housing opportunities.

This paper will explore alternative slum development through the lens of circular economy (CE) principles. While CE has become a major policy goal in Europe and other “Western” contexts, it is hardly used in the developing context, still, circular processes are deeply embedded in the socio-economic realities in cities of the Global South. The main focus of the paper is to evaluate the potential of CE to alleviate poverty and address the challenges of informal settlements. Can CE be applied in cities of the Global South to reduce socio-spatial segregation?

Building on notions of spatial justice and urban survivalism as well as the literature on the dynamics and resilience of informal areas, the paper proposes a contextualised circular economy (CCE) framework for the integration of slums. The framework is then tested empirically on the case of Casablanca, Morocco. Taking existing assets of les bidonvilles as a starting point for development of circular activities, which potentially can lead to the integration of these slums at local and metropolitan scales by providing new economic opportunities as well as links across the socio-spatial dividing lines. The empirical material is collected through a combination of methods: stakeholder interviews, spatial analysis and mapping, site observation of (circular) socio-economic activities and spatial conditions and explorative spatial design. On that basis, the paper identifies the key opportunities and barriers for harnessing local assets for a contextualised circular economy as a means for integration of les bidonvilles into the socio-economic systems of the city. This is done by proposing a circular slum integration design that takes the local scale as a starting point to inform the vision on the city scale.

The paper contributes to the literature by investigating the (often neglected) spatial dimension of circular economy and exploring the potentials for improving the well-being and socio-spatial integration of vulnerable urban groups. It also innovates by demonstrating the potential of relatively low-tech solutions, based on traditional crafts or necessity-driven entrepreneurialism. While this paper offers policy and planning recommendations mainly for cities in developing countries, potential lessons can also be drawn for local circular economy strategies in more developed economies.

### KEYWORDS

Casablanca, Circular Economy, Global South, Productive Identities, Planning.

### 1. INTRODUCTION

The cities around the Global South tend to suffer from economic and racial segregation, spatial inequality, and entrenched poverty. These deep inequalities are exacerbated in the context of rapid urban expansion and the growing urgency of environmental challenges, while the municipal authorities in those cities struggles and fail to address them.

One can argue that the rising rates of extreme poverty is one of the most critical concerns of Global South countries. Poverty encompasses and generates many other problems such as crime, violence, safety and social exclusion, which all have impacts on space. The spatial aspect of destitute poverty is partly manifested in the existence and fast expansion of slums. At the same time, climate change impacts the poor and vulnerable areas the hardest. The responses to those challenges seldom take into consideration the context and the specific socio-spatial and economic challenges of slums. With the advent of sustainability transitions of cities, insufficient attention has been paid to circular economy (CE) pathways in developing countries and, in particular, to the potentials and opportunities that circular transitions can bring for the urban poor dwelling in slums, despite considerable innovation and policy progress happening in this field across the globe (Pretson et al., 2019). CE has a potential to generate positive socio-spatial outcomes once social and institutional dimensions are treated intrinsically with the transition (Moreau et al., 2017).

CE has several definitions that mostly revolve around closing of material cycles and increasing resource efficiency (Ayres et al. 1996; Von Weizsacker et al. 1998). The most cited definition is that of the Ellen McArthur Foundation (EMF):

*A circular economy is restorative and regenerative by design, and aims to keep products, components, and materials at their highest utility and value at all times. The concept is a continuous positive development cycle that preserves and enhances natural capital, optimises resource yields, and minimises system risks by managing finite stocks and renewable flows. It works effectively at every scale. (EMF, 2015)*

Casablanca, a city that has always been a laboratory of urban experiments (Cohen and Eleb, 2002), will be taken in this paper as a study case to explore potentialities of CE in mitigating socio-spatial and economic challenges of its slums. Generally, most cities have their own local terms for slums, most of which are descriptive of the look of the degraded settlements or of the way that they were formed. In the case of Morocco and French colonised countries in Africa, the French term *Bidonvilles* - which means 'oilcan cities' - describes the way they were built, by using cans from nearby landfills which represents the method used by rural migrants consisting of using local materials to build shelters. This nomination by itself represents one of the fundamentals of the circular economy concepts: building with local, often discarded, materials.

Since the emergence of the first bidonvilles in Casablanca in the 1920's, these areas are seen by the authorities as territories that need to be eradicated. They represent the extreme life conditions of a vulnerable population in dwellings that were built without plans or building permits and often do not have access to drinking water and/or sewage, electricity and experience unsanitary conditions. Therefore, authorities pushed the bidonvilles dwellers out of the city by providing "formal" social housing in the outskirts. The implications of these processes are harmful and do not remedy the poverty symptoms (which is the root cause). On the contrary, it makes it even worse since this population survives on informal practices that occur within the city fabric.

This reveals the urgency of questioning the existing development methods and thinking about an alternative model where the vulnerable inhabitants are part of the transformation processes and the city goals to achieve resilient economic growth on a global scale. This paper will explore the potential of CE to provide opportunities for integration of slums within the 'formal' city and to reduce socio-spatial segregation in cities of the Global South. The paper also seeks to identify the barriers for seizing those potentials. This exploration will be carried out on the case of Casablanca, a city which could be considered a typical example of a rapidly expanding city of the Global South with deepening inequality and growing tensions around slums.

The remainder of the paper is organised as follows. The next section will discuss the failures of slum clearance policies to date and posit that informal survivalism and entrepreneurialism which prevail in these areas could be seen as fertile ground for experimentation with CE, used as a means for socio-spatial integration of slums. Then, methodology and the features of the case study will be outlined. After this, the empirical section will overview the existing circular practices in selected slums of Casablanca and built on those to shed light on the potential of CE to be used as vector of socio-spatial integration of slums within Casablanca. The article closes with a discussion and conclusion, summarising the key insights and contribution to the literature and outlining the implications for planning and policy as well as areas for future research.

## 2. SLUM DEVELOPMENT AND CIRCULAR ECONOMY

### 2.1 The failure of slum clearance policies

The problem of slums has been experienced - at some point of time - by almost all the major cities in the developing countries. As mentioned in the introduction, slums can be defined as the physical and spatial manifestation of urban poverty and intra-city inequality. Slums and urban poverty are not only indications of a population explosion, demographic change, and the forces of globalisation that bring people toward cities, but also the result of a failure of housing policies, laws and delivery systems, as well as national and urban policies (UN-Habitat 2003).

Resettlement is one of the most commonly used approaches in dealing with slums. It consists of moving the slum inhabitants in public housing provided by the state. However, this approach revealed many limitations with severe consequences (Amado et al., 2016).

In this section, several arguments against resettlement processes that were privileged and used the most will be laid out. While trying to argue why resettlement processes failed several times in different places and not only in Morocco are the question of financial affordability, the way of living, social relations and access to income generating activities (Bolay et al., 2016).

Argument 1: Displacing Poverty does not solve it... it can even worsen it!

The relocation of residents, often far from their original residential location, decreases access to income that they were able to earn within the city and their neighborhoods. Thus, relocation tends to destroy a very fragile but very real economic fabric (Bolay et al., 2016, p: 231).

Argument 2: Resettlement causes Urban Sprawl.

Resettlement of inner-city communities served as an instrument to reinforce the development of 'new towns' or 'satellite towns'. In the case of Casablanca, 600ha of public space have been made available for mobilisation and planning at the expense of fertile valuable agricultural land. Still, this land supply is not enough to relocate all slum dwellers. This represents a huge bottleneck for resettlement in Casablanca. And not only the availability of land but also the construction of flats as well as the 'new town' concepts with all the required new infrastructure could no longer be financed by the governments and did not meet with the social and economic problems the urban poor faced.

Argument 3: Resettlement kills the strong community bonds.

The move into apartments weakens people's sense of community and solidarity networks that are major driver of collective action in bidonvilles (cf. Zaki 2010; Iraki 2006; Essahel 2015).

And women suffer the most. In the new sites, women have more difficulty integrating and end up staying at home more often (Toutain and Rachmuhl 2014, 34-35).

Argument 4: Resettlement is expensive for both parties.

Physical intervention in a space that has already developed is obviously less complicated, as land holdings for the creation of basic infrastructure like water and sanitation systems, or the paving of certain main streets, are clear, do not require the displacement of residents and can begin quickly.

Argument 5: Resettlement is refused by the people who are supposed to benefit from it.

More often than not, communities have not been involved in the primary choices pertaining to their own development, but rather have been asked to adhere to a program that had, to a large extent, been previously defined.

There are indeed people who want to move out and get out of the misery, and that is their right. But their right is also to know the consequences of resettlement and give them enough instructions and a holistic picture in order for them to be able to make an informed decision.

## 2.2 Informal survivalism and entrepreneurialism as an opportunity for Contextualised Circular Economy

So much has been said about the challenges and problems of the slums and so little about their potentials. In these extreme daily life conditions, the slum dwellers developed innovative abilities in order to be able to survive and make a living. This fosters creativity and gives them a very important entrepreneurial character that needs to be highlighted. As Mike Davis stated in his famous Planet of Slums that 'informal survivalism' is the new primary mode of livelihood in a majority of Third World cities' (2004, p:24).

Although, it is true that these conditions could lead to other negative turn of events (violence, ecological vulnerability, terrorism, safety issues...), media and governments rarely show the positive side depicted above, which consequently, limits the potential and proliferation of these ideas, knowledge and underutilised intelligence.

Obviously, no city can afford to neglect the capital of 30 - 40% of its population. Especially if this population possesses special adaptive capacities that make it resilient by character in very vulnerable contexts. An example of this impressive capacity is the Dharavi slum in Mumbai. This slum represents a true economic success story that grew from a small settlement in the marshlands to become a million dollar economy model providing food to Mumbai and exporting goods worldwide (Roy 2015).

Another important incentive to look at this entrepreneurial character is the necessity to focus first on upgrading the slum dweller rather than the slum itself. Gilbert (2007) argues that in poor cities, housing improvements can be counterproductive as "the priorities of the desperately poor almost always lie beyond shelter".

"Above all else, the poor need to eat and to drink clean water. Overcrowding is clearly undesirable but hunger is worse!" (Gilbert, 2007, p: 709)

Therefore, the integration process should start by looking at these potentialities in specific identities and expertise by observing and analysing the 'survival' behaviour rather than focusing on getting rid of these areas. Then, by looking at structuring systems you can inform the space. In other words, the most problematic flows such as food, water, and waste can be catalysts of change, present economic opportunities, and can upgrade the quality of the living environment. Furthermore, in order for this to happen, closer attention should be paid to governance issues by investigating how 'bottom-up' approaches should be presented and integrated with the 'top-down' approaches in a balanced model.

Survivalism presents opportunities for CE, because it is based on reuse of waste materials out of necessity. By the same token, CE as a new paradigm of sustainability (Geissdoerfer, 2017) and sustainable urban development, offers opportunities of integration of slums within the 'formal' city, by making them integral element of the circular economy transitions / strategies. Therefore, the integration process should start by looking at these potentialities in specific identities and expertise by observing and analysing the 'survival' behaviour rather than focusing on getting rid of these areas.

To achieve this we propose a Contextualised Circular Economy (CCE) concept that follows the CE principles while taking under consideration the sensitive character of the targeted population, the weak institution structure of developing countries and the limited resources. CCE investigating existing economic practices (Productive Identities), connects them to the urgent social issues in order to improve the spatial conditions.

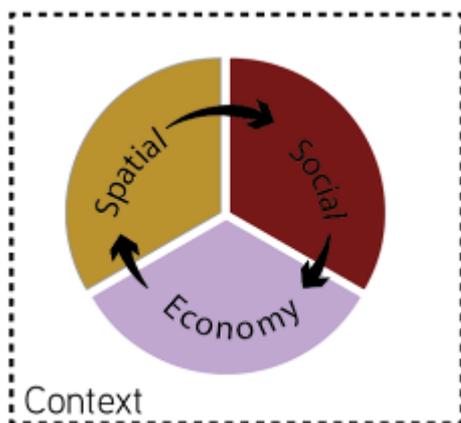


Figure 1: Contextualised Circular Economy Diagramme

### 3. METHODOLOGY AND CASE STUDY

#### 3.1 Introduce Casablanca as a case study

The city of Casablanca is located in the north-western part of Morocco on the west coast of the Atlantic Ocean. This rapidly growing North African port city can also be classified as an “emerging megacity”. The Grand Casablanca metropolitan area is the most densely populated area of Morocco. It is a crossroads city for the land-based transport network and a convergence point for trade and the national and international flow of goods, which makes it the driving engine of the Moroccan economy. Its power radiates across the entire country (Gisek et al. 2015).

Within 100 years, Casablanca has grown from a small coastal settlement of 20,000 inhabitants to a metropolis of more than 4.6 million. Casablanca can be qualified as a fragmented and a segregated city. The city conveys a strong image of poorly articulated fragments of urban mosaics. Socially speaking, Casablanca is a city under tension, with serious violence linked to the increasing inequalities and poverty that is becoming more and more visible. Its metropolitan character is the frame of socio-spatial transformations that represents daily life challenges for its inhabitants - urban sprawl, high density, increasing recourse to activities of the street economy, persistence of slums, impoverishment of public facilities, dilapidated housing, insufficient transport network. This raises the question of the experience of socio-spatial differences linked to the size of the differences between standards of living (Anglade, 2016).

The forces that contribute to socio-spatial segregation are many and vary from place to place. It is considered to be a major social pathology that often results in unequal living conditions and unequal access to services and labour markets. In Casablanca, segregation dates back to the beginning of the colonial era: the city was colonised by France from 1912 to 1956. The French refused to cohabit with locals inside the inner city centre -the Medina- while they also refused to let Moroccans live in the newly built area. However, they still needed labour forces for the growing industrial areas.

The “bidonvilles” are settlements built by their inhabitants out of canisters (French: bidon) and arose on the outskirts of North African cities from the 1930s onwards. They were perceived as overcrowded, putrid and unsafe. In 1931, an attempt to ban their construction failed (Cohen and Eleb, 2002, p. 222).

Morocco’s bidonvilles were partly, a product of colonisation. Hygiene concerns and the fear of potential uprisings against the colonial hegemony made the French implement strict plans of spatial ethnic segregation by keeping the medinas untouched and building new European cities next to them. (Beier, 2019, p:58)

The growth and expansion of the bidonvilles was a result of a rural-to-urban migration. By the end of the French protectorate in 1956, around 75% of Casablanca’s population had immigrated from the countryside (Puschmann, 2011). Chasing prosperity in the newly global city and the illusion of escaping poverty in the countryside, pushed many Moroccans - especially from the southern part of the country - to leave their rural and familial lives. In this process, they lost contact with their tribes and villages and the communal support, just to replace it with feelings of isolation, disconnections and overcrowding. The rural migrants, becoming now bidonvilles dwellers, found it hard to integrate within the city since there were neither provisions in housing nor public facilities (Cohen and Eleb, 2002, p:325).

And even though the emergence of most of the existing bidonvilles is closely connected to industrialisation, occupations amongst residents are diverse and spread all over the city: varying from mobile street vendors in the bidonville itself or in the city to teachers, employed professionals in Maarif (one of the wealthier inner-city districts of Casablanca) and business owners who value the bidonvilles as a safe place within the city without exorbitant rents (Beier, 2019).

If we fast forward in time and we go to 2003, one bidonville, Sidi Moumen, was home to perpetrators of bomb attacks in Casablanca in 2003. These attacks instilled an even greater sense of urgency into the commitment to eradicate slums. In response to these bombings, the most recent strategy surged. In 2004, the Villes Sans Bidonvilles (VSB) programme (Cities without slums), had been announced by order of the King. However, ignoring urban blight until it became a security threat had dire consequences for the states' ability to address its “slum problem.” (Zemni and Bogaerts 2011)

The objective of the “Villes Sans Bidonvilles” programme is to provide decent accommodation to the households living in urban slums across Morocco by 2010. Evaluations of previous slum upgrading programmes provided an overview of learnt lessons and suggestions, which gave further motivation for new plans for substandard housing. The basic principles of the Government’s new bidonvilles upgrading strategy were as follows:

- a. the integration of single operations at city-wide level
- b. contractual engagements of private and public actors in the slum eradication efforts
- c. increased provision of social housing by private developers
- d. the involvement of the slum population through a process of social support and participation. (Ministry of Land Use and Planning, 2019).

#### 3.2 Research Methods

Data for this research was collected over a period of several months in 2019-2020. The research design is based on a critical case study approach. Critical cases are the ‘most likely’ or the ‘least likely’ cases that can help clearly refute or confirm research propositions or hypotheses (Flyvbjerg, 2006). In this study, Casablanca can be considered as a ‘most likely’ critical case, being a typical example of rapidly expanding large city located in a country of the Global South, with dramatic socio-spatial inequalities and presence of slum areas, which are the object of ‘slum clearance’ policies to make way for more ‘desirable’ and ‘formal’ urban development. The research can also be considered an exploratory case study (Yin, 2014), typically used to answer the ‘what’ and ‘how’ questions and explore social under-researched social phenomena in their context, without a predetermined outcome.

The data for the study was collected through a combination of qualitative research methods. First, planning and policy documents were collected and analysed to explore the approaches and practices to slums, urban development and circular economy, in particular. Second, to triangulate the insights from document analysis, semi-structured interviews with local planning institutions, civic and private sectors actors dealing with CE and slum integration, academic experts were conducted. Third, to gain insight into the social and spatial conditions of the slum dwellers and identify circular economy practices conducted by them, site visits were conducted in several *bidonvilles* located in the core of Casablanca, combining photographic evidence collection, observation of public space use, and street interviews with the inhabitants. Fourth, multi-scalar spatial analysis was conducted on the basis of Google Earth maps and satellite photography. Validity of findings is ensured by a combination of those various methods, allowing for triangulation of results and cross-checking insights from each of them, allowing to paint a nuanced and balanced picture of the conditions on the ground and the stakeholders' perspectives on the slums question and circular economy's potentials for socio-spatial integration of slums and their dwellers within the city.

The limitations that we had to face were difficult access to official spatial information and to the stakeholders in the slums. The latter was due in particular to mistrust of slum dwellers towards an 'outsider' and safety concerns during site visits by a female researcher. These limitations were mitigated by collaborating with local inhabitants (to ensure access to slums and safety during the site visits) and local non-governmental organisations. To avoid biased perspective a diverse set of stakeholders was interviewed, representing different points of view and interests. To overcome difficulty in access to spatial data tracing and manual mapping was done on the basis of satellite imagery and site photographs.

## 4. CIRCULAR ECONOMY AND CASABLANCA

### 4.1 Catalogue of existing circular processes

Inspired by the appellations; "Joutiya" for local markets, which is a Moroccan slang term coming from French: *Jetez-là* meaning throw it away or the term *bidonvilles* itself, one cannot help but wonder about the essence behind these nominations.

Re-use of materials is a concept part of the culture and consumption trends are pretty low due to the poverty state. Moreover, looking at closing the loops in the main flows of a city is the big focus of the Circular Economy. Lastly, the imperativeness of thinking of new sustainable business models in order to create new job opportunities is part of the Circular Economy agenda. These three elements were also identified as potentials that can be guided by circular economy and better governance.

The main hypothesis is that Circular Economy can be a proposal for an alternative framework that covers the spatial, social, economic and ecological aspects of the problem in question. The research conducted by Pretson, Lehne and Wellesley (2019) states that Circular Economy offers a promising alternative strategy for industrial development and job creation by providing new opportunities for economic diversification and value creation.

As an example, *Derb Ghallef bidonville* in the centre of Casablanca. It is a notorious informal market that is visited by at least half of the country's population annually. It is portrayed as a hub of creative intelligence and vital IT knowledge. It also has the notion of *Ghallel Valley* attributed to it (Mörtenböck and Mooshammer, 2015). It is located within the city centre and connected to the tram network. It has the identity and reputation of fixing and repairing electronics. The success of this bidonville is mainly related to the repair, reuse and recycle behaviours in relation to the e-waste. And parallelly it makes it a safer and more enjoyable destination compared to the other bidonvilles.



**Figure 2: Derb Ghallef Bird View. Source: My MOracle – WordPress.com**

Another example of already existing circular activities with high social impact is *Ressour'In* association; a social enterprise for integration and recovery of plastic and paper waste. From the conducted fieldwork

Three workshops were developed to allow the integration of people having hard time to find employment, and are in a precarious situation. They contribute in the creation and manufacturing of designer products, from creators, from collected waste: - creation of plastic pouches and handbags, woven paper packaging - manufacture of furniture and lighting in recycled plastic - manufacture of recycled paper. Ressourc'In was founded by the NGO Ikram for social insertion of the most vulnerable.

This demonstrates the possibilities and potentials of social integration and waste valorisation. The brand is called Koun, which literally translates to "Be" or "Exist".



**Figure 3: Product display of carpets made out of plastic waster. (Photo by author 2020)**

A final example is waste workers. Garbage can quickly suffocate the million inhabitants of Casablanca. However, small hands are making sure that large quantities of waste do not pile up on landfills by giving them new life. Despite the amount of work, they remain excluded from society because of the informal aspect of their work, and where they come from. Waste workers live on the margins of legal urban areas, in slums and makeshift houses, which are regularly demolished or threatened by real estate and urban projects. While working in the streets, they are often victims of violence either committed by the authorities or other inhabitants (Florin & Azaitraoui, 2017). The business of recycling factories and export wholesalers depends heavily on the activities of street collectors. Thus, working on improving the livelihoods of this vulnerable population while leveraging the recycling sector, present a path to explore.



**Figure 4: A wastepicker working in the streets of Casablanca. (Photo Pascal Garret, 2013)**

In this section, we presented examples of three existing circular, necessity driven and bottom up circular practices that provide not only livelihoods and socio-economic integration opportunities for the bidonvilles dwellers, but also they provide services for the dwellers of the more affluent parts of the city. Thus, they demonstrate the potential for integration of slums in that sense. These potentials are further explored in the next section where we will investigate a bit further the social and spatial dimensions and potentialities on the map.

## 4.2 Social and spatial potential

Activities and flows shape the cities we live in. They shaped the current spatial characteristics of the bidonvilles and made them what they are. And what makes them special and different in that sense, is that the people who built these spaces did not look at what needs to be built first and then what kind of materials are required; it is the other way around. What materials are around and what can be done with that.

Improving the spatial conditions of these areas should also follow the same path, and bring out what is existing around to connect, attract and create. Connecting to the existing opportunities (formal or informal), attracting by phasing out gradually the flows or activities negatively impacting the general conditions and creating new ones that fit the agenda and help the development process.

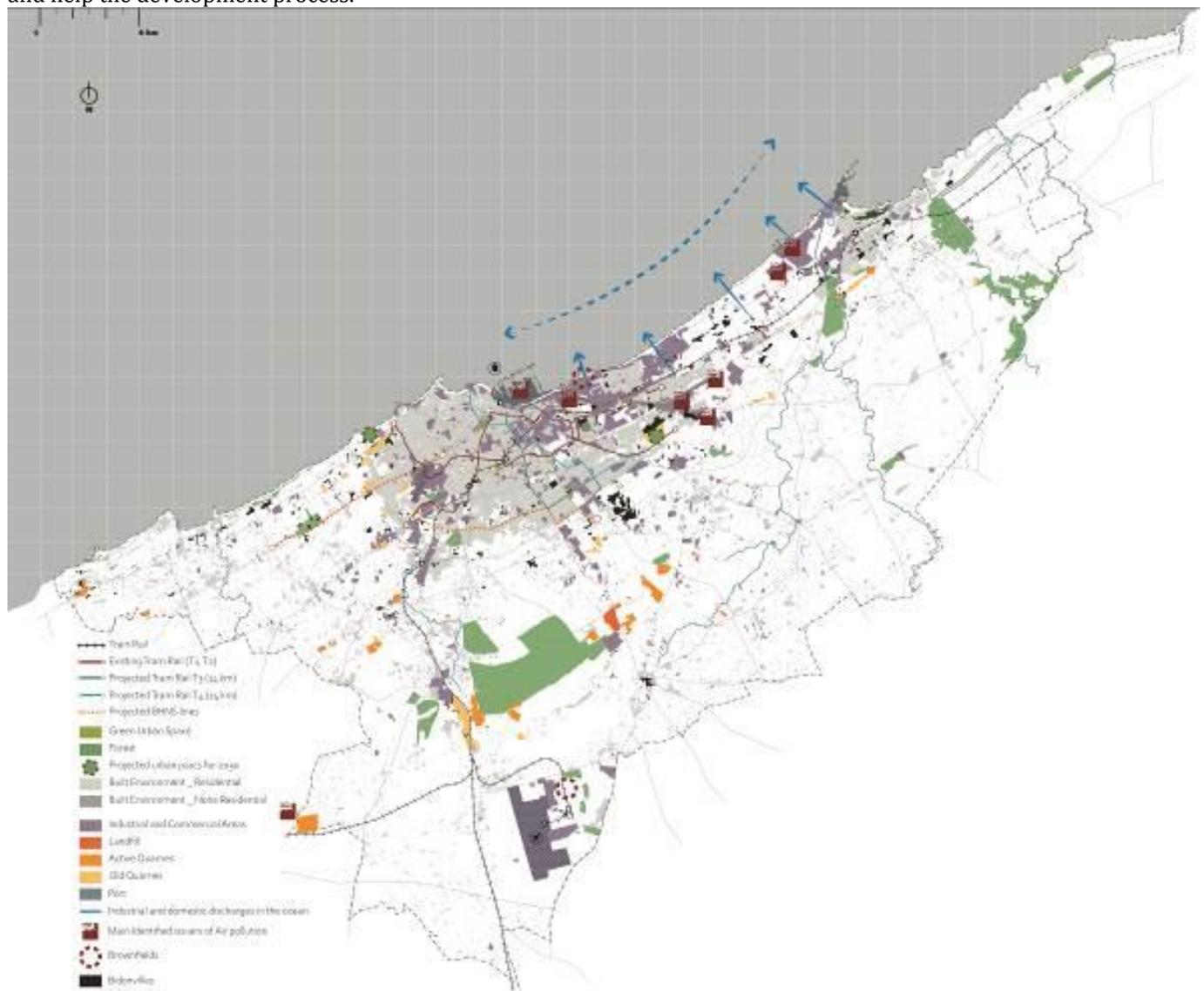


Figure 5: Bidonvilles and Land Use. Map by Author

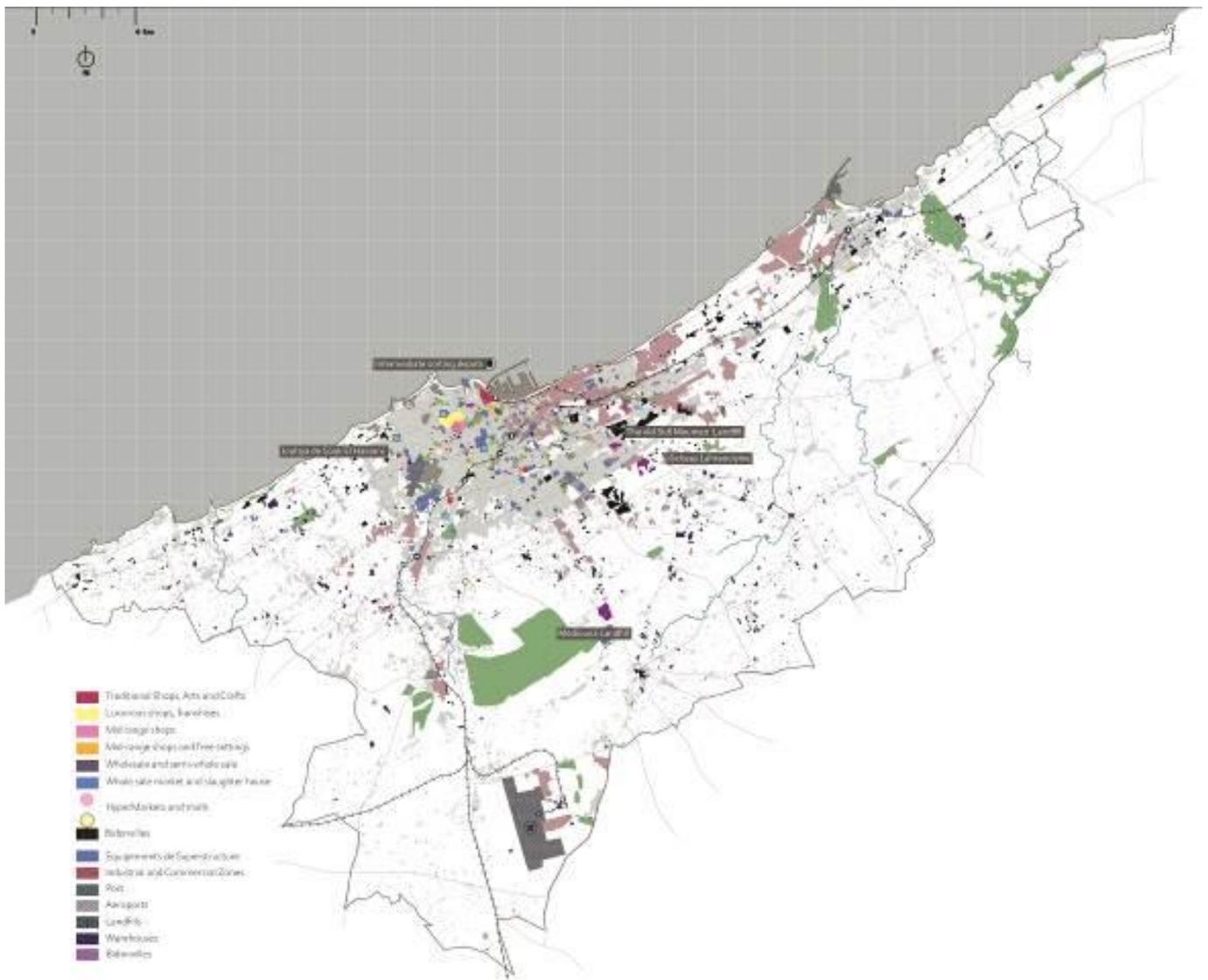


Figure 6: Bidonvilles and Economic activities. Map by Author

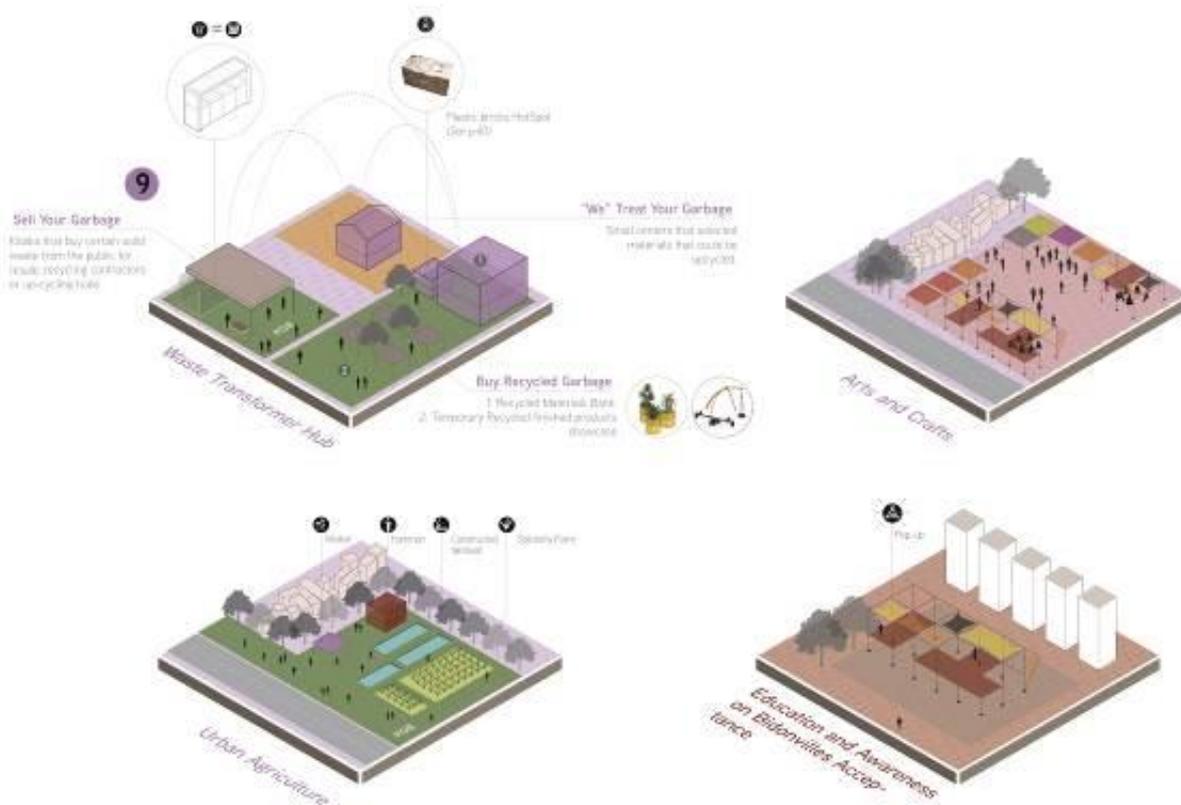
The elaboration of alternative slum development approaches requires a shift in the **common negative perception of slums**. Thus, an important element to mention is the destigmatisation\_processes that are essential for the social integration throughout the scales.



Figure 7: Zoom in. Map by Author

Designing for plinth activation, small urban scale interventions in opportunistic locations can play a big role in how the place is perceived.

Bringing out to the formal city all of these informal activities in attractive settings is also a step towards destigmatisation. However, it is important that this process should be consolidated by the government. In other words, Villes Sans Bidonvilles slogans should be banned and replaced with more accepting and empowering messages. A first step would be to map these areas and not assume that they are already gone in the official documents.



**Figure 8: Zoom in possible interventions. Axonometries by Author**

## 5. CONCLUSION AND DISCUSSION

This study set out to explore the potential of contextualised circular economy practices to drive the process of spatial, social and economic integration of slums in Casablanca. This potential was clearly identified, building on the existing, necessity-driven and long-established circular practices, involving recycling and upcycling of waste products and materials or repair services offered to people not only within the slums, but also the city at large. We also showed how circular economy practices and spaces designated for them could play a role of connectors between the formal and informal areas of the city, breaking down the physical barriers between them and reducing the social stigma associated with les bidonvilles by creating space for encounter and economic activities and making the socio-economic value of slums more evident to the outsiders.

An important caveat is that there are many social and institutional barriers for unlocking that potential of circular economy to promote slum integration. These relate mainly to focus of the city authorities and planners on unjust urban development involving 'modernisation' through clearance of slums and displacement of their dwellers to the periphery of the city to make space for dwellings for high income populations and the service sector. In this approach, based on deeply entrenched social stigma associated with slum dwellers, there is hardly any room for experimentation, acknowledgement of the value of the activities taking place in and the socio-economic potential of slums, deemed undesirable and unsightly.

To overcome that stigma and overcome the path dependency concerning the approach to slums among the planning professionals and the general public, one needs to promote the awareness of the negative social consequences of slum clearance policies and of the circular economy potentials for valorising the existing circular practices in slums, providing arguments for integration of existing slums as important providers of circular products and services within, as opposed to outside, of the core city. Showcasing the existing 'unplanned' success stories of such integration, as that of Derb Ghallef, and experimentation with spatial and social interventions to promote and valorise similar kinds of stigma-breaking integration through circular processes in slum areas with diverse contextual potentials for creating links across the formal-informal boundary using circular principles are needed to change the narrative on slums in the wake of the new paradigm for urban sustainability based on circular economy. Beyond this, there are also important barriers for

implementing the Contextualised Circular Economy approach in Casablanca related to the lack of data of waste flows, which could make integration strategies for slums based on circular processes more precise and evidence-based.

This study contributes to the literature in at least three ways. Firstly, it offers a fresh perspective on the potential of CE could that could be harnessed for slum integration and reducing inequalities in the cities of the Global South, by capitalising on context-specific socio-spatial features and 'survivalist' economic practices. By the same token, these practices are commonplace in slums and deprived urban areas across the world, but their potential to support place-based circular transitions strategies in cities is overlooked. Secondly, the paper responds to the call to deepen our understanding of the neglected socio-spatial factors in transitions towards CE (see Moreau et al., 2017, Williams, 2019), by bringing new empirical evidence on how the spatial, socio-cultural and economic contextual features could be mobilised to support CE strategies going beyond spatially blind industrial symbiosis approach to CE. Thirdly, we demonstrate how a Contextualised Circular Economy approach could work in a particular context of a highly polarised city of the Global South. In this, we propose to build on place-specific potentials, linked to endogenous everyday practices, and harnessing CE to address local socio-spatial challenges rather than following the good practices in CE emergin from the leading cities of the Global North, which tend to focus on designerly or high-tech solutions to use waste as a resource and reduce material consumption.

The case of Casablanca, discussed in this paper, offers lessons for other cities in Global South that circular economy strategies could underpin urban development and slum integration policies by building on the existing circular processes and services carried out by the slum dwellers, thus changing the negative narrative on slums and their inhabitants. In a nutshell, the case of Casablanca presented here shows the potentials of slums as urban circular economy hubs. Thus, redevelopment of slums oriented towards valorisation of circular processes present opportunities not only for the slum dwellers but for the sustainable development of the city as a whole, offering circular services for its inhabitants and reducing social tensions, stigma of the bidonvilles and, potentially, also the resulting violence. To achieve this we need education and awareness-building among planners, developers, and industrial actors to overcome the negative bias towards the informal settlements and make them realise that there are 'hidden' potentials of slums to drive urban sustainability transitions and experiment with circular economy. In other words, this will require a change of perceptions of slums from a socio-spatial phenomenon to eradicate, to a place where sustainability can be catalysed.

The limitation of this study was that it merely took a 'snapshot' of the situation in Casablanca and identified potentials for change, while we need to observe and evaluate how those potentials can be seized and deployed as part of spatial planning process and slum integration policy over a longer period of time. Future research should conduct more exploratory case studies to identify further potentials and examples of circular practices and services in slums to collect a critical mass of knowledge on valorising 'informal survivalism' as part of circular economy transitions in the cities of the Global South. We also need more interdisciplinary research to integrate sociological knowledge and identify means to overcome the mistrust and stigma which are the main barriers for using circular economy as a vector of slum integration and for changing the approach to slums in the planning practice.

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## **Regular Session: RS10.4- Regional development**

**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/81342024716>**

**Chair Zoltán Gál**

## GEOECONOMICS OF TRANSFORMATION AND ECONOMIC BORDERING OF CENTRAL AND EASTERN EUROPE

[Zoltán Gál](#)<sup>1,2</sup>, [Szilárd Rácz](#)<sup>1</sup>

<sup>1</sup>Centre for Economic and Regional Studies, Hungary. <sup>2</sup>University of Pécs, Hungary

### ABSTRACT

This contribution relates the process of economic bordering to the systemic and geo-economic features of Central Europe's post-socialist integration process. The major pattern that emerges is one of a high dependency on FDI, foreign multinational firms, European Union funds and exports to Western Europe. An innovative aspect of this contribution is the argument that long-term problems of capital accumulation in the context of centre-periphery dependency (and world systemic models) reflect bordering processes that are both structural as well as political in nature. The economic transition of Central Europe, and Hungary in particular, was fuelled by neoliberal ideologies and political agendas of "East-West convergence" that involved marketization and privatization. Both of these created a moral, legal and structural environment that rapidly cemented new modes of dependent integration into the EU and the global division of labour. At the same time, the most important historical dependencies of the CEE region, such as financial, technological and market ones, have remained constant (Gál and Schmidt 2017). This is complemented with the large energy dependency of CEECs on Russia. This not only further strengthens the external vulnerability of the region, but also makes re-interpretable the geopolitical and geo-economic features of Central Europe as a 'buffer zone' situated between German and Russian spheres of interest.

We will first examine the geo-economic features of the externally managed and financed integration of post-socialist transition countries of CEE into the global economy and the European Union. We will also focus on the impacts of FDI and European Union structural funds on growth, gross fixed capital accumulation, per capita GNI and export in selected Central European countries. Preliminary results do not indicate a strong correlation between convergence and FDI, rather domestic savings and higher incomes are the most important factors. As a result, domestic policies based on wage competition and that give little support to small and medium-sized enterprises exacerbate core-periphery asymmetries and support an economic buffer zone narrative. In conclusion, we suggest that such economic bordering processes within the EU could have long-term consequences for political and economic cohesion in the EU as a whole.

## DIGITAL INNOVATION HUBS AS NEW PARADIGM IN EUROPE FOR DIGITAL ECOSYSTEM DEVELOPMENT IN SMART CITIES

Tamas Gyulai

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### ABSTRACT

Regional development in European Union have been connected to digital transition and the strict restrictions due to COVID made it even more significant. Consequently, the re-starting of a "new normal" operation of cities and regions require new methods for creation of more resilient communities and regional ecosystems alike. The new European network of Digital Innovation Hubs shall therefore provide a new layer of regional actors that can help primarily SMEs but also provide services to the public sector which shall open up new ways for cooperation between regions and cities. The city of Szombathely in Hungary is a good example of smart city development with the support of the Intelligent Cities Challenge that brings together more than 100 cities in Europe with the objective to shape together the cities of the future in Europe. The Digital Innovation Hub in Szombathely is called am-LAB which was selected as the winner of the European Digital Innovation Hub Challenge in 2021. Consequently, the ecosystem in Szombathely is a good example of coordinated development initiatives for green and digital transition between the administration of the city and the regional stakeholders.

The first part of the presentation describes the key factors of success in Szombathely and the second part of the presentation compares it to similar cities in Central Europe with the objective to draw conclusions and make some recommendations for city planning.

Artificial intelligence shall be described as one of the key elements that shall guide the strategic planning of the sustainable and resilient cities therefore the human factor shall also be analysed beyond the technological aspects. The lessons drawn from the analysis can be used for practical implementation of smart city policies especially in cross-border zones of economic development activities.

Research actions with future scope for human-machine interaction that can complement the already realised work of the international team of researchers shall be presented in the final part of the presentation.

## **Special Session: SS18.4 - Urban Future in the Global South**

**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/84114610826>**

**Chair Abdul Shaban**

## ONSLAUGHT OF URBANIZATION AND ANTHROPOGENIC ACTIVITIES ON KAMWARI RIVER: DYING RIVERS IN THE GLOBAL SOUTH

[Oneza Farid](#)

Aqsa Women's Degree College, India

### ABSTRACT

The Global South is undergoing an urban revolution. Not only major cities are experiencing significant rise in population, but thousands of new towns are born every year. This city making process is expanding the built-up area and severely damaging the natural environment, specifically water bodies. The ponds, lakes and other wetlands, on which the communities were traditionally dependent for freshwater and food supply, are being reclaimed for settlement building. This is mainly due to unchecked human induced activities happening in the name of development at the banks of rivers. Study of Rivers has become very vital as unpredictable unexpected anthropogenic activities occurring habitually. The present study is basically focused on impact of population leading to disappearance of the water bodies with reference to religious, cultural, municipal activities and present status and future strategy for conservation of Kamwari River in Bhiwandi. Bhiwandi being a power loom Industry, how these Power loom and dyeing industries in the vicinity have been discharging chemical effluents into the river resulting in its deterioration. The direct release of untreated effluents from these sources along with untreated sewage water in the river has worsened the situation. The present study is mostly based on primary survey and interviews conducted in the vicinity. The study intends to understand the current pollution status of Kamwari River and other water bodies. The rivers which used to be lifelines for lakes, ponds, wetlands and used to wash out the pollutants with their flows have become special victims of this urbanization process. The rivers are not only being destroyed through land filling for expanding settlements and other infrastructure but also town garbage (both solid and liquid wastes) are being discharged indiscriminately into the same. Rivers initially nurture the cities and towns with their water, but now the same cities and towns are eating up and destroying the water bodies. This paper examines the interrelationship between urbanization disappearing rivers, water shortage and water environment changes in cities in the global South. The case of Kamwari River in Bhiwandi for demonstration of argument it was concluded that the sewage textile industries discharge causes pollution to the water bodies and serious problem for living beings and ecological environment. Therefore, the urbanization should be planned and the effluent water to be discharged by these industries must be adequately treated before discharge.

## SUSTAINABLE URBAN MOBILITY INFRASTRUCTURE IN CITIES OF THE GLOBAL SOUTH: EVIDENCE FROM MUMBAI METROPOLITAN REGION

Sanjukta Sattar

University of Mumbai, India

### ABSTRACT

The Global South is undergoing an urban revolution in terms amassing people in cities and also massive building of cities (Datta and Shaban 2016). However, this urban revolution is characterized by what Albert O Hirschman (1958: 89) called 'disorderly' and 'compulsive' development as this amassing of the population in cities is not preceded by the infrastructure development, rather its following of the demand in gradual and piecemeal way, be it housing, water supply, educational or health infrastructure. Among these, the congestion and unplanned development of the cities, accompanied by the lack of resource allocation and sustainable policies of urbanization, have created enormous issues to urban transport infrastructure and mobility. Indian cities are typical example of this symptom and can be called as archetypes of this problem.

The present paper examines the urban mobility policies, modal transportation and development in Mumbai Metropolitan Region (MMR). The paper demonstrates that Mumbai, the financial capital of India and the core of the MMR, could not keep pace with the infrastructural requirements for the urban mobility and in recent years it has become more exclusionary and 'disorderly'. The paper is based on review of the policy for urban mobility in Mumbai Metropolitan Region, specifically the Mumbai Municipal Corporation, and data on the commuters and means of transportations from various departments of the Government. The factors determining the urban mobility will be identified from the existing literature on urban mobility which will be used to select indicators like "passenger-carrying capacity, public-private carrying capacity ratio, vehicle density by area, vehicle density by population, energy intensity of travel"(Reddy & Balachandra 2011) to measure the pattern of urban mobility. Interview schedule will be used to collect data about the users of different modes of transport and their opinion about the available transport facilities. Samples will be drawn from different age groups and gender as well as from different occupational background. Also, in-depth interviews of the people using various mode of transportation like suburban railways, metro rails, city buses, autorickshaws, motorbikes, cycles, and pedestrians in the MMR will be conducted. The mobility of the population from one area to different area will be assessed from the information collected from local transport authorities like BEST, Mumbai Suburban Railways, Autorickshaws and taxi organisation. Data will be also collected from pollution monitoring bodies. The data obtained will be analysed using suitable statistical techniques like Cluster Analysis and Principal Components and Factor Analysis. The paper demonstrates the 'disorderly' nature of development of urban mobility infrastructure in the city. The disorderly here means delayed supply following the demand. The paper contributes to the existing literature on urban mobility in the Global South and demonstrates that sustainable urbanization in the Global South is seriously challenged by appropriate development of urban mobility infrastructure.

**EDUCATIONAL INTUITIONS IN BRIDGING THE SOCIO-SPATIAL EXCLUSIONS AND PROMOTING SOCIAL MOBILITIES: A STUDY OF MUSLIM AND DALITS WOMEN IN MUMBAI**

**Zinat Aboli**

Mithibai College, University of Mumbai, India

**ABSTRACT**

The pre-capitalist social institutions play major role in socio-spatial and inclusions in Global South cities (Shaban and Zinat 2021). The caste, religion and ethnicity shape the individual and families' voluntary or involuntary residential choices and options, and, as such, produce enormous segmentations and exclusions. Marginality in space also produces the economic marginality of communities, thus producing the overlaps and superimpositions of both the social and economic (class) marginalities. The socio-spatial segmentations of urban spaces inhibit the possibilities of social mobilization and/or formation of secondary alliances among disparate social and economic groups. However, the educational institutions, specifically the undergraduate colleges have become sites of interactions of youth of these disparate groups and create affections, bonds, networks, and mutual learnings furthering educational and employment/occupational mobilities, specifically, among youths of marginalised communities. The colleges are found to be more important site in this process than schools and universities offering post graduate degrees, because (a) they are situated at intermediate or meso level in spatial scale which cut across the geographies of caste, religions, ethnicity, and class, and (b) the society is reaching to such level of development where families aspire to educate their youth at least till graduate level. As such the colleges are becoming interesting intersection and assemblage sites for the youths. The present paper examines this process in Mumbai. The study is based on the structured interview of more than 2000 college going women from different communities and income groups, and case studies of 15 women from Muslims and Dalit communities, the socio-spatially excluded groups in Mumbai.

## **Special Session: SS28 - Smart Actors for Smart Regions**

**11:00 - 12:15 Wednesday, 26th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88689482335>**

**Chair Chiara Tagliaro**

## WHAT'S NEW FOR UNDERSTANDING AND MANAGING PEOPLE'S USE OF THE BUILT ENVIRONMENT?

Alice Pomè, Silvia Leoncini, Chiara Tagliaro

Politecnico di Milano, Italy

### ABSTRACT

#### SCOPE:

Cities consume over two-thirds of the world's energy and produce 70% of global CO2 emissions, mainly due to construction activities and buildings' functioning. Urbanization is one of the great challenges of this century, therefore the development of sustainable strategies to manage (and reduce) energy and natural resources demand in buildings is urgent. The way people use buildings plays a central role. Building performances are impacted by how people utilize spaces, maintain them, and adapt them to their changing needs. Today ranges of technological tools make it relatively easy to understand how users' behaviours occur into buildings and cities, and to inform people's interactions with the built environment. However, only few studies investigate users' behaviours in buildings, and consider them in environmental models. Thus, it is interesting to understand how sensors and digital tools can help to reduce buildings' impact by informing, on one hand, the end-users and, on the other, developers, building owners, and facility managers. With the aim to fill this gap, the objectives of this study are to: a) Map available tools, methods and data, including the scale of their application; b) Detect the extent to which tools, methods, and data integrate with one another, and evaluate new information that can be obtained by matching them; and c) Figure out the involved actors: who plays a role in data collection and analysis? Who produces data?

#### METHODS:

Through a literature review, the paper compares existing tools and methods for data gathering on space utilization and user behaviour, in particular: a) The most diffused technological/digital tools for space utilization analysis; and b) The most diffused approaches/methods for energy and resource consumption analysis (i.e. Life Cycle Assessment, Ecological Footprint, and Post Occupancy Evaluation). These are analysed by: the data they rely on, their scale-up potential (from different types of buildings, to cities and territories), the actors involved in their application, and the beneficiary of the information produced.

#### RESULTS AND PROVISIONAL CONCLUSIONS:

Results will show the extent to which different data and methods can be matched to obtain novel insights. It will be discussed how this match can advance extant models to manage users' behaviours toward reducing energy consumption. The article drafts possible protocols of data collection and analysis that can be applied at different scales, and that will involve different stakeholders. This study has the potential to encourage the digitalization of built environment products and processes, which can support real estate management strategies and responsible users' behaviours. Potentially, these could be expanded to the urban scale, through urban planning and crowd management models.

## IDENTIKIT OF PROPTECH PLAYERS FROM ITALY TO FINLAND: UNDERSTANDING THE REAL ESTATE EVOLUTION

Alessandra Migliore<sup>1</sup>, Chiara Tagliaro<sup>1</sup>, Vitalija Danivska<sup>2</sup>, Silvia Leoncini<sup>1</sup>, Alice Pomè<sup>1</sup>

<sup>1</sup>Politecnico di Milano, Italy. <sup>2</sup>Aalto University, Finland

### ABSTRACT

In the past five to ten years the real estate sector has been facing the beginning of an evolution, mainly due to the introduction of digital technologies. These are embedded into a variety of products, are modifying traditional processes, and are shaping new cultural approaches to managing buildings and the built environment. This phenomenon is commonly defined as 'PropTech', because it merges property and technology. However, this term still lacks a proper definition. It includes a wide range of companies, from start-ups to major real estate players. It embraces a vast array of building types, from residential to commercial and industrial. Furthermore, it comprehends a broad selection of industries, from legal to construction. Due to the newness of PropTech, theoretical studies are still scant. Especially, a quantification and qualification of the different companies that work in the PropTech sector does not exist yet. Many PropTech maps are available for different countries, but the criteria to include or exclude companies from these maps remain fuzzy and unclear. Methods for PropTech scouting are mainly based on a roll-your-snowball approach. A better understanding of the nature and main activities of these companies could support: (i) more precise definition of PropTech; (ii) analysis of trends; and (iii) development of policies and measures to support this new-born sector. The goal of this paper is to provide an exploratory study on PropTech players. This will compare players in two different European countries: Italy and Finland. Extensive lists of Italian and Finnish PropTech companies will be searched on multiple databases (e.g. UNISSUU, Orbis, CBInsights), in order to build a comprehensive picture of the sector in the two countries. Data elaboration will attempt to explain the differences in categorization/terminology between the countries. This can enable to identify inclusion and exclusion criteria in existing PropTech maps. The Italian and Finnish PropTech players will be compared, to shed light on country-specifics including business characteristics and ecosystems around PropTech. In conclusion, the paper proposes an identikit of PropTech players that can support the elaboration of a taxonomy and proper definition of this promising sector.

## LOCATION ANALYSIS: NEW PERSPECTIVES FOR REAL ESTATE PLAYERS

Chiara Tagliaro, Gianandrea Ciaramella

Politecnico di Milano, Italy

### ABSTRACT

The real estate market relies on traditional business models that are driven by building types and functions (e.g. housing, retail, offices, etc.). Social and economic changes have been requiring an evolution of these models. Location becomes one of the most important factors to attract demand. How can real estate players find the best location for their investments? This choice can be grounded on solid data, not only about the physical asset in itself, but also about the urban context (e.g. consumption models, demographic trends, purchasing power, safety & security, etc.). Despite massive data being available today, an appropriate tool is still missing to combine all useful information on cities and territories into an integrated platform to support decision-making. The objective of this work is to propose a categorization of useful data and a first exploration of integration opportunities into a unified system that real estate actors can use for their investment decisions. In this paper, the following research questions are addressed: 1) What kind of tools exist to guide operators and investors in the location analysis process? 2) What data categories are available to different actors? 3) How could these data be organized and integrated in order to support various actors? In the first part, the paper reviews the state of the art of existing tools to check what data is already available and can be considered for merge. In the second part, the paper proposes a demo version of an integration tool. The instrument is composed of six sections that can be filled with data extracted from public sources and/or search engines. Through a weights system, a data ranking is created, based on the supposed interest of future investors and operators. Finally, this tool is tested in the hospitality market. A trial application is built on an electronic datasheet. Nine case studies located in Milan (Italy) are compared and ranked through the tool to determine which investment option is more desirable. The main advantages and limits of the proposed tool are discussed. Especially, the tool shows to be useful for simplifying and supporting selection of new investment opportunities on the Italian territory, where the combination of key information for real estate players is still challenging. Digital implementation and extension to the other real estate sectors and countries are considered as possible developments of the proposed tool. In conclusion, solutions to support data elaboration should take into account that analyses must be dynamic and constantly updated. New expertise is necessary besides the traditional real estate competences. New jobs might emerge in the near future, hybridizing proficiency in economics, programming/analytics and territorial planning.

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# PARALLEL SESSIONS (8)

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## National Session: SS44 - Mapping Co-Working Spaces: Spatial Patterns and Location Factors



**BÖLGE BİLİMİ TÜRK MİLLİ KOMİTESİ**  
TURKISH NATIONAL COMMITTEE OF REGIONAL SCIENCE

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/86856640416>**

**Chair Tüzin Baycan**

## LOCAL VARIATIONS OF SPATIAL COLOCATION OF CREATIVE INDUSTRIES AND COWORKING SPACES IN EUROPEAN METROPOLITAN AREAS

Pavel Bednář<sup>1</sup>, Ilaria Mariotti<sup>2</sup>, Lukáš Danko<sup>1</sup>, Federica Rossi<sup>2</sup>

<sup>1</sup>Tomas Bata University in Zlin, Czech Republic. <sup>2</sup>Politecnico di Milano, Italy

### ABSTRACT

The post-Fordist economy transition in developed countries featured by economies of scope and flexible specialization has brought into cities new challenges transforming their urban economics, land use, and commercial structure. The structure is gradually transformed by development of ICT technologies and advantages of economies of agglomeration resulting in Jacobs spillover and economies of density based on spatial proximity of suppliers or providers. Such transformation of commercial structure in European metropolitan areas have been affected by rapid increase of knowledge intensive business services - here represented by creative industries allowing flexible jobs due to digitalisation (Architecture, Advertising, Design, and Media), and new form of working places representing sharing economy - coworking spaces. Their spatial interactions given by their location decisions based on trade-off theory resulted in local variations of spatial collocation. Previous studies have confirmed Tobler's 'First law in geography' in investigation of such spatial association both in general or specifically setting spatial distances. Nevertheless, this study examines such collocation on particular coworking centre. The given approach allows to use an asymmetric approach to the study as preceding research studied a symmetric variation of the problem whether a collocation is present or not having missed any inspection of the issue whether coworking spaces are spatially attracted by specific creative industries sector or vice versa. The presented study treats the issue by a research question on whether coworking spaces are spatially attracted to creative industries; i.e. alternatively that location of a particular coworking space is spatially dependent on location of specific neighbouring creative industries sector firms. Applying investigation of such spatial collocation on particular coworking centre the study contributes to the research on the given type of the third place by a question whether multiply collocations in local variations of spatial interaction between coworking spaces and specific coworking spaces exist and whether such multiple collocations are spatially clustered or not. To fulfil presented research questions, the study uses a Localized Collocation Quotient for investigating spatial association between coworking spaces and creative industries sectors and choropleth map for revealing spatial clusters of coworking spaces showing multiply collocation. Comparing two European metropolitan areas, namely Milan and Prague, which are a commercial capital of the country with the highest number of coworking spaces. The preliminary results show that coworking spaces are collocated to creative industries sectors by means of local variations and several coworking spaces have demonstrated a multiple collocation. To summarize the preliminary results spatial dependency of coworking spaces on creative industries clusters has been confirmed in particular places. Specifically, comparing Milan and Prague, Milan has displayed much profounder of coworking spaces collocation to Architecture comparing to Prague. Subsequently, all revealed collocation is going to be analysed and explained by the local variation of urban development trajectories.

## LOCATION PATTERNS AND SPATIAL DISTRIBUTION OF CO-WORKING SPACES IN ISTANBUL

[Meltem Parlak](#), [Tuzin Baycan](#)

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### ABSTRACT

Co-working spaces are a rising phenomenon for cities to attract creative workers and to enable knowledge exchange. These spaces provide a flexible, shared working environment for small firms, start-ups, and freelancers to collaborate, share ideas, and network. İstanbul, as the country's cultural and creative capital, hosts the most significant number of co-working spaces in the country. They locate in different city locations, from the CBD to new emerging working environments of the city such as airports. Although their rapid expansion becomes more visible in the city, the literature on the analysis of their location effect is absent. This empirical study aims to understand their geographical footprint and location patterns. It shed light on understanding the location factors of co-working spaces in İstanbul deeply. In this context, it discusses the location concept in three levels: building level, the neighborhood level, and the city level. It investigates the former use and the current function of the building at the building level where the co-working spaces are nested. At the neighborhood level, it identifies the motivation behind their location decisions from the co-founders' perspective. At the city level, it aims to understand their spatial distribution in the city by mapping their locations. The study's finding contributed firstly to the so-far very limited empirical data on the spatial analysis of co-working spaces. Second, it provides a perspective to discuss a policy framework to strengthen the city's co-working space ecosystem.

**GEOGRAPHIES OF COLLABORATIVE SPACES IN POLAND****Grzegorz Micek<sup>1</sup>, Karolina Małochleb<sup>1</sup>, Katarzyna Wojnar<sup>2</sup>**<sup>1</sup>Jagiellonian University, Poland. <sup>2</sup>Centre for European Regional and Local Studies (EUROREG), University of Warsaw, Poland**ABSTRACT**

Before COVID-19 pandemic era the increase of various types of collaborative spaces had been observed. Even if during the pandemic period, such spaces as coworkings, makerspaces and hackerspaces are making their attempts to survive, they may still play an important role in collaborative behaviour. It is argued that collaborative spaces (CSs) provide facilitative milieu for knowledge sharing and enhance proximity in various dimensions (Micek, 2020).

Since recently, little was known about spatial patterns of CSs. Some case studies (e.g. Mariotti et al., 2017) revealed their location is central and they tend to heavily concentrate in metropolitan areas. However, the recent research carried out in the most advanced economies showed that there is also a tendency of spatial diffusion of CSs to small-sized cities and rural areas.

The paper looks at geographies of collaborative spaces in a very specific national context. The case study of location patterns of collaborative spaces in Poland as one of the largest countries in post-socialist Europe, is conducted. It is based on the longitudinal database of various types of collaborative spaces. The database has been constructed based on registries of CSs such as coworker.com, spacing.pl, but also numerous other web resources on makerspaces and hackerspaces.

The research carried out in two spatial scales: regional and intra-urban. The spatial structure of collaborative spaces is compared and contrasted with the distribution of other economic and social indicators. The dominance (hypertrophy) of the capital city of Warsaw in terms of attracting collaborative spaces is revealed. The large role of other metropolitan areas is also shown. Rural peripheries and small-sized cities in Poland do not house collaborative spaces as it is becoming common in the US, Western and Northern Europe. In this respect, it shows the semi-peripheral position of Poland in the evolution of spatial patterns of collaborative spaces.

Intraurban spatial patterns are examined in the case of the capital city of Warsaw. Spatial patterns of collaborative spaces largely follow the location of old and new business districts. The number of CSs in intraurban peripheral locations is highly limited in Warsaw.

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## MAPPING SPATIAL PATTERNS OF CO-WORKING SPACES IN EUROPE

Tüzin Baycan, Gülfiye Özcan Alp

Istanbul Technical University, Turkey

### ABSTRACT

Digitalization has transformed the economy, the ways of working and spatial arrangements of businesses and co-working spaces have emerged as a new type of workplace organization in the last decades. Following the first co-working space established in San Francisco in 2005, the number of co-working spaces has increased and spread around the world rapidly. Today, major cities of the world have increasing number of co-working spaces. According to the global survey conducted by co-working magazine deskmag.com, the estimated number of co-working spaces in 2020 is 26.300. Globally, it is estimated that 2.680.000 people are working in these spaces. The average annual growth rate of co-working spaces has been 58% for the years between 2011-2017. It is obvious that the co-working market presents a growing trend in all over the world. This rapid spread of co-working spaces all over the world has raised new questions: How do co-working spaces present themselves distinctively in different countries and regions? How do location choices and spatial patterns of co-working spaces transform our cities? In order to answer these questions, this paper aims at investigating and mapping spatial patterns of co-working spaces in Europe at the country and city levels. Using the data from the specific website of coworker.com and addressing 3838 co-working spaces in Europe, this paper compares European countries and cities in order to understand similarities and differences in spatial patterns of co-working spaces.

## National Session: SS64 - Portuguese Regional Science



**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84728052596>**

**Chair Francisco Carballo-Cruz**

## REGIONAL VALUE CHAINS: AN INPUT-OUTPUT MODEL APPLICATION

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University of Florida, USA. GOVCOPP, University of Aveiro, Portugal

### ABSTRACT

This work details the concept of value chain at the regional level and how they can be defined by a particular good, produced by a specific industry in a certain region. The main idea is that the location analysis of the production activity should not only consider the top of the chain, meaning the specific place and industry that produces the product that is ready to be consumed as final demand. Value chain analysis is a method that allows to allocate the value-added to the specific industries and regions that are involved in the production process and to estimate how much was their contribution to the final product. Here, we suggest the use of multi-regional input-output analysis as a method that allows to disentangle the complex web of intersectoral and interregional dependencies that characterize the modern and global economies. In this work, we will also present several examples of value chains estimated for Portugal.

**REGIONAL SCIENTISTS IN PORTUGAL: AN ANALYSIS OF WHAT THEY  
THINK THEY ARE**

**Tomaz Dentinho**

University of Azores, Portugal

**ABSTRACT**

Science is the object of analysis of science. In recent years, many studies have been developed to understand the boundaries of the state of the art in various scientific domains with structured consultations with specialists. This chapter aims to contribute to the analysis of the dynamics of regional science in Portugal based on the application of Method Q to 23 of the 94 regional scientists of the Portuguese Association for Regional Development, who were asked to rank 27 sentences about what is and what matters to regional science. Results indicate that there are complementary views on regional science or the study of the creative human interaction within space. Geographers and social scientists favour understanding, academics with rooted theories and economists and engineers prefer methods. It is suggested an evolution of regional science to territorial medicine where the effort of science mobilizing various disciplines is oriented towards decisions that promote the development of people, sites and places.

## HOW TO DEFINE ENTREPRENEURIAL ECOSYSTEMS?

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### ABSTRACT

This paper carries out a systematic literature review on Entrepreneurial Ecosystems (EEs). Innovation, clusters and open innovation are revealed to be the most important streams of literature. From an analysis of social networks, word co-occurrence and co-citations, and cluster analysis, EEs are defined as a set of interdependent actors and coordinated factors, in order to allow entrepreneurship within a given territory. Here, innovation is considered to reflect a new idea and that clusters originating in the spatial concentration of principal and supporting companies use open innovation combining intentionally internal and external knowledge flows, to accelerate internal innovation and market expansion for the purpose of using innovations externally.

## SPACE AND TERRITORY IN THE CONTEXT OF REGIONAL DEVELOPMENT

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### ABSTRACT

The debate around the broader notion of space has a long history, becoming an important topic in several scientific domains, in physics, philosophy, geography, planning, and of course in regional science. Many authors in these domains of knowledge have developed different theoretical frameworks and conceptions of space (see, for example, the works of Benenson & Torrens (2004), Harvey (2006), Lefebvre (1991) or Park (1984)), however, still exist some lack of conceptual clarity, if not in the definition of the concept, in how these different notions of space are operationalized. If the analysis of space, in physics and mathematics, is done with great rigour, defined by metrics and objective criteria, in the social sciences the difficulty is obscured by the undefinition of what space is. If time is what is measured with a watch, what is space and how is it measured? Can we say that space is what is measured with a ruler? To a certain extent, yes, but it all depends on the type of ruler we are using.

Space can be more than two-dimensional Euclidean geometry and can be more than a medium in which social, economic and political processes operate. Two main ideas emerge throughout this reflection, the first is that space involves not only a concept associated with its physical arrangements, but is also socially lived and produced, and can mean different things to different people. A distinction is made between a geometric view of space, in which it can be described and analysed by the position of objects in space itself and the relationship established between those objects (perspective associated with the concept of absolute and relative space of (Harvey, 2006)); and a view in which space is not a "container", but a product of biunivocal relations, which result from the permanent interaction between objects and the space itself, reinforcing the idea that space depends both on physical constructions, but also, and above all, on different conceptions and cognitive perceptions.

Starting from a positivist vision (the desire to create a spatial order), the scientific disciplines which have space (territory) as its primary object of analysis, have rapidly evolved towards a post-structuralist perspective, focusing on socially produced space and place. As a consequence, the understanding of space has also followed this change, towards an apparent loss of the physical and isotropic substance of the notion of space, becoming more immaterial and intangible. This reflection also allowed us to assess the challenges associated with the analysis of space, identifying four distinct but interdependent elements, namely, i) the definition and measurement of the attributes of objects, ii) the assessment of the spatial patterns of these objects (heterogeneity), iii) the analysis and interpretation of the relationship between these objects (dependence, interaction or spillover effects) and, finally, iv) the level of detail or resolution at which these phenomena are described and understood (scale).

### KEYWORDS

Euclidean notion of space, Heterogeneity, Interaction, Non-Euclidean notion of space, Scale

**THIRTY YEARS OF REGIONAL SCIENCE IN PORTUGAL**

**Francisco Carballo-Cruz**

Universidade do Minho and NIPE, Portugal

**ABSTRACT**

In this session, some papers from Portuguese academics will be presented. Additionally, I will moderate a short discussion on the last three decades of Regional Science in Portugal, from the creation of the Portuguese National Section of RSAI. We will use as starting point for discussion a recent book that gathers some contributions by the most prominent Portuguese regional scientists.

## **Regular Session: RS07.2 - Migration and regional labor markets**

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/84223142845>**

**Chair Vicente Royuela**

## MARKET POTENTIAL WITH REGIONAL PRICE DEFLATORS

[Bartłomiej Rokicki](#)

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### ABSTRACT

Does market potential decrease or increase, if regional price differences are taken into account? This paper applies regional price deflators to calculate regional market potential and compares its values with the ones obtained without taking into account the existence of regional price differentials. Furthermore, we assess the impact of newly estimated market potential on regional wages. Additionally, we verify the relative adequacy of the market potential approach and the wage curve approach in terms of explaining regional wage differentials. Applying data for the US and Poland, we find that market potential changes significantly if regional price indices are included. We also prove that the impact of market potential on regional wages is weaker than previously assumed. Moreover, we show that it has less explanatory power in explaining regional wage differentials as compared to the wage curve.

## AN ITALIAN GOOD PRACTICE OF INCLUSIVE TEACHING FOR MIGRANT STUDENTS IN AN INTERSECTIONAL PERSPECTIVE

**Giovanna Filosa<sup>1</sup>, Maria Parente<sup>2</sup>**

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### ABSTRACT

The Covid-19 emergency hit like a tsunami on the education and training system, requiring a sharp rethinking of traditional ways of organizing education for children, young people and adults. The introduction of distance learning on one hand has brought down strenuous resistance to the new technologically enhanced learning tools, on the other it has highlighted all the limitations of training interventions that are not adequately designed. The quality of training/education does not only concern the introduction of innovative technological tools (hardware and software infrastructures capable of supporting them), and the digital competence of the professional figures who have to use them (teachers and trainers), but also and above all, a methodologically based design.

The reference context of this research is the State Institute of Specialized Education for the Deaf (Isiss) "A. Magarotto" in Rome that includes the cycles of kindergarten, primary school, lower secondary school and upper secondary school. It was born from a school inclusion project, developed by the CNR, which transformed a boarding school for the deaf into a specialized school that hosts hearing and deaf students with various disabilities, mainly of Italian nationality but also of other origins ("second generations"). The goal is to describe a good practice in terms of inclusive distance learning, which can also be extended to other public and private schools, and to give policy indications regarding the post-Covid education and training system. The hypothesis of this paper is that a methodologically based design is a critical success factor for teaching and an important indicator for the quality of the training offer as an alternative to face-to-face teaching. From this case study, a good practice of inclusive teaching was reconstructed, able to adapt to the specificities of individual deaf and /or foreign pupils. Distance learning, accompanied by individualized interventions for deaf children with autonomy and communication assistants, ensured the necessary didactic continuity even in the most dramatic phases of the pandemic. This practice could also guide other school contexts in a post-Covid period. As a matter of fact, distance learning is not a substitute for face-to-face teaching, but could be considered from a complementary perspective.

### KEYWORDS

Disability, distance learning, emergency, health

### 1. INTRODUCTION

Distance learning is not a new phenomenon: it dates back to just before the mid-nineteenth century with the aim of overcoming the space-time limits that characterized traditional training. The first distance university course was organized in 1921 in Salt Lake City, USA. Meanwhile, in Europe, in 1926, Radio Luxembourg and the BBC created educational radio programs. In the 1980s, thanks to the birth of the video recorder, video cassettes, floppy disks and, later, CD-Roms and DVDs, it became possible for a large group of people to take advantage of real self-learning courses. But it is with the creation of the Internet and telematic networks that we have passed from the information society to the knowledge one, with a sharing in the creation of knowledge by a vast audience. The distance education learning model, therefore, pushes towards the modernization of the school's methodological approach, starting from these premises (Fundarò 2020).

#### 1.1 The international context

At the beginning of the pandemic, the closure of schools was an almost generalized measure worldwide, while the causes, epidemiological dynamics and possible remedies for the Coronavirus infection were not yet well known. From a study by the Institute for International Political Studies (Ispi 2021), on UNESCO data, it emerges that in the midst of the pandemic (21 April 2020), almost all countries on every continent, have adopted local or national school closure measures. This closure involved 90% of primary, secondary and university students in the world, for a total of about one and a half billion students.

Obviously, the possibility of activating digital teaching that compensated for these closures was a "luxury" that could be afforded only by the countries with advanced economies: around half of the students in the world do not have a computer at home, a percentage that rises to 89% in sub-Saharan Africa. Observers and international researches immediately analysed the impact of Covid on educational inequalities and educational poverty, reaching alarming conclusions (D'Addio 2020).

#### 1.2 The Italian context

In Italy, following the closure throughout the national territory of educational services for children, educational activities in schools of all levels and higher education, established by the Prime Ministerial Decree of 4 March 2020, many Italian schools, in order not leave students alone, tried to "invent" a teaching method, unknown to most of the people<sup>90</sup>.

In our country, as elsewhere, some justified questions immediately arose regarding the impact of the Coronavirus on educational poverty<sup>91</sup>, and on the adequacy of distance learning in replacing, at least temporarily, face-to-face teaching, to minimize the impact (Mascheroni *et al.* 2021).

A first limit is constituted by the possibility of access by the students to digital teaching, characterized by a strong heterogeneity throughout the national territory. An Invalsi (Istituto nazionale per la valutazione del sistema educativo di istruzione e di formazione) study (Argentin *et al.* 2021), showed that just about one third of students of all levels were able to use distance learning; because they had:

- an internet connection at home (regardless of the quality/speed of the connection itself);
- a workstation used for studying, with connected PCs or tablets;
- both teachers of the main subjects (Italian and mathematics) who regularly use any digital device to teach.

From the point of view of teachers, almost a third of them tend to reject digital tools, with negative repercussions on satisfaction with their distance teaching activity (Agasisti *et al.* 2021), while 73.6% would like to continue to use technology also in face-to-face teaching and 91.2% require specific training on it (Inapp 2020: 8).

Distance learning has created many complications also from parent's perspective: it was mainly mothers who had difficulty in reconciling work at home and teaching assistance for their children (Pastori *et al.* 2020), with negative repercussions also on employment levels and on the economic condition of women in general (Ipsos 2021).

## 2. THE IMPACT OF DISTANCE LEARNING ON THE SCHOLASTIC INCLUSION OF PUPILS WITH DISABILITIES

Further and legitimate concerns arise regarding the effectiveness of distance learning regarding the inclusion of disadvantaged children/young people: because they are disabled (Fondazione Agnelli 2020), and/or with a migratory background<sup>92</sup>, or with specific disorders learning (SLD) and special educational needs (SEN)<sup>93</sup> etc. Many authoritative commentators have underlined the fact that Covid has not created new inequalities, but has exacerbated and exasperated the already existing ones: gender, socio-economic status, opportunities to access digital etc. (Guidetti 2021). Not to mention that, from an intersectional perspective, discrimination on the base of disability is often a multiplier factor<sup>94</sup>.

Disadvantaged pupils represent a numerically important reality in the Italian school landscape: 268,671 pupils with disabilities and 808,953 pupils with non-Italian citizenship were expected in the school year 2020/2021 (out of a total of 7,507,484 students, from kindergarten to upper secondary school) (Ministero dell'Istruzione 2020a).

According to Istat data, in the academic year 2018/2019 pupils with disabilities were equal to 3.5% of those enrolled, but between April and June 2020 over 23% of them did not take part in lessons (among other students the percentage of those excluded from the distance learning drops 8%, with highest peaks in southern Italy). Among the reasons for non-participation of pupils with disabilities in distance learning: the severity of the disease (27%), the difficulty of family members to collaborate (20%), the socio-economic problems (17%), the difficulty in adapting the IEP (Educational plan for inclusion) to the distance learning (6%), the lack of technological tools (6%), the lack of specific teaching aids (3%), (Istat 2020a).

These difficulties are added to the scarcity of specialized teachers and assistants in autonomy and communication especially in the South of Italy (among these only 5% know the sign language, essential for communicating with deaf signing children), the lack of training in educational technologies to support people with disabilities, the scarce availability of technology as a facilitator of school inclusion, the lack of computer stations in the classroom, architectural barriers and the difficulties linked to the poor digital skills of the Italian population including parents and caregivers, (Istat 2021).

### 2.1 The impact of distance learning on the inclusion of pupils with a migrant background in school

Even before the pandemic (academic year 2018/2019) one in ten students were foreigners, and foreign students represented 13.4% of students with disabilities, with varying percentages depending on the region, with a higher presence in northern Italy "Ministero dell'Istruzione (2020b)".

Pupils with a migratory background (with or without disabilities), therefore, deserve special attention from our school system: inclusion for them, like learning (especially digital), is a lifelong process, from childhood to old age. The gaps that could be accumulated already at an early age, in the learning path of the host country's language, can have repercussions on subsequent education cycles, leading them to lose the connection with the system of training and job placement in adulthood. Furthermore, a failure to acquire or reacquire basic digital skills (also given their rapid obsolescence) puts their future permanence in the school-training system as well as in the production system at risk.

90 Ecass webinar: "La scuola in casa. Gli effetti del lockdown sulle disuguaglianze educative", 4 marzo 2021.

91 <https://www.invalsiopen.it/impatto-coronavirus-poverta-educativa/>.

92 <https://www.piuiculture.it/2020/04/alunni-stranieri-dad/>.

93 In Italy, pupils with SEN represent almost 9% of those enrolled. More than half are students with SLD, while 35% are students with socio-economic, linguistic or cultural disadvantage (Istat 2020a).

94 <https://www.fishonlus.it/progetti/multidiscriminazione/azioni/>.

At the same time, the digital divide of their families of origin makes participation in the digital learning more difficult (Papavero and Menonna 2021), just as any linguistic and cultural gaps of their parents affect their academic performance even in face-to-face learning (Istat 2020b).

### 3. DIDACTIC METHODOLOGIES

The tsunami of the Covid-19 emergency has therefore forced a sharp rethinking of the traditional ways of organizing education for children, young people and adults. From a lifelong perspective, the introduction of distance learning and smart working, on one hand has brought down strenuous resistance to the new technologically enhanced learning tools, on the other it has highlighted all the limits of didactic interventions that are not adequately designed.

The quality of training/education does not only concern the introduction of innovative technological tools (hardware and software infrastructures capable of supporting them), and the digital competence of the professional figures who have to use them (teachers and trainers), but also and above all, to a methodologically founded planning.

In a first phase, after having overcome the initial bewilderment, many teachers limited themselves to transferring the traditional model of frontal lesson, based on the explanation-interrogation dyad, onto the platform; it was soon understood that this model, which was already showing its limits in face-to-face teaching, was totally ineffective in a digital environment. As emerged from various testimonies from headmasters and teachers<sup>95</sup>, it was necessary to radically rethink didactic planning in a more participatory, interactive and inclusive way, taking into account the fundamental mechanisms of formal and non-formal learning, as codified in decades of researches<sup>96</sup>.

In this direction it would be useful to rediscover constructivist (Piaget 1971) and constructionist (Papert 1989) didactics, already successfully used in training. They have placed three fundamental elements at the center of the learning processes (Deplano 2020):

- a reliable and qualified source of information (teacher or trainer, but also the didactic material they provide);
- an environment of social interaction, with the teacher but also between peers (class or classroom), real and/or virtual, synchronous but possibly also asynchronous;
- a concrete goal, to be achieved through the knowledge acquired, which is motivating: any learning, as a matter of fact, involves both the cognitive axis (skills, abilities, skills) and the emotional axis (interests and motivations).

In simple terms Covid has further highlighted the need for a paradigm shift, useful in face-to-face learning but indispensable in distance learning: the transition from the so-called "Nuremberg funnel" model to a constructivist teaching, based on the centrality and autonomy of the subject who learns. The schools that already practiced this kind of teaching in an inclusive perspective, were probably more easily able to translate it into distance learning, in order to ensure the necessary didactic continuity without an excessive dispersion of attention and energy. The schools and training organizations that already practiced inclusive teaching were advantaged in distance learning, probably because their methodologies, theoretically founded, already aimed at creatively exploiting all the tools, technological and otherwise, aimed at facilitating learning to all, able-bodied and disabled. From this point of view, diversity (not only functional, but also cultural, ethnic and social) was truly a resource that "taught" how to transmit content in an accessible way to the widest possible audience of learners (Filosa, Parente 2020).

### 4. THE CASE STUDY

#### 4.1 Methodology

On the web, it is possible to find several virtuous examples of inclusive distance learning based on participatory and innovative methods, and various useful tools<sup>97</sup>. In this work it is presented the experience of Isiss Magarotto in Rome, through a case study carried out through in-depth interviews with privileged witnesses (teachers, parents, operators, Headmaster, for a total of six interviews) coming from the context taken in exam, with the aim of describing a good practice in terms of inclusive distance learning. The hypothesis is that a methodologically based planning is a success factor for teaching and an important indicator for the quality of the training offer alternative to face-to-face one.

The selection of the reference context took place by combining a criterion of opportunity (convenience sampling), linked to the availability of a school in the territory of Rome and therefore accessible in a pandemic period, with a criterion of a reasoned choice (purposive sampling), aimed at involving a specific category of disabled pupils, the deaf signers, whose problems (mainly related to the sphere of language and communication) are similar to those of foreign pupils.

The conduct of the interviews was preceded by a desk analysis of the three-year educational offer plans (PTOF) and the self-assessment reports (RAV) of the school, including the results of the Invalsi tests.

The focus of the interviews, carried out from July to the end of August 2020 (after the first lockdown period), focused on teaching methodologies, coping strategies regarding the Covid emergency of teachers, parents, pupils, and lessons learned for the post-Covid period.

A qualitative textual analysis was carried out on the transcription of these interviews. The research combines, from an anthropological point of view, an emic perspective (the "native" perspective) with an etic one (the external observer's perspective, Headland *et al.* 1990).

<sup>95</sup> <https://lab.gedidigital.it/gedi-visual/2020/oltre-le-distanze/>.

<sup>96</sup> Cf. in this regard, the Fourteen theses for learning from the Training & Change Working Group (2020).

<sup>97</sup> Cf. Digital resources in the appendix

## 4.2 The reference context

The State Institute of Specialized Education for the Deaf (Isiss) "A. Magarotto" in Rome includes kindergarten, primary school, lower secondary school and upper secondary school. It was born from a school inclusion project, developed by the CNR, which transformed a boarding school for the deaf into a specialized school that hosts hearing and deaf students with various disabilities, mainly of Italian nationality but also of other origins ("second generations"). It has a total of 7 places, 5 of which in Rome, one in Turin and one in Padua.

The tenured teachers are in possession of the monovalent specialization title; for substitutes who do not hold this qualification, basic LIS (Italian Sign Language) courses are organized to promote inclusion and communication and meet the needs of deaf signing and bilingual students. As a matter of fact, LIS is a curricular subject also for hearing students. A large part of the teaching staff also has Ecdl (European Computer Driving License) certification.

The training offer is enriched by various figures in support of teaching, such as the signing psychologist, the deaf and/or hearing assistant (AsCo) (figure provided for by Law 104/92, art.13), the educational operator for the school autonomy (OEPA), the speech therapist, the logogenist, the LIS interpreter for interviews with deaf parents.

The expert teachers have a wide repertoire of teaching strategies, and in the Ptof 2019 / 2020-2021/ 2022 various innovative methodologies are listed for participatory and inclusive teaching:

- active and participatory lesson, guided discussion;
- accessible teaching, laboratory, skills, metacognitive, experiential teaching;
- problem solving;
- flipped classroom;
- Montessori methodologies;
- brainstorming;
- cooperative learning;
- problem setting e finding;
- tutoring e modeling;
- peer education;
- debriefing;
- circle time;
- research and action;
- role playing;
- team teaching;
- mastery learning;
- participatory heuristic method;
- learning by doing;
- audiovisual and multimedia tools: tablet, digital camera, DVD player, multimedia room, computer room, video library;
- interactive multimedia whiteboard (IWB).

The attendance of hearing students is in an "equal" relationship, so that the concept of disability becomes absolutely marginal, in order to enhancing differences as an expression of the uniqueness of each individual. The limited number of students per class allows a real individualization and personalization of learning paths.

The methodological approach chosen by the school aims to encourage active and interested participation, pupils are guided in the acquisition of knowledge starting from "knowing how to do" to "knowing how to be"<sup>98</sup>. Inclusion projects are proposed every year to promote integration between deaf and hearing pupils and reduce early school leaving. The Institute also has frequent relations with the social context in which it operates.

## 4.3 Interviews: Magarotto during the lockdown

The Magarotto Institute, like all Italian schools, during the lockdown, tried to find a solution that would guarantee educational continuity, not leaving students and families alone. This dynamism and attention to inclusiveness is evident in the interviews carried out, although the objective difficulties, due to the emergency situation, are not hidden.

In the stories of the first lockdown it emerges that the first measure taken by the Institute, since the beginning of the period of health crisis, was to try to guarantee students all the IT support they needed: a survey on the need for computer equipment (computers, tablets, etc.) of the children and their families, as well as the computer equipment of the various locations and plexuses, and a sort of ranking has been conducted.

Thanks to the help and funding of the Ministry of Education, the Institute immediately proceeded to purchase and distribute the computers to the various locations and families who needed them, sending some computers, in full lockdown, from Padua to families residing in Milan or Trapani, in a few days.

In the general difficulty in finding an effective tool to continue lessons, after an initial moment of bewilderment, teachers tried to maintain contact in every way with the students, using all the available platforms (Google Meet, Zoom, etc.) and even WhatsApp, until it was established a single platform throughout Italy.

<sup>98</sup> <https://www.isiss-magarotto.edu.it/silvestri/45-silvestri/generico-silvestri/69-metodologie-didattiche.html>.

It was then implemented a careful didactic planning, based on listening to the needs of students and verifying the effectiveness of the interventions. They tried to have, as reference models, the schools and masters already operating in the distance learning sector.

After the first 15/20 days, it was possible to structure a precise defined timetable: with lessons duration of no more than 2/3 hours a day, except for the primary and secondary schools, where pupils were already used to full hours until the afternoon, and where it was decided to do 4 hours.

The maximum duration of each lesson was 40 minutes, to allow pupils to maintain concentration. They tried to respect what was the weekly routine, in continuity with the school in presence, trying not to exceed. As a matter of fact, it was important that teaching was "targeted and measured", trying to "explain less and activate more", with a lot of flexibility<sup>99</sup>. It was fundamental to rethink the teaching strategies: the frontal lesson, which was initially used, was replaced by a much more integrated teaching method, participated by the students. The model used was the flipped classroom, that is the upside-down class, giving the subjects of the lesson in advance to the students. Thanks also to a reinforced interaction with the families, the children began to understand what would be discussed the following day, thus creating greater awareness. The same process was used in the verification tests: at the beginning it was used the traditional oral questioning, then there was the necessity to find different tools. They proceeded by learning from experience, by trial and error, thanks also to the support of communication assistants, who translated both the lessons and the audiovisual tools into sign language and used sometimes a second screen.

Several deaf children, as a matter of fact, made use of a double screen: one to follow the teacher and the class, and another dedicated to the AsCo, which translated in sign language everything the teachers and classmates said. In addition to group lessons, some individual meetings were also organized, their maximum duration was 30 minutes, with deaf children and the teacher or with the teacher, the deaf child and the communication assistant, depending on the children's needs.

In particular, with deaf foreign children, if they had difficulties with Italian language, individual meetings were organized with the communication assistant or with the teachers, to repeat the topics already addressed during the synchronous lesson with the class, in order to make an individualized and personalized teaching in response to the diversified needs of the students. The arrangement of individual meetings was very flexible: they were done even at the weekend, or in the evening, in order not to be held during parent's smart working (Eccas 2021).

The teaching model followed by the Magarotto Institute has always been extremely visual, and especially during the lockdown, it was aimed at fully exploiting the potential of new technologies and multi-media, intended both as effective tools for transmitting content and as digital skills, object of learning.

Games have been used as a resource and a didactic tool, especially to keep the attention of children high. Interactive educational games were also used: teachers sent a link of *edutainment* games available on the web or designed specifically for them as tests.

There were several technical problems relating to the internet connection, due to the patchy spread of broadband throughout the country, or to the lack of computer stations dedicated exclusively to study and not shared with parents in smart working. However, these efforts have pushed children in the direction of a greater digital autonomy, and have forced a sharp acceleration of digitization in education.

Another problem was the risk of addiction and fatigue of children, due to the many hours spent in front of the computer. On the other hand, this has led parents to a greater awareness, towards a more responsible use of IT tools and greater attention to the student's learning rhythms.

Many of the teaching strategies that were already used in face-to-face learning have been transposed into the distance learning of the Magarotto Institute, not only adapting them to the emergency situation, but also strengthening them to stimulate a greater interactivity and autonomy of the students in finding and using educational resources, digital and otherwise. The experience during the distance learning will contaminate also face to face teaching, in a reciprocal and virtuous exchange of instruments and methodologies.

In a post-pandemic future, it is expected to use distance learning, in synergy with face-to-face teaching, for example during online meetings of teachers, for homework and for hospitalized students, with chronic illnesses or with health problems, (Ministero della Salute, 2020).

## 5. CONCLUSIONS

From this case study, a good practice of inclusive teaching was reconstructed, able to adapt to the specificities of individual deaf and/or foreign pupils, who have never been left alone. The distance learning, accompanied by individualized interventions for deaf children with autonomy and communication assistants, ensured the necessary didactic continuity even in the most difficult phases of the pandemic. This practice may also guide other school contexts in post-Covid, in order to reduce inequalities in educational paths. As a matter of fact, distance learning is not a substitute for face-to-face teaching, but complementary to it.

Although in several schools there has been a "physiological" loss of some students, due to lack of familiarity with technologies, in other realities online teaching has tried to be at least as functional as face-to-face one, especially for some types of more receptive pupils or with character problems such as social anxiety or shyness.

In the case of foreign children who have just arrived in Italy and have difficulties in understanding Italian, a model of visual teaching, similar to that used at Magarotto for deaf children, can be useful as well. Foreign children, on the other

<sup>99</sup> This is what emerges from the testimonies of several teachers, including the intervention at the Invalsi seminar "Evaluation and enhancement in the Dad" by Prof. Paola Andreoli of Liceo A. Maffei - Riva del Garda (Invalsi 2020).

hand, are often very familiar with the internet and social networks: young foreigners represent a spearhead of the generation of digital natives (Istat 2020b), but they are often among the most disadvantaged for what concern digital environments useful to develop their potential.

The lack of socialization opportunities is another one of Covid's biggest problems in recent times. In the case study, for example, it was made an attempt to support children also from a psychological point of view, with a service desk activated by a signing psychologist, who has organized a meeting with more or less each class.

The impossibility of socialization, as experienced in face-to-face learning, has led to a rediscovery of the emotional and social dimension of learning. The collaboration of families has proved to be fundamental, especially for the little ones, for whom an "alliance" between parents and teacher has often been created. Family participation was most evident during the first lockdown, when all families were housebound, and to a necessarily lesser extent more recently, upon resumption of work (Eclass 2021).

The experience of distance learning has also contributed to making students acquire a methodological habit that will be useful in the future: an "important challenge", to which the teaching staff, in the best cases, responded by reviewing their teaching strategies, with a change of perspective compared to the past, a conspicuous effort in training that has led to a general growth of the digital school.

Only thanks to this careful and flexible planning work distance learning can prove to be a useful tool for inclusion even in non-emergency situations, not repropounding traditional teaching, but articulating it in a more congenial form to the needs of deaf students as well as students with other forms of disability<sup>100</sup>.

That's not what happened everywhere: despite the DPCM of 10 April 2020 renewed the provisions approved at the beginning of March, suggesting a particular regard to the specific needs of students with disabilities, in many cases it was necessary to ascertain the absence operational plans capable of avoiding the harmful effects that the new suspension of face-to-face teaching would have had on the training of young people and, in particular, on the maturation and social inclusion of pupils with disabilities and sensory deficits. Entire cohorts of students, who were entitled to educational accompaniment, were unable to enjoy this possibility in the second half of the 2019/2020 school year. When the schools were closed, what happens inside the classroom walls became even more evident, namely the delegation of this inclusive function only to specialized teachers. They found themselves managing distance learning without having adequate strategies for educational success (Massagli 2020).

How to respond, then, to the countless critical issues that have arisen? We should think of calibrated and well thought-out training activities for users (teachers) that can be classified at different levels. A certain cyclicity in training should be considered because in technologies subjects a course alone is not enough, but a repeated and monitored practice is necessary. If we have to consider that teaching could have new interruptions and a more widespread use of technologies, a well-calibrated training on users, must be planned adequately and in time (Ajello 2020).

It would also be desirable to consider more accurately the relationships between analogue culture, which is typical of the generation of teachers, and is characterized by deepening, reflection and selection, and the digital one, to which children are more accustomed, and which is exclusively a knowledge of the internet, that conveys "another way of looking", more attentive to speed, to colors, which is now widespread among the entire population, and which entails a rethinking, of a magnitude similar to the difficult relationship between orality and writing considered by Plato (Ajello 2021).

Even if distance learning can never completely replace the presence in the classroom, nor can compensate the social interaction typical of traditional schools, it still represents a methodological device and a digital tool that goes in the direction of ensuring the right to education, maintaining direct contacts between teachers and students even in situations of extreme emergency, as well as a way of learning that in the future can advantageously complete the face-to-face activity. It would be a real shame if we wouldn't capitalize on this experience.

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<https://www.piuculture.it/2020/04/alunni-stranieri-dad/>

## Appendix: digital resources (link accessed March 24, 2021)

Bicocca con le scuole: <https://bicoccaconlescuole.unimib.it/>

De Agostini: <https://deascuola.it/didattica-a-distanza/>

Fondazione Agnelli – Oltre le distanze: <https://lab.gedidigital.it/gedi-visual/2020/oltre-le-distanze/>

Generazioni connesse – Ministero dell'Istruzione, Commissione europea, programma CEF (Connecting Europe Facility):

<https://www.generazioniconnesse.it/site/it/0000/00/00/didattica-a-distanza/>

Ministero dell'Istruzione: <https://www.istruzione.it/coronavirus/didattica-a-distanza.html>

Progetto Idee per la Scuola: <https://ideeperlascuola.it/>

Rai Scuola: <http://www.raiscuola.rai.it/articoli/la-scuola-in-tv-gli-orari-ellelezioni/45140/default.aspx>

Save the children – Fuoriclasse in movimento on line: <https://fuoriclasse-in-movimento-hub-savechildren.hub.arcgis.com/>

## SPATIAL HETEROGENEITY IN THE SPANISH LABOUR MARKET AFTER THE GREAT RECESSION

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### ABSTRACT

The Spanish labour market is characterised by strong and persistent spatial differences in unemployment rates. These differences could have been affected by the internal wage devaluation policy adopted during the Great Recession and the 2010 and 2012 reforms promoting greater wage flexibility. In this paper we apply a geographic and time weighted regression to estimate a dynamic spatial panel wage curve using microdata from the Continuous Sample of Working Lives for 2002-2018. Our results show spatial heterogeneities in the time varying relationship between wages and unemployment that must be considered to assess regional resilience capacity for future crises.

### KEYWORDS

GTWR, Resilience, Spatial panel, Unemployment, Wage curve.

### 1. INTRODUCTION

Economic downturns have a deep impact on regional labour markets, with varying effects and responses. The depth and diversity of such reactions have been evident since the 2008 Great Recession, as job losses and unemployment skyrocketed and local labour markets became sluggish for several years. The concept of resilience entered economic discourse as key tool to describe responses to shocks to local economies. Martin and Sunley (2015) describe three main interpretations of the concept: engineering resilience (the ability to recuperate from a shock), ecological resilience (changes in growth patterns after a shock), and adaptive resilience (course changes in economic activity after a shock). As highlighted by Ubago Martínez et al. (2019), there are no standards for measuring resilience, although measures of employment outcomes are commonly used, as employment takes longer to recuperate than output, it is not dependent on deflation, and it is statistically stable (Martin, 2012, Di Caro, 2015 and Sensier et al., 2016). Moreover, considering employment allows for an accounting of the determinants of resilience (Fratesi and Perucca, 2018) and contributes to the study of labour market conditions (Eriksson and Hane-Weijman, 2017). Other works use alternative indicators to capture resilience: Lewin et al. (2018) use personal income data, Pontarollo and Serpieri (2020a, 2020b) use GDP per capita, and several other use composite indicators of economic and employment outcomes (Rizzi et al., 2018, Ubago Martínez et al., 2019).

Interestingly, most analysis of the impact of the Great Recession has concentrated on the analysis of output or employment measures and not on unemployment, with the exception of those estimating the so-called Okun's law (see, for instance, Groot et al. 2011). Our paper departs from this literature,<sup>101</sup> as we investigate how the global shock affected the stability of the wage curve, i.e., the negative relationship between regional unemployment and the real wage level, for the Spanish labour market. Following the seminal works of Blanchflower and Oswald (1990, 1994, 2005) and the meta-analysis of Nijkamp and Poot (2005), a consensus has emerged (an empirical law of economics, according to Card, 1995) on a stable long-term elasticity of wages with respect to regional unemployment, which has been averaged between -0.07 and -0.1, although there are substantial disparities over population and employment groups.

The wage curve parameter can be analysed as a measurement of wage flexibility, as strong and fast wage responses to growth in unemployment can lead to lower rates of unemployment, and consequently, to a faster recovery from economic shocks (Johansen et al., 2019). Consequently, our work allows for a novel inspection of resilience. We do not analyse employment or economic outcomes, but the underlying mechanism of efficiency in labour markets, which is behind regional recoverability. We try to better understand previous results in the literature, such as that more developed economies are expected to be more resilient (Deller and Watson, 2016).

Our work is innovative in several ways. First, it is the first to implement a flexible approach to the wage curve, both in terms of all spatial and time units, using Geographical and Temporal Weighted Regression (GTWR) techniques. Second, we implement the analysis over a full economic cycle of the Spanish economy, starting in 2002 and ending in 2018, once the economic recovery after the Great Recession was fully stabilised. Third, we link the study of labour market flexibility

<sup>101</sup> Monastiriotis and Martelli (2021) also adopt a different approach to examine adjustments to shocks in Greek regions during the Great Recession. Using micro-data from the Greek Labour Force Survey (LFS) they first estimate the contribution of various individual and household characteristics to individual unemployment risk during and after the crisis. Next they apply a decomposition analysis to identify the relative contribution of the shock, compositional effects, and price adjustments.

with the literature on resilience, as we study the association between wages and unemployment within the framework of the wage curve in a very interesting period from a policy perspective, as the strategy of the Spanish government was precisely to increase wage flexibility as a way to restore international competitiveness during the crisis.

Our main findings show that the elasticity of wages to regional unemployment is associated with the business cycle and the changes in labour market institutions, including two labour market reforms in 2010 and 2012. We also find large heterogeneities in the elasticity of wages to regional unemployment rates, and also in the changes in the parameters. The wage curve can be seen as a measure of resilience and efficiency of local labour markets, as less dynamic regions have less elastic wage curve parameters—a result that clearly establishes the relevance of structural characteristics of regional labour markets in Spain.

In relation to the literature, our paper connects, on one hand, to studies on labour market resilience, and on the other hand, to papers looking at the spatial dimension of the wage curve. Both strands are described in section 2, while section 3 presents the case of study and the Spanish labour market in the context of the resilience and wage curve literatures. Section 4 presents the empirical strategy, section 5 describes the data used in our analysis, and section 6 discusses the results. Finally, section 7 concludes with the main findings and implications of this study.

## 2. LITERATURE REVIEW

The interest of scientists and policy makers has recently moved to analyse the factors that have allowed some regions and cities to resist and/or to recover from the large shock experienced by the Great Recession in 2008. The notion of regional resilience has found currency among those interested in economic geography. In economics, resilience has been defined as the return to a status of equilibrium (Christopherson et al., 2010). Labour market resilience usually refers to the deviation of unemployment from its pre-crisis structural level, usually proxied by a counterfactual trend considering potential employment rates and demographic outcomes (Hitzen, et al., 2017).

Resilience in the labour market, from a spatial perspective, is linked to adjustment channels: migration, wages, and unemployment are three ways workers and firms adapt to changing conditions. National labour markets that are more flexible are those in which people move *between* local labour markets, looking for more and better job opportunities, while *within* labour markets wages adapt to increasing unemployment rates, making regions and cities more competitive. The association between wages and unemployment rates defines the so-called wage curve, an empirical regularity that is backed by several theoretical approaches by Blanchflower and Oswald (1995). Card (1995) criticises the labour contract model for its inconsistency with the compensating differentials model, which assumes a positive correlation between wages and unemployment in the long run. In a proposal based on the work of Shapiro and Stiglitz (1984), the efficiency wage approach, employers will offer a premium to workers in order to minimize costs related to monitoring workers' productivity. In the labour turnover model, employers use higher wages to discourage current employees from quitting (Campbell and Orszag, 1998).

These theories do not consider the possibility of migration, which ensures spatial equilibrium in wages and the erosion of the wage curve, for instance, due to compensatory wage differences (also in line with Harris and Todaro, 1970). Still, as migration is a costly and slow process, regional disparities slowly fade away, and the wage curve becomes a short run phenomenon (Blien, 2001) reinforced by the existence of costs associated with job searching or commuting.

Following a spatial economics perspective, Suedekum (2006) provides a justification for the negative association between wages and unemployment by considering a theoretical model based on increasing returns in production. Large and affluent regions enjoy higher wages and employment levels, while sluggish areas deal with the bad side of the curve. According to this model, such a relationship holds both in the short run and in the long run. Also, from a spatial perspective, Longhi et al. (2006) consider the theory of monopsonistic competition and assume that local labour markets are not isolated islands: workers can commute and migrate, and consequently unemployment elasticity may depend on employment opportunities in neighbouring areas. Longhi et al. (2006) argue that local monopsony power due to fewer job opportunities can result in more pronounced wage curve relationships. Similarly, Baltagi et al. (2012), Baltagi and Rokicki (2014), and Cholezas and Kanellopoulos (2015) find lower elasticities in larger cities than in smaller cities or rural regions, although Jokinen (2020) finds that the impact of agglomeration disappears when accounting for unobserved worker heterogeneity.

One can also expect to observe changes in labour market institutions or in other global characteristics affecting the functioning of the labour market. Local wage responsiveness to unemployment is contingent on labour market institutions, such as the (de)centralisation of wage bargaining systems. These characteristics are usually shared by all regions in a country, and still, there is evidence of heterogeneous slopes of the wage curve across regions of the same country (Deller, 2011). Changes in labour market institutions have been considered drivers of changes in wage curve elasticity. Devicienti et al. (2008) and Daouli et al. (2017) analyse the change in elasticity as a result of labour market reforms in Italy and Greece: both works find that legislative changes played a role in promoting labour market flexibility. Examples of these reforms are changes in the bargaining process or declines in the level of minimum wages.

It is worthwhile, then, to study the changing patterns of the elasticity of wage curve in light of institutional changes in the labour market and over the business cycle. Alternative and competing theories stress the differentiated short versus long run dimension of the wage curve. Consequently, we inspect the evolving changes of elasticities over time in order to gain further knowledge of tidal movements of spatial labour markets.

### 3. THE SPANISH LABOUR MARKET

The impact of the Great Recession on the Spanish economy has been huge, particularly in a European context. It was the deepest and longest crisis since the civil war in the 1930s: unemployment rates climbed to 25% and 3.5 million jobs were destroyed. Despite these catastrophic outcomes, the recovery has been formidable, averaging some 400,000 net jobs created per year from 2014 to 2019.

Several authors have studied resilience in Spanish regions. According to Cuadrado-Roura and Maroto (2016), the most resilient Spanish regions are those previously specialised in dynamic and productive industries, which are reinforced by location advantages (Angulo et al, 2018). Ríos et al. (2017) remark on the role of social and demographic factors as resilience predictors, while Geelhoed et al. (2020) emphasise the role of inequality in employment resilience.

Ramos et al. (2015, p. 127) describe the Spanish labour market as “characterised by an intermediate collective bargaining system with high coverage, high firing costs, a quite generous benefit system, and a very high volatility of employment, with very high rates of unemployment during economic crisis.” Melguizo and Royuela (2020) describe the active role of migration in the spatial labour market equilibrium. Several other authors confirm that there are persistent and wide employment growth disparities linked to the business cycle (Bande and Martín-Román, 2018; Sala and Trivín, 2014). The limited flexibility of wages is compensated by a large share of fixed-term contracts, which are linked to the monopsonistic power of firms to settle wages and, subsequently, to the existence of a wage curve. This empirical law has been confirmed in a number of studies (García-Mainar and Montuenga-Gómez, 2003, 2012, Sanromá and Ramos, 2005). The spatial dimension of the wage curve has been analysed by Bande et al. (2012) and Ramos et al. (2015). Both articles reinforce the importance of spatial spillovers and the need to deepen the analysis of the spatial heterogeneity of the association.

From a historical perspective, the Spanish labour market displays inadequate adjustment mechanisms, with strongly volatile cyclical responses, important contract duality, weak and rigid growth in real wages, massive job losses during recessions, and high structural unemployment rates. The persistence of these circumstances helps to affirm that it is simply not true that the weaknesses of the Spanish labour market are due to temporary or cyclical circumstances (Hidalgo, 2012). In the context of labour market regulations, two important reforms were undertaken in 2010 and 2012. Both reforms, developed by governments of different political parties, tried to improve labour market efficiency (see Doménech et al., 2016, 2018, for further details). These transformations mainly sought to improve internal flexibility in terms of wages and worked hours rather than in terms of employment and deriving collective agreements that aligned with the changing economic conditions. The reforms focused on improving the decentralisation of the collective bargaining system, prioritising agreements at the firm level; reducing the cost of dismissal; and increasing internal flexibility mechanisms. Our hypothesis is that these reforms should have increased the responsiveness of wages to labour market conditions in the different labour markets, with greater effects on regions that were more affected by the crisis.

### 4. EMPIRICAL STRATEGY

We focus on the analysis of wage curve elasticities as a measure of the efficiency and adaptation resilience of Spanish local labour markets by estimating local responses to the changing labour market conditions. Our empirical approach involves estimating local wage curves, assuming spatial heterogeneity in local labour markets.

Blanchflower and Oswald’s (1990, 1994) specification of the wage curve consisted of a regression of the logarithm of individual wages on a number of control variables related to individual and job characteristics and the regional unemployment rate. However, as Moulton (1986) demonstrates, the OLS estimation of this equation, which includes a variable of interest (unemployment rate) that is defined at a higher level of aggregation than the dependent variable (individual), will bias the values of the test of individual significance for this variable upward. Moreover, the inclusion of additional variables in order to correct for the possible omission of relevant variables at the regional level usually induces collinearity problems.

For these reasons, the standard approach in more recent literature consists of applying a two-step procedure, as in Bell et al. (2002) and more recently in Ramos et al. (2015) for the Spanish case. The first step consists of a Mincer equation estimated at the individual level, including controls at the individual and the firm level and time-varying regional dummies. These dummies can be interpreted as adjusted wages in the local labour market, corrected for composition effects. In particular, the first step of the procedure involves estimating the following equation:

$$\ln(w_{irt}) = \alpha Z_{irt} + \delta_{rt} + \pi_t + \theta_r + \varepsilon_{irt} \quad (1)$$

where  $\ln(w_{irt})$  is the natural logarithm of the wage of individual  $i$  who lives in region  $r$  at time  $t$ ;  $Z_{irt}$  is a set of individual factors that can affect the individual’s wages, such as the level of schooling, his/her experience, or other characteristics such as occupation;  $\pi_t$  and  $\theta_r$  are monadic period and region fixed effects; while  $\delta_{rt}$  are region-period dyadic specific effects that can be interpreted as average wages in region  $r$  at time  $t$  corrected for composition effects and free of global business cycle and region fixed effects. Finally,  $\varepsilon_{irt}$  is a random error term that follows a normal distribution with zero mean and constant variance.

In the second step, the wage curve is estimated using the composition corrected wages  $\delta_{rt}$  obtained in the first step, as the endogenous variable and the natural logarithm of the regional unemployment  $\ln(u_{rt})$  is introduced as an explanatory variable together with time fixed effects  $\gamma_t$ , that control for all common shocks to the considered regions; regional fixed effects  $\delta_r$ , capturing unobservable regional heterogeneity; and additional time varying regional characteristics  $Z_{rt}$  that can also affect regional wages, such as aggregate regional productivity:

$$\widehat{\delta}_{rt} = \beta \ln(u_{rt}) + \theta Z_{rt} + \gamma_t + \delta_r + v_{rt} \quad (2)$$

Usually, this second equation is estimated by OLS or instrumental variables procedures, depending on the assumption of the endogeneity of the level of unemployment on wage formation. There is a vast body of literature developing spatial analysis in order to capture the spatial nature of the association. Nevertheless, we are not interested in the estimation of the elasticity of the wage curve alone. We want to describe the local response of every administrative region, which we see as a strong enough approximation to every local labour market, during the Great Recession. Consequently, we are interested in the local heterogeneity of such elasticity.

Several works have been focused on the study of the spatial heterogeneity of the wage curve. Longhi et al. (2006) hypothesise that the cause of spatial non-stationarity is differentiated labour market accessibility, and that this parameter can be stronger in rural than in urban areas. Both Longhi et al. (2006) and Deller (2011) estimate cross section Geographic Weighted Regressions (GWR) to show local heterogeneity in the wage curve, finding important differences over the space. Other works consider heterogeneity from different points of view, including rural-urban (Baltagi and Rokicki, 2014; Jokinen, 2020), level of development (Bande et al., 2012), and time (Devicienti et al., 2008, Daouli et al., 2017).

In our work, we simultaneously consider a double source of heterogeneity. Specifically, we use a GTWR approach to simultaneously account for spatial and time heterogeneity in the estimation of equation (2). GTWR (Huang et al., 2010, Wu et al., 2014, Fotheringham et al., 2015) is an extension of GWR accounting for local effects in both space and time. The main advantage of the chosen approach is that time effects are not constrained to being constant over space. This technique extends the traditional regression framework and assumes the existence of non-stationarity. In addition to GWR, time is also a variable considered in the weighting scheme of the estimation. The GTWR can be expressed as:

$$Y_i = \beta_0(u_i, v_i, t_i) + \sum_k \beta_k(u_i, v_i, t_i)X_{ik} + \varepsilon_i \quad (3)$$

The parameters will vary in space and time, and the estimation is based on a weighting scheme in which the weighting matrix depends on the spatial and time distance between observations. In the traditional GWR framework, weights are defined as spatial kernels based on the physical distance,  $d_{ij}$ , and are usually transformed following Gaussian or bi-square functions, which can be fixed or adaptative. In GTWR models, distances are also complex, as they include time distance. Wu et al. (2014) propose a spatio-temporal distance between observations  $i$  and  $j$  observed in different locations and times, labelled as  $t_i$  and  $t_j$ :

$$\begin{cases} d_{ij}^{ST} = d_{ij}^S \otimes d_{ij}^T = \lambda d_{ij}^S + \mu d_{ij}^T + 2 \sqrt{\lambda d_{ij}^S \mu d_{ij}^T} \cos(\xi), & t_j < t_i \\ d_{ij}^{ST} = \infty & t_j > t_i \end{cases} \quad (4)$$

where  $d_{ij}^{ST}$  is the spatio-temporal distance,  $d_{ij}^S$  and  $d_{ij}^T$  are the physical and time distance respectively, and  $\lambda$ ,  $\mu$  and  $\xi \in [0, \pi]$  are adjustment parameters that can be optimised with cross validation procedures in terms of  $R^2$  or AIC values. The interaction between space and time is governed by parameter  $\xi$ : when  $\xi = 0$ , space and time have the maximal effects, while if  $\xi = \pi/2$ , if there is no interaction between both dimensions. In practical terms, the weight assigned to the spatial ( $\lambda$ ) versus the time distance ( $\mu$ ) can be normalised assuming  $\mu = 1$ , which leaves parameter  $\lambda$  with the relative weighting role. Consequently, in addition to the usual spatial kernels parameters, two additional parameters,  $\lambda$  and  $\xi$ , need to be chosen.

## 5. DATA

In this paper, we use information from the Continuous Sample of Working Histories (*Muestra Continua de Vidas Laborales*; hereafter MCVL). In particular, we use data from the 2006 to 2018 waves. Every wave provides information on more than one million individuals (representing around 4% of the total population) who have had relationships with the Social Security system during that year, regardless of the duration or the nature of the type of relationship (work, unemployment benefits). The MCVL is an administrative longitudinal matched employer-employee dataset that reproduces the labour history of affiliated workers starting from their first job. To build our sample, we have merged the 2018 wave with the waves from 2017 to 2006. Since we know the full work history of these workers, we have information back to 2002.<sup>102</sup> We have limited our analysis to individuals between 16 and 65 years old without disabilities who are observed for at least for two quarters during the considered period. The total number of observations considered in the analysis is 33,462,242 covering 52 provinces, the NUTS III level regional units in Spain that provide a good approximation to local labour markets. This is also the maximum regional level of detail for which unemployment rate data is available from the Labour Force Survey carried out by the Spanish National Institute of Statistics (INE).

MCVL provides information on monthly wages, type of contract (permanent/fixed-term), part-time/full-time, occupation (*grupo de cotización*), and the number of workers, the activity sector, and the location of the firm. It also contains information about the worker such as gender, country of birth, age, and schooling levels, that can be transformed into schooling years and allow us to compute potential labour market experience by applying the usual expression, age-schooling years-6.

Regarding wages, as provincial unemployment rate data from the Labour Force Survey is only available at the quarterly frequency, we construct earnings by averaging monthly wages considering the time worked by each individual. If the individual had more than one job during the considered period, we took the job with the greatest earnings. We use

<sup>102</sup> Considering years before 2002 increases the risk of attrition, because the database is not representative in this time frame, except for in the years where extraction is done. However, from 2002 to 2006, the Spanish economy was in an expansionary phase with no significant regional differences.

quarterly averages of provincial Consumer Price Indexes provided by the INE to deflate quarterly wages, expressed in real terms and transformed using natural logarithms.<sup>103</sup>

Finally, we have also constructed a quarterly indicator of aggregate regional productivity using provincial Gross Domestic Product (GDP) per Worker from the *Contabilidad Regional de España* carried out by the INE. However, as these data are only provided at the annual frequency, we have applied Denton's (1971) method using as indicator the quarterly data on GDP per worker at the national level as provided by the *Contabilidad Trimestral de España* (INE).

**6. RESULTS**

In this section, we present the results of estimating the models discussed in the previous section. The results of estimating equation (1), the Mincerian wage model, are shown in Table 1. As we can see in in this table, the results are well in line with those in the literature. There is a wage gender gap of around 10 log points in favour of men in the Spanish labour market after controlling for several characteristics. Coefficients related to schooling year and potential experience are statistically significant at the usual level and show the expected signs, detecting a positive relationship between human capital and wages. Individuals who worked only part-time received significantly lower wages than those who worked full-time. The dummy variables related to fixed-term contracts also show the penalisation that these workers experience in the labour market compared to those with permanent positions. Workers in publicly-owned firms also have a positive wage premium compared to those employed by private firms. Occupational dummies also have the expected sign, as the reference category corresponds to high-skilled occupations while firm size also has a positive effect on wages. Information related to industry sectors (not reported but available from the authors on request) permitted us to control for the effect of the various productive and employment structures in the various provinces. Time dummies allowed us to control for common shocks to all regions in each quarter (also not reported but available from the authors on request), while province dummies control for permanent differences in local labour markets.

In equation (2), we use the estimates of time-varying region specific effects from equation (1) as the endogenous variable, and the natural logarithm of regional unemployment is introduced as an explanatory variable together with the logarithm of regional aggregate productivity and time and regional fixed effects. Table 2 presents the main results of the global model with no time or spatial varying effects. As can be seen in this table, the elasticity of adjusted wages to unemployment rate is quite weak. Once we account for regional productivity and province and period fixed effects, the parameter is significant and negative, but the size is rather small: -0.007. This value is in line with the impact parameter in Ramos et al. (2015), although it falls below their total effect once they account for the spatial effect (-0.073).

**Table 1. Mincerian wage equation**

Variables	(1)	(2)
Male	0.103*** (0.000233)	0.107*** (0.000231)
Immigrant	-0.0323*** (0.000294)	-0.0482*** (0.000295)
Schooling years	0.0195*** (5.02e-05)	0.0185*** (5.03e-05)
Potential experience	0.0258*** (4.01e-05)	0.0274*** (4.01e-05)
Potential experience squared	-0.000336*** (7.67e-07)	-0.000367*** (7.63e-07)
Part time contract	-0.583*** (0.000328)	-0.577*** (0.000326)
Fixed-term contract	-0.297*** (0.000261)	-0.288*** (0.000259)
Publicly-owned firm	0.121*** (0.000595)	0.130*** (0.000584)
Technical Engineers, experts, and qualified assistants	-0.0762*** (0.000471)	-0.0701*** (0.000467)
Administrative and Workshop Managers	-0.128*** (0.000476)	-0.131*** (0.000472)
Assistants without official qualification	-0.268*** (0.000549)	-0.269*** (0.000545)
Administrative Officers	-0.297*** (0.000417)	-0.300*** (0.000414)
Subordinates	-0.518*** (0.000648)	-0.520*** (0.000643)
Administrative Assistants	-0.502*** (0.000463)	-0.499*** (0.000459)
First and Second Category Officials	-0.490*** (0.000460)	-0.481*** (0.000458)
Third Category Officials and Specialists	-0.568*** (0.000504)	-0.564*** (0.000500)

103 Table A1 in the appendix shows basic descriptive statistics of variables computed from MCVL.

General Assistants without qualifications	-0.717*** (0.000523)	-0.706*** (0.000519)
Number of workers in the firm	0.0248*** (6.47e-05)	0.0225*** (6.49e-05)
Constant	7.151*** (0.00107)	7.247*** (0.00164)
Sectoral FE	Yes	Yes
Regional FE	No	Yes
Time FE	No	Yes
Observations	33,462,242	33,462,242
Individuals	1,024,445	1,024,445
R-squared	0.520	0.533

Note: Reference categories: female, native, full-time, permanent contract, private firm, Engineers, and Graduates. Robust standard errors in parentheses. Significance: \*\*\* p<0.01; \*\* p<0.05; \* p< 0.1. We consider 68 periods of time (2002.q1-2018.q4) and 52 provinces.

**Table 2. Wage curve basic models**

	(1)	(2)	(3)	(4)	(5)
ln Unempl rate	-0.001 (0.001)	-0.002** (0.001)	-0.006*** (0.002)	0.001 (0.001)	-0.007*** (0.002)
ln GDP pw				0.354*** (0.033)	0.758*** (0.046)
Constant	0.002 (0.002)	0.001 (0.004)	0.008 (0.005)	-2.864*** (0.264)	-6.122*** (0.371)
Time FE		Yes	Yes	Yes	Yes
Region FE		No	Yes	No	Yes
Observations	3,536	3,536	3,536	3,536	3,536
R2	0.0003	0.017	0.019	0.049	0.092
Adjusted R2	0.00001	-0.002	-0.015	0.030	0.060
F Statistic	1.044 (df = 1; 3534)	0.871 (df = 68; 3467)	0.552 (df = 119; 3416)	2.593*** (df = 69; 3466)	2.870*** (df = 120; 3415)

Note: Robust standard errors in parentheses. Significance: \*\*\* p<0.01; \*\* p<0.05; \* p< 0.1. For the fixed effects we consider 68 periods of time (2002.q1-2018.q4) and 52 provinces.

We next look at the results of estimating equation (2) applying GTWR, in which we see time and spatial varying effects of unemployment on wages. In order to balance spatial and temporal distances, we opted to work with the maximum interaction parameter ( $\xi = 0$ ), and we performed a battery of estimations to find the optimal weight for space/time. The parameter was obtained considering a fixed kernel and using a cross-validation procedure in terms of goodness-of-fit, reporting a value of parameter  $\lambda = 0.0001$  ( $\mu=10,000$ ).<sup>104</sup> We first display the results of two extreme situations of the GTWR specification. When  $\lambda = 0$ , the specification fully accounts for time varying effects. On the contrary, when  $\lambda = 1$ , all variation is spatial. Panels (a) and (b) of Figure 1 plot the results of these analysis, and panel (c) plots the results for  $\lambda = 0.0001$  and  $\xi = 0$ .

As seen in panel (a), the temporal evolution of the parameter increases until the first quarter of 2006. Beyond that period, and close to the start of the Great Recession, we observe a decreasing pattern in the parameter. Interestingly, despite the start of the recovery of the economy in 2014, we can see a further decline in the value of the elasticity of adjusted wages to the unemployment rate, which we interpret as an improvement in the efficiency of the labour market. We want to believe that the reforms of the Spanish labour market are somehow associated with these results.

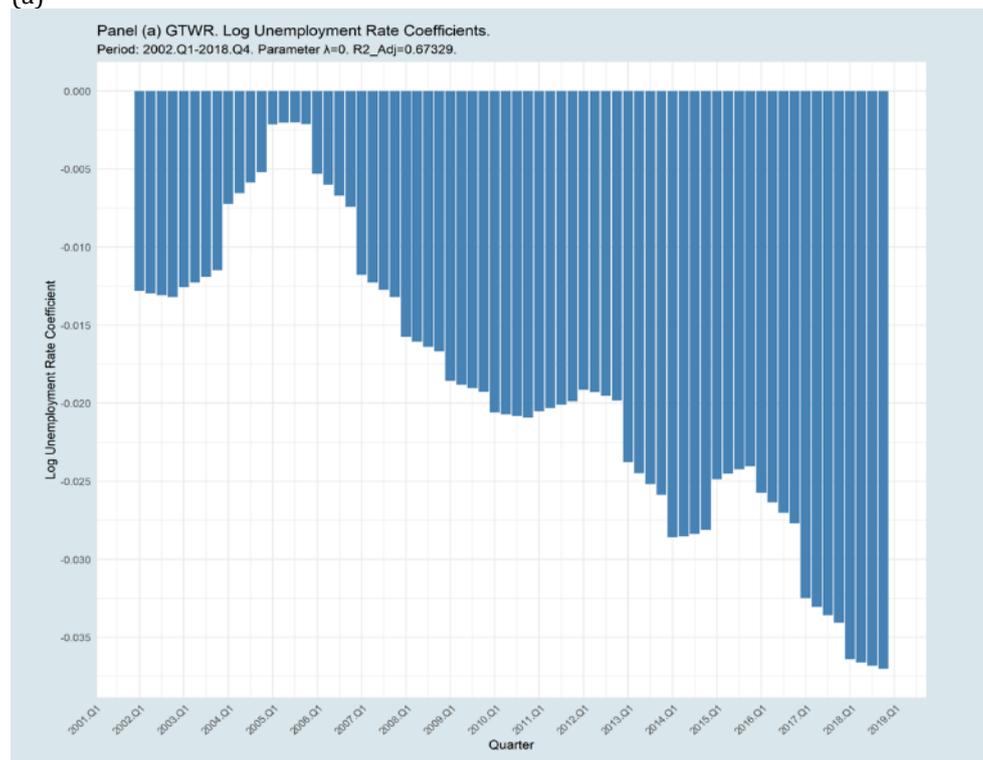
Results in panel (b) capture the cross section dimension of the data, as time has no impact on the weighting function of the GTWR estimates ( $\lambda = 1$ ). We observe a strong spatial heterogeneity of the parameters. We find negative and significant parameters in Eastern regions (including Catalonia and Valencia and Aragon), Northern regions (such as the Basque Country, Cantabria, and Asturias), and some neighbouring Castilian provinces. These provinces are in line with the traditional negative sign of the wage curve: as unemployment increases, wages experience a declining pattern, in line with the efficiency wage approach, the labour turnover model, and the spatial model based on increasing returns in production. On the opposite side, we find southwestern provinces (particularly the less dynamic region of Extremadura), other western Andalusian provinces (including Seville), and some neighbouring provinces in the Castilian La Mancha. For these provinces we find non-significant and even positive parameters, a result that is opposite to findings explained in the literature by the theory of monopsonistic competition and the lack of employment opportunities. Consequently, our results report that more dynamic regions display more elastic and efficient labour markets, while the less developed regions are characterised by wages that are not responding to the local conditions of the labour market. These outcomes are in line with those of Bande et al. (2012), who find a stronger negative sign for more dynamic provinces, and they are partially aligned with Melguizo (2017), who detects spatial heterogeneity in provincial parameters of the Okun’s law (that there is an inverse relationship between unemployment and GDP).

104 We have used the `gtwr` command of the `GWmodel` package in R (Gollini et al. 2015, Lu et al. 2019). Figure A1 in the Appendix displays the details of parameter selection according to goodness of fit (Adj R2) and AICc statistics, while Figure A2 displays the relative distance resulting from different parameters of  $\lambda$ . The final results using different parameters of weighting space and time did not change the main results of the basic specification. Additional results with different combinations of values for these parameters are available from the authors on request.

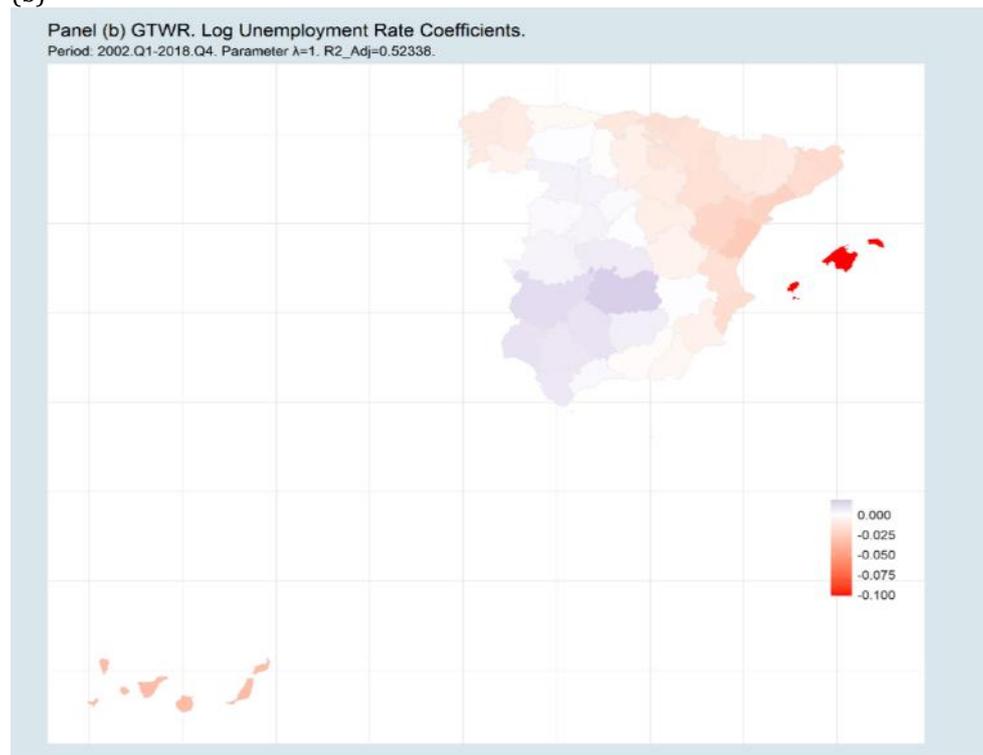
Next, Table 3 and Panel (c) in Figure 1 report the results of the GTWR model with additional combinations of parameters that depart from the extreme cases shown in Figure 1, and they optimise the adjustment criterion. Figure 1c displays a new picture of the wage curve. In line with what we find in Figure 1b, there are negative and significant parameters of the wage curve in the northeastern provinces, while we hardly find any positive and significant parameters other than some periods in Castilian provinces such as Avila. Non-significant parameters are present in large areas, including in the northwestern and central provinces. Interestingly, southern provinces, such as Seville and Málaga, display results that are negative and significant, in contrast with what we found in the cross-section picture resulting from Figure 1b. In addition to the spatial heterogeneity, Figure 1c adds to the results the evolution of these parameters in every province. Figure 2 complements the results by linking the evolution of the parameters in every province by sub-periods over the business cycle.

**Figure 1. GTWR results**

(a)



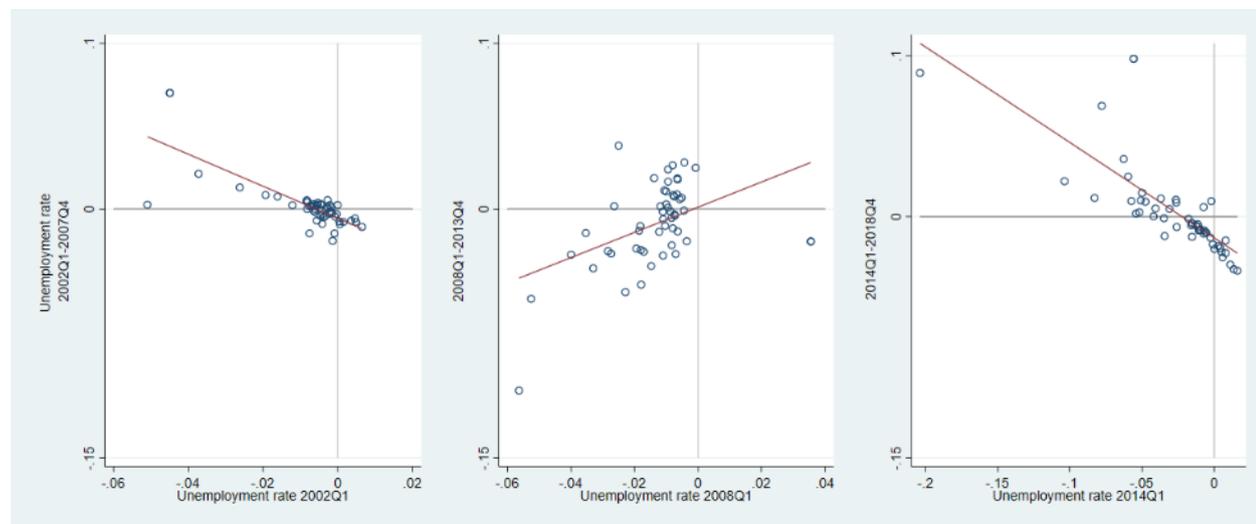
(b)





drawn in Cuadrado-Roura and Maroto (2016), and it is also in line with the results of Deller and Watson (2016). While these authors devote their work to connecting resilience to sectoral specialisation, we add as an explanation the heterogeneous behaviour of local labour markets. From an institutional labour market perspective, we see how a non-spatial policy, such as the labour market reforms in 2010 and 2012, had limited effects in terms of improving the conditions in non-efficient local labour markets.

**Figure 2. Changes in the elasticity of wages to unemployment over time: 2002-2018**



Note: Scatterplots represent the 52 Spanish provinces. The horizontal axis displays the parameter in the starting period and the vertical axis represents the change over the subsequent years.

Specific attention to Madrid, the strongest and most dynamic province in Spain, is warranted. We find few significant and negative results for this region. In this case, we interpret the results as a combination of the dynamic effect of the province itself and the weaknesses of surrounding provinces, which are being *absorbed* by the capital of the country. One can argue that Madrid can be understood as having the opposite situation of monopsonistic competition in the labour market, as firms face a very competitive environment and difficulties in lowering salaries.

Finally, figure A4 in the appendix plots the GTWR results for the log of GDP per worker. The results are positive and significant, and consequently the adjusted wages respond to changes in our measure of productivity, although this effect declines in more recent periods.

We checked the robustness of our results to several estimation techniques. We have inspected the role of the spatial bandwidth in our results. While we have mainly opted for Gaussian kernels, we considered spatially adaptive rather than fixed kernels. While there were some alternative results, the overall picture and our main conclusions do not change.<sup>106</sup>

## 7. CONCLUDING REMARKS

In this paper, we have studied the resilience of local labour markets in Spain during the Great Recession. Rather than analysing traditional outcomes such as income and employment, we study the association between wages and unemployment, the so-called wage curve. This association is a measure of labour market flexibility, a characteristic that helps local labour markets to achieve a faster recovery from economic shocks—a key dimension of resilience. We have used microdata from the Continuous Sample of Working Lives, a random sample of 4% of all individuals who contributed to the social security system, and we have computed adjusted wages free of personal characteristics for all Spanish provinces (NUTS-III), our main unit of analysis. We have analysed the responsiveness of the locally adjusted wages to unemployment rates between 2002 and 2018 and considered the spatial heterogeneity in a dynamic wage curve by means of a Geographic and Time Weighted Regression (GTWR).

Our findings show weak elasticity of wages to the unemployment rate. Still, we observe an increasing pattern in the absolute value of the parameter during the Great Recession, which continues over time despite the start of the economic recovery in 2014, which we link with the reforms of the labour market implemented by two consecutive governments (2010 and 2012). We also find a strong spatial heterogeneity of the parameter, which is negative and significant in a subset in the northeast of the country. On the opposite side, we find southwestern provinces, particularly the less dynamic region of Extremadura and other western Andalusian provinces. When we estimate together spatial and time varying parameters, we find a time-varying response that is more intense in those provinces with already high elasticity values.

Our results suggest that the labour market reforms of 2010 and 2012 had important effects, which are observed nationally and at the local level. Nevertheless, the effect is heterogeneous over local labour markets. In policy terms, we

<sup>106</sup> These results are available upon request.

find that global labour market reforms are important mechanisms to improve the efficiency of the labour market. Nevertheless, they should be also be defined in local terms, as suggested by López Mourelo and Malo (2015). We understand that our work can be improved a several areas. First, we assume that we could have worked with a more sophisticated empirical model, for instance assuming lagged wages as an explanatory variable or including spatial dependence in the analysis, as other papers in the literature have done. In any case, as our focus is the analysis of spatio-temporal heterogeneity, we believe that our results are not invalidated for alternative specifications. We also agree that we do not perform a causal evaluation of the labour market reforms, which is not our main aim. Finally, we understand that the inspection of the causes of the observed heterogeneity in the spatial labour markets can be of substantial interest for further research.

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## UNCOVERING THE INTER- AND INTRA-REGIONAL HETEROGENEITIES IN THE MINIMUM WAGE – EMPLOYMENT RELATIONSHIP

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### ABSTRACT

We study the employment effects of minimum wage changes by uncovering and explaining inter- and intra-regional heterogeneities. For this purpose, we explore variations in the minimum wage bite across age groups, economic sectors, regions in time. Compared to previous studies, we use a novel, multidimensional panel data approach that allows us to simultaneously analyze the heterogeneous effects of minimum wage changes on employment elasticity among different groups of workers. We found regions characterized by factors that simultaneously stimulate employment elasticity and rigidity. Those factors influence different groups of workers and tend to mitigate the impact at a regional level.

### KEYWORDS

Employment, minimum wage, regional labor markets, hidden heterogeneities, Poland

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### 1. INTRODUCTION

Considerable research has been conducted on the relationship between minimum wages and employment; however, both the direction and strength of this relationship have not been unanimously determined. Meta-analyses for both developed (see Neumark and Wascher, 2007) and developing countries (Neumark and Munguia Corella, 2019) point to the heterogeneity of the workforce as the main source of inconsistency in the results. Minimum wage increases tend to negatively affect the employment of vulnerable groups of workers (young and less educated).

Workers with basic qualifications and less labor market experience usually receive the lowest wages. Moreover, the diverse levels of qualification required in some occupations, together with both personal and firm characteristics, cause differences in the distribution of low-wage workers across economic sectors and regions. Therefore, as Autor et al. (2016) argue, changes in minimum wages may have different impacts across regions and their effects on employment can induce heterogeneous responses. Analyses performed among US regions indicated that employment elasticity due to minimum wage changes is significantly diversified across states (Williams, 1993) and counties (Thompson, 2009).

Most prior analyses of minimum wage changes on employment usually considered only two dimensions. The employment effects were investigated across, for example, age groups, educational groups, or regions, over time. This study adopts a multidimensional panel model to account for the latent heterogeneities in the minimum wage effects on employment. Given the contentious background in the minimum wage and employment literature, Wang et al. (2019) argue that the versatility of the panel model in accommodating heterogeneity offers a fresh approach to this long-standing issue.

In our approach, we take advantage of the extensive database of individual wages and employment characteristics available and analyze the effects of minimum wage changes on employment across four dimensions simultaneously. We construct a panel using three-dimension cells formed by three age groups, three economic sectors, and 16 regions, separately for each year. These cells are our units of observation.

We commence by estimating the average employment elasticity concerning a minimum wage for all cells before applying the slope homogeneity verification test recently developed by Bersvendsen and Ditzen (2020) for panel data. After rejecting the homogeneity of the employment effect across cells we simultaneously vary the parameter of the minimum wage variable across cells (age-group, economic sector, and region). Finally, we perform a cluster analysis to explain the differences in employment elasticity across clustered cells of workers.

The multidimensional approach enables analyzing differences in employment elasticities for relative minimum wage among regions, economic sectors, and age groups. Moreover, we can simultaneously analyze the differences in employment effects within regions: for the same age groups but in different sectors, or the same sector but for different age groups. For example, we compare employment elasticity in a group of young workers in an industry for a given region to that obtained by the same group in another region. We can also compare employment elasticity in a group of young workers in an industry in a given region with the employment elasticity in the group of middle-aged or older workers in the industry in the same region. Thus, we can conduct these analyses for all age groups, all economic sectors, and all regions.

This multidimensional approach has the inevitable advantage over prior studies in that it allows for a more detailed picture of the analyzed phenomenon. We study differences among regions together with heterogeneous reactions to policy changes within regions. We observe how regional differences in the sectoral and workforce age composition affect employment with increases in the minimum wage. To the best of our knowledge, this is the first study of this kind.

This study presents the empirical application of this approach to the Polish labor market. Analysis of the employment effects of minimum wage changes in Poland is interesting for several reasons. First, is the long history and simplicity of the minimum wage policy—it is conducted at a national level and covers almost all workers (see Appendix 1). Second, is the extent of its coverage. According to Eurostat data, Poland has amongst the highest share of minimum wage workers of all European economies. Third, a sustained increase in the national minimum wage in Poland was observed in recent years. Fourth, Poland exhibits large and enduring regional differences.

We use data on individuals from the Structure of Earnings Survey 2006–2016, the most comprehensive and reliable database on individual wages in Poland. We analyze employment in non-agricultural private sector firms with at least 10 workers, computing precise minimum wage bite measures based on regional, sectoral, and age-group wage distributions. In contrast to previous studies, we construct two minimum wage bite indicators—a nominal and real relative minimum wage. The latter uses both real minimum wage and real average wages (with different deflators), thereby creating a more robust bite measure of minimum wages.

In confirming the existence of regional differences in employment elasticity arising from changes in minimum wages, we discovered latent heterogeneities in the regional employment effect, with some regions simultaneously experiencing both negative and positive employment effects of minimum wage changes. Negative employment effects are observed mostly in the youngest groups of workers, while positive employment effects are predominantly in the groups of workers aged 50 and over.

The employment effect of changes in the minimum to higher wage levels is the result of a combination of regional labor market features. Negative employment effects are more probable in small, private sector firms where it is more difficult to increase the prices of goods or services produced. Conversely, positive employment effects are more probable in regions with high share of employed in public sector and with high share of employed in large enterprises. Significantly, these two completely different labor market environments can coexist within a given region which may explain why the empirical analyses at a regional level often indicated insignificant values of employment elasticity for minimum wage changes.

The remainder of this study proceeds as follows. Section 2 contains the literature review. Section 3 describes the data and the empirical approach. Subsequently, Section 4 reports the results and robustness analyses. Section 5 concludes.

## 2. REVIEW OF LITERATURE

In theory, the potential impact of minimum wage increases on labor demand depends on the market structure. While negative employment effects are expected in a competitive price-taker setting, a monopsonistic labor demand does not imply negative effects in general. Depending on the minimum wage level, the demand for labor may increase when workers are paid below the marginal product of labor (Caliendo et al., 2018).

The empirical literature on the employment effects of minimum wage increases is enormous, however, no definite consensus has been reached. Most studies indicate a small and negative impact of minimum wage growth on employment, particularly among the young and less educated (Neumark and Wascher, 2007; Kuddo et al., 2015; Broecke et al., 2017; Neumark and Munguia Corella, 2019). The findings that young workers are particularly vulnerable to minimum wage changes have been confirmed for many countries. Recently, Kiss (2018), using a sample of EU countries, found young workers to be characterized by significantly higher negative employment elasticities than older workers.

Moreover, a growing number of authors underline the heterogeneity of labor markets across regions as the main source of inconsistent elasticity estimates. Williams (1993) found that the elasticity of employment due to minimum wage changes in the US is highly heterogeneous among states, with the lowest elasticity observed in those less developed. Thompson (2009) confirmed the existing differences in employment elasticity with respect to minimum wage across US counties. Recently, numerous studies in Germany have been conducted. The vom Berge and Frings (2017) study finds that the minimum wage caused a contraction in employment growth in East Germany with a relatively high bite, while the Western part of Germany experienced no change in employment. These results were confirmed by Ahlfeldt et al. (2018). In Poland, few studies confirmed significant differences in employment or unemployment elasticity arising from minimum wage increases across regions (Melnyk, 1996; Majchrowska and Żółkiewski, 2012; Broniatowska et al., 2015; Majchrowska et al., 2016; Albinowski and Lewandowski, 2020).

Numerous studies also underline the impact of the regional labor market structure on the vulnerability of employment levels to minimum wage changes. Harasztosi and Linder (2019) found that disemployment effects were greater in industries that found it more difficult to pass the wage costs onto consumers. Munguía Corella (2020) found the elasticity of youth employment due to minimum wage changes negative and significant under perfect competition and positive, but insignificant, effects were found under full monopsonistic labor markets.

In this study, we follow the approach suggested by Card (1992), which relies on the extent to which regional labor markets are affected by the minimum wage. Wages differ among regions due to differences in the characteristics of workers and employers. This variation implies that the minimum wage affects workers in each region to a different extent. The minimum wage is supposed to affect less skilled and less experienced workers, for whom the literature has consistently established negative and significant employment effects. Therefore, the uneven distribution of young or less-educated workers across economic sectors and regions may result in differences in the impact of minimum wage on

employment in particular sectors of regional labor markets. We adapt this framework to the Polish case and apply a multidimensional approach to analyze the effects of the minimum wage changes on employment.

### 3. DATA AND MODELING APPROACH

#### 3.1 Data

To identify the minimum wage effects on employment across subgroups of workers we need comprehensive and reliable wage data on the eligible population and their employment level, thus we use individual data on wages and employment characteristics from the Structure of Earnings Survey (SES). The SES is a large enterprise sample survey providing detailed and comparable information on the relationships between the level of remuneration and individual characteristics of workers (gender, age, occupation, work experience, and the highest educational level attained, among others) and those of their employers (economic activity, ownership sector, size, and the location of the enterprise). The SES, conducted biennially, covers around 13% of all enterprises of the national economy that employ more than nine workers. We select data from 2006 to 2016, totaling 6 periods. The advantages of this database include its high reliability and extent. The high reliability of the information on salaries is because wages are reported by the accounting departments of enterprises. Each sample is very large—over 660,000 observations in 2006 and nearly 800,000 in 2016. Although the database represents only entities employing more than nine workers when considering the employment structure in Poland with its very high share of self-employed individuals operating without job contracts (own-account workers), the authors estimate that the SES database covers nearly 90% of all contract workers in Poland<sup>107</sup>.

We make adjustments to the initial database. First, we focus on the workers for whom the minimum wage is binding; we exclude workers younger than 18 years old or above the retirement age (older than 60 for women and 65 for men) from the initial sample. Second, we analyze only the private sector because the share of minimum wage workers<sup>108</sup> in the public sector in Poland is negligible—0.3% in 2006 and increasing to 1.2% in 2016. In the private sector, the share of minimum wage workers was 11% and 15% in 2006 in 2016<sup>109</sup>, respectively. Third, we analyze those employed in non-agricultural sectors. Fourth, we include both full-time and part-time workers. The wages of part-time workers are recalculated as full-time equivalents.

The SES database is our source of data about the number of workers and their average wages. The other data included in the model (regional and sectoral GDP, population by age groups, and unemployment rate) is based on the 16 regions according to the NUTS2 level of regional classification and taken from the local data bank of the Central Statistical Office of Poland, Poland's largest publicly available database of the economy, society, and the environment.

#### 3.2 Modeling approach

From the SES database, we obtain information about monthly salaries and individual characteristics of workers. Since the survey sample is randomly drawn every reporting period, it is impossible to create a panel of individuals. However, it is possible to simultaneously analyze the elasticity of employment across different sub-groups of workers, including by *age group*, *economic sector*, and *region*. We construct three-dimension cells separately for each year comprising three age groups (up to 30 years old, 30-50 years old, and 50 years and older), three economic sectors (manufacturing and construction, market services, and non-market services), and 16 regions at the NUTS2 level. These cells are our units of analysis.

We follow the standard approach proposed in the literature and estimate the parameters of the log-linear relationship between employment, minimum wage measure, and other variables. In particular, following the theoretical model proposed by Dickens et al. (1994) we include both demand and supply-side variables in the model. We use *gross value added* in economic sectors and regions as a measure of local demand shocks. We also include time effects to control for the aggregate demand shocks. *Population size* approximates the supply shocks. *Workers' unemployment rate* approximates business cycle changes. The 4-dimensional panel data model we used in our analyses is expressed as

$$emp_{R,N,A,T} = \alpha_0 + \alpha_1 wrel_{R,N,A,T} + \alpha_2 gva_{R,N,T-1} + \alpha_3 pop_{R,A,T} + \alpha_4 ur_{R,T} + \sum \delta_{R,N,A} + \sum T_T + \varepsilon_{R,N,A,T} \quad (1)$$

where

$emp_{R,N,A,T}$  indicates the logarithm of the number of workers employed<sup>110</sup> in region R (R=1, 2, ..., 16), economic sector N (N=1 - industry and construction, 2 - market services, 3 -non-market services), age group A (A=1 - less than 30 years old, 2 - 30-49 years old, 3 - 50 years old and above) in year T (T=2006, 2008, 2010, 2012, 2014, 2016);

$wrel_{R,N,A,T}$  represents the logarithm of the relative minimum wage (minimum to average wage ratio) in region R, economic sector N, age group A, at time T;

$gva_{R,N,T}$  indicates the logarithm of gross value added in region R, economic sector N, at time T (millions of PLN, constant 2010 prices);

$pop_{R,A,T}$  denotes the logarithm of the population in region R, age group A, at time T (thousands of people);

$ur_{R,T}$  is the logarithm of the unemployment rate of male workers of working age in region R at time T (%);

$\delta_{R,N,A}$  is the cell fixed effect;

107 According to the data from the Central Statistical Office in Poland, only 34% of workers in micro firms in 2016 were employed on a job contract.

108 According to the Eurostat definition we treat minimum wage workers as those receiving less than 105% of the minimum wage ([https://ec.europa.eu/eurostat/statistics-explained/index.php/Minimum\\_wage\\_statistics#Proportion\\_of\\_minimum\\_wage\\_earners](https://ec.europa.eu/eurostat/statistics-explained/index.php/Minimum_wage_statistics#Proportion_of_minimum_wage_earners)).

109 Source: SES data; own calculations.

110 We use small letters for the variables in logarithms, and capital letters for the variables in real values.

$T_T$  are time effects, and

$\varepsilon_{R,N,A,T}$  represents the error term.

As a measure of employment, we take the number of workers in a given cell—those employed in enterprises with at least 10 workers within the non-agricultural, private sector in Poland. Following Caliendo et al. (2018) we decide to use the log employment level, not an employment-to-population ratio because the latter not only reflects changes in employment levels but also changes in the population. We include population at the cell level as a control variable.

The definition of minimum wage bite used in the model is crucial to our analysis. Prior studies mainly focus either on the Kaitz index (which measures the ratio between the minimum wage and the mean wage) or the proportion of minimum wage workers in the given group—both have advantages and disadvantages (see Caliendo et al., 2018). Our minimum wage bite measure is the Kaitz index—the relative minimum wage calculated as the minimum to average wage ratio for a given cell. Specifically, the intensity with which wages need to change following minimum wage changes is heterogeneous between regions, age groups, and economic sectors. In those cells where the minimum wage bites hardest, adaptations in wages will be stronger along with those of labor demand (Caliendo et al., 2018).

For our analysis, we calculated both the nominal and real relative minimum wage. In the first approach, we use the difference between the log of nominal minimum wage level applicable in a given year and the log of nominal average wages (average monthly wage of individuals without bonuses) in a given cell. Since the minimum wage is unique to all workers, the variation in this minimum wage bite measure comes from minimum wage differences over time and the differences in average wages across cells over time. This variable—*nominal relative minimum wage*—can be shown as

$$wmin_T - wave_{R,N,A,T} = nwrel \quad (2)$$

where  $wmin_T$  is the log of the national minimum wage at time  $T$  and  $wave_{R,N,A,T}$  is the log of the average wage level in a given cell consisting of region  $R$ , economic sector  $N$ , and age group  $A$ , at time  $T$ .

However, as Card and Krueger (1994) observed, in times of prosperity, both employment and average wages rise, causing a decline in the calculated value of the relative minimum wage measure. Similarly, in times of recession, employment and the average wages fall, generating a rise in the relative minimum wage. As a result, there is a negative correlation between employment and the relative minimum wage due solely to movements in average wages, regardless of whether employers respond to a higher minimum wage with lower employment or recruitment levels (Belman and Wolfson, 2016).

Consequently, another proposition in the literature is to use a real minimum wage measure (Williams, 1993)—the ratio of the real minimum wage to real average wages. The problem frequently encountered in empirical analyses is the unavailability of regional price indices. We took advantage of the data availability of regional price levels and constructed the real value of the minimum wage and real average wages. The nominator and denominator were deflated using two different price level measures: i) to calculate the real regional average wage a consumer price index published by the Central Statistical Office of Poland is used and ii) to calculate the real value of the minimum wage at the regional level we use the information on the minimum subsistence (social) level calculated and provided by the Institute of Labor and Social Studies<sup>111</sup> (see Appendix 2 for more information). The rationale for using two different deflators is straightforward: if we divide the numerator and denominator by the same deflator value, there will be no change at all.

Therefore, for the second approach, we calculated the difference between the log of the real minimum wage in a given region  $R$  at time  $T$  and the log of the real average wage in a given cell. This variable—*real relative minimum wage*—is shown as

$$real\_wmin_{R,T} - real\_wave_{R,N,A,T} = rwrel \quad (3)$$

where  $real\_wmin_{R,T}$  is the log of the real minimum wage (nominal minimum wage deflated by regional price level calculated from the social minimum) in a given region  $R$  at time  $T$ , and  $real\_wave_{R,N,A,T}$  is the log of real average wage (nominal average wage deflated by the regional CPI) level in a given region  $R$ , economic sector  $N$ , age group  $A$ , at time  $T$ . From further analyses, the real relative minimum wage is our superior option as the minimum wage bite measure of the higher quality. However, having these two minimum wage bite measures allows us to compare whether the employment effects across different groups of workers are systemic. We use the nominal relative minimum wage in the robustness checks.

In our model, we use contemporary values of minimum wage bite variables. In Poland, the information on the minimum wage increase for the next year is usually available in June of the previous year (in September at the latest<sup>112</sup>). Therefore, entrepreneurs have sufficient time to adjust their firms' policies to upcoming changes.

We use *gross value added* in a given economic sector and region as a measure of *demand shock* which can affect employment. It is measured at 2010 constant prices and is lagged one period to avoid simultaneity problems—a recently increased minimum wage may influence both the levels of employment and production. Production can be modeled as a persistent stochastic process; and changes in the current minimum wage level do not affect production levels in the previous period. We use the regional male unemployment rate as a measure of the regional business cycle. The unemployment rate affects men of working age as most vulnerable to changes in aggregate demand.

Following the literature, we add the measures of supply shocks affecting employment. In particular, information regarding population size in a given age group and region to capture the idiosyncratic difference among regions. The population is measured in thousands of inhabitants. Table A1 in Appendix contains descriptive statistics of the variables used in the model across the cells. Table A2 contains additional information about the distribution of employment

111 <https://www.ipiss.com.pl/?zaklady=minimum-socialne>

112 For more about minimum wage policy in Poland see Appendix 2.

variables across age groups and economic sectors. It indicates that the number employed in the non-market services sector is much lower than in other economic sectors.

Our main parameter of interest in Model (1) is  $\alpha_1$  which shows the direction and strength of the relationship between the minimum wage bite and employment. Our identification strategy is based on Card's (1992) observation that "a rise in local (state) minimum wage will typically affect a larger fraction of workers in some regions (states) than in others". The induced variation creates a simple natural experiment for measuring the effect of minimum wage change. The intensity of how wages need to change under a new minimum wage should be related to the fraction of workers initially earning less than the new minimum wage (Caliendo et al., 2018).

To test this empirically, we first estimate the parameters of equation (1) for the full sample to obtain an average value of the parameter of interest. We assume the homogeneity of the employment elasticity concerning the minimum wage variable across cells, which we use as units of observations. However, both theoretical consideration and previous empirical results emphasize that minimum wage increases affect different groups of workers to a different extent.

Thus, our second step is to test the slope homogeneity of the coefficient of minimum wage bite measures across cells recently developed by Bersvendsen and Ditzen (2020). It allows for verification of slope homogeneity in a panel data context with no correlation (Pesaran and Yamagata, 2008) or using the heteroscedasticity and serial correlation version (Blomquist and Westerlund, 2003), which we employ due to our cells differing in size. The influence of control variables such as gross domestic product, population, and the unemployment rate is held constant. We start from 4-dimension cells and if the homogeneity is rejected, we reduce dimensionality. As the test requires a panel setting, we are unable to eliminate the time dimension.

In the third step, we relax the homogeneity of the employment elasticity of the minimum wage variable and allow the parameter  $\alpha_1$  in Model (1) to vary simultaneously across age groups, economic sectors, and regions. In the fourth step, we explain the results using cluster analysis.

A generalized least squares technique that allows for heterogeneous error structure is used to correct for heteroscedasticity arising from aggregation. We do not weight the units of observations in the model and treat each cell as a separate observation since we are interested in estimating the employment elasticity separately for each cell and thereby comparing them with each other.

#### 4. EMPIRICAL ANALYSES

We first estimate the parameters of Model (1) for the full sample of non-agricultural, private-sector workers in Poland grouped in cells. As our main minimum wage bite measure the real relative minimum wage is used (nominal relative minimum wage acts as the robustness check). The sample includes workers from all regions, all age groups, and all economic sectors as defined. Time effects are included to control for the common shocks across regions and the fixed effects to consider the cells' specific features. Therefore, to choose the model best fitted to empirical data, different specifications are tested: (a) with no cell fixed effects and no time effects, (b) with time effects only, (c) with cell fixed effects only, and (d) with both cell fixed effects and time effects.

**Table 1. Results of Model (1) with real relative minimum wage bite for three economic sectors**

	3 Economic Sectors			
	(a)	(b)	(c)	(d)
<i>rwrel</i>	-0.412*** (0.086)	-0.302*** (0.088)	0.037 (0.072)	0.080 (0.071)
<i>gva(-1)</i>	1.621*** (0.025)	1.699*** (0.024)	0.672*** (0.049)	0.347*** (0.126)
<i>pop</i>	-0.219*** (0.033)	-0.235*** (0.036)	0.831*** (0.084)	0.942*** (0.076)
<i>urate</i>	0.116** (0.050)	0.434*** (0.077)	-0.180*** (0.019)	-0.103*** (0.036)
<i>constant</i>	-4.054*** (0.381)	-5.166*** (0.434)	-6.808*** (1.352)	-4.861*** (1.563)
N	720	720	720	720
Cell fixed effects	No	No	Yes	Yes
Time effects	No	Yes	No	Yes

Note. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

Source: Own calculations.

Table 1 presents the estimation results for all specifications. Models without cell fixed effects (a) and (b) the coefficient beside minimum wage variable is negative and significant. When cell fixed effects are introduced into the model the results change substantially. The relationship between employment and relative minimum wage becomes insignificant independently of time effects. The cell fixed effects are significant in all the specifications where they are included. Moreover, the results of the Wald test for the model with and without cell fixed effects— $\chi^2=83.77$  (0.000) and  $\chi^2=169.11$  (0.000), respectively—indicate that the time fixed effects should be also included. Therefore, our preferable specification contains both cell fixed effects and time effects (Model (d)). When the minimum wage bite measure is included, the real relative minimum wage is our superior option as the wage bite measure of the higher quality. The average employment elasticity for real relative minimum wage is 0.080 but is statistically insignificant. The results of the

model with nominal relative minimum wage bite measure are similar—with an elasticity of 0.088 and statistically insignificant (see Table A3 in Appendix 3). The statistical insignificance of our parameter of interest value in the full sample follows our intuition and former studies. The sample is based on information from all workers—whether the minimum wage is binding or not. The results of previous research indicate that negative and significant values of employment elasticity for minimum wage applied to the most vulnerable groups of workers (young and less educated) only.

Regarding other variables in the model, we observe that employment is positively correlated with *gross value added* and *population* (see Table 1). Labor demand is derived, hence higher production in a given industry and region translates into higher employment. The level of employment also increases with the size of the population in a given age group and region. Moreover, a negative correlation between the local unemployment rate and level of employment is found. All the results are in line with economic theory and estimates obtained in other research. The value of (lagged) gross value added captures the differences in economic development across economic sectors and regions but also contains a common production trend in the time dimension. Therefore, a statistically significant estimate for lagged gross value added in models with time effects should be interpreted as significant regional and sectoral deviation from this trend. The results in Table 1 show that the value of the parameter by lagged gross value added is significant in specifications that include time effects, which indicates that the regional and sectoral deviation of production from the aggregate trend.

Our model estimated the average employment elasticity affected by minimum wage changes for the full sample, indicating that we assumed the homogeneity of employment effects across age groups, economic sectors, and regions (cells) in time—this assumption is not necessarily valid. Therefore, we perform the Bersvendsen and Ditzen (2020) homogeneity test, with results summarized in Table A4 in Appendix 3. They indicate that when observations are divided into 4-dimension cells, substantial differences in the impact of minimum to average wage on employment are observed. A different picture arises in the case of 3-dimensional cells. The most significant factor causing the diversity of employment effects is regional variation in industry composition and age structure. When these are removed from the model, the impact of relative minimum wage on employment remains identical in each cell defined by age group, economic sector, and time. On the other hand, the model with cells defined by regions and time shows no statistically significant deviation from the homogeneity.

Therefore, in the third step, we relax the assumption of the homogeneity of employment elasticity for minimum wage variable across cells and simultaneously allow the parameter  $\alpha_1$  to vary across age groups, economic sectors, and regions. The estimation results of the elasticity of employment due to minimum wage changes are presented in Figure A1 of Appendix 3. We observe that the elasticity of employment differs considerably across cells. The estimate of the real relative minimum wage variable ranges from -11.0 to 9.0. These very high values of elasticity are difficult to explain from an economic standpoint and are possibly the side effect of using small sample sizes in the case of some cells in the non-market services sector (see Table A2 in Appendix 3). Therefore, we decided to remove the non-market services sector from the sample and analyze the employment effects only in the industrial and market services sectors.

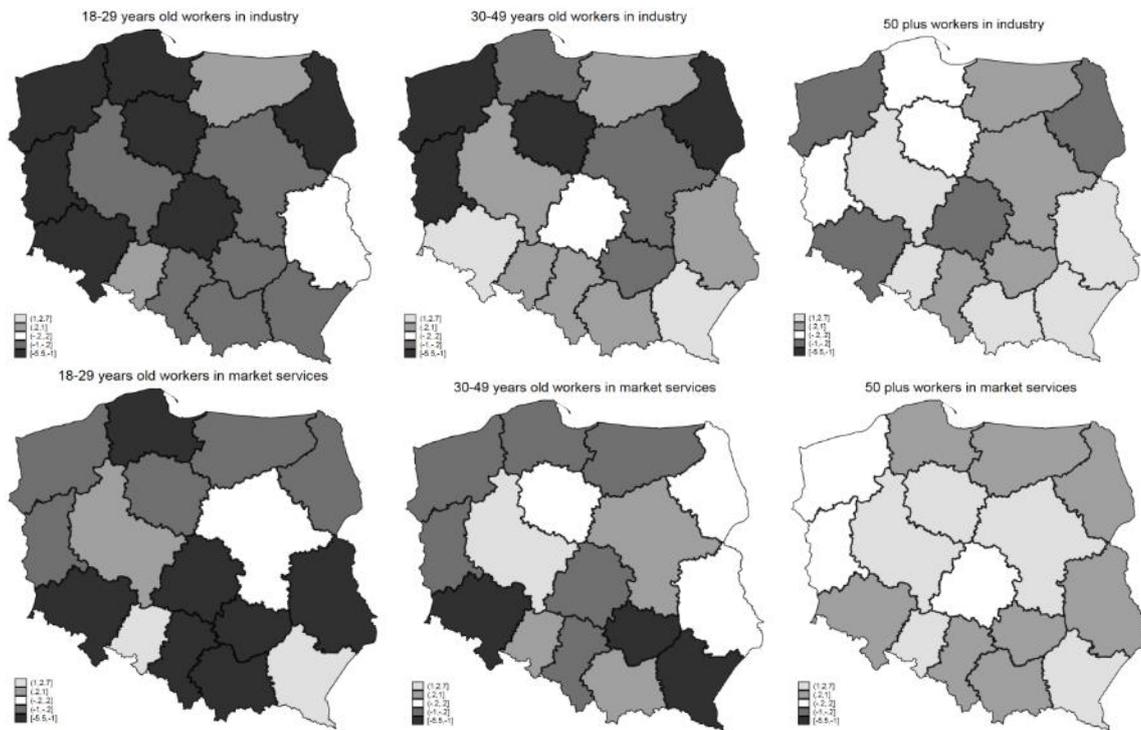
**Table 2. Results of Model (1) with real relative minimum wage bite for the two economic sector model**

	2 Economic Sectors			
	(a)	(b)	(c)	(d)
<i>rwrel</i>	-0.440*** (0.051)	-0.566*** (0.049)	0.034 (0.084)	0.034 (0.087)
<i>gva(-1)</i>	-0.034 (0.022)	-0.126*** (0.022)	0.372*** (0.049)	0.147 (0.105)
<i>pop</i>	1.357*** (0.029)	1.442*** (0.026)	1.012*** (0.080)	1.068*** (0.078)
<i>urate</i>	-0.253*** (0.030)	-0.269*** (0.045)	-0.179*** (0.020)	-0.148*** (0.039)
<i>constant</i>	-6.692*** (0.267)	-6.682*** (0.259)	-5.981*** (1.288)	-4.331*** (1.528)
N	480	480	480	480
Cell fixed effects	No	No	Yes	Yes
Time effects	No	Yes	No	Yes

Note. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01

Source: Own calculations.

Since the number of observations removed is relatively small, the results for the full sample of workers in 2 economic sectors (see Table 2) do not differ significantly from those obtained with the non-market services sector included. We repeat the Bersvendsen and Ditzen (2020) slope homogeneity test for the panel structure with 16 regions, 3 age groups, and 2 economic sectors. The results show that again the most important factor causing the diversity of effects are regional variations in age structure and industry. Removing one of these from the model is insufficient in not rejecting slope homogeneity—when they are both removed from the model, the impact of minimum to average wage on employment remains identical in each region (see Table A5 in Appendix 3).



**Figure 1. Elasticity of employment for real relative minimum wage across age groups, two economic sectors, and regions in Poland (2006–2016)**

Note. Darker colors denote regions with negative employment elasticity across given age groups and sectors. Lighter colors indicate regional labor markets with positive employment responses. Small, mostly insignificant employment effects, are indicated in white.  
Source: Own calculations.

Figure 1 presents the elasticity estimates for the model with two sectors (industry and market services) only<sup>113</sup>. The employment elasticity estimates are far more reasonable: they vary from -5.4 to 2.6. The results show that elasticity of employment for real relative minimum wage differs significantly across cells. Young workers (less than 30 years old) in the industrial and market services sectors are the most vulnerable to minimum wage changes (see Figure 1). Some regions indicate employment elasticities less than -1 while in others the employment effect is weaker; in general, however, in almost all regions, we find negative employment elasticities for young workers regardless of the economic sector.

Middle-aged workers (30–49 years old) are also affected by changes in the minimum wage, however, to a lesser extent. In about half of the regions, employment elasticities for this group of workers are negative regardless of the economic sector. In other regions, the reaction was either positive or insignificant. For workers aged 50 and older, we observe negative employment effects due to minimum wage changes only in four regions and the elasticity is less than -1. For this age group in most of the regions, positive and significant relationships are noted both in the industrial and market services. For robustness, we estimate models with nominal instead of a real relative minimum wage, the results of which confirm the main findings (see Figure A2 in Appendix 3).

Noteworthy in our approach is the fact that we can see the existing heterogeneity within regions. These differences are undetectable in one-dimensional or two-dimensional approaches. Prior studies indicated that, in some regions, employment levels were unaffected by minimum wage changes. By contrast, our approach indicates that statistically insignificant values of employment elasticity at the regional level very often completely mask diverse employment effects across age groups and economic sectors. Existing factors in those regions favor high elasticity of employment on minimum wages, including low levels of employment in sectors with high elasticity of demand with respect to prices or in the public sector with factors that simultaneously stimulate labor market rigidity, such as high employment in agriculture and large firms. Those factors influence different groups of workers, therefore they tend to be mitigated at an aggregate level.

The crucial question of why employment elasticities differ strongly among regions arises. Why in some regions do minimum wage changes negatively affect young workers but not in others? Why in some regions are middle-age workers negatively affected by the minimum wage and not in others? Why in some regions are negative relationships between youth employment and the minimum wage observed in the industrial sector and not in the market services and vice versa?

To explain these differences in employment elasticity among cells we further investigate the available regional employment structures and both employers' and workers' characteristics. These include educational structure (share of

<sup>113</sup> With 96 employment elasticity estimates (16 regions times 3 age groups and 2 sectors) for cells it is difficult to present the results in tables. Full results are available upon request.

the population with lower than secondary education), the size of the employer (small versus large firms), and the proportion of workers in the agricultural, manufacturing, and public sectors. We also utilize the proportion of minimum wage workers and the minimum to average wage ratio.

Following prior empirical findings, we expect less-educated workers to be more vulnerable to minimum wage changes, with cells containing a larger share of workers with lower than secondary education indicating a greater elasticity of employment. Disemployment effects should be more pronounced in industries where it is difficult to pass wage costs onto consumers. Therefore, in the cells with a larger share of workers employed in the tradable sector, approximated by manufacturing, the elasticity of employment should also be greater. Similarly, following the empirical evidence (see Gibson and Stillman, 2009), we expect that large enterprises pay higher wages than small firms whose elasticity of employment should be higher. Conversely, we expect employment elasticity to be positively correlated with the proportion of workers in the public sector. Alfonso and Gomes (2014) show that the growth in public sector wages and employment positively affects the growth of private-sector wages. We expect that in less competitive environments—in cells with a higher proportion of workers in the public sector—the elasticity of employment is lower than in cells with more private-sector workers. Similarly, we expect the elasticity of employment to be lower in regions with a larger proportion of agricultural workers.

We perform a k-medoid cluster analysis with a Manhattan distance. We cluster employment elasticities using all the factors as data group determinants separately for each elasticity interval<sup>114</sup>, and choosing the best solution according to the Caliński and Harabasz criteria.

The cluster with the highest negative elasticity of employment (less than -1) is composed of young and middle-aged workers. These cells are characterized by the low proportion of workers in the public sector and a relatively high share of employment in manufacturing which indicates that in a more competitive environment the effect on employment is greater. These cells consist to a large extent of low-wage workers in some cells with 60% having less than secondary education, and with a relatively high minimum to average wage ratio. In these cells, we observe a relatively high proportion of workers in small firms. Interestingly, the group with very high employment elasticities consists of practically the same number of industrial and market services cells.

The cluster with a lower, but negative, elasticity of employment [from -1 to -0.2) includes workers across all age groups. Their characteristics are similar to those noted in the first cluster. This cluster consists of two sub-clusters: i) mostly less-educated middle-aged and older workers and ii) young, better-educated workers employed mainly in low-paid jobs. The relationship of the minimum to the average wage in both sub-clusters is high as well as is the share of minimum wage workers. A significant proportion of them is also employed in small manufacturing firms. All these factors make these workers vulnerable to minimum wage changes.

Apart from these clusters with negative employment elasticities, there are comparable numbers of cells where employment positively reacts to minimum wage changes. The cluster with the highest (above 1) and the second-highest (between 0.2 and 1) positive elasticity of employment consists of workers aged 50 and older and middle-aged workers. Positive values of employment elasticity are noted both in the industrial and market services sectors. These cells are characterized by a relatively large share of those employed in big firms (with 250 or more workers) where both the propensity and possibility to dismiss workers are lower than in smaller enterprises. Moreover, these cells exhibit the highest share of workers in the public sector suggesting that private employers are likely to follow public sector wage policy. These features explain why in these cells we do not observe negative employment elasticity even though a sizable proportion of low-wage workers is observed.

## 5. CONCLUSIONS

Our study aimed to analyze the differences in employment elasticity involving minimum wage changes across different groups of workers. We analyzed the employment effect of minimum wage changes across age groups, economic sectors, and regions simultaneously. According to our best knowledge, it is the first study of this kind.

At first, we assumed homogeneity of the employment elasticity of minimum wages. Next, using Bersvendsen and Ditzen's (2020) approach, we tested that assumption and rejected slope homogeneity. Then we constructed a four-dimensional panel to allow employment elasticity to vary across age groups, economic sectors, and regions simultaneously. Finally, we explained the obtained results using cluster analysis.

We confirmed the existence of regional differences in employment elasticity due to minimum wage changes. However, we discovered latent heterogeneities in the effect on regional employment. We were able to find regions with insignificant employment elasticities at the overall regional level but existing, latent heterogeneities inside. In many of the regions, the insignificant and close to zero overall results contain both strongly positive and strongly negative values of employment elasticities due to minimum wage changes for different groups of workers. It explains why the average value of the employment elasticity for all the groups is small and insignificant. Without implementing our four-dimensional approach finding these heterogeneities would be impossible.

*Age* is found to be the most important determinant of employment elasticity diversity. Negative employment effects are observed mostly among the youngest groups of workers. Conversely, positive employment effects are observed mostly in the groups of workers aged 50 and older. Among middle-aged workers, both negative and positive reactions are observed. However, the reaction of employment to changes in the minimum wage is also the result of the combination of other regional labor market features. In some regions, there is a high intensity of features that increase the probability of

<sup>114</sup> Intervals used:  $(-\infty, -1)$ ;  $[-1, -0.2)$ ;  $[-0.2, 0.2]$ ,  $(0.2, 1]$ ,  $(1, \infty)$ .

negative employment effects, in some regions, there is a high intensity of features that increase the probability of positive employment effects.

Negative employment effects are more probable with a larger proportion of workers in the private sector, industries where it is more difficult to increase the prices of goods or services produced, and where small firms are widespread. In these regions, the employers act in a highly competitive environment, have more bargaining power, and the probability of unemployment is relatively high not only for young workers but also for middle-aged workers, especially those less-educated.

A positive employment effect is more probable in regions with a high share of workers in the public sector, large enterprises, or in the agricultural sector. In these regions, private sector employers have less bargaining power because they have to adjust their wage policy to wages offered in the public sector or to the income arising from agricultural production. Being employed in a big firm also diminishes the probability of dismissal even among less-educated workers. Significantly, these two completely different labor market segments coexist within a given region which explains why the empirical analyses at the regional level often resulted in insignificant values for the minimum wage parameter.

Our study presents limitations. First, the data used included only companies with at least ten workers. Unfortunately, individual data on micro-firms in Poland are not available. Small firms are usually found in the market services sector, in which labor costs are more important than capital cost, and those firms probably are more intensively affected by minimum wage changes. This may cause the effects of market services which we have ascertained can be underestimated. The second limitation stems from only being able to construct a biannual panel. Thus, we are unable to capture very unsuccessful firms that only survived for a shorter time. Third, there is a discrepancy in the data. Since workers are identified in the data through their firms, we infer the residence of the worker as the location of the firm. Since workers can commute to work over a long distance, spatial interactions should be considered. However, due to this being a very broad topic it should be subject to a separate study.

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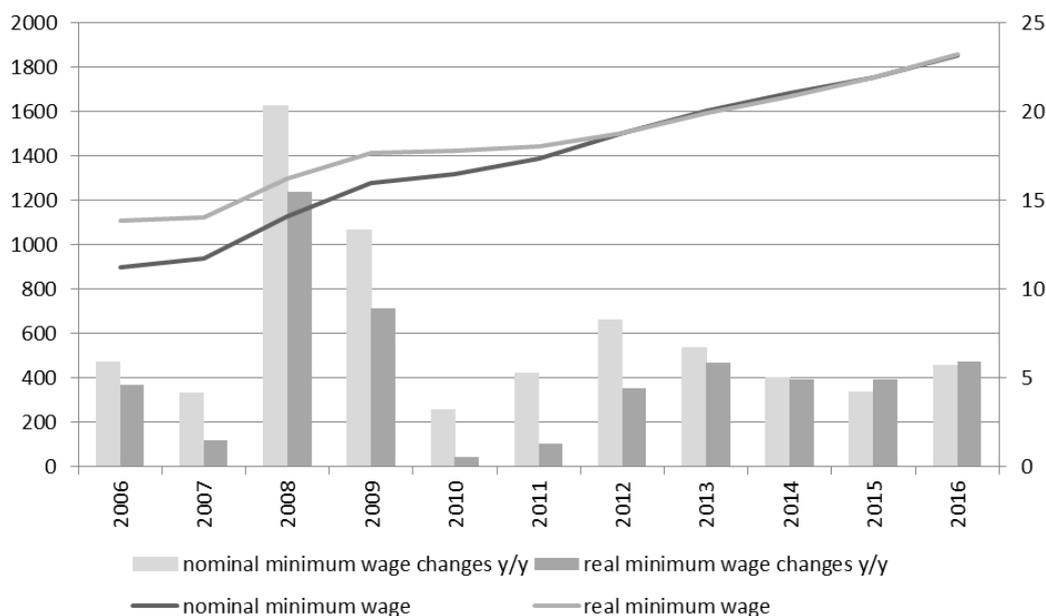
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## Appendix 1. Minimum wage policy in Poland

The national minimum wage in Poland is regulated by law. The level of the monthly gross minimum wage is established every year through negotiations within the Socio-Economic Council, composed of representatives chosen from the government, employers' organizations, and trade unions. If the Council is unable to reach a consensus, the minimum wage level for the following calendar year is decided solely by the Council of Ministers by no later than September 15<sup>th</sup>. The minimum wage in Poland is set up at the national level and covers workers in almost all sectors, regions, and occupations.

The annual increase in the minimum wage is guaranteed to be at least match the amount of the rise in price levels projected for the following year. In 2005 the Polish government introduced an automatic annual increase in the minimum wage, which reflects two-thirds of the forecasted GDP growth rate. This rule is set until the minimum wage reaches half of the average monthly wage in the national economy (Minimum Wage Act of October 10<sup>th</sup>, 2002 with changes).

Observing the evolution of the national minimum wage in Poland during the period analyzed it is noticeable that for 11 years it has more than doubled. It increased from 899 PLN<sup>115</sup> in 2006 to 1850 PLN in 2016. Even in real terms, an increase of almost 70% is significant (see Figure 1). It is mostly due to a substantial increase from 2008–2009. In that period the national minimum wage in Poland was augmented by 20% and 13% y/y (16% and 10% respectively in real terms).



**Figure A1.1. Minimum wage level (left scale, PLN) and minimum wage growth (right scale, %) in Poland (2006–2016)**

Source: Eurostat and Central Statistical Office of Poland data; own calculations.

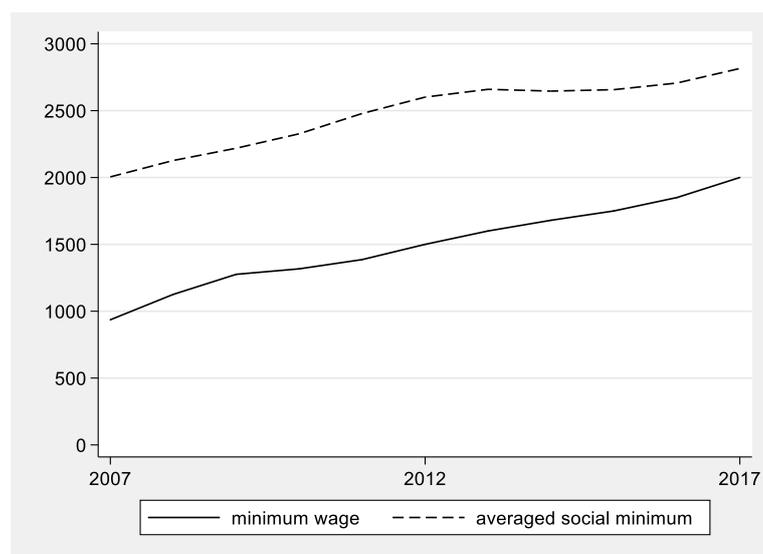
## Appendix 2. The calculation of minimum wage deflator at regional level.

The Local Data Bank of the Central Statistical Office of Poland (CSO) does not provide any data regarding regional variations in price levels. The only data at the regional (NUTS2) level includes price dynamics as chain indices. However, to calculate real minimum wages at the regional level we need data on regional price level. To overcome that problem and anchor wage dynamics we used data from the Institute of Labor and Social Studies (ILSS) on the minimum subsistence (social) level. The social minimum is defined as the bundle of resources that a person needs to lead a minimally decent life in their society<sup>116</sup>. The social minimum is calculated separately for different types of households, defined by the number of adults and their age, and the number of children and their age. Unfortunately, the information regarding the number of households of different types is not available annually. Therefore, we decided to compute the

<sup>115</sup> Polish New Zloty (PLN)—official currency of Poland.

<sup>116</sup> See: <https://www.ipiss.com.pl/?zaklady=minimum-socialne>

average value of social minimum for all types of households excluding retired persons. The results are presented in Figure A2.



**Figure A2.1. Minimum wage level and social minimum level in Poland (2007–2017) at current prices, PLN**

Source: Own calculations based on CSO data.

Significantly, the dynamics of minimum wage and average social minimum are very similar. The actual correlation coefficient between these two measures is 0.96. For instance, up to 2012, the social minimum level for a one-person household was about 70% of the minimum wage level. Additionally, the consumption structure of households with a single minimum wage earner is similar to the consumption structure of a social minimum household.

ILSS provides data on the social minimum not only at the national level but also separately for each NUTS2 region. We use this variation to mimic variation in the real minimum wage level in 2007. For the subsequent years, we used the dynamics of the social minimum to deflate the minimum wage in a given region.

### Appendix 3.

**Table A1. Descriptive statistics of the age group-economic sector-region cells for the 3 economic sectors model**

		3 economic sectors N=864, n=144, T=6			
		Mean	Standard deviation	Minimum	Maximum
EMP (number of workers)	overall	33,323	45,715	116	408,199
	between		45,055	460	326,111
	within		8,466	-84,243	115,411
NWREL (%)	overall	46.3	9.8	20.1	80.3
	between		8.1	22.4	66.6
	within		5.6	21.2	64.6
RWREL (%)	overall	44.6	9.3	19.7	72.3
	between		8.2	20.8	67.5
	within		4.5	21.2	64.9
GVA (millions of PLN, constant 2010 prices)	overall	26,403	27,632	4,189	200,264
	between		27,299	4,949	169,831
	within		4,750	-6,945	56,836
POP (number of people)	overall	508,703	294,826	150,288	1,652,661
	between		293,946	179,200	1,524,174
	within		31,917	366,669	637,190
UR (%)	overall	9.2	2.9	4.4	16.7
	between		1.4	6.8	12.0
	within		2.5	4.2	15.7

Note. EMP – number of employed, NWREL – nominal relative minimum wage (ratio of nominal minimum wage to nominal average wage), RWREL – real relative minimum wage (ratio of real minimum wage to real average wage; different deflators used), GVA – gross value added, POP – total population, UR – male unemployment rate. Source: Own calculations.

**Table A2. The descriptive statistics of the employment variable across age groups and economic sectors**

Economic sectors	Age groups	Mean	Standard deviation	Minimum	Maximum	Number of observations
Industrial	18-29	36,162	22,448	9,985	91,756	16
	30-49	81,919	47,765	23,415	206,933	16
	50-60/65	30,907	17,810	8,398	82,725	16
Market services	18-29	45,003	51,065	5,998	239,057	16
	30-49	72,125	77,984	12,321	408,199	16
	50-60/65	22,273	18,157	4,538	90,276	16
Non-market services	18-29	2,480	2,165	166	9,536	16
	30-49	6,377	5,042	577	24,637	16
	50-60/65	2,659	2,225	116	10,643	16

Note. IND – industrial sector, MSV – market services, NMS – non-market services.  
Source: Own calculations.

**Table A3. The results of Model (1) using nominal relative minimum wage bite**

	3 economic sectors			
	(a)	(b)	(c)	(d)
<i>nwrel</i>	-0.616*** (0.085)	-0.486*** (0.099)	0.116 (0.068)	0.088 (0.071)
<i>gva(-1)</i>	1.631*** (0.025)	1.692*** (0.025)	0.600*** (0.064)	0.342*** (0.125)
<i>pop</i>	-0.267*** (0.034)	-0.257*** (0.037)	0.844*** (0.085)	0.943*** (0.076)
<i>urate</i>	0.131** (0.049)	0.460*** (0.077)	-0.179*** (0.019)	-0.103*** (0.036)
<i>constant</i>	-3.689*** (0.404)	-4.943*** (0.455)	-6.149*** (1.416)	-4.827*** (1.557)
N	720	720	720	720
Cell fixed effects	No	No	Yes	Yes
Time effects	No	Yes	No	Yes

Note. \* p<0.1, \*\* p<0.05, \*\*\* p<0.01  
Source: Own calculations.

**Table A4. Results of the Bersvendsen and Ditzen (2020) homogeneity test for 3 economic sector model**

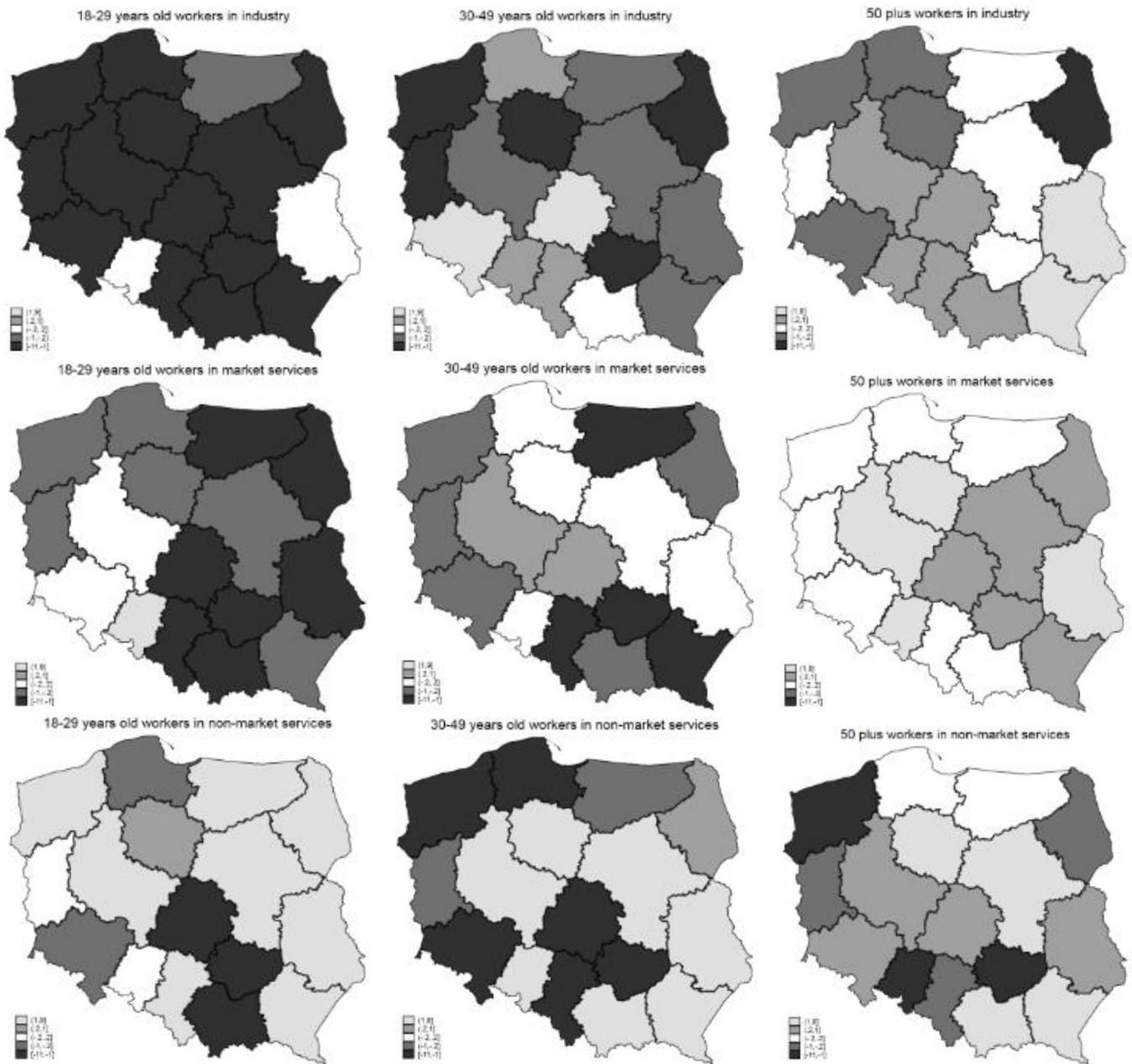
3 economic sectors			
Dimensions	Number of cells	Delta	p-value
4: Region, Age, NACE, Time	16 x 3 x 3 = 144	3.987	0.000
3: Age, NACE, Time	3 x 3 = 9	-0.034	0.973
3: Region, NACE, Time	16 x 3 = 48	3.290	0.001
3: Region, Age, Time	16 x 3 = 48	2.304	0.021
2: Region, Time	16	1.767	0.077

Note. Null hypothesis: Slope homogeneity  
Source: Own calculations.

**Table A5. Results of the Bersvendsen and Ditzen (2020) homogeneity test of 2 economic sector model**

2 economic sectors			
Dimensions	Number of cells	Delta	p-value
4: Region, Age, NACE, Time	16 x 3 x 2 = 96	3.339	0.001
3: Age, NACE, Time	3 x 2 = 6	0.894	0.372
3: Region, NACE, Time	16 x 2 = 32	2.468	0.014
3: Region, Age, Time	16 x 3 = 48	2.239	0.025
2: Region, Time	16	1.688	0.091

Note. Null hypothesis: Slope homogeneity  
Source: Own calculations.



**Figure A1. Elasticity of employment for real relative minimum wage across age groups, three economic sectors, and regions in Poland (2006–2016)**

Note. Those regions with negative employment elasticity across given age groups and sectors are indicated in dark shading, regional labor markets with positive employment responses are indicated in light shading, and areas with small, mostly insignificant employment effects are in white.

Source: Own calculations.





**Figure A2. Elasticity of employment for nominal relative minimum wage across age groups, two economic sectors, and regions in Poland (2006–2016)**

Note. Dark colors indicate those regions with negative employment elasticity across given age groups and sectors. Light colors indicate regional labor markets with positive employment responses. Areas with small and mostly insignificant employment effects are in white.  
Source: Own calculations.

## **Regular Session: RS18.2 - Resilience and Risk Management**

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/87822655076>**

**Chair Imane Boutahri**

## FLASH FLOOD HAZARD DIAGNOSIS BASED ON GEOMORPHOLOGY, HYDROLOGY AND GIS TECHNIQUES (CASE STUDY OF KERT BASIN, MOROCCO)

**Imane Boutahri<sup>1</sup>, Larbi Barhazi<sup>2</sup>, Rachida El Morabet<sup>2</sup>, Taieb Boumeza<sup>1</sup>**

<sup>1</sup>Faculty of Art and humanities, Morocco. <sup>2</sup>FLSH Mohammedia- Université Hassan II de Casablanca, Morocco

### ABSTRACT

Of all the natural disasters that hit the world each year, flash floods remain the most damaging and deadly. This study focuses on the assessment of sudden flood risk in the Kert basin based on the detailed morphometric characteristics of the Kert basin and its sub-basins. For a detailed study, a geographic information system (GIS) and mathematical formulas were used to evaluate the linear, superficial and relief aspects of the morphometric parameters. Twenty-five morphometric parameters were measured, calculated and interconnected to produce nine effective parameters for assessing the flash flood hazard in the study area. Two methods were used to assess flash floods and generate flood hazard susceptibility maps. The first method is the El-Shamy approach and the second is the morphometric risk assessment method. Based on nine morphometric parameters that affect the hydrological behavior of Wadi as a function of concentration time. The mapping of flood zones aims, in particular, at the identification of the fields of flood expansion to preserve urbanization. In terms of natural risks, the absolute prerequisite for information, prevention and protection actions is the proper identification of the risk. The latter is assessed by the evaluation of two notions: "the hazard", the potential for destruction or degradation that represents the natural phenomenon and "the stake" which represents the value of this who is exposed to the incident. The hazard maps produced are intended to help planners and decision-makers develop appropriate plans to mitigate the adverse effects of floods and cope with flood risks.

## COUNTRIES CLUSTERING IN THE CONTEXT OF THE PANDEMIC COVID-19

[Carolina Guevara-Rosero](#)

Departamento de Economía Cuantitativa, Ecuador

### ABSTRACT

As early as 2019, the Global Preparedness Monitor Board called for political action to be prepared for global health emergencies. Recommended actions were to build solid systems with high responsibility and community participation that generates confidence among population (GPMB, 2019). Nevertheless, the rapid growth of COVID-19 has revealed the state of underlying conditions of countries in terms of health system, sanitary infrastructure, income inequality and governance. Governments have managed the pandemic given such pre-existing conditions. Other than this, the response of governments in terms of regulations and actions to halt the spread of the pandemic was a decisive factor. Such responsiveness has been varied across governments. The measures ranged from travel restrictions to lockdown restrictions. Some countries acted more rapidly than others and not necessarily according to their level of development. Although it is expected that developed countries perform better in face to the COVID-19 pandemic, different dynamics are in play and developed countries are highly affected. In this respect, this study aims to classify countries in function of COVID-19 variables such as the lethality rate, the contagion growth and the number of days that elapsed until the country registered the first case with respect to China.

To determine the clusters, we use a set of 209 countries from all regions (24 from East Asia and Pacific, 59 from Europe and Central Asia, 42 from Latin America and The Caribbean, 22 from Middle East and North Africa, 6 from North America, 8 from South Asia and 48 from Sub-Saharan Africa) for two periods: 30 days and 150 days. The k-means partitioning method is used to conduct the clustering analysis. This approach consists in constructing partitions and evaluate their intra-class and inter-class similarity. The results show that the collection of observations is partitioned into 4 clusters. The first cluster corresponds to the countries that first presented confirmed COVID-19 cases after China and report lower contagion growth and lethality rates with respect to other countries. The second cluster is characterized by countries that experienced confirmed COVID-19 cases after the first cluster countries, the highest contagion growth rates and low lethality in the first 30 days but high lethality rate in the 150 days. The third cluster corresponds to countries with more days of the first confirmed COVID-19 cases with respect to China. These countries present low contagion growth and lethality rates. Finally, the fourth cluster is characterized by the largest period of time that elapsed until the first confirmed COVID-19 case with respect to China. These countries record a low contagion growth rate but high lethality rate at first and then a moderate level of the lethality rate. Based on these characteristics, we have named these four identified clusters as:

1. Very rapidly infected countries with moderate contagion and moderate lethality
2. Rapidly infected countries with severe contagion and increasing lethality
3. Slowly infected countries with low contagion and low lethality
4. Very slowly infected countries with low contagion and decreasing lethality

**MANAGED RETREAT IN THE FACE OF CLIMATE CHANGE: WHAT INFLUENCES BUYOUTS OF FLOODPLAIN PROPERTIES**

**Qing Miao<sup>1</sup>, [Meri Davlasheridze<sup>2</sup>](#)**

<sup>1</sup>Rochester Institute of Technology, USA. <sup>2</sup>Texas A&M University at Galveston, USA

**ABSTRACT**

This paper uses a double-hurdle model to empirically examine the factors influencing government buyouts of floodplain properties, with a particular focus on the local fiscal resources and flood management practices. Using nation-wide panel data of buyouts funded through the federal Hazard Mitigation Grant Program, we find that counties with more property tax revenues or a lower fiscal reliance on property taxes have more buyouts. We also find that higher flood insurance take-up rates are associated with smaller amounts of floodplain buyouts. Our results provide insights into the barriers and challenges for government buyouts and managed retreat.

## **Regular Session: RS12.3 - Spatial implications of climate and environmental change**

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/83755733224>**

**Chair Linda Jemily**

## BEDFORMS CHARACTERIZATION OF THE BOUREGREG ESTUARY USING REMOTE ACOUSTIC TECHNIQUE

Linda Jemily, Nadia Mhammdi, Amine Raki

Institut Scientifique, Morocco

### ABSTRACT

Bouregreg estuary is located on the Atlantic side of Morocco at the junction between Rabat and Salé. Both present large populations and new infrastructure development. During the last years, remote acoustic technique has revolutionized the way we are able to image, map and understand the riverbed environment. An integrated approach, combining side scan sonar (SSS), echo sounder (ES) and seabed sediment sampling collected with a Van Veen bottom grabber, was performed to characterize subtidal and intertidal dune morphology on the Bouregreg estuary. In addition, morphometric parameters and temporal variability, to estimate migration rate according to the dune type, were analysed. The aim of this work is to improve knowledge about the formation, evolution and present-day dynamics of these bedforms on a mesotidal estuary receiving little sediment input. The results led to the identification of different groups of bedforms. The main groups of bedforms in the area are ripples, 2D dunes, 3D dunes, flat bottom. The dunes are exhibiting different morphological configurations differentiated into straight, sinuous and barchan dunes. The largest dunes of the estuary reach 6 m of heights and 100m of wavelengths. The dunes, mostly asymmetrical in cross-section with a downstream direction, shows an NNW-SSE orientation. The estuarine channel is filled by sandy to muddy sediments. From geometrical analysis of the morphometric parameters, the dunes show no clear correlation between dune height and wavelength as too between dune height and water depth.

## CLIMATE CHANGE IMPACT ON SPATIAL DISTRIBUTION OF MOROCCAN FOREST ECOSYSTEMS

**Said Moukrim<sup>1</sup>, Said Lahssini<sup>2</sup>, Hicham Alaoui<sup>3</sup>, Adnane Labbaci<sup>4</sup>, Laila Rhazi<sup>1</sup>**

<sup>1</sup>Mohammed V University, Morocco. <sup>2</sup>National Forestry School of Engineers- Sale, Morocco. <sup>3</sup>Climatic and forest risk management center, Morocco. <sup>4</sup>Ibn Zohr University, Morocco

### ABSTRACT

Climate Change (CC) is one of the extreme factors that threatens biodiversity and affects all organisms and their habitat. It will lead to degradation of the natural environment, ecosystem productivity, food security and could create conditions of social instability. Understanding the impacts of CC on forest ecosystems is a prerequisite for any strategy that underlies their conservation and restoration. This study aims at studying CC impact on two remarkable species of Moroccan forest ecosystems (*Argania spinosa* et *Cedrus atlantica*). It was based on species distribution modeling using the Maximum Entropy approach. Results of this work could contribute to improve our knowledge related to the biogeography and the ecology of these species through identifying environmental variables, which limit their distribution, developing predictive models and characterizing geographical extent of the areas, which is favorable to these species under current and future climate conditions. Predicted potential suitable areas show that large parts of Morocco are bioclimatically suitable for these two species and that the suitable areas are site specific and will be negatively affected by the future climate. The use of predictive suitability maps of these forest species are valuable tools for developing adaptive strategies in time and space to deal with CC. These results will provide technical and scientific support to scientists and forest managers in order to improve decisions process and to include CC into conservation and rehabilitation strategies to avoid any future extinctions of these hotspots of national biodiversity.

## ASSESSING THE ECONOMIC IMPACTS OF SILTATION IN THE DAM OF OUED EL MAKHAZINE

Widad Darif<sup>1</sup>, Abdellatif Khattabi<sup>2</sup>

<sup>1</sup>Département des Eaux et Forêts, Morocco. <sup>2</sup>Ecole Nationale Forestière d'Ingénieurs, Morocco

### ABSTRACT

The large hydraulic structures are strategically important, they fulfil multiple functions that sustain the economy of the country. They contribute decisively to supply water sectors, mainly irrigation, drinking water and energy production. They provide also protection against flooding of large areas of the country, improving the environment and water quality. Unfortunately, siltation is detrimental to these large hydroelectric structures, whose consequences generate significant economic losses through negative impacts on the population, sectors and on the state. The Oued el Makhazine dam is not immune to this problem of siltation, because the watershed upstream of this dam has pedoclimatic characteristics that make it particularly vulnerable to erosion. This study aims to estimate economic losses based on the relationship between erosion and yield loss in off-site effects. While for on-site effects, the analysis focused on the costs caused by siltation on storage capacity, the supply of irrigation water, the supply of drinking water and industrial and the production of hydropower. Calculations were made using 2013 as a base year data. The results show that siltation cause relatively large losses in this area. At the scale of the entire Oued El Makhazine watershed, economic losses are estimated at 1.80 billion dirhams, including off-site costs of 1,6 billion DHS and those on-site of 190 million DHS.

## **Regular Session: RS17.2 - Globalization and territorial intelligence**

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/81342024716>**

**Chair Andrea Omizzolo**

## ECONOMIC VALUATION OF ECOSYSTEM SERVICES IN AL HOCEIMA NATIONAL PARK

[Youness Kasstib, Abdellatif Khattabi](#)

Ecole Nationale Forestière d'Ingénieurs, Morocco

### ABSTRACT

Ecosystem services refer to the tangible and intangible benefits provided by natural ecosystems. In many studies' ecosystem services are not taken into account in economic studies. Failure to take this externalisation into account leads to wrong decisions on the use of land and resources. Indeed, the absence of a value indicator with a price has often led economic actors to attribute a zero value to these goods and services of nature at the time of decision making. Additionally, these ecosystem services are subject to degradation due to overexploitation and lack of public awareness of their value. In the Moroccan strategy elaborated by the HCEFLCD for the conservation of fauna and flora, the Al Hoceima National Park was created in 2004 in the heart of the Western Rif. It is endowed with an exceptional physical and biological originality that offers numerous ecosystems providing goods and services (fishing, grazing, diving, bird and dolphin watching, exploitation of dwarf palm and Alfa, beach in summer, dead wood lying, ...). But also, this area is at great risk of resource disturbance due to the economic activities of the local population in addition to the behaviour of visitors. The present work aims to contribute to the identification and categorization of the different supply services that the park offers. As well, to propose a monetary evaluation of each service determined according to an appropriate method. The first part sheds light on the monetary evaluation of the supply services according to the market price method. The second part deals with the monetary valuation of biodiversity using the contingent valuation method and the third part is devoted to the economic valuation of ecotourism using the transport cost method.

## OPEN INNOVATION, THIRD PLACE AND LIVING LAB: STATE OF THE LITERATURE RELATING TO THE NEW GENERATION OF TERRITORIAL DEVELOPMENT MODELS

Elbroumi Soufiane, Eddelani Oumhani, Eddahmouny Hicham

FSJES FES, Morocco

### ABSTRACT

In the new landscape of open innovation, we are witnessing the emergence of strategies, concepts, ideas or organizational forms, which aim to strengthen the role of users and of civil society in responding to diversity and complexity of their needs. In this context, third places, and more particularly Living Lab approaches, are experiencing considerable growth on a global scale in several fields of activity. (Dubé et al, 2014; p. 12). Living Lab approaches have historically emerged from user association practices in the definition and development of solutions inspired by information and communication technologies and are part of the evolution of territorial models of innovation. They bear witness to major transformations in the very conception of the development of territories and of the role that the different types of actors must play in it. It shows social experiments which present new arrangements between these actors and which aim to build conditions which promote the well-being of communities. (Doyon & Al, 2017, p.2). Based on an analysis of the literature and via the "Living Lab" approach, this research aims to examine the contribution of open innovation and third places in terms of territorial development. To this end, we will briefly present the concepts of open innovation and third place before focusing on the main concept of this research, in this case the Living Lab. We will then identify the forms, the forms of contributions of these new approaches to innovation in terms of territorial development. References: Doyon, M, Klein, J-L, & Arsenault-Héту, C. (2017). « LAB Lieu de création: une expérience de coworking créatif en milieu rural québécois ». Canadian Journal of Regional Science / Revue canadienne des sciences régionales 40(1), 71-80. Dubé, P, et al. (2014). « Qu'est-ce qu'un Living Lab? Le livre blanc des Living Labs ». Montréal: UMVELT.

## TRADITIONAL AND INNOVATIVE MONITORING METHODS AND TOOLS TO IMPROVE THE MANAGEMENT OF FLOWS AND 'OVER-TOURISM' IN (WORLD) NATURAL AND CULTURAL HERITAGE SITES: THE CASE STUDY OF THE DOLOMITES UNESCO WHS

[Andrea Omizzolo](#)<sup>1</sup>, [Dario Bertocchi](#)<sup>2</sup>

<sup>1</sup>European Academy of Bolzano/Bozen (EURAC), Institute for Regional Development, Italy. <sup>2</sup>Ca' Foscari University, Italy

### ABSTRACT

The natural and cultural sites recognized through UNESCO programs, thanks to their extraordinary importance and outstanding value, represent case studies regarding tourism flow management in limit-situations and can provide very useful reference examples at a global level. UNESCO, through its programmes (World Heritage Convention, Man and the Biosphere Programme, UNESCO Global Geopark), has contributed to define the concept of world heritage as a value to be shared at a global level, transforming already known places into popular icons that 'every tourist must'. This type of recognition has contributed at increasing the attractiveness of these sites but, in many cases, it has led to compromise the balance between the opportunity and the quality of the visit and the integrity of the heritage. Moreover, this can also negatively affect the perception and willingness of the local communities to accept any new constraints and to actively support the preservation of the Site. Therefore, the overall management strategies of recognized sites normally include medium- and long-term socioeconomic monitoring actions of the effects of the recognition. In many cases, in an attempt to manage tourist pressure in iconic places, are also studied and implemented various methods and tools based on data and information collected from different sources and using different techniques. In the case of the Dolomites WHS the Overall Management Strategy has recently been developed and monitoring studies and socio-economic analysis have been carried out. Special attention was given to visitors, economic operators and inhabitants of the municipalities within and close to the Site. Traditional methodologies and techniques have been used such as qualitative interviews, the use of data from classical sources such as national and regional statistical databases and studies such as carry capacity using consolidated knowledge. In addition, big data analysis, carrying capability study and the use of data from social networks have also been tested. Author aim to present and bring to a common discussion the first results of the analyses carried out and to evaluate the use of different and 'new' sources and techniques to actively contribute to the overall aim of managing tourism-related flows and to tackle or prevent the potential phenomenon of 'over-tourism' in these worldwide but fragile Sites.

## **Special Session: SS19.1 - The spatial dimension of energy transition policies, practices and technologies**

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/84114610826>**

**Chair Marcello Graziano**

## NETWORKED REGIONAL URBAN SYSTEMS, COMMUNITIES OF INTEREST OR PLACE? INVESTIGATING REGIONAL APPROACHES AND DECENTRALIZATION IN RENEWABLE ENERGY TRANSITIONS OF URBAN CITIES

Christina Hoicka, Jessica Conroy

York University, Canada

### ABSTRACT

Renewable energy transitions are associated with major land use and landscape changes and new actors, leading to increasing investigation of regional approaches and decentralization. This study considers how 47 urban and highly populated cities, “urban cities”, are pursuing goals of carbon neutral and 100% renewable energy cities to shed light on how the largest demand centres propose to influence spatial patterns of energy production and consumption. The main findings that this preliminary analysis offers is that there are a number of dense urban cities pursuing large shares of renewable energy, and that these involve a range of stakeholders, RETs and innovations. The full range of stakeholders, RETs and innovations were not specified by location as on-site, district/neighbourhood scale, with the city’s boundaries, or imported into the city. Despite this, the findings demonstrated that urban cities are employing a range of spatial strategies with different approaches to decentralization, reflected in four categories: 1) relying on incumbent actors in centralized approaches, consistent with a hierarchical regional urban system (n=13); 2) a local focus, in which urban citizens and firms invest locally as communities of place, and some municipally owned utilities source energy (n=5); 3) local focus combined with coordinating with the region, in a networked regional urban system, and neighbouring communities, as communities of interest (n=12); 4) a diversified approach combining all three strategies (n=5). Future investigation can compare strategies for effectiveness, and examine how geographic and governance aspects affect their emergence. For the urban cities with more decentralized plans, further analysis of the benefits to citizens and firms in the urban city and surrounding region could be compared to the benefits in a centralized or less regional approach. These benefits could, for example, include labour and equity considerations, increased revenue to communities and firms and sectoral growth, affordability and reliability of energy.

## INTERNATIONAL COLLABORATION IN GREEN ENERGY TECHNOLOGIES: EMPIRICAL EVIDENCE ON OECD AND BRIICS COUNTRIES

[Nicoletta Corrocher](#)<sup>1</sup>, [Maria Luisa Mancusi](#)<sup>2</sup>

<sup>1</sup>ICRIOS - Bocconi University, Italy. <sup>2</sup>Università Cattolica, Italy

### ABSTRACT

The development of environmental innovations has the potential to reduce the environmental impacts of economic activities, by addressing different environmental challenges referring to energy production and distribution, transport, buildings, and waste management among others (Haščič and Migotto, 2015; Fabrizi et al., 2018). Cross-country cooperation in environmental innovations generates sizeable benefits (Haščič et al., 2012; Shapiro, 2014; Haščič and Migotto, 2015), as confirmed by the tendency of countries to collaborate more in climate change mitigation technologies than in other technological domains (Haščič et al., 2012; Kahrobaie et al., 2012; Shapiro et al., 2014). The issue is particularly relevant for the energy sector: developing countries have to engage heavily in emission reduction, but most innovations occur in the developed countries (Bosetti and Verdolini, 2017). Thus, the development of international collaborations is important to stimulate the exchange of knowledge and technology across countries, allowing latecomers to embrace a process of sustainable growth. This paper investigates the determinants of the intensity of international collaborations in energy-related technologies across OECD and BRIIC countries through a gravity model. It focuses not only on the geographical and cultural distance between countries but also on the distance in the stringency of environmental regulation, as well as on the economic relevance of the energy sector and on the revealed technological advantage in energy-related technologies. The gravity model has been used to analyse the patterns of bilateral trade in (Anderson, 1979; Baldwin and Taglioni, 2006; Ceglowski, 2006; Disdier and Head, 2008) and the internationalization of and cooperation in inventive activity across countries (e.g., Maruseth and Verspagen, 2002; Montobbio et al., 2010; Picci, 2010; Scherngell and Barber, 2011; Cecere and Corrocher, 2013). To our knowledge, however, no research exists that has applied such a model to the international patent collaborations in green energy-related technologies. The analysis relies upon an original dataset, which merges time-series data between 1995 and 2014 on green patents and co-patenting activity, indicators of environmental policy stringency, and economic, geographical and cultural variables. Preliminary results show that the distance in market-based policy measures is a positive determinant of cross-country collaboration in green energy innovation in BRIICS, but not in OECD countries. Furthermore, the distance in non-market-based measures also shows a positive effect on collaboration involving BRIICS, however, it acts in the opposite direction for collaborations among OECD countries. Interestingly, technological specialization does not play a role in BRIICS. The paper contributes to the existing literature on green technological development in two ways. First, while scholars have already provided some descriptive evidence on the co-patenting activity in green technologies (Shapiro, 2014; Haščič et al., 2012; Haščič and Migotto, 2015; Walz et al., 2017), we provide an in-depth analysis of the determinants of collaboration in green energy-related sectors across different sets of countries. Second, we put emphasis on the role of environmental policy stringency, assessing the role of the distance in environmental regulation between countries in affecting co-patenting activities in green energy-related technologies (Dechezlepretre et al., 2015; Bosetti and Verdolini, 2017).

## ENERGY EFFICIENCY-ENHANCING POLICIES AND FIRM PERFORMANCE: EVIDENCE FROM THE PAPER AND GLASS INDUSTRIES IN ITALY<sup>117</sup>

[Andrea Caragliu](#)

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### ABSTRACT

This paper presents an empirical analysis of the impact of adopting energy efficiency measures, labeled “*White Certificates*”, on the economic performance of companies active in the paper and glass sector in Italy. White Certificates, launched in 2005, represent the longest-lasting and effective policy tool to stimulate energy efficiency, in particular for the manufacturing industry.

My analyses exploit financial statements of Italian companies available from the AIDA (Computerized Analysis of Italian Companies) database with the aim to quantify the impact of these measures on the performance of firms in the two industries. The impact of energy efficiency policies is assessed on both productivity and profitability, and the effect is broken down into direct and indirect impacts, obtained by calculating spatial lags of energy efficiency support based on geographical as well social, relational, and technological proximity matrices.

Results suggest the existence of a positive and significant association between White Certificates and firm performance. This effect is fostered when support also goes to other firms that are relationally, socially, and technologically close to treated firms. Instead, no synergy between social, relational, and technological connectivity and the geographical co-location of firms is found.

### KEYWORDS

Energy efficiency; spatial spillovers; geographical proximity; relational proximity; social proximity; technological proximity; firm productivity.

### JEL CLASSIFICATIONS

R11, D24, O47, Q48

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<sup>117</sup> I would like to gratefully acknowledge funding from *Ricerca Sul Sistema Energetico (RSE)* for the contract “*Analisi dell’impatto di misure di efficientamento energetico sulla performance d’impresa*”; I would also like to thank RSE for making data on White Certificates available. I am also grateful to Maria Elena Gobbi, Marcello Graziano, participants in the 67th Annual Meeting of the North American Section of the RSAI and the 41st meeting of the Italian Regional Science Association (AISRe), the Handling Editor, and two anonymous reviewers for useful comments to a prior version of this paper. Maria Elena Gobbi also provided details on the functioning of the market for White Certificates. All remaining errors are my own.

## SPREADING RESILIENCE: A SPATIAL ANALYSIS OF THE BENEFITS OF HARDENING TECHNIQUES FOR A TROUBLED POWER GRID

[Marcello Graziano](#)<sup>1,2</sup>, [Adam Gallaher](#)<sup>2</sup>, [Maurizio Fiaschetti](#)<sup>3</sup>

<sup>1</sup>Southern Connecticut State University, USA. <sup>2</sup>University of Connecticut, USA. <sup>3</sup>University of Nottingham, United Kingdom

### ABSTRACT

Tree-trimming operations (TTOs) are costly, yet widely used grid-management procedures utilized by electric utility companies globally. As diffused generation, electrification of the economy, and climate change pose challenges to utility companies, power grids and their reliability play an increasingly important role for developed and developing regions. Using data from a uniquely detailed dataset of outages and tree-trimming operations from 2009-2015 undergone by Eversource Energy in Connecticut, this study identifies the relationship between tree-trimming operations and power outages from three perspectives: i) number of outages; and ii) number of affected customers for occurred outages; and iii) duration of occurred outages. Methodologically, we employ four sets of models: Panel Fixed-Effects, Difference-in-Difference, Spatial-lagged models and a Temporally Spatial Autoregressive models. Areal units are author-specified raster, with a size of 2by2km (preferred), and 4by4km (as a robustness check). This modelling strategy accounts for both spatial and temporal relationships. Our results show that at the 2-km cell size TTO translate to 4.17% fewer tree-associated outages per year. In addition, occurring outages affected 465,187 fewer customers. These results are consistent at a lower resolution. In addition, TTOs have relevant spatial and temporal spillovers. Our work represents a novel approach in the quality of the grid-level data and the temporal coverage utilized. Our results are particularly relevant to utility companies and policymakers in areas exposed to climate change such as the U.S. Eastern Atlantic Coast, and they support further expansion of expensive, yet effective TTOs in densely forested regions.

## **Special Session: SS33 - Plastic pollution and its environmental impact**

**13:15 - 14:30 Wednesday, 26th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88689482335>**

**Chair Abdellatif Khattabi**

## ASSESSMENT OF VISITORS' PERCEPTION OF SOLID WASTE POLLUTION AND THEIR WILLINGNESS TO PAY IN THE AL HOCEIMA NATIONAL PARK BEACHES

**Abdellatif Khattabi, Zakia Rahmani**

Ecole Nationale Forestière d'Ingénieurs, Morocco

### ABSTRACT

Al Hoceima National Park is the most important protected area on the Mediterranean coast of Morocco. Although this protected area is important from an ecological and economic point of view, it is increasingly under pressure from human activities (productive fishing, pollution, etc.). One of the main causes of the degradation that this park is undergoing is pollution from solid waste. This solid waste has considerable negative impacts on the environment. They constitute a threat to human and animal health and the degradation of the natural landscape. This study aims to find out the perception of visitors to the beaches of Al Hoceima National Park, the suggestions of visitors for an improvement in the landscape quality of these beaches, and their willingness to pay for this improvement. Questionnaire and face-to-face surveys were conducted during the month of August 2019 on five important beaches of the park (Bades, Torres, Cala iris, Tala Youssef and Boumehdi). It emerges from the results of the study that 57.8% of the visitors consider that these beaches are clean. The statements of 79.6% of the visitors interviewed show that the most common waste found on the five beaches are bottles and their caps, while 61.2% of visitors cite cigarette butts as the dominant waste. In order to avoid the nuisance produced by waste, 76% of the interviewees agreed to participate financially in an improvement action of solid waste management in the beaches. The majority of the visitors interviewed (83.2%) proposed the organization of awareness programs in schools or through websites to inform people about the problem of waste and its impact on the natural environment and on the population.

## WASTE QUANTIFICATION (MACRO\_MICRO) IN THE BEACHES OF THE AL HOCEIMA NATIONAL PARK

Zakia Rahmani, Abdellatif Khattabi

Ecole nationale forestière d'ingénieurs, Morocco

### ABSTRACT

Al Hoceima National Park, much of which is marine, faces significant environmental challenges, including solid waste pollution. The pollution is a complex and multidimensional problem with negative implications for the marine, coastal and continental environment. The objective of this study is to characterize and quantify the solid wastes (macro and micro) that accumulate on the 5 beaches of al Hoceima National Park (Bades, Torres, Cala iris, Tala Youssef and Boumehdi). This knowledge would allow enlightening the decision making in order to bring solutions adapted to the reduction of this pollution or its eradication. Two waste collection protocols (micro-macro) were used. The collection of macro waste was carried out on three plots of 100m<sup>2</sup> each, for each beach; and the collection of micro waste was carried out on 3 quadrats of one square metre each on each beach. Using a 10cm<sup>2</sup> model, five random samples were taken from each quadrat. The results showed that 69.3% of the collected waste is of plastic type, 13.4% are of paper/cardboard and 13.2% are of organic composition. The main types of products identified among the collected waste are cigarettes butts (11.22%); plastic bottles and plastic caps (9.28%); and 6.01% are polystyrene pieces. Secondary mesoplastics and other primary micro-plastics are the majority of waste. They represent respectively 55.53 pieces collected and 49 pieces (Polystyrene: fragments and balls). These results show that plastic pollution is the main source of solid waste on the five beaches of Al Hoceima National Park.

## POTENTIAL IMPACTS OF MICROPLASTICS IN THE MEDITERRANEAN MARINE ENVIRONMENT: AL HOCEIMA BAY CASE STUDY

**Oumayma Bouadil<sup>1</sup>, El Ouarghi Hossain<sup>1</sup>, Benomar Mostapha<sup>2</sup>, Benbrahim Samir<sup>2</sup>**

<sup>1</sup>National School of Applied Sciences of Al Hoceima, Morocco. <sup>2</sup>National Institute for Fisheries Research, Tangier, Morocco

### ABSTRACT

Micro-plastics contamination of the marine environment has been the subject of growing concern among scientists around the world. They have been reported to be ubiquitous contaminants in all marine environments all over the globe. Micro-plastics are characterized by their spatio-temporal variability due to sea currents, as well as by their physico-chemical characteristic, on the one hand and they are known by their persistence and their toxicity on the other. Due to their high absorption capacity, these contaminants can facilitate the transfer of hydrophobic pollutants from the water to the biota, in particular Polycyclic Aromatic Hydrocarbons (PAH), and therefore they involve indirectly the trophic chain degradation. It is in this context in which our thesis work lies, which generally aims to assess the extent of pollution of Al Hoceima Bay by these micro-pollutants. This project targets specially various objectives, firstly the identification of microplastics concentration sites, by distributing the sampling points within Al Hoceima bay, secondly the characterization of microplastics that exist in the bay, by summarizing their properties, their nomenclatures and their sources, thirdly the quantification of the abundance, density and distribution of these contaminants in this marine environment and finally the environmental impact assessment of Micro-plastics on the marine environment (water, sediment and biota) in our study area. To ensure the smooth functioning of our work, we did a bibliographic study in view of synthesize the various works carried out on the site of our study or on similar sites. Furthermore, we realized a summary of the various methods used to identify, characterize and analyze Micro-plastics. Moreover, we performed a prospective study in order to identify and locate the concentration sites of Micro-plastics inside Al Hoceima bay. During this study, we developed sampling and analysis methods for Micro-plastics in favor of each compartment of marine environment. In this regard, we did several field missions to collect samples from the three bay compartments. Concerning the surface water sampling we used the Manta net and for the sediment sampling we used the Van Veen tipper. Microplastics samples taken from 19 sampling sites showed various shapes, colors, composition, sizes, surface morphology, abundance and strong spatial heterogeneity. Microplastics collected from samples were classified into four types: fiber, film, granule and fragment. Some impacts of these micro-pollutants have been assessed through the analyzes that have been made in aquatic sediments, surface waters and marine organisms. Altogether, our study provides a better understanding of microplastic pollution status and prevention policy-making of Al Hoceima region habitats.

## SOLVING A PLASTIC POLLUTION PROBLEM WHILE CREATING BETTER INCOME FOR MARGINALIZED WOMEN

[Diane Pruneau](#)<sup>1</sup>, [Abdellatif Khattabi](#)<sup>2</sup>, [Zakia Rahmani](#)<sup>2</sup>

<sup>1</sup>Université de Moncton, Canada. <sup>2</sup>École Nationale Forestière d'Ingénieurs, Morocco

### ABSTRACT

The «Plastic-Free Surf Project» took place in Bades, in Al Hoceima Park, in Morocco. It was aimed at reducing local plastic pollution and at contributing to increase the local craftwomen's income. In this Park, located along the Mediterranean Sea, the presence of plastic waste negatively impacts the continental and marine biodiversity.

Three intervention tools were chosen to support 20 craftwomen in the search for solutions to the plastic problem: design thinking, Facebook and Whatsapp. The research question was: What is the relevance of the solutions proposed by craftwomen to the problem of plastic, when they are supported with design thinking and Facebook?

Twenty artisans were accompanied by researchers for a year with the aim of reducing plastic objects thrown in the region. The idea was to allow these women to manufacture new products that would reduce the plastic objects used locally or reuse the plastics composing these objects. In workshops and on a Facebook group (during Covid-19 confinement), the project followed the steps of design thinking: observation, synthesis, ideation, prototyping, testing and communication. On Facebook, the craftwomen and the researchers shared, assessed and improved prototypes.

After 9 months, Canadian and Moroccan evaluators (n=37) were invited to comment and to put scores on 35 craftwomen's prototypes. They analyzed the participants' prototypes with creativity criteria: environmental value, adaptation, novelty, originality, elaboration and fluidity. The craftwomen made jewelry, home decorations, toys and fashion accessories from plastic. They created innovative manufacturing techniques: sticking microplastics on paintings, stuffing objects with plastic scraps and used bags, assembling compact discs to make decorations, embroidering plastic jewelry covered with felt, etc. The environmental value of their products was judged as quite good. Several prototypes contributed to reduce the quantity of plastics thrown into the Sea. The adaptation criterion (marketable product) was given a good score. The criteria of novelty and originality were fairly reached. The elaboration criterion received a lower score. The participants carried out the construction of varied prototypes, meeting the criterion of fluidity (large number of ideas).

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## PLENARY SESSION III

14:45 - 15:45 Wednesday, 26th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/83433510496>

### Keynote Speech



*Air Pollution, Extreme Weather and Infectious Diseases: How Health Hazards Threaten Urbanites' Happiness and the Value of Consumer Cities*

**Prof. Siqi Zheng**

Massachusetts Institute of Technology, United States

**Chair Neil Reid**, University of Toledo, USA

**Discussant Peter Nijkamp**, Open University, Heerlen, Netherlands

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# PARALLEL SESSIONS (9)

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## National Session: SS55.2 - Regional Science in Angola



**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/86856640416>**

**Chair Tomaz Dentinho**

**REGIONAL EXTERNALITIES OF THE ANGOLAN OIL INDUSTRY: AN INTERREGIONAL INPUT-OUTPUT ANALYSIS**

**Cesar Pakissi**

FEC-UJES, Angola

**ABSTRACT**

The economy of Angola is highly dependent up on the oil industry whose production is concentrated in the northern part of the country. In this paper we analyze the economic effects of this natural-resouce-based export amounted sector in the contexto of an integratted interregional imput-autput system calibrated for the 18 Angolan provinces. The model takes into account the regional interdependence imbedded in the production structure of the country trough linhages. We show that in spite of the averall importance of the oil sector for the economy, it does not genarate strong interregional spillovers to the rest of the country, runforcing regional disparteis in Angola.

## TOURISM AND NATURE CONSERVATION IN THE HUAMBO PROVINCE. AN ANALYSIS OF VISITORS TESTIMONIALS

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### ABSTRACT

This paper analyses tourism in the Province of Huambo, its interrelation with the natural and cultural heritage and nature conservation. Tourism is an important element in society, because it addresses the multidisciplinary nature of sciences. It is a natural phenomenon, of cooperation between peoples, linked to the science of life, promoting development, understanding and mutual respect between men and society. Tourism has been at the center of attention in the current and future perspective, it is the largest service industry in the world because it aggregates complementary businesses, and however, it is among those that cause more impacts and negative effects on the receiving location. However, it can contribute to the development of the city of Huambo, with indicators pointing to the ranking of economic activities that generate income, foreign exchange and direct and indirect employment in its different modalities. From the studies carried out, it was analyzed the data collected by questionnaire to a sample of 39 visitors. The statistical analysis of the responses obtained, carried out with the support of the Q method, made it possible to identify the factors of choice of the tourist spots to visit, namely the heritage value and the quality of the environment, confirming the hypothesis of the relationship between tourist attractiveness and environmental quality. The research has a non experimental character, mixed because it uses qualitative and quantitative techniques having as variables the knowledge and the visitation and transversal because it makes the connection with other sectors of the economic apparatus of the Country and the Province. The method referred to above has made it possible to ascertain that tourism in Huambo is done in a raw way and at shy steps, and the tourist sites still need more attractions and environmental quality, besides the beyond the natural beauty, and the little that is known and explored is mostly consumed by domestic tourists, and domestic tourism being the most prevalent. In addition to being an economic engine, tourism can be used as an alternative for nature conservation.

### KEYWORDS

Tourism, conservation of environmental nature, environment Huambo, Angola.

### 1. INTRODUCTION

Tourism is an important component of regional and local development, since it has the potential to generate work and income, and is in the index of activities that have grown the most in the last 30 years worldwide. Its exploitation has a direct link with the environment and with the natural and cultural heritage, in which the product to be sold is the nature and culture that values it. Tourist activity depends on supply and demand.

The province of Huambo is a region with great natural and cultural biodiversity (waterfalls, mountains, forests, valleys, crevices, climate, altitude, culture, rivers, diversity of animals, plants and historical stones) which encourages the development of tourist activity, transforming it into a tourist destination preferred by domestic and foreign tourists, and converting tourism into the strategic sector for the development of the Province. However, it has been a great challenge to create and maintain the points of attraction for tourism activity due to the economic crisis in Angola associated with the fall in the price of oil. Thus, it is thought appropriate to know the context of tourism in the city of Huambo and what interactions between tourism and nature conservation, in ways to leverage the tourism sector in Huambo province, taking into account the aspects of environmental sustainability.

The scientific question is what are the interactions between tourism and nature conservation in Huambo? More specifically it is intended to know the engines and conditioners of tourism in Huambo and their impact on nature conservation. For this we propose to build a theoretical framework on tourism and its effects on nature conservation. Based on a questionnaire given to a significant sample of tourists identify the most visited sights, the reasons for visit and the conservation status of the tourist sites in Huambo province. And also propose solutions to enhance tourism and motivate the conservation of tourist sites.

#### 1.1 Concept of Tourism

According to the WTO (World Tourism Organization), tourism is on the scale of the main economic activities as the second largest activity in the world in income generation, foreign exchange and jobs, (Silva, at all, 2016). Second, tourism allows the growth of income from the place visited with the entry of foreign exchange, disparta investors, creates jobs, affects wealth, and enables the integration of peoples. Given the importance of the activity, the alternative possibilities, needs, responsibility should involve all actors in the tourist market (Medeiros, at all, 2013).

Tourism integrates different activities. First ly the tour, carried out by the tourist who moves from his comfort area to other areas in search of difference, the unusual, the imaginary, the fantastic, the incredible, especially the natural beauty, associating with them leisure and fun. Secondly, the accommodation that becomes the most important concern of the tourist, because, it needs the tourist to know if the place where he sleeps has conditions of hygiene, comfort, health and safety to which is added the latest concerns with the conservation of nature and the preservation of the environment. When analyzing different statements it is perceived that tourism is linked to the action of traveling, but the purpose may differ from each other, among them, the business, the search for health services, rest, leisure, visit to friends, relatives and others. Thus it is understood that tourism is an activity carried out by people moving from their usual surroundings to another for a period of more than twenty-four hours and less than one year for the purpose of resting, leisure, health search, business, research, knowing other cultures and establishing a close relationship with nature. Tourism is a social phenomenon of political, technological, inter-people exchange, and its main attraction is nature.

**1.2 Types de Tourism**

There are several types of tourism. Heritage tourism, arts tourism, urban tourism, rural tourism, ethno tourism, indigenous tourism, ethnic or nostalgic tourism, religious tourism, creative tourism and many others.

**Table1:Types of Tourism**

Types	Caraterização Characteristic	Lugares Places
Heritage tourism	Directly linked to the interpretation and representation of the past, it refers to visits and activities to know sites, goods or property expressions. All related to the Unesco World Heritage Site, (Smith, 2003).	Visits to castles, palaces, cottages, archaeological sites, monuments, architectural works, museums and others.
Arts tourism	It refers to visits and tourist activities carried out for the purpose of enjoying or representing the arts, such as theater, dance, music and visual arts, cinema and other creative industries. Activities can be developed in the form of concerts, concerts, exhibitions and performances, among other modalities, (Smith, 2003).	Visits to the theatre, concerts, art gallery, festivals, events and events, sites of literary or cinematographic interest
Urban tourism	They are visits to urban centers of different dimensions to know or revisit places of interest, such as parks, museums, historic buildings, neighborhoods, traditions or commerce, among others, (Sernatur, 2008).	.Visits to historic cities. cities or industrial sites, coastal border protection projects, infrastructure, shopping centres or nightlife sites.
Rural tourism	It refers to activities that occur in a rural environment, with customs and activities that are lived in environments far from cities and industrialized areas, such as villages, farms, etc.(UNWTO, 2015). Agrotourism is a derivative of rural tourism that is characterized by bringing visitors to the activities of the agrarian world and its productive processes, showing you the systems of cultivation of land, crops or forms of irrigation and giving them the possibility to participate in some tasks and become familiar with rural life, (CNCA, 2011) .	Visit to small towns, farms or agrotourism initiatives, ecomuseums, cultural landscapes, national parks, product routes and historical routes.
Indigenous Tourism or Ethnotourism	It includes all the instruments and means by which the tourist activity is developed tending to make known the way of life, culture and customs of the native peoples (Ministry of Tourism, 2018). The condition is that indigenous peoples do not necessarily participate in the planning or implementation of these activities. Tourist activity addressed and managed by indigenous communities and/or families that develop in a rural or natural area, historically occupied by indigenous peoples, combining their customs and traditions, ancestral and contemporary, thus fostering a process of cultural exchange with the visitor or tourist (Castro, K., Liancarleo, 1993). Contrary to the definition of "ethnotourism", the definition of "indigenous tourism" places the focus on the provision of service by indigenous communities or families themselves, and incorporates the characteristics of the space where it is developed and the traditional and contemporary expressions of the indigenous host groups.	Visit to the communities, visits to cultural centers and museums, festivals, arts and crafts.
Ethnic or nostalgic tourism	It includes visits to places of own or ancestral origin and which, therefore, consists of visits motivated by the desire to know their roots, whether in the places where the visitor spent part of his life or those where the ancestors of the family spent all or part of his life, (CNCA, 2011) .	Visits to sites of biographical importance. Typical kitchen
Religious tourism	Includes commuting activities and motivated mainly by the faith of visitors His most typical expressions are pilgrimages to places considered sacred or of high spiritual value, religious or spiritual meetings and festivities, and itineraries or roads that lead to places of pilgrimage, (O.M.T, 2007).	Visit to religious sites: temples and / or sacred sites. Meetings and religious festivals. Pilgrimage routes.
Creative tourism	It offers visitors the opportunity to develop their creative potential through active participation in learning experiences that are	Photography, painting, pottery workshops, local cooking classes,

Types	Caraterização Characteristic	Lugares Places
	characteristic of the tourist destinations for which they are taken and this is linked to the development of cultural industries (Richards, Gy Raymond, 2000). The global trend towards creativity suggests that there is an opportunity for the art and culture organizations of the territories to create interactive and active experiences for visitors, provided that they want to live experiences that engage them, challenge and allow them to develop their creative potential.	craft workshops. Language learning to.
Sports or Recreational Tourism	It offers the tourist an opportunity to participate or observe a sports activity.	Sports practice and sports activities
Environmental Tourism	Refers to the interest of tourists in moving to places to enjoy the amenity and recreational value resulting from the relationship with nature.	Jardins, mantenhas, florestas, rios, mares, cachoeiras e outros. Gardens, keep, forests, rivers, seas, waterfalls and others
Cultural Tourism	It refers to visits to localities with the aim of interacting with the community and knowing more about lifestyles the festive representations ritual habits and customs or are motivated visits to know other worship, traditions historical sites, monuments art, architecture and festivities characteristic of a society.	Visit to communities, monuments and historical sites.
Internal Tourism	In this the tourist is resident of the locality itself, this becomes the consumer of the local tourist products, (Brazil, n.d.).(Pimentel, T.D., Pimentel, M. P. C., Vidal, 2017)	Visit to different locations
External Tourism	It refers to the tourist coming from other localities, this one that has a different look to that of the locals, because he can find more news in the way of speaking, in gastronomy, culture, in history, which is no longer news will put the inhabitant himself, (Brazil, n.d.).(Pimentel, T.D., Pimentel, M. P. C., Vidal, 2017).	Visit to different locations

Source: Guia metodológico - Turismo cultural (Cruz, Javiera Montes; Alcayaga, 2014)

### 1.3 Advantages and disadvantages of tourism

Modern tourism is an activity that has grown a lot in the last 30 years, generating many benefits for the development of communities and the environment, if well planned, otherwise it can produce great damage, (Chilembo, 2017)

The tourist activity introduces major changes in the receiving place, not only from a positive point of view but also from a negative point of view (Medeiros, Linbdenberg da Câmera e Moraes, 2013). A Tabela 1 sintetiza as desvantagens e vantagens para o turismo para os descritores ambientais e socioeconômicos.

**Table 1: Advantages and Desadvantages of Tourism**

	Advantages	Disadvantages
<b>Environmental</b>	<ul style="list-style-type: none"> <li>- High investment in infrastructure destroys agricultural and forestry areas</li> <li>- Destruction of ecosystems (Mountains, natural parks, coastal shores);</li> <li>- Water pollution, increases waste production, the exploitation of freshwater reserves, the large number of tourists and their numerous oversights.</li> <li>- Degradation of the resources of fauna, flora, mineral products, semiprecious stones etc.;</li> <li>- Disappearance of natural landscapes due to real estate construction</li> <li>- Degradation of the landscapes of historical sites and monuments due to increased pollution</li> </ul>	<ul style="list-style-type: none"> <li>-Valorization of natural and constructed heritage;</li> <li>-Facilitates the close relationship between man and nature; (Kraemer, 2005)</li> <li>-Recognition of the natural potential of places;</li> <li>- When well planned, it can stimulate the conservation of ecosystems and natural resources. (Chilembo, 2016);</li> </ul>
<b>Economic and social</b>	<ul style="list-style-type: none"> <li>- Promotion of low-quality jobs in a single period of the year;</li> <li>- Lack of spatial planning. In particular on the coastline;</li> <li>- Dependence on foreign investors and tour operators;</li> <li>- Use and exploitation of child labour;</li> <li>- Increased poverty and social exclusion due to the gulf between the wealth of resorts and poverty of the population.</li> </ul>	<p>It is the largest industry in the world, because it is linked with the different sectors of life (Maria &amp; Manuel, 2017)</p> <ul style="list-style-type: none"> <li>- Increased improvement of infrastructure (airport, road networks, basic sanitation, etc.);</li> <li>- Allows the entry of foreign currency, since tourists make expenses with accommodation, food, activities and purchases;</li> <li>- Creates jobs in hotels, travel agency, contributes to the wealth and economic growth of a country.</li> <li>- Promotes the development of other activities such as transportation, commerce, crafts, banks.</li> </ul> <p>Helps promote local and regional products and keep alive and disseminate traditions Of Singing, costumes, gastronomy.</p>

Fonte: <https://sites.google.com/a/agvv.edu.pt/geo-dinamica/conteudos-temas/9o-ano/1-5--o-turismo/b-impactos-do-turismo> processaed by 29-01-2019

## 1.4 Tourism and Nature Conservation

In many tourist places some visitors adopt behaviors that harm the environment visited, which shows that they have no responsibility and or concern to preserve and preserve the traces of nature, beauty and originality of the places, because because they have paid, they understand how sacred their free time and with rights and the short time that remain there find it very small so that they are responsible for the damage caused to the environment (Maria & Manuel, 2017).

The tourist activity developed taking into account the conservation and preservation of nature is called by (Beni, 1999) ecotourism and defines it as the displacement of people to natural spaces delimited and protected by the State, private initiative or controlled in partnership with local associations and NGOs. This in turn presupposes a controlled use of the place, with a management and planning of use within the parameters of the sustainability of nature and cultural resources, perceived through an environmental impact study

There are several concepts about sustainable tourism, although none of them are fully accepted; (Swarbrooke, 2002) (...) says that any definition of sustainable tourism emphasizes the environmental, social and economic elements of the tourism system. It also explains that all theories can bring us the following concept "sustainable tourism means tourism that is economically viable, but does not destroy the resources on which tourism in the future will depend, mainly on the physical environment and the social fabric of the receiving community. because tourism developed in localities with ecological potential, in a conservationist way, seeking to reconcile tourism exploration with the environment, harmonizing actions with nature, as well as offering tourists an intimate contact with the natural and cultural resources of the region, seeking the formation of an ecological awareness.

(Doris, 1997) makes an appeal in relation to tourism in the near future, stressing that "'soft', ecological, naturalistic, personalized and carried out in small groups of people tends to characterize the tourist flows of the future". The same author also points out four special characteristics that surround the sustainable development of tourism, where she explains, that the former are directly related to the services offered and the last to the visitor; I then state them:

- a) *Respect for the natural environment: tourism cannot endanger or irreversibly harm the regions in which it develops;*
- b) *Harmony between culture and the social spaces of the receiving community: without harming or transforming it;*
- c) *fair distribution of tourism benefits among the community*
- d) *Receiver, tourists and entrepreneurs of the sector; A more responsible and attentive tourist, receptive to environmental conservation issues, sensitive to limitations with the receiving communities, educated to his understanding and understanding of the peoples and places visited (Ramos & Direito, 2004.*

## 1.5 Tourism of África, Angola and Huambo

In Africa, the OMT foresees a major expansion of tourism in the coming years, especially for Botswana, Cape Verde, Namibia and South Africa (Chilembo, 2017).

In 2014 the Daily Government of Angola published that the country has 7 biogeographic regions considered wonders, and the province of Huambo is one of them, with a great diversity of landscape and is privileged with tourist destinations to develop tourist activities through which one can have a close relationship with nature without leaving aside aspects related to the conservation of natural elements. To this end, we will cite sites such as:

The Morro do Moco, highest point in the country, the águas frias and quentes do Alto Hama, the Pinturas Rupéstris do Okaniñgili, the Mupas do Rio Cuiva, Reserva Florestal do Kavongue, Centro Agronómico da Chianga, Albufeira do Cuando, Albufeira e Barragem do Ngove, Museu Antropológico Municipal, Ruínas da Embala Grande, Túnel Subterrâneo do Soba Candumbu, Morro de Santo António do Bailundo, Complexo turístico da ilha dos Amores, As Pedras de Ganda la Kawe, Morro do Moco, Águas Térmicas do Wama, Águas Térmicas do Lépi, Monte Mbanjela, the Monte Halavala, the ilha do Cuilo, the Mupas da Rio Luvulu II, the Mupas do Rio Cutato, the Mupas do Rio Cuiva, the Nascente do Rio Cubango, the Tumulo do Wambo Calunga, the Estufa-fria, the Praça do Governo Provincial Dr. António Agostinho Neto, the Catedral de eventos, the Mercado da Alemanha, centro turístico cantinho da paz from Chipipa.

Moreover, the Development Plan of the Government of the Province of Huambo demonstrates that the Province has a hotel network of 75 lodging establishments between hotels, inn, residential, guesthouses, hostels, resorts, which represents 2.2% of the country's total hotels, 50 restaurants, 150 transport agencies, a daily flight to other provinces, with the possibility of the train making two weekly trips to Benguela , Bié and Moxico (Chilembo, 2017); the author continues and maintains that tourism in 2014 employed 1981 people making 3.1% of all employment in the Province having received 28,160 tourists that same year, which represents, 2.4% of the total universe of visits in the country, a lower amount compared to other provinces visited by tourists. Still the Master Plan mentions 157 (one hundred and fifty-seven) places of tourist attraction, despite the places being registered, still many of these places are practically abandoned with a low rate of visitation, without assistance and maintenance. In Huambo, tourism began with the inauguration of the bridge over the Kuito River in September 1993, the bridge workers held a lunch there, having requested the approval of the local king (soba Chipala) with knowledge of the administrator of chipeco (Senhor Raposo) and the attractions of the island of loves that preserve the infrastructure built by the settler for tourist activities. Such activities grew with commercial practice, to point out that the most frequent tourism was business tourism.

The province of Huambo is a region with vast natural and cultural biodiversity, which boosts the desire to develop tourism activity and can become a tourist destination more preferred by nationals and internationals. Huambo was once considered the second largest commercial and industrial park in Angola before the war. Today, despite the economic crisis, the provincial government continues to focus on tourism as a development factor for the province and the country, (Chilembo, 2017).

2. METODOLOGY

The present work presents a non-experimental, mixed investigative character because it uses qualitative and quantitative techniques with knowledge and visitation and transversality as variables because it is linked with other sectors of the economic life of the country and the Province of Huambo. The scientific novelty is based on its contribution to the development of forms of integrated actions between the Ministry of Tourism and the Ministry of the Environment with other sectors of economic life. Interviews and questionnaires were chosen as a data collection instrument and to approach the questions, the Q method was used.

2.1 The Method Q

The question is what are the interactions between tourism and nature conservation in Huambo? For this we will analyze to what extent the preferences of visitors for the various tourist sites of Huambo are related to nature conservation? And to what extent are these choices explained by the characteristics of visitors?

The approach to these issues is done through the use of the Q methodology, (Stephenson, 1953) to understand the motivations of the agents (Hermans-Thissen, 2009.) who are responsible for the choices, namely the analysis of the hierarchy they make of the selected tourist sites, allowing to address the subjectivity of the respondents and establish the implicit factors that bring them closer and distance them (Addams, & Proops, 2000).

The Q Sort Method aims to structure the speeches of respondents on a topic that concerns them. It has three steps:

- a) first, through the analysis of documents, the places of visitation are identified;
- b) Second, through a questionnaire, the evaluation of the places of visitation is requested;
- c) Finally, an analysis of the choices of the respondents is carried out, identifying points of agreement and disagreement.

2.2 Presentation of Collected Data

The Methodology Q requires that the number of respondents is less than the number of choices. Thirty-nine questionnaires were collected, of which 15 were validated, complying with the formula  $Q \frac{28 \times 27}{2} = 378$  comparisons, whose data we present in Table 3, 4 and 5.

Table3: Respondent scan

do	Número Questionado	Idade	Género (M=1;F=0)	Anos de Educação formal total	Cidade de residência	de Província Residência	de País de Residência	Cidade de Nascimento	de Província Nascimento	de País de Nascimento	Ocupação (Dom=0; Estudante=1;Funcioná	Rendimento(Baixo=0; Médio=1;Alto=2)	Visitas ao Huambo (0;1;3;5)	Viaja (Sózinho=0; Mais 1=1;Mais 2=2; Mais de 3=3)	ObjetivodaVisita(Trab alho=0; Lazer=1;	FicaHotel Centro=3;Hotel	Quantos dias fica 1,2,5,10	Chegou de (Automóvel=1;Autocar	Desloca-se (Pé=0; Autocar=1; Taxi=2;
1	61	1	25	Hu	Hu	Ang	Hu	Hu	Ang	2	2	5	0	3	1	10	4	3	
2	42	1	20	Hu	Hu	Ang	Hu	Hu	Ang	2	1	5	3	1	1	10	2	2	
3	26	0	19	Hu	Hu	Ang	Bie	Bie	Ang	3	0	5	0	3	1	10	1	2	
4	47	0	1	Hu	Hu	Ang	Bie	Bie	Ang	2	0	4	0	0	2	10	2	2	
5	45	1	20	Lub	Lub	Ang	KwS	KwS	Ang	2	2	4	2	1	3	3	1	3	
6	45	1	21	Hu	Hu	Ang	Hu	Hu	Ang	2	1	5	0	0	3	3	1	3	
7	41	0	21	Hu	Hu	Ang	Hu	Hu	Ang	2	1	1	3	2	3	10	1	3	
8	37	0	12	Hu	Hu	Ang	Hu	Hu	Ang	2	1	1	2	0	3	10	4	3	
9	35	1	14	Hu	Hu	Ang	Hu	Hu	Ang	2	1	5	0	0	0	1	1	3	
10	38	0	19	Hu	Hu	Ang	Hu	Hu	Ang	2	0	5	0	2	1	10	4	3	
11	46	0	27	Hu	Hu	Ang	Hu	Hu	Ang	2	0	5	3	0	1	2	2	3	
12	38	0	21	Hu	Hu	Ang	Hu	Hu	Ang	2	2	1	2	1	1	10	4	2	
13	33	1	22	Hu	Hu	Ang	Hu	Hu	Ang	1	2	4	3	1	0	10	2	0	
14	33	1	14	Hu	Hu	Ang	Hu	Hu	Ang	1	0	4	2	2	2	7	4	2	
15	42	0	21	Lua	Lua	Ang	Hu	Hu	Ang	2	1	4	0	2	1	7	2	3	
16	33	1	18	Lua	Lua	Ang	Lua	Lua	Ang	2	1	5	0	0	3	7	4	2	
17	65	1	0	Ben	Ben	Ang	Hu	Hu	Ang	3	2	4	2	0	3	1	1	3	
18	56	1	19	Lua	Lua	Ang	Mal	Mal	Ang	2	2	5	0	0	0	10	1	3	
19	39	0	19	Lua	Lua	Ang	Fra	Fra	Fra	3	3	5	0	0	3	10	2	0	
20	45	1	20	Lub	Lub	Ang	KwS	KwS	Ang	2	2	4	2	1	3	3	1	3	
21	60	0	0	Ben	Ben	Ang	Por	Por	Por	3	2	1	3	1	3	3	1	3	
22	31	1	21	KuK	KuK	Ang	KuK	KuK	Ang	0	0	1	2	1	3	3	1	3	
23	35	0	8	KwN	KwN	Ang	KwN	KwN	Ang	2	0	4	1	1	3	7	1	3	
24	39	1	20	Lua	Lua	Ang	Lua	Lua	Ang	3	2	1	0	0	3	7	4	3	
25	38	0	0	Ben	Ben	Ang	Ben	Ben	Ang	3	2	5	2	1	3	5	1	3	
26	21	0	8	KwN	KwN	Ang	KwN	KwN	Ang	0	0	1	1	1	3	3	1	3	
27	38	0	21	Uige	Uige	Ang	Uige	Uige	Ang	3	1	5	2	0	3	7	4	2	
28	29	0	25	Lua	Lua	Ang	Hu	Hu	Ang	2	2	4	3	1	3	10	4	3	
29	25	0	16	Ben	Ben	Ang	Ben	Ben	Ang	1	0	1	0	1	1	10	2	2	
30	42	0	21	Lua	Lua	Ang	Hu	Hu	Ang	2	1	4	0	2	1	7	2	3	
31	34	1	22	Ben	Ben	Ang	Ben	Ben	Ang	2	0	5	3	0	1	7	4	3	

32	65	1	20	Prt	Prt	Por	Hu	Hu	Ang	2	2	5	0	0	1	8	4	2
33	37	1	19	Ben	Ben	Ang	Ben	Ben	Ang	2	1	5	0	1	0	8	4	2
34	25	0	10	Bie	Bie	Ang	Hu	Hu	Ang	3	2	4	3	2	2	1	1	2
35	24	0	10	KuK	KuK	Ang	KuK	KuK	Ang	3	2	2	2	0	2	1	1	2
36	30	1	15	Lua	Lua	Ang	Lua	Lua	Ang	2	1	1	0	1	3	10	3	2
37	29	0	8	Bie	Bie	Ang	Bie	Bie	Ang	3	2	2	3	2	1	1	1	2
38	29	1	10	Lua	Lua	Ang	Lua	Lua	Ang	3	1	4	0	0	3	7	1	3
39	40	0	10	Soy	Soy	Ang	Soy	Soy	Ang	2	1	4	3	0	3	3	4	3

Respondents are on average 41 years old, 47% are men and 53% are women. They have an average of 18 years of schooling, which is equivalent to graduation, 33% live in Huambo and 44% were born in Huambo. 97% live in Angola and 92% were born in Angola.

**Table 4: Analysis of Characteristic of Respondents.**

	0	1	2	3	4	5	6	7	8	9	10
Ocupação (Doméstico=0; Estudante=1;Funcionário=2; Privado=3)	5%	8%	59%	28%							
Rendimento (Baixo=0; Médio Baixo=1; Médio Alto=2; Alto=3)	26%	33%	38%	3%							
Visitas ao Huambo (0;1;3;5)	0%	23%	5%	0%	33%	38%					
Viaja (Sózinho =0; Mais 1=1;Mais 2=2; Mais de 2=3)	0%	23%	5%	0%	33%	38%					
Objetivo da Visita (Trabalho=0; Lazer=1; Família=2; Outro=3)	41%	36%	18%	5%							
Onde Fica no Huambo (Hotel no Centro=3; Hotel Periferia=2; Casa Centro=1; Casa Periferia=0)	10%	31%	10%	49%							
Quantos dias fica 1,2,5,10	0%	13%	3%	18%	0%	3%	0%	23%	5%	0%	36%
Como chegou ao Huambo (Automóvel=1; Autocarro=2; Comboio=3; Avião =4)	0%	44%	21%	3%	33%						
Como se desloca no Huambo (Pé=0; Autocarro=1; Taxi=2; Automóvel=3)	5%	0%	36%	59%							

The analysis of Table 3 allows us to better understand the respondents:

- a) 5% of respondents are domestic, 8% students, 59% civil servants and 28% private.
- b) 26% believe they have a low income, 33% a low average income, 28% a high average income and 3% a high yield.
- c) 23% visit Huambo more than once a year, 5% two and three times a year, and 71% more than four times a year.
- d) 41% visit Huambo for work reasons, 36% for leisure reasons, 18% for visiting family and 3% for or for reasons.
- e) 10% stay in a house on the outskirts, 31% in a house in the center, 10% in a hotel on the outskirts and 49% in a hotel in the center.
- f) 44% stay less than 4 days and the rest tend to stay more than a week.
- g) 44% arrive by car, 33% by plane, 21% by bus and 3% by train.
- h) In Huambo 59% travel by car, 36% by taxi, and 5% on foot.

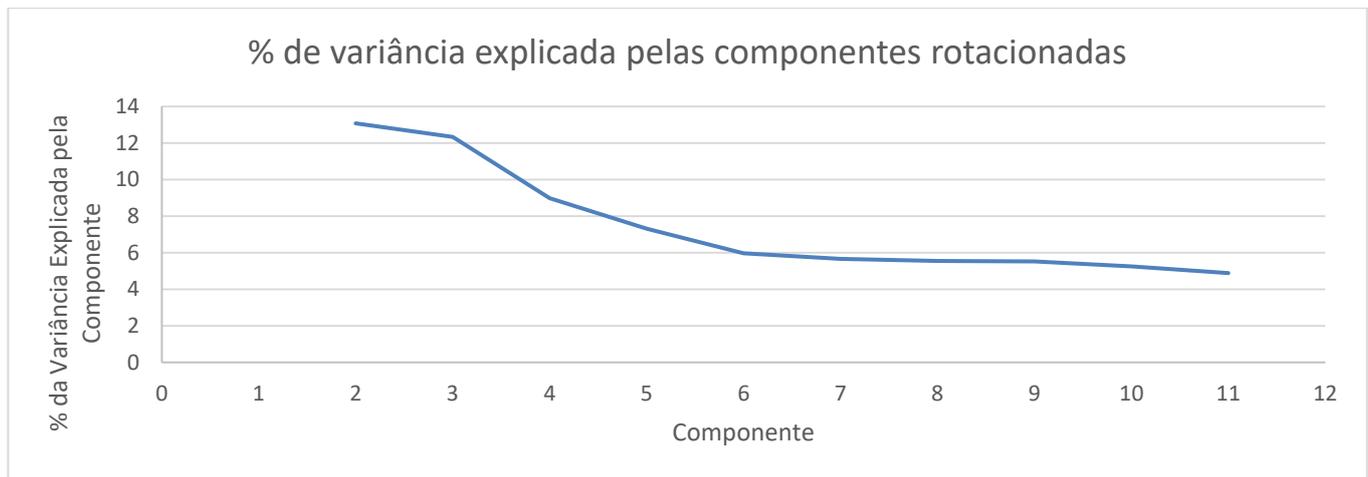
In the evaluation of the places of visitation by the respondents, without any consideration, it is verified that the Provincial Government Square, the Cathedral, the Mbanjela Hill and the Ngove Dam and Albufeira are the most valued places and that the Springs of the Cuando River, the Ruins of the Big Embala and the Mupas of the Cutato River and Luvulu II are the places apparently least valued.

However, if we make a linear regression, having as control variables the knowledge of the place and the characteristics of the respondent, it is verified that the Provincial Government Square, the Cathedral, Mount Ombanjela and the Ngove Dam and Albufeira remain the most valued sites and that the valuation of the rest is not significant.

This time it is interesting to note that the knowledge of the places of visitation increases the value by 1.4 points on a scale from 1 to 10 and that the visitation adds 4 points to the value of the sites. The level of education and income has no significant influence on valuation but, compared to students, staff and private individuals devalue visitation sites by about 4 points on a scale of 1 to 10, Interestingly men tend to value the visitation sites less by about 0.5 points and the fact that the person was born in Huambo lowers the value given by 1 point.

### 3. DATA ANALYSIS AND PROCESSING

The Analysis of the Rotated Main Components explains 71% of the data Variance being the first rotated component responsible for 25% of the total data variation and the first five components explain 55% of the data.



**Figura 1: Variância Total Explicada**

The classification of the Main Components extracted by the Q Method is very important for the analysis and discussion of the results and it is convenient to relate it as much as possible with the theoretical framework presented in Chapter II.

**Tabela 2: Características dos Questionados associados às Componentes**

	Idade	Género (M=1;F=0)	Anos Estudar fora	Anos de Escola	Moram Cidade do Huambo	Moram Provincia Huambo	Moram em Angola	Nascera m Cidade Huambo	Nascera m Provincia Huambo	Nascera m em Angola
C1	42	0,50	2,83	14,2	67%	67%	100%	67%	67%	100%
C2	41	0,50	3,30	16,8	20%	20%	100%	60%	60%	100%
C3	25	0,50	0,00	9,0	0%	0%	100%	0%	0%	100%
C4	45	1	0	20,0	0%	0%	100%	0%	0%	100%
C5	36	1	0	18	100%	100%	100%	100%	100%	100%

All respondents from the five most representative components are residents of Angola and were born in the country. There are, however, differences between supporters of the various components.

**Component 1: Reservoirs**

Component 1 is mixed, with supporters who have studied abroad, two-thirds of whom are residents and naturals of the city and province. The chosen sites are reservoirs and dams, gardens and monuments. The least valued places are distant places.

**Component 2: Urban Attractions**

Component 2 only differs from the first because it has 80% of residents and naturals from outside the city and 40% from outside the province. It strongly values urban sites such as the German Market or the Cathedral and does not favor more peripheral sites such as the Gove Dam and other reservoirs.

**Component 3: Central Green Zones**

What characterizes the supporters of Component 3 is the low level of education, being residents and naturals from outside the city and the province and the lower age than those adhering to the other components. They will have heard of the Gove Dam, but prefer urban green areas such as the Cold Greenhouse or Government Square.

**Component 4: Peripheral Green Areas**

Components 4 and 5 have male supporters with high education level. The difference in Component 4 is that its supporters reside and are from outside the city. They prefer green areas in peripheral areas such as the Tourist Complex of The Island of Loves and do not like the German Market.

**Component 5: Morro do Moco**

Supporters of Component 5 reside and are from the province. They prefer Morro do Moco, Chianga's Agronomic Research Center and Government Square as visitation sites.

**4. DISCUSSION OF RESULTS**

The literature shows that tourism is the action of traveling to distant places, from the place where the person resides with a certain purpose, be it rest, leisure, visit to relatives and friends, seek health, research, knowledge of other cultures and another, because (O.M.T, 1993), refers to tourism as the activity carried out by people who want to move from their

usual environment to another, which is not part of your productive environment. In this, there should be no paid activity. Travel reasons can range from the need to do business, health, rest, leisure, visit and others. Thus it is understood that tourism is an activity carried out by people moving from their area of residence to another for a period determined for the purpose of rest, leisure and to know other cultures.

It is well known that the development of tourism activity depends heavily on supply and also on demand, in component 1, Respondents are 40-year-olds, living in Huambo, of both genders and with an average level of schooling. They value and appreciate more the Reservoirs, Mount Ombanjela, the German Market and chianga's Agronomic Research Center, to remember that this is the most representative component.

Making a synapse with the literature review and taking into account the characteristics of the respondents, one can explain the reasons for choosing the following: first because they are places closer to the city, and with easy accessibility, regardless of the type of vehicle, because they are located mostly in places where there is connection by asphalt, which makes a point in favor, the fact that our province has the main road network that connects to the municipalities all the roads and the visit to these places above, involves less costs, as mentioned (Almeida, et al, 2017), accessibility allows the places to be more visited, so that places with access receive more tourists compared to those with access difficulties.

Secondly, they are places with more attractive and safe conditions and show that they benefit from more attention on the part of the entities in preserving them per hour.

On the other hand, the most distant places are less valued, because they are places further away from the urban strip, the striped urban road network does not extend to these same places, which makes it difficult for visitors to access tourist places. The difficulties of the forum of the transport conditions and the high costs involved in such visits should be raised. There are several places, each with its natural beauty, but mostly need to be explored and more disseminated. Moreover, in the view of (Almeida, et al, 2017) for the development of tourism, it is not enough to exist natural resources, but it is necessary the intervention of man to transform them into tourist attractions, because it is the diversity of attractions that invites tourists to visit existing tourist sites whether in urban centers or in peripheral centers. The tourist centers of huambo province, with greater expression of peripherals, only have their natural potential, and do not exploit this potential, which makes them in only a beautiful place and that only depends on the simple will and predisposition of the tourist to visit that same place. Still component 1, reveals a predominance of internal tourism, because the respondents are residents and naturals of the city and province, Huambo, these being the ones that shows more interest in knowing and visiting the existing tourist places, remember that internal tourism is one in which residents are the main consumers of the local tourist product, as it maintains (Fernando, 2015), while in foreign tourism the tourist is foreign. When making marriage with the types of tourism, in relation to the motivations of visitors, we have the practice of sports that we are reputed to sports or recreational tourism, visitors travel with the aim of carrying out artisanal fishing in the Ngove reservoir and the race of water bikes and speedboats in the Cuando reservoir, to remember that the two reservoirs are in the raking of the visitors' choices, we point out that sports or recreational tourism, being one of the main drivers of visitor travel, its main motivation is the participation and /or observation of sports activities. Still, nested to this interest, it is noted that there is an attraction for landscape beauty and the desire to maintain a closer relationship with nature, which is related to environmental or ecological tourism, because here the tourist moves in order to carry out activities in landscape dwellers, which should awaken the entities in order to ensure that this activity does not wear the resources currently exploited. Generally, the visit time is three days onwards, depending on the conditions of the place, the type of activity and the fishing conditions. When the travel time lasts less than 24 hours, then it is considered excursion.

The most visited monuments are mostly related to religious activity, which reminds us of religious tourism, motivated by the faith of visitors.

It is worth remembering that one of the moires motors to develop tourism activity is local development, because it is certain that a developed locality offers more conditions to be able to carry out the tourist activity, as mentioned (Doria, 2016) and (Cunha, et al, 2013), so tourism requires a marriage with other sectors, such as the construction sector, the emigration sector and foreign, the energy, water and basic sanitation sector, the hospitality and restaurant sector, the communication sector. The tourism industry depends heavily on the progress of other sectors, which is why the development of the country and Huambo can define the development of tourism in Huambo and Angola still makes reference (Fernando, 2015).

In Huambo tourism has many weaknesses, it is timidly practiced in an insipid way, for lack of infrastructure to relaunch it, because there is a lack of roads and public transport to improve access, lack health services, safety and communication, lack of energy, water and basic sanitation, lack hotels and restaurants in the periphery and lack of entertainment in the city of Huambo to boost the tourist machine.

Component 2: Urban Attractions, shows that 80% of respondents are people who elected Huambo as a city of residence, which differs from component 1, but these also value urban sites more, such as the German market for being a shopping center, we can mark here commercial or business tourism and tourism can be considered as a gateway to capital and people, still tourists may be motivated by the interest of acquiring some local products; the Cathedral of Events is a hall where festive activities take place with a certain frequency and is located within a tourist space, feet although considered dormant. Peripheral sites do not favor, nor are they valued by respondents, because they do not offer attractiveness to them. It should be noted that the urban component offers more convenience and safety as mentioned in the previous component.

Component 3 highlights the central green areas, still remains the same mat of preferences, although the respondents are of low level of education, residents and natural people from outside the city of Huambo and are the youngest. They prefer the cold greenhouse and the square Dr. António Agostinho Neto. Young people use these places as a meeting point to

discuss points of view, for leisure, to make photographic posters, to note that the cold greenhouse is a place where the landscape offers us a relative calm to rest and study, even without created conditions, such as changing rooms for example. The square Dr. António Agostinho Neto is the center of the city and you can enjoy from this point the architectural and landscape structure of the city. This fringe of visitors values leisure more and have no interest in knowing peripheral places. Unlike component 4, supporters prefer peripheral green areas, are mostly male with high education level and are residents and naturals of the city of Huambo, but do not like the market of Germany, since component 5 brings the Morro do Moco as the first place elected by residents and naturals of the city of Huambo, in addition to chianga's Agronomic Research Center and government square. It is noted that the level of education appears as a great conditioning factor for components 3, 4 and 5, because it significantly improves income, because it is directly related to quality of employment, interest in travel, level of curiosity, also grow with the level of education, achieved by years of study which encourages the individual to meet history, note that the level of education associated with employment facilitates in the process of social integration..

Analyzing the five components, with main enhancement components 3, 4 and 5, it can be noted that the respondents attribute little value to peripheral sites, because they hardly attend these places, so the marriage between tourism with the aspects of nature conservation in the green areas now elected, both urban and peripheral, tends to negativity, because the devaluation of the places is directly linked to the lack of attractions that would boost the motivations of tourists. Behavior that proves threatening to nature conservation.

It is interesting to note that the knowledge of the places of visitation increases the value by 1.4 points on a scale from 1 to 10 and that the visitation adds 4 points to the value of the sites, but it is not a satisfactory fact. Making a synapse with the motivations of tourists to move to the tourist sites, there is a lack of attractiveness in tourist sites because, despite these are places possessing a natural potential, they are just a beautiful place, and it is the diversity of tourist attractions that attracts, because they are the ones that will add the attractive value to the places, these are infrastructures to support tourist activity, which is consequently reflected in the tourist's behavior in observing aspects related to nature conservation.

The tourist when meeting in a place without supervision, in most situations, can adopt by an irresponsible behavior that can harm nature and shows no concern for nature conservation. This is a consequence of the lack of exploitation of most potentially touristic places, and tourism can be a good alternative for nature conservation, acting as a supervisory and management body.

The level of education and income has no significant influence on valuation but, compared to students, employees devalue visitation sites more, by about 4 points on a scale of 1 to 10, Interestingly men tend to value the visitation sites less by about 0.5 points and the fact that the person was born in Huambo lowers the value given by 1 point.

When the level of education increases, the level of knowledge increases and consequently the concern with the environment around us, should also increase, but our research shows us that the reality in Huambo is very different from what the literature shows it should be, the fact that by increasing the level of education, the level of knowledge grows and also the individual should have moral awareness, ethical and responsible in its relationship with the natural environment.

The level of income may increase the possibility of the individual traveling on his own, but the behavior to be adopted in relation to the care to be observed with the place visited, from the point of view of conservation should not have a direct influence, the same can be thought about men, employees and naturalness.

The conservation of nature shows that tourists grouped into 5 components described above, relegate this aspect to the background, with an average of 4 points, on a scale of 1 to 10. However, with the relaunch of tourism activity, concern with the conservation and preservation of nature must grow in ways to avoid consequences such as the destruction of agricultural and forest areas, the destruction of ecosystems, pollution of water, increased production of waste, the exploitation of freshwater reserves, the large number of tourists and their numerous oversights, the degradation of the resources of fauna, flora, mineral products, semiprecious stones etc., disappearance of natural landscapes due to the deposition of real estate construction waste, degradation of historical sites and monuments due to increased pollution. The provisions refer to the conclusion in Chapter IV.

## 5. CONCLUSIONS

Depending on the objectives of the research, the documentary methodology carried out shows that:

Tourism can be used to promote local development and as an alternative to nature conservation, within an integrated management.

The tourist places of Huambo Province, although registered, few are disclosed, and appear in a confusing way, so much so that Morro do Moco, one of the seven (7) natural wonders of Angola is replaced by Mount Luvili in the Google search engine.

The most visited tourist sites are the closest to the urban centers, due to the conditions of access and attractiveness they offer since others are only natural resources.

The interactions between tourism and nature conservation in Huambo tend towards negativity, due to the lack of exploitation and supervision of tourist sites that are mostly abandoned or without proper use.

The Province of Huambo has many tourist places, but there are the most appreciated, valued and most visited by tourists, such as the Provincial Government Square (Dr. António Agostinho Neto), Mount Ombanjela, the Gove Dam, the Events Cathedral, which suggests an underload of use in these places which in itself becomes negative from the point of view of sustainability.

The tourist sites of the Province have connoisseurs residing in Huambo and other provenances. Tourists are mostly in the 34 to 46 year old age group, are young, with gender balance and higher education level. Tourism in Huambo is still done in a rudimentary and incipient way because it needs more attractions, because the many resources still need to be transformed into tourist attractions.

## 6. RECOMMENDATIONS

That the Government of Huambo invest more in tourism support infrastructure and, without harming nature, disclose the tourist product, and create an e-mail address of publications to attract local and foreign investors.

May the provincial government find in tourism an alternative tool for the conservation and preservation of tourist spaces most valued, appreciated and visited by tourists.

That the Government favour the incorporation of good sustainable tourism practices by operators and service providers. That the tourist agents of the Province provide conditions that favor the realization of tourism animation to add value to places of tourist interest.

That an environmental awareness be created in the individual from an early age, through lectures, studies related to the environment, seminars, workshops and tele and radio information.

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## National Session: SS58.1 - Argentinean social and economic challenges

# **SAER**

SOCIEDAD ARGENTINA DE  
ECONOMÍA REGIONAL

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room NEREUS**

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**Chair Pedro Luis Elosegui**

## INTERPROVINCIAL TRADE IN ARGENTINA: MAIN DETERMINANTS

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### ABSTRACT

This paper is part of a broader agenda and constitutes a first step to empirically understand the main determinants of the interprovincial trade in Argentina. We use a novel database of regional trade flows between the 24 Argentinean provinces for 2017. Using a structural gravity model and novel econometric techniques we analyze the main variables influencing trade between the provinces. In fact, the main determinants of trade flows between the provinces are analyzed by adding to a canonical gravity model several variables that can possibly affect trade between sub national jurisdictions, such as informality, commercial channels, government transfers, financial inclusion among other variables that may be correlated with formal trade. Additionally, the potential impact of shocks in the regions is considered according to their origin and transmission capacity through trade flows. The results indicate that national transfers from the redistribution federal arrangement are an important determinant of inter provincial trade generating relevant spillover effects between the provinces.

## LONG-LASTING EFFECTS OF PANDEMICS: THE CASE OF THE 1918 INFLUENZA PANDEMIC IN ARGENTINA

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### ABSTRACT

The 2019 novel coronavirus disease pandemic poses a severe threat. While its short-term effects are evident, its long-term consequences are a matter of analysis. In this work, long-lasting negative effects derived from exposure in utero to a great pandemic 1918 influenza pandemic are analysed for the Argentine case.

Outcomes of interest include educational achievement and unemployment status in adulthood -50 years after the pandemic. Based on a Local Linear Regression plus a Difference-in-Difference regression specification, temporal differences in the spread of the pandemic and between close birth cohorts are exploited.

The results indicate a significant reduction in educational achievement for people exposed in utero to the pandemic. However, the decline in educational attainment is not homogeneously distributed across the different regions of Argentina. In the region with the highest incidence of cases (Noroeste), this reduction is 0.5 years of education. There are no significant changes in the chances of being unemployed. Besides, the results are also robust to the implementation of placebos in which the treatment group is falsely defined based on cohorts that were not exposed to the pandemic. As expected, no significant differences are observed. In the context of climate change, these results constitute a call of attention for the implementation of child protection policies from gestation.

Some caveats should be made regarding the results of this paper. For the Argentine case, the estimates are subject to the limitations of the primary sources of information. In the future, it is desirable to explore the specific channels through which exposure to natural biological disasters can generate long-lasting negative effects. Two of these channels widely indicated in the literature, malnutrition and maternal stress, take on relevance in the current economic crisis and obligatory social distancing. The availability and easy access to microdata for a broad population group are essential to advance in this analysis direction.

## BEYOND THE POLITICAL OR ADMINISTRATIVE DEFINITION OF THE ARGENTINEAN ECONOMIC REGIONS, DO THEIR PROVINCES HAVE A COMMON ECONOMIC CYCLE?

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### ABSTRACT

In this article, the clustering methodology is applied to group Argentinean provinces by regions according to the cyclical behavior of their economies. We implemented three grouping techniques: the well-known k-means procedure, first without imposing geographic contiguity in the grouped provinces, and then with contiguity restrictions, and the third based on agglomerative hierarchical grouping. On the other hand, we measured the economic cycle of each of the Argentinean provinces by constructing coincident indices using the Stock and Watson (SW) methodology. This approach, based on probabilistic state space models, rest on the hypothesis that the observed co-movements in indicator series can be captured by a single unobserved variable that represents the unknown “state of the economy”. Instead of applying equal weights as traditional NBER’s methodology does, SW uses maximum likelihood procedure to estimate the weights of the component series that best identifies that single underlying factor, so it is statistically more rigorous. We find that clustering provinces according to their economic cycle, presents differences regarding the official regionalization of the Argentinean Institute of Statistics and Censuses (*INDEC*). We also find that the provinces that concentrate the country’s agro-industrial production and exports -*Córdoba* and *Santa Fe*- present similarities in their cyclical behavior, which are robust to the different grouping methods. Finally, provinces such as *Formosa* and *San Luis* appear repeatedly grouped with provinces that belong to other *INDEC* regions. Even in some cases, the results show isolated provinces, surrounded by others with marked differences in their economic cycles, such as *Jujuy*, *Misiones* and *Entre Ríos*, which are grouped with neighboring provinces only when contiguity is a restriction. Our work makes a valuable contribution to the empirical literature on regional economic dynamics, scarce in studies of the state of the economy in Argentina. Additionally, we contribute by obtaining coincident indices for the twenty-four provinces, with a statistically precise methodology, which until now has been used exclusively to calculate indices in a few bunch of provinces. As a whole, the results show that regionalization based on static criteria may not be the most appropriate approach when dynamics matter.

### KEYWORDS

Business Cycles, Coincident Indicators, Clusters, Regional Economic Activity

### 1. INTRODUCTION

Subnational heterogeneity among the regions in which the Argentine provinces are generally classified, has been studied in aspects such as unemployment (Félicz, Panigo and Pérez, 2000; Figueras, Díaz Cafferata, Arrufat, Descalzi and Rubio, 2002; Galiani, Lamarche, Porto, and Sosa Escudero, 1999, 2005), returns to education (Paz, 2009) and distributive inequalities (Zacaria and Zoloa, 2005). However, for the most part, subnational studies limit the analysis to the provincial level or for a bunch of them, which composed a particular region. One of the exceptions is the recent article by Blanco, Elosegui, Izaguirre and Montes-Rojas (2019), in which the authors analyze the possible asymmetric effect of monetary policy on employment, at the level of provinces as well as for the Argentinean economic regions. In addition, subnational business cycle has also been studied from the provincial perspective to show whether they are correlated or not with the national cycle (Garegnani and Di Gresia, 1999), or the effects of the national business cycle on provincial tax revenues (Carrera and Saller, 2000), the degree of synchronization between the economic cycle of an urban area with the provincial and national cycle (Lapelle, 2015), or seeking to build a coincident national index and its counterpart for each of the twenty-four Argentinean provinces, like Muñoz and Trombetta (2014).

The estimation of coincident synthetic indices at the provincial level is quite widespread in Argentina from the pioneering studies of Jorrot (2003, 2005) for the Province of *Tucumán* and later for *Córdoba* (Michel Rivero, 2007), *Santa Fe* (D’Jorge, Cohan, Henderson and Sagua, 2007) and *Misiones* (Heredia and Alvarez, 2017), as well as Lapelle (2015) for the area of *Rosario*, are based on the traditional methodology of the National Economic Research Office (NBER). On the contrary, in Berardi, Navarro and Uría (2010), a coincident synthetic index for the Province of *Santa Fe* was presented, following the methodology of Stock and Watson (Clayton-Matthews and Stock, 1998/1999; Stock and Watson, 1989, 1991), and then, in Navarro and Sigal (2012), several modifications were introduced to the index seeking to adapt it to changes in available information. However, there have been no attempts to measure regional cycles, using the Stock and Watson methodology (SW from now on), except one incipient program that is being developed by a group of researchers at *Universidad Austral*

for the provinces grouped in a politically defined region called "*Región Centro*" (*Santa Fe, Córdoba* and *Entre Ríos*) due to its location at the center of the country.

For some economic interesting issues, the Argentinean Institute of Statistics and Censuses (*INDEC*) groups the Argentinean provinces into five or six regions<sup>118</sup> and defines the "Central Region" of the country made up of the three aforementioned provinces of the "*Región Centro*", plus the Province of *Buenos Aires* and the Autonomous City of *Buenos Aires (CABA)*, the latter being sometimes presented isolated as the sixth region. In addition, for employment statistics the *INDEC* groups the main urban agglomerates of the three aforementioned provinces together with others from the Province of *Buenos Aires* and *La Pampa*, calling it "*Región Pampeana*".

In general, these definitions of the Argentinean economic regions respond to similarities in a broad set of socioeconomic and territorial characteristics at a point in time. This type of approach resembles the Bureau of Economic Analysis (BEA) one, which since the 1950s has grouped the fifty states of the United States into eight regions based primarily on cross-sectional similarities in their socioeconomic characteristics. As Crone (2005) points out, economists have tended to use the BEA regions to examine various regional trends and cycles assuming that the regions are properly defined.<sup>119</sup>

However, when the analysis focuses on business cycle phenomena, multistate regions based on similarities at a given moment may not be the appropriate set of observations. For this reason, Crone (2005) groups states into regions based on similarities in their business cycles. Using a consistent set of coincident indexes, estimated from a SW-type model, the author applies k-means cluster analysis to the cyclical components of these indexes to group the forty-eight contiguous states into eight regions with similar cycles. Then, the author determines the relative strength of cohesion among the states in the various regions and finally provides a comparison of the regions thus defined with the BEA regions. Likewise, Miller and Sabarrese (2012) estimate a state space model for Georgia and test if it produces reasonable forecasts for the real growth rates of the gross domestic products of Alabama, Florida, Georgia, North Carolina, South Carolina, and Tennessee for 1991 through 2008. For Argentina, Brida, Garrido and London (2012) study the economic performance of the Argentinean provinces –using real per capita Gross Domestic Product (GDP)- during the period 1961-2000. Applying hierarchical clustering techniques, they detect groups of provinces with similar performance, but their regions do not correspond with *INDEC*'s regions, at all.

The main objective of this work is to investigate whether the provinces that make up the *INDEC* regions and in particular those that make up the so-called "*Región Centro*" have a common economic cycle. The specific interest in the latter lies in the fact that most of the country's agro-industrial production and exports are concentrated there. This study uses information from a wide set of series at the state and metropolitan area level for the twenty-four provinces obtained from different official sources and sectoral chambers that have been compiled and seasonally adjusted. Based on Crone (1998/1999, 2005), composite indices are constructed for each of the twenty-four provinces of Argentina. These indices are estimated following the SW methodology, which is especially suitable for constructing synthetic indicators for provinces and regional economies because it does not require having a timely series of regional GDP, due to the assumption that the "state of the economy" underlying is unobservable. Then, we group the provinces into five or six regions using cluster analysis.

This paper is inserted on the field of empirical analysis that studies regional economies performance and, specifically, into the empirical study of the regions' composition from a dynamic perspective of cyclical similarity of the provinces that comprise them.

One contribution of this paper is the application of clustering methodology to select the provinces that make up the different regions according to the cyclical behavior of their economies. In turn, when applying this analysis to Argentina, it allows us to observe whether the regional disparity found in developed countries between the definitions at a point in time and those that arise from analyzing cyclical behavior of the provinces that make up regions, is also verified in an emerging economy. An additional contribution consists of obtaining coincident indices for the twenty-four provinces, with a statistically precise methodology, which until now has been used exclusively to calculate indices in a few bunches of provinces.

One of the main results of our work is that, beyond the clustering method applied, grouping provinces according to their economic cycle presents some differences with the official regionalization of the *INDEC*. However, some clear patterns regarding regionalization were found in our results. A particularly interesting result is that *Córdoba* and *Santa Fe* - provinces that concentrate the country's agro-industrial production and exports- appear together in almost all the clustering procedures.

The outline of the paper is as follows. In Section 2 data and methodology for building coincident indices for each province and the procedures to combine them in regions based on the similarity of their economic cycles are presented. Section 3 show the results of our cluster analysis and the comparison of these respect to the official regionalization of *INDEC*, with particular interest in the analysis of *Región Centro*. Finally, the study closes in Section 4 with a global evaluation of the results.

## 2. DATA AND METHODOLOGY

### 2.1 Data

118 *Área Metropolitana de Buenos Aires (AMBA), Región Cuyo, Región Noreste Argentino (NEA), Región Noroeste Argentino (NOA), Región Pampeana* and *Región Patagonia*.

119 See Crone (2005) for a complete list of studies.

When subnational coincident indexes are used to compare the state of the economy across the whole country, they must have a certain degree of consistency. To achieve it, the indexes should be constructed from the same set of indicators for each jurisdiction. Several criteria have been proposed in the literature to select the variables better suited for that purpose.<sup>120</sup>

The data used herein comes from the database named *Indicadores Regionales* built by *IDIED-Universidad Austral* which compiles public and private economic information for the twenty-four provinces of Argentina. For each province we have about fifty monthly series to analyze them in light of canonical criteria. This bunch of time series could be classified in eight broad categories: employment, consumption, investment, sector production, energy, prices and wages, public finance, and financial services. On these, for selecting the series to be incorporated in the coincident index we apply the standard economic and statistical criteria.

First, we verify that the length of the series reaches the minimum amount of one hundred twenty months for each indicator and that these variables have economic significance. Second, to check for smoothness, we construct the boxplots for each of the series that pass the first selection stage. Third, we analyze the business cycle properties of the series. Since a key notion of the business cycle is that fluctuations are common across all sectors, the series should exhibit a consistent timing pattern over time as a coincident indicator and fit well with the business cycle. Following Stock and Watson (1989), for each variable we analyze both the basic univariate characteristics and the co-motion properties with the aggregate activity. For this we need a reference series for the business of the entire economy. Ideally, the reference series would be the Gross State Product, but this is reported on an annual basis and with a lag of several years. Thus, we use the number of employees registered in the Private Sector, an indicator available for all provinces that naturally shows an adequate correlation with the economic activity in most of them. This amount comes from the Argentine Integrated Pension System (*SIPA*). The criterion of consistent timing is tested by calculating the co-movements -through contemporaneous correlations- between each series and *SIPA*'s employment. Since we are looking for strong indicators, we prefer the series with high correlation, notwithstanding, *a priori* we do not discard any of the series based on a lower level of correlation.

There are twenty-one series that best accomplished all the tests for being included in the coincident index. All these series were included in the estimation of successive versions of the index. The model finally selected was the one that produced the best index in terms of smoothness and conformity. This means that it satisfies the required assumptions of SW model. The series finally included in the best model are "registered employees"<sup>121</sup>, "total tax collection", "electric power provided", "car sales", "gas provided", "cement sales" and "gasoline sales".<sup>122</sup>

## 2.2 Methodology

### 2.2.1 Background in the empirical literature

For a frequent and timely monitoring of the "state of the economy", the empirical literature usually estimates a composite index of coincident indicators since, by aggregating the movements of several key economic indicators, it represents a single summary statistic that tracks the economy's current state. The National Bureau of Economic Research (NBER) based in Mitchell (1927) and Burns and Mitchell (1938, 1946), developed one of the first methodologies to estimate this type of composite indexes, which has been widely used since then.<sup>123</sup> The NBER approach it is easy to understand at conceptual level and the calculations it involves are not complex. However, since business cycle is not precisely defined, it is not entirely clear what the index is really measuring. Moreover, the vector of weights used to aggregate the set of data series and construct the index is exogenous and arbitrary, so it is not based in a statistical or economic optimization process.<sup>124</sup>

Given the limitations of the traditional approach, in the late 1980s NBER's economists developed new methodologies to construct coincident and leading indexes (Stock and Watson, 1989, 1991). The SW methodology, mathematically based in probabilistic state space models, rest on the hypothesis that the observed co-movements in indicator series can be captured by a single unobserved variable that represents the unknown "state of the economy". This methodology assumes that each series has a component attributable to the unique variable unobserved and a particular or idiosyncratic component. The problem to be solved in this approach is to estimate the current state of the economy, namely the common element in the fluctuations of each time series. The main contribution of their research was the use of a statistical technique called the Kalman filter for the estimation of the optimal weights on the component indicators. In contrast to the traditional composite index methodology which applies equal weights once the volatility in each series

120 See, for example, Crone (1998/1999) and Muñoz and Trombetta (2014).

121 From the SW methodology it is not clear whether the variable used as a reference for the selection of series - when the GSP is not available - could also be included in the estimation of the coincident index. For this reason, and considering that employment is naturally related to the state of the economy, we decided to include the *SIPA*'s employment series in the estimates of our coincident index. In addition, the possible problems are reduced due to the fact that the weight that this variable has in the index is relatively low. Also, we are currently exploring new results by selecting the component series by using alternatives criteria.

122 A great advantage of the seven selected variables is that all of them are published almost simultaneously. Another advantage is that these series are published by the national offices of each area, so we can trust that the series for each state are calculated with the same methodology.

123 In Argentina, this traditional approach was widely applied in academic works for the measurement of the evolution of subnational and national economic activity (Arredondo *et al.* 2009; Jorrat, 2003, 2005; Michel Rivero, 2007).

124 Burns and Mitchell (1938, 1946) define the coincident indicators as coincident with the "reference cycle," that is, with the broad-based swings in economic activity known as the business cycle. This definition is intuitively appealing but, as Burns and Mitchell (1946) recognized, lacks precise mathematical content, so is unclear what conclusions one should draw from swings in the index.

is standardized, in SW approach are statistically estimated the weights of the component series that best identifies the single underlying factor that is time dependent and that best represents the co-movement in the components, using a maximum likelihood procedure. Hence, from a statistical point of view this approach is more rigorous than the former NBER's methodology (Orr *et al.*, 1999) and the index also provides a better definition of the underlying state of the economy from a mathematical perspective. This statistical optimal methodology is currently being used for several estimations both at state or regional level (e.g., Crone, 1998/1999; Crone and Clayton-Matthews, 2004; Méndez, 2007; Orr *et al.*, 1999; Orr *et al.*, 2001; Tebaldi and Kelly, 2012) and at national (e.g., Dias, 1993; Fukuda and Onodera, 2001; Hall and Zonzilos, 2003; Reklaitė, 2011).

### 2.2.2 Stock and Watson's Model

The underlying assumption of SW's methodology is that in addition to stochastic component that represents an idiosyncratic movement, each macroeconomic variable has a common unobserved component, called "state of the economy". The authors formulate a linear model in the unobserved variable for estimating the common component using the Kalman filter to build the likelihood function and to obtain the maximum likelihood estimators of the parameters of the model. Following Clayton-Matthews and Stock (1998/1999), the structure of the model as applied here is:

$$\Delta \mathbf{x}_t = \boldsymbol{\beta} + \gamma(L)\Delta \mathbf{c}_t + \boldsymbol{\mu}_t \tag{1}$$

$$D(L)\boldsymbol{\mu}_t = \boldsymbol{\varepsilon}_t \tag{2}$$

$$\varphi(L)\Delta \mathbf{c}_t = \delta + \eta_t \tag{3}$$

where  $\Delta \mathbf{x}_t$  is a  $G \times 1$  vector of observable series in first-difference log form to achieve stationarity and  $\text{var}(\eta_t) = 1$ . A scalar latent stationary series that is common to the  $G$  observable series is captured by  $\Delta \mathbf{c}_t$  which, in this context, can be interpreted as deviations from the average growth rate of the economy or, alternatively, as the growth rate of the unobserved state of economy. This component follows an autoregressive moving average (ARMA) process and enters in the equation (1) with different lags and weights. The  $\boldsymbol{\mu}_t$  vector, called the idiosyncratic portion, consists of  $G$  mutually uncorrelated, mean zero, stationary ARMA processes. The  $G \times 1$  vector  $\boldsymbol{\varepsilon}_t$  and the scalar  $\eta_t$  comprise  $G \times 1$  mutually uncorrelated white noise processes. The symbol  $L$  is the lag operator, i.e.,  $L^k \mathbf{x}_t = \mathbf{x}_{t-k}$ . The lag polynomial matrix  $D(L)$  is assumed to be diagonal, hence  $\boldsymbol{\mu}_t$  in each of the  $G$  series in equation (2) are serially uncorrelated among them. The parameters of the model can be expressed as follows:

$$\gamma(L) = [\gamma_1(L), \gamma_2(L), \dots, \gamma_G(L)], \text{ where } \gamma_g(L) = \gamma_{g0} + \gamma_{g1}L + \gamma_{g2}L^2 + \dots, \quad g = 1, \dots, G. \tag{4}$$

$$D(L) = \text{diag}[d_1(L), \dots, d_G(L)], \text{ where } d_g(L) = 1 - d_{g1}L - d_{g2}L^2 - \dots, \quad g = 1, \dots, G. \tag{5}$$

$$\varphi(L) = 1 - \varphi_1L - \varphi_2L^2 - \dots \tag{6}$$

$$\Sigma = \text{cov}(|\boldsymbol{\varepsilon}_t, \eta_t|) = \text{diag}(\sigma_{\boldsymbol{\varepsilon}_1}^2, \sigma_{\boldsymbol{\varepsilon}_2}^2, \dots, \sigma_G^2, \sigma_{\eta}^2) \tag{7}$$

The system of equations (1)-(3) is estimated by maximum likelihood procedure. It is accomplished by representing the system in state space form, using the Kalman filter. Following the literature, we normalize each of the coincident series  $x_{it}$  by subtracting its mean difference and dividing by the standard deviation of its differences. This identifying restriction constrains the constant  $\boldsymbol{\beta}$  to be zero. Therefore, the obtained Kalman filter, denoted by  $\Delta \mathbf{c}_{t/t}$ , can be considered as a composite coincident index of the economic activity, constructed using data on the coincident variables available through time  $t$ .

Following Clayton-Matthews and Stock (1998/1999), we perform a calibration of the coincident index of each province transforming its first two moments of growth -the average growth rate and the average deviation tendency- in the first two moments of a common indicator for all provinces. We use *ICASFE*, a coincident index estimated by *Bolsa de Comercio de Santa Fe*. By doing this, the level and scale of the index is comparable to other indexes.

### 2.2.3 Cluster analysis using coincident indexes

As a first approximation, we implement a clustering procedure in the spirit of Crone (2005) but with some modifications to group the twenty-four provinces into regions based on the cyclical behavior of their economies and their geographic proximity. We use  $k$ -means procedure, which separates the observations into a predetermined number of clusters ( $k$ ) based on minimizing some measure of dissimilarity among the observations in each cluster. Our measure of the dissimilarity is the squared Euclidean distance from the center of the cluster:

$$\sum_{m \in c} \sum_{i=1}^N (X_{im} - \bar{X}_{ic})^2 \tag{8}$$

where  $X_{im}$  is the variable  $i$  ( $i = 1, 2, \dots, N$ ) for observation  $m$  ( $m = 1, 2, \dots, M$ ), and  $\bar{X}_{ic}$  is the center of cluster  $c$  to which  $m$  is assigned, or the average  $X_i$  for all the observations in cluster  $c$ . The set  $X$  includes two types of variables. First, following Crone (2005), we include our estimated coincident index but on a biannual frequency, averaging monthly values of each semester. Thus, since our period analysis covers ten years, we have twenty variables that represents the business cycle of each province. Second, we add twenty-four dummy variables that indicates if a given pair of provinces are or not contiguous<sup>125</sup>, to consider geographic proximity as information but not as a constraint. Since we expressed the coincident indexes on a biannual frequency instead of a monthly basis, there is an equilibrium between the number of variables that captures business cycle and dummy variables for geographic proximity. Regarding the predetermined number of regions, we apply two variants, consisting in five and six clusters respectively, to do our clustering exercise comparable to *INDEC*'s regionalization.

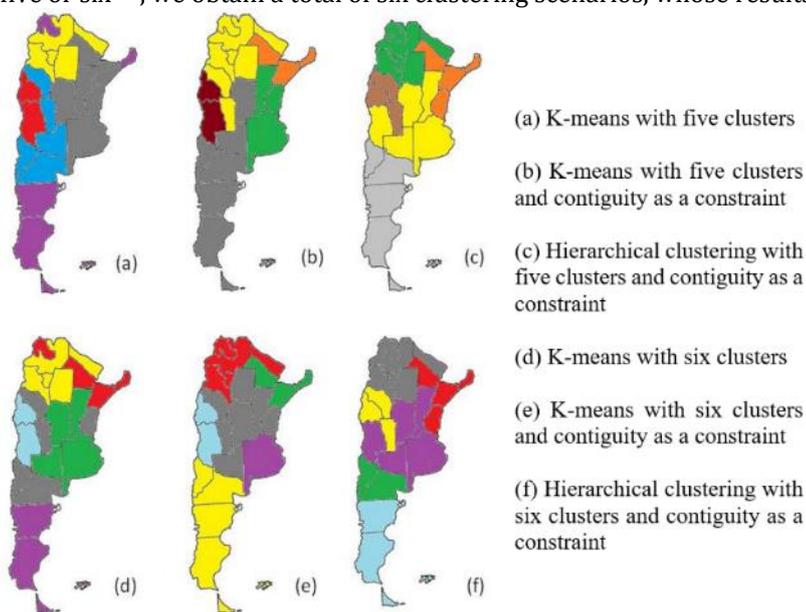
125 For example, the dummy variable "Santa Fe" assumes value one for all provinces that are contiguous to *Santa Fe* (including the province itself) and zero for the others.

As a second step, we use a contiguity-constrained version of *k*-means procedure, following the algorithm of Costanzo (2001), which is specifically designed for classifying spatial units. Applying this method, we not only group provinces in a region taking account of their economic cycles, but we restrict clusters to be formed only by contiguous provinces. The difference with the approach explained above is that Costanzo’s algorithm incorporates contiguity as a restriction not as information for clustering. Since this latter method does not require including dummy variables for geographic proximity, we use coincident indexes on monthly frequency. Again, we restrict the number of clusters to five and six, respectively. Finally, we use an agglomerative hierarchical clustering procedure (Anderberg, 1973). With this technique, initially each data point is considered as an individual cluster. Then, at each iteration, the similar clusters merge with other “bordering clusters” until one cluster or *k* clusters are formed.<sup>126</sup> Since we restrict the number of regions to five and six, we cut the hierarchical tree when five or six clusters are formed.

### 3. RESULTS

As mentioned in the introduction, firstly, coincident composite indexes were estimated for each province using the SW methodology. Here, we present the results obtained from the clustering process and the resultant regions based on these indicators.

As explained in Section 2, three different clustering techniques were applied in order to build groups of provinces according to their business cycle similarities and geographical proximity. Since we restrict the number of regions to be five or six<sup>127</sup>, we obtain a total of six clustering scenarios, whose results are shown in Figure 1.



**Figure 1: Resulting clusters applying three different techniques with five and six clusters.**

Source: own elaboration with data from different official sources and sectoral chambers.

The application of *k*-means clustering techniques generates different groupings of provinces, which in turn change when the predetermined number of clusters is modified. On the contrary, the addition of a sixth group in the hierarchical approach produces minor modifications, only changing the composition of a single group, the most southern one.

Beyond the clustering method applied, one of the main results of our work is that grouping provinces according to their economic cycle presents some differences with the official regionalization of *INDEC*. However, some clear patterns regarding regionalization were found in our results.

Applying the aforementioned techniques to construct five regions, very varied results are found, but with a certain regularity that can be highlighted. For example, the three clustering techniques match *Formosa* -a province located at the northeastern part of the country- with all the northwestern provinces, while *Jujuy* -a province located at the northwestern part of Argentina- is excluded from this group in the first estimate. Besides, *San Luis* -a member of *Región Cuyo*- is repeatedly grouped together with provinces that belong to other *INDEC*'s regions. An interesting result is that we found that some provinces are isolated, surrounded by others with noticeable differences in their economic cycles, such as *Jujuy*, *Misiones* and *Entre Ríos*, that only are grouped with neighboring provinces when contiguity is a constraint.

<sup>126</sup> The basic algorithm is straight forward: first, compute proximity matrix (in this case, with Euclidean distance measure); second, let each data point be a cluster; third, merge the two closest clusters and update the proximity matrix, repeating this process until determine where to cut the hierarchical tree into final clusters. The third step of this process is restricted according to contiguity. In this sense, each cluster is restricted to be formed by, at least, two contiguous provinces.

<sup>127</sup> *INDEC*'s statistical regions are six, but one of them is *Buenos Aires*' Metropolitan Area (in Spanish, *AMBA*). Because of this regionalization, the selected number of clusters is six. The techniques were also proven with five clusters, considering *AMBA* as a city belonging to the same region of Province of *Buenos Aires*.

Likewise, the three southern provinces are grouped together in all estimates that constrain the number of clusters to be five. The Province and the City of *Buenos Aires* appear grouped in all the techniques, although they are not distinguished on the maps. In the estimations with six clusters, corresponding to the three lower maps of Figure 1, some of the regularities found with five clusters are maintained, but the Central Region is more unstable in its configuration.

Comparing the results of the six clustering scenarios, only the hierarchical clustering with five groups produces a similar classification to the *INDEC*'s regionalization (Table 2), coinciding exactly in the case of the Patagonian region, and having differences in a single province in each of the other four regions. According to *INDEC*, *Mendoza* belongs to *Región Cuyo*, along with *San Juan* and *San Luis*. Although, the mentioned clustering technique groups *Mendoza* with Central Provinces such as *Córdoba*, *Santa Fe* and *Buenos Aires*. Also, *Entre Ríos* is clustered in Northeast Region, and not in *Región Pampeana* as in *INDEC*'s regionalization.

As is mentioned before, *Formosa* is clustered with Northwestern provinces, while according to *INDEC* it belongs to *Región NEA*.

**Table 2: INDEC's regionalization and clusters resulting from hierarchical clustering in five groups**

<i>INDEC</i>	Hierarchical clustering with five groups
<i>Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego (Región Patagonia)</i>	<i>Neuquén, Río Negro, Chubut, Santa Cruz and Tierra del Fuego</i>
<i>Córdoba, Santa Fe, Entre Ríos, La Pampa and Province of Buenos Aires without Gran Buenos Aires (Región Pampeana)</i>	<i>Córdoba, Santa Fe, Mendoza, La Pampa, Province of Buenos Aires and City of Buenos Aires</i>
<i>Mendoza, San Juan and San Luis (Región Cuyo)</i>	<i>La Rioja, San Juan and San Luis</i>
<i>Jujuy, Salta, Tucumán, Santiago del Estero, Catamarca and La Rioja (Región Noroeste Argentino - NOA)</i>	<i>Jujuy, Salta, Tucumán, Santiago del Estero, Catamarca and Formosa</i>
<i>Chaco, Corrientes, Formosa and Misiones (Región Noreste Argentino - NEA)</i>	<i>Chaco, Corrientes, Entre Ríos and Misiones</i>
<i>City of Buenos Aires and Gran Buenos Aires (Área Metropolitana de Buenos Aires - AMBA)</i>	(included in the second cluster)

Source: own elaboration with data from different official sources and sectoral chambers.

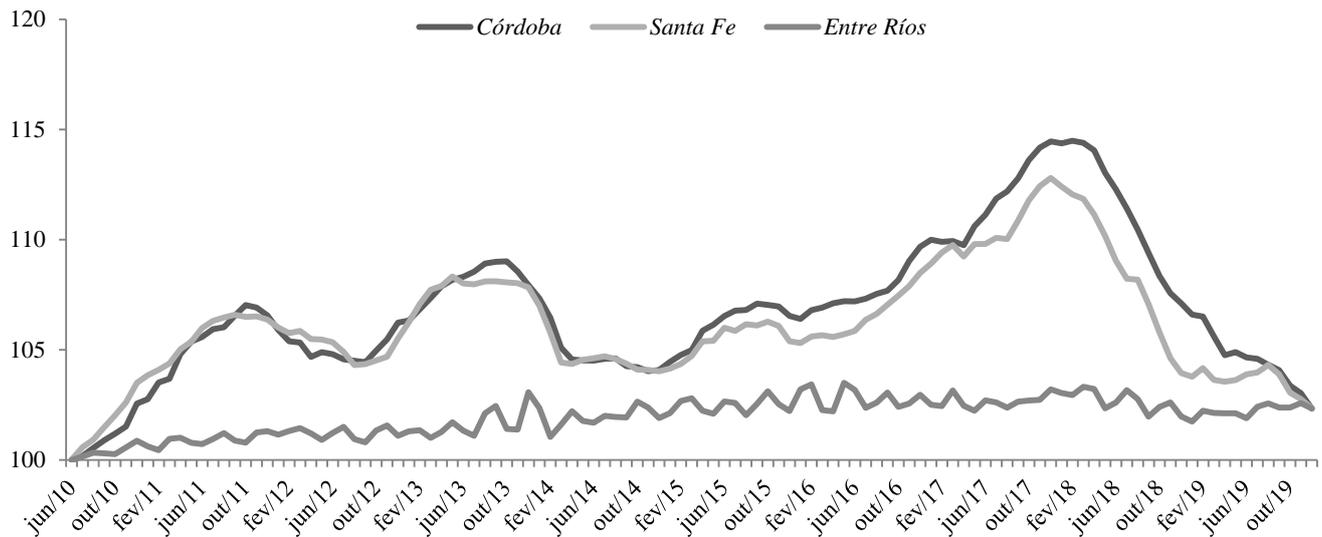
Given the different clustering scenarios commented above, which one offers the “best” statistical results? It is well-known that a good clustering method must minimize within-group distances and maximize between-groups distances. As Table 3 shows, whenever k-means technique is used, these goals seem more feasible. On the contrary, largest distances within-groups and smallest distances between-groups were produced by hierarchical clustering. Among the methods that used k-means, the ones that produced non-partitioned clusters -that is, clusters with adjoining provinces- are preferred and the best performance is achieved by the k-means with six clusters, considering business cycle as an input and fixing contiguity in every group.

**Table 3: Descriptive measures for different clustering techniques applied**

Technique	Clusters' sizes	Average distance within groups	Average distance between groups
K-means with five clusters	2 - 7	34.84	34.76
K-means with six clusters	2 - 5	32.84	39.74
K-means with five clusters and contiguity as a constraint	2 - 8	35.43	33.31
K-means with six clusters and contiguity as a constraint	2 - 7	31.45	32.24
Hierarchical clustering with five clusters and contiguity as a constraint	3 - 6	43.57	24.59
Hierarchical clustering with six clusters and contiguity as a constraint	2 - 6	40.00	27.59

Source: own elaboration with data from different official sources and sectoral chambers.

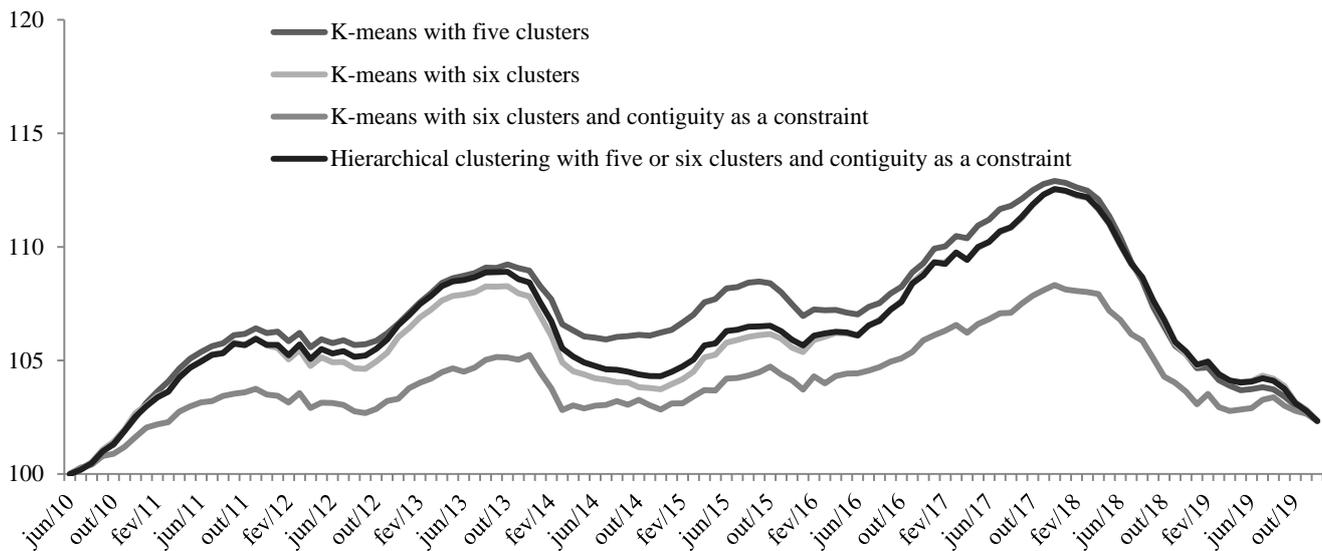
The provinces that concentrate agro-industrial production and exports in Argentina -*Córdoba* and *Santa Fe*- seem to have much similarity in their economic cycles. These provinces, in addition to *Entre Ríos*, make up the *Región Centro*, which is a regional integration bloc created from a political decision of their governors. Although, our results suggest that, beyond geographical proximity, the similarities of the economic cycles of *Córdoba* and *Santa Fe* are stronger than those shared, separately, with the Province of *Entre Ríos*. Besides, *Córdoba* and *Santa Fe* are grouped in five of the six scenarios, the exception being only one of the k-means applications, which corresponds to the method with contiguity restrictions and five groups. Secondly, *Entre Ríos* qualifies in the same *Santa Fe* group three times, and only twice with *Córdoba*. Thus, the grouping estimates kept all the *Región Centro* provinces in the same group only twice, when k-means without restriction is applied with five groups, and when the same technique includes contiguity restriction and six groups. As can be seen in Figure 2, the movements in the economic cycle are very similar for *Santa Fe* and *Córdoba*, while *Entre Ríos* moves away from the pattern.



**Figure 2: Business Cycle (ILCE) of *Región Centro* provinces from jun-10 to dec-19.**

Source: own elaboration with data from different official sources and sectoral chambers.

As a robustness test, we compare the average economic cycles of each cluster that includes the provinces of *Santa Fe* and *Córdoba* to see if they move simultaneously in a similar way. As can be seen in Figure 3, the economic cycles estimated for four clusters that include both provinces have similar inflection points and peaks. Furthermore, it is interesting to note that the one calculated with k-means for six clusters plus contiguity restriction has less variability than the others.



**Figure 3: Average Business Cycle (ILCE) of clusters that include *Santa Fe* and *Córdoba* simultaneously, from jun-10 to dec-19**

Source: own elaboration with data from different official sources and sectoral chambers.

Given the latter results, the case of *Región Centro* is a useful and illustrative precedent to show that regionalizing the country ignoring economic cycles and only considering political or geographical issues may not be the most appropriate choice when formulating targeted economic policies.

**4. CONCLUDING REMARKS**

In this paper, we construct coincident composite indices for the twenty-four provinces of Argentina as a measure of their economic cycles applying the SW methodology, a statistically precise procedure which until now has been used exclusively to calculate indices in a few bunches of provinces. Then, by implementing three clustering methods, we group the provinces whose cyclical behaviors are similar among them and different from the rest. In this sense, our work also makes a valuable contribution to the empirical literature on regional economic dynamics, scarce in studies of the state of the economy in Argentina.

The application of different clustering techniques generates different groupings of provinces, which in turn change when the predetermined number of clusters is modified, except in the case of agglomerative hierarchical clustering, in which,

due to the characteristics of the method, the differences between the results only imply dividing one of the five clusters in two.

Beyond the clustering method applied, one of the main results of our work is that grouping provinces according to their economic cycle presents some differences with the official regionalization of the *INDEC*. In this sense, provinces such as *Formosa* -that according to *INDEC* regionalization belongs to *Región NEA*- or *San Luis* -a member of *Región Cuyo*- repeatedly appear grouped together with provinces that belong to other *INDEC*'s regions. Even in some cases, the results show isolated provinces, surrounded by others with noticeable differences in their economic cycles, such as *Jujuy*, *Misiones* and *Entre Ríos*, that are only grouped with neighboring provinces when contiguity is a constraint. Different is the case of the City of *Buenos Aires*, which only borders the province of the same name, which is always grouped together with the latter. On the other hand, applying hierarchical clustering for five clusters, the closest grouping to the statistical regions determined by *INDEC* is obtained, being exactly coincident in the case of the Patagonian region, and having differences of one province at most in each of the other four regions.

Another particularly interesting result of our work is that *Córdoba* and *Santa Fe* -provinces that concentrate the country's agro-industrial production and exports- appear together in almost all the clustering procedures. This was expected, since the coincident composite indicators obtained for both provinces have an almost perfect linear relation, with a correlation coefficient close to one. The same is not the case with the Province of *Entre Ríos*, also a member of the -politically defined- *Región Centro*, in which the correlation of its coincident index with respect to those of *Córdoba* and *Santa Fe* is considerably lower.

Finally, the results as a whole show that, at least in those cases where the purpose is to analyze the economic performance of a region over time, the impact of a national economic policy or the effects of an external shock on the performance of the economic activity, it seems that groupings based on static criteria may not be the most appropriate.

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## **Regular Session: RS06.2 - Methods in Regional Science and Urban Economics**

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/84223142845>**

**Chair Peter Batey**

## EFFECTS OF INDUSTRIAL AGGLOMERATION ON THE EVOLUTION OF REGIONAL LABOR PRODUCTIVITY (2010-2017)

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### ABSTRACT

The production stagnation that affected the Brazilian industry since the Crisis in 2008, is due, in part, to the lack of protagonism of the technology-intensive sectors, which were unable to induce the necessary transformations to sustain long-run growth. On the other hand, the strong international demand for energy, agricultural and mineral commodities has stimulated the growth of sectors that are intensive in natural resources. This problem can be examined through regional differences, in which regions based on the production of capital goods and durable goods would be growing less than those specialized in the production of commodities.

Thus, this paper aims to estimate and analyze the regional impacts of changes in industrial labor productivity in Brazil in the period 2010 to 2017. To facilitate the analysis, labor productivity indices from 26 industrial activities were aggregated according to four regional technological standards: (1) Traditional industry, (2) Mineral commodities, (3) Chemicals, energy and fuels, (4) Capital goods and durable goods. This identification is an important initial step for the control of spatial heterogeneity, a typical problem in spatial models of panel data.

In model, productivity gains result from access to value chains in the international market, as well as domestic factors related to local markets, such as externalities formed by density in the labor market, and by multifirm interactions within the local productive structure.

Among the main results, it is worth mentioning.

1. There is a high productivity corridor forming in less dense regions, in the North and Midwest of Brazil. Growth in these areas is driven by exports, reinforced by Marshallian externalities and local intersectoral connections.
2. The production of mineral commodities is strongly concentrated in Pará and Minas Gerais. As it brings together exporters of basic products, its performance does not depend on connections with dynamic sectors, and there is no evidence of externality on the labor market, refuting the labor pooling hypothesis.
3. The growth of the Brazilian industry is driven by Chemicals, energy and fuels. The main refining firms seek to establish themselves in the vicinity of offshore oil and gas fields. The strong international insertion, strengthened the labor market and the connections with Capital goods and durable goods.
4. The critical point of the analysis is the export performance of capital goods and durable goods, whose elasticity coefficient was estimated with a positive and significant sign, but below average. Furthermore, productivity did not react significantly to agglomerations within the standard itself, nor between different arrangements.
5. Finally, econometric tests have shown that the SARFE (Spatial Autoregressive with Fixed Effects) model has better control over space spillovers imputed by the performance Chemicals, energy and fuels. In other technological standards, more efficient control results from the SEMFE (Spatial Error Model with Fixed Effects) model.

## CHARLES BOOTH AND GEODEMOGRAPHICS: HIS LONDON LEGACY IN HISTORICAL PERSPECTIVE

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### ABSTRACT

Geodemographics is concerned with the classification of neighbourhoods into categories or clusters based on their socio-economic characteristics. In layperson's terms, it can be said to be 'the analysis of people by where they live'. It uses a qualitative description – a 'pen portrait' – to summarize the distinctive attributes of each category or cluster. It works on the principle that 'birds of a feather flock together': people who live close by (i.e. in the same neighbourhood) are assumed to have more in common than a random group of people.

Urban planners and policy-makers have long had a practical interest in geodemographics, usually directly related to policy formulation, analysis and evaluation. Typically, the aim is to develop a consistent and systematic approach to spatial resource allocation, involving the definition of priority areas to receive favoured treatment. Such areas may be defined in relation to particular policy sectors, such as education, housing, crime or health or, in a more general sense, as in the case of designating 'inner city areas'. The geodemographic classification here serves as a composite measure of need and is usually constructed using census data, where feasible supplemented by other sources of small area data. It generally takes the form of a map displaying the spatial distribution of neighbourhood types, together with a set of pen portraits.

Use of the term 'geodemographics' is comparatively recent, dating from the 1980s, but the basic principles, in one form or another, have a much longer history. The earliest example is generally attributed to philanthropist Charles Booth who prepared pioneering street-by-street surveys and poverty maps in late nineteenth century London. Booth wanted to find and present clear evidence of the extent of poverty in London, in an effort to convince politicians to take urgent action. The full results of his research, including his poverty map, were published under the general heading of the Life and Labour of the People of London.

As the world's first urban social survey, Booth's survey had a big influence in London and elsewhere. Here we present an historical review, starting with Booth's original survey and drawing on three later efforts to produce surveys of London Life and Labour, intended to show how, over the years, London's social and economic spatial structure had changed. We focus particularly on how geodemographic classifications have evolved as an analytical planning method, spurred on by advances in computing power and the increased availability of small area socio-economic data. In a final section, again focusing on London, the paper first examines the recent development of workplace geodemographic classifications, to sit alongside the more familiar residential classifications, opening up the possibility of creating a classification of travel to work flows and, secondly considers the availability of open geodemographics, where users have the opportunity to customise their geodemographic classification according to the application they have in mind.

## THE BATEY-MADDEN MODEL: FORTY YEARS AND COUNTING (OR SHOULD THAT BE MULTIPLYING?)

[Peter Batey](#)

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### ABSTRACT

In 1980, the present author and his late colleague, Moss Madden published their first paper in an international regional science journal<sup>[1]</sup>, on regional demographic-economic forecasting. The paper identified a serious flaw in modelling the effect that population has on the economy. Up till that point a population forecast would typically be fed into the final demand vector of an input-output model as consumption. This consumption then produces changes in the gross outputs of the industrial sectors represented in the model, which are combined with changes caused by other factors (such as exports) to represent overall changes in the economy. The problem is that in order to obtain a consumption vector from a population, we have to know (or make some assumption about) unemployment, which is a determining factor in the level of consumption.

Batey and Madden developed a solution to this problem by embedding an extended input-output model within an activity-commodity framework. The key innovation here was that instead of having one type of household, in the extended model there were now two types: employed and unemployed. The activity-commodity framework had a number of benefits: it offered flexibility in the choice of variables (demographic and economic), in the units in which these variables were measured, and in its solution method (in the form used here solved by inverting the (square) matrix of coefficients to give a single determinate solution.

The inverse of this new, extended input-output model, known as the Batey-Madden model, provides a rich source of impact multipliers that are more realistic, including so-called Type 4 income, employment and production multipliers, and a range of demographic-economic multipliers that measure the effect of population change upon the regional economy. What is more, the model provides a simultaneous solution to the inconsistency problem, so that by inputting economically active to the model, consistent values of unemployment are calculated.

Activity-commodity frameworks have proved useful in many ways, providing a means to compare the structure of existing models, as well as serving as a useful tool in designing new forms of extended model.

In this paper, several aspects of the Batey-Madden model are explored: how the model came about; the benefits of activity-commodity frameworks in developing extended input-output models; why the household sector matters so much in regional modelling; a survey of how the model has been applied, where and when; new forms of the model capable of measuring the economic impact of changes in particular population cohorts, including an ageing population, an enhanced skill structure, and the impact of changing dependence on in-migrant workers.

The paper aims to show that more than forty years after it was first introduced, the Batey-Madden model continues to offer useful insights about the nature of demographic-economic change.

[1] Madden, M. and P.W.J. Batey (1980) "Achieving Consistency in Demographic-Economic Forecasting", *Papers of the Regional Science Association*, 44: 91-106.

## **Regular Session: RS21.2 - Agriculture, fisheries and food security**

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/89003478979>**

**Chair Sandy Dall'erba**

## EXPLOITATION OF EUROPEAN HAKE AT THE PORT OF LARACHE OF MOROCCO

**Chaimae El Bouzidi<sup>1</sup>, Mounir Hassani Zerrouk<sup>2</sup>, Said Benchoucha<sup>3</sup>, Mohammed Bakkali<sup>1</sup>**

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### ABSTRACT

The Atlantic region of Morocco is rich in marine resources. Its marine ecosystem is characterized by exceptional biodiversity. For thousands of years, its marine species have been a source of human livelihood, on the one hand, and the engine of the region's national economies, on the other hand. However, population growth and increased demand for marine resources raise concerns about the decline of species and the loss of local marine diversity as a whole. Besides the potential overexploitation of marine resources. For a long time, demersal species occupy a major place in the fresh fishing of the Moroccan North Atlantic region. Among these species, we have chosen, as part of this project of this research; the European hake (*Merluccius merluccius*) which represents the most important of the demersal fish species with high commercial value exploited at the port of Larache from the point of view of landings, which reveals the economic importance attributed to this port. European hake are targeted by both inshore and artisanal fishing, however, European hake catches come mainly from trawl fishing. These last ten years, a drop in landings has been observed reducing the catches by half. This is likely due to the combined effects of fishing and the environment conditions. In this context, appropriate management measures are necessary to be able to rectify the state of this stock. In fact, the *Merluccius merluccius* has been exploited, especially in the northern part of Morocco, by the Moroccan, Spanish and Portuguese fleets until the end of the fishing agreement with the European Union in 1999. After this year, only the Moroccan fleets made up essentially of small longline trawlers with short range and the boats continued to fish this resource. This work took up a diagnosis of the state of exploitation of the stock of this species (*Merluccius merluccius*) by monitoring the state of the resource which is ensured by examining the exploitation indicators which are: catches of hake common in level of the port of Larache, the fishing effort of the trawlers exerted on the stock at the level of the port of Larache and the catch per unit of effort (CPUE) also called index of abundance is used to estimate the level of exploitation of the resource, in order to follow the exploitation status of the hake and show the interest of the species landed at the port of Larache during the period 2005-20014 by the trawl fleet.

**IV-SDID: MODEL AND APPLICATION**

**Sandy Dall'erba<sup>1</sup>, Bill Ridley<sup>1</sup>, Andre Chagas<sup>2</sup>, Yilan Xu<sup>1</sup>**

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**ABSTRACT**

The most recent report of the IPCC predicts a continued increase in the frequency and intensity of extreme weather events. Agriculture, the economic sector most sensitive to changes in weather conditions, will be greatly affected by such changes regardless of a country's geographical location. Because of concerns about food security, a growing literature has investigated the capacity of international trade to act as a major adaptation mechanism to climate change. In this paper, we rely on a difference-in-difference setting with endogenous trade interactions (IV-SDID) to assess how the trade of wheat, a crop grown across 89 countries, and its production respond to drought. Based on fine spatial and temporal resolution drought data, our panel data results indicate that a drought promotes export when it takes place in the importing country, but it discourages export when it occurs in the exporting country. As a result, the true marginal effect of a drought on wheat production is based on a combination of its local impact and its impact abroad. Projections based on future weather and drought data by 2038-2070 challenge the estimates of the current climate impact literature by revealing that international trade is capable of mitigating the impact of adverse weather events on yield.

## **Regular Session: RS09.3 - Regional and urban policy**

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/83755733224>**

**Chair Zeynep Elburz**

## URBANIZATION AND HUMAN DEVELOPMENT INDEX: CROSS COUNTRY EVIDENCE

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### ABSTRACT

We assess the impact of urbanization on the value of country-level Human Development Index (HDI), using random effect Tobit panel data estimation from 1990 to 2017. We find that total urban populations, percentage of the urban population, and percentage of urban population living in the million-plus agglomerations have a positive effect on the value of HDI. Urban population growth rate and percentage of the population residing in the largest cities negatively affect on the value of HDI. Therefore, developing countries need to promote balanced urbanization with an improvement of urban basic services for improving the HDI rank.

### KEYWORDS

Urbanization, human development index, cross country

### JEL CLASSIFICATION

R11, R13, 015

### 1. INTRODUCTION

No country has developed without sustainable urbanization. Urbanization has a potentially positive effect on economic activity, higher provision to employment opportunities, and enhances access to basic services. Cities switch low-productivity agriculture into high productive industry and service sector-led economy. In developing countries, cities are the engine of economic growth. Cities account for about 70 percent of global gross domestic product (World Bank, 2009). Several studies (Williamson, 1965; Martin and Ottaviano, 1999; Fujita and Thisse, 2002; Baldwin and Martin, 2004; Henderson, 2003; Brühlhart and Sbergami, 2009; Tripathi, 2013) found that urbanization has a positive link with economic growth.

Urbanization is a typical characteristic of development and a process strongly associated with economic and social development. Hence, urbanization has a direct positive effect on the income of a country if it is managed properly. However, it is important to know, whether urbanization has led to an improvement in a person's capabilities and wellbeing. It is well known to all of us that the Human Development Index (HDI) is far more crucial than a gross domestic product (GDP) in capturing the progress that has been achieved. HDI captures not only GDP but also the other two important aspects such as life expectancy and education. However, higher urbanization does not mean that higher rank in HDI. For instance, the Russian Federation has 74.6 percent urban population but it holds 49th rank in HDI ranking by all countries in the world. In contrast, Switzerland with a similar rate of urbanization ranked in the second position in HDI ranking in the world. Therefore, countries with a higher level of urbanization do not guarantee a higher rank in the HDI ranking. This compels us to assess the impact of urbanization on the HDI.

Very few studies attempted to establish a link between urbanization and HDI. Anisujjaman's (2015) district-level analysis found that there is a positive relationship between the level of urbanization and the HDI in West Bengal, India. Huang and Jiang (2017) conducted a partial correlation analysis between the HDI and urbanization rate whilst controlling for the effects of the GDP for Mongolia. They found that urbanization rates are positively correlated with the HDI even when they controlled the effects of the GDP ( $p < 0.001$ ). Maiti (2017) argued that China was able to create a greater intensity of sustainable development from urbanization than India. The author also found that HDI has a negative and statistically significant effect on the urban population growth rate for China and India. Malik (2014) argued that the relationship between urbanization HDI is not direct and is dependent on how urbanization is managed. Though urbanization offers many opportunities, it can also drive places of deprivation, inequality, and exclusion. For example, though Sub-Saharan Africa has a higher level of urbanization compared to South Asia, but its human development performance is lower than South Asia. Overall, an increasing level of urbanizations is associated with a higher level of HDI.

The study by the United Nations Human Settlements Programme (UN-Habitat, 2016) examined the relationship between the degree of urbanization and HDI by considering countries from Asia, Africa, and Latin America. The analysis suggested that there are huge variations among continents, although the association is positive for all countries except the Philippines and Sri Lanka. Among the African countries, Botswana and Ethiopia have reached a threshold level of the HDI where the index becomes inelastic to the urban population growth. Only in Thailand, among all other Asian countries, HDI reached a threshold level of 0.72 and became inelastic to the degree of urbanization at the level of 44.08 percent of the urban population. Except for Bolivia, all countries in Latin America, the HDI reached a threshold level at some point

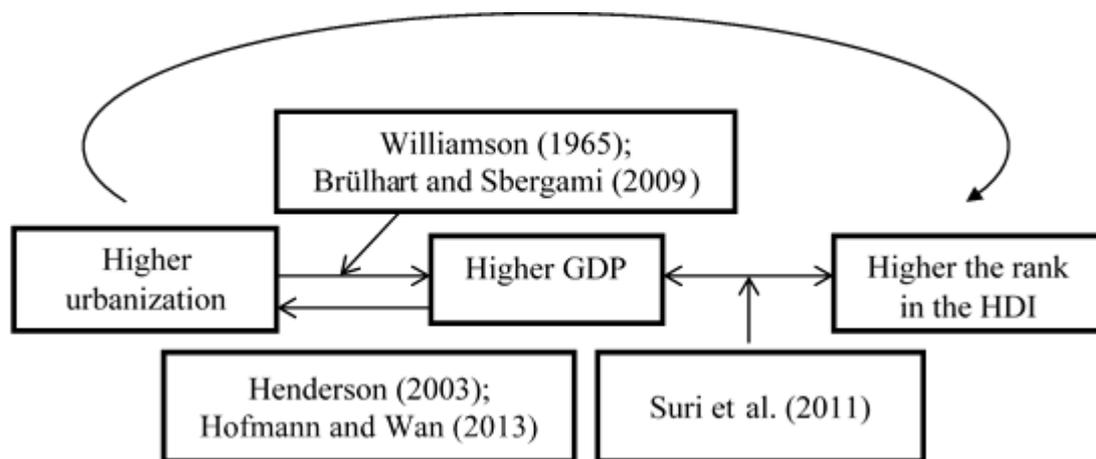
from 2005 to 2013. On the other hand, in the rest of the Latin American countries, the HDI became inelastic to the urban population as they have reached a saturation level in terms of the urban population.

However, the HDI not only depends on only urbanization but also many other factors. A cross country study by Shah (2016) found that GDP, life expectancy rate, literacy rate have a positive effect on the HDI, while the Gini index, fertility rate, and Co2 emissions have a negative effect on it. Arisman (2018) found that for the ASEAN countries population and per capita income growth rate affects the HDI, while inflation rates and unemployment rate do not have an impact on it. Bhowmik (2019) argues that there were significant long-run causalities from education expenditure, health expenditure and GDP per capita to the HDI of SAARC but they had no short-run causalities. Khan et al. (2019) find that in the case of Pakistan, information and communication technology and economic growth promote the HDI. On the other hand, urbanization, trade, and foreign direct investment (FDI) discourage it. Sangaji (2016) found that life expectancy at birth and gross domestic per capita had a positive effect, while the variables of inflation and the fertility rate had negative effects on the HDI in several Buddhist countries in the world. Binder and Georgiadis (2011) argued that macroeconomic policies affect development with less delay than suggested by conventional econometric frameworks, yet impact HDI with longer delay and overall less strongly than GDP.

A brief review of the literature indicates that the relationship between urbanization and economic development is well established. Higher income which is generated by a higher level of urbanization does not guarantee that quality of life has improved. Therefore, it is pivotal important to assess the impact of urbanization on the HDI from cross country perspectives. In this context, the present study assesses the impact of urbanization on the HDI. We consider 187 countries for the analysis. We find evidence that urbanization has a positive impact on HDI. We also analyze by considering high, upper-middle, lower-middle, and low-income countries separately. We estimate the random effect of Tobit panel data models for the period of 1990-2017. We start with 1990 as this is the year when Pakistani economist Mahbub ul Haq created HDI. The results are very important for the promotion of urbanization in the world mostly from developing countries perspectives.

The paper adopts the following structure. The next two sections present the conceptual and empirical frameworks, respectively. Regression results are given in section 4. Discussions based on the estimated results are highlighted in section 5. The major conclusions and policy implications are made in section 6.

**2. CONCEPTUAL FRAMEWORK**



**Figure 1: Linking between urbanization and the HDI**

Figure 1 presents the main conceptual framework for linking between urbanization and the HDI. Our conceptual framework for linking urbanization and the HDI is based on two famous and prominent hypotheses. First, Williamson (1965) suggested that agglomeration matters for an early stage of development. When transport and communication infrastructure is limited and the reach of the capital market is scared, efficiency can be significantly enhanced by concentrating production in space. However, as availability of infrastructure improves and the market expands, congestion externalities may favor a more dispersed economic geography. This structure is consistent with the model of urbanization and growth with the focus on human capital accumulation by Bertinelli and Black (2004).<sup>128</sup> Brülhart and Sbergami (2009) found evidence that supports the “Williamson hypothesis”: agglomeration boosts GDP growth only up to a certain level of economic development. Henderson (2003) found that urbanization does not seem to cause growth. Hofmann and Wan (2013) argued that the direction of causality runs from growth to urbanization.

Second, Suri et al. (2011) suggested that there is a two-way relationship between economic growth and human development, building on an earlier work by Ranis et al. (2000). They found that human development is not only a product of economic growth but also important to it. They hypothesized that upgrading human development for higher subsequent economic growth, in turn, leads to improved human development.

Now the question arises if urbanization may affect HDI via GDP, can we measure the causal relationship between urbanization and HDI. The answer is yes. As higher urbanization does not mean higher GDP. For example, in terms of the

<sup>128</sup> More details explanation can be seen from Brülhart and Sbergami (2009).

percentage of the urban population, Jordan is ranked 13 whereas in terms of per capita GDP its rank is 116 out of 180 countries in the world in 2017. Similar stories can be repeated for Chile and Brazil too. On the other hand, a higher GDP does not guarantee a higher rank in the HDI. For example, as per the per capita GDP Luxembourg is ranked top whereas it is ranked 22 in the HDI ranking out of 180 countries in the world in 2017. In contrast, Sri Lanka is ranked 110 in per capita GDP whereas it stands 76 in the HDI rank with only 18% urbanization for a similar comparison. Therefore, it is not always true that urbanization impacts on the HDI via GDP. It is also to be remembered that HDI depends on life expectancy and education rather than the only GDP. So, higher development as per higher GDP per capita always does not guarantee that the country will rank high in the HDI and the results also differ for different income group countries (Dev, 2015). On the other hand, urbanization provides higher employment opportunities, higher productivity, wages, localized technology spillovers, greater efficiency benefits, and enhances access to basic services. Therefore, urbanization may have a positive effect on the HDI. In fact, Cutler et al. (2005) found that the reductions in mortality and improvements in life expectancy have been induced by technology improvements, which came from improved incomes, helped by improvements in education. Therefore, it is expected that higher urbanization not only improves income but also the HDI. Based on these theoretical arguments, the present study quantifies the associations between urbanization and quality of life which is measured by the human development index.

### 3. EMPIRICAL FRAMEWORK

The Tobit model or censored regression model is used to estimate the linear relationship between the HDI and urbanization as we find the evidence of the right-censoring in the dependent variable of HDI. Histogram in the Appendix of Figures A1 confirms that HDI is right-censoring. A Tobit model with random effects is used as it is capable of accounting both serial correlations and censoring effects. The random effect Tobit model is efficient to account for correlations across observations in addition to unobserved heterogeneity.

The Tobit model for panel data is defined as follows

$$y_{it}^* = x_{it}\beta + \epsilon_{it} \tag{1}$$

$$y_{it} = \begin{cases} 0 & \text{if } y_{it}^* \leq 0 \\ 1 & \text{if } y_{it}^* \geq 1 \\ y_{it}^* & \text{if } 0 < y_{it}^* < 1 \end{cases} \tag{2}$$

Where  $y_{it}^*$  is an unobservable latent variable,  $\epsilon_{it}$  is normally, identically, and independently distributed with zero mean and variance  $\sigma_u^2$ .  $x_{it}$  is a vector of explanatory variables and  $\beta$ , a vector of unknown coefficients.

Following, Sangaji (2016), who investigated relevant determinants of HDI in several counties, we also consider random effect model for the estimation. The rationale behind using random effect model is that the variation across countries is assumed to be random and uncorrelated with the independent variables included in the model.

The following equation is specified to assess the impact of urbanization on HDI.

$$HDI = \nu_i + \beta_1 urbanization_{it} + \beta_2 Co2_{it} + \beta_3 FDI_{it} + \beta_4 fertility\ rate_{it} + \beta_5 gdp\ growth\ rate_{it} + \beta_6 Gini_{it} + \beta_7 inflation\ rate_{it} + \epsilon_{it} \tag{3}$$

where  $i$  and  $t$  represent country and time, respectively, while,  $\nu_i$  is the random effects term which follows normal distribution with mean 0 and variance  $\sigma_u^2$ , and  $\epsilon_{it}$  is the disturbance term which follows normal distribution with mean 0 and variance  $\sigma_u^2$ . Our data set contains up to 187 countries, over the period 1990-2017. The HDI data is sourced from the United Nations Development Programme (UNDP) and other data are from World Development Indicators (WDI) provided by the World Bank. Appendix table 1 provides the definitions of variables used for the regression analysis.

Based on Henderson (2003), Brühlhart and Sbergami (2009) and Tripathi (2013), we measure urbanization in five different ways: percentage of urban population, total urban population, annual urban population growth, population in urban agglomerations of more than 1 million to total population, and population in the largest city to urban population. Five different measures of urbanization have very important implications for capturing various patterns of urbanization in different countries. Some countries/cities are over urbanized and some of them are under urbanized. Some cities are overcrowded and some of them are less. Therefore, these five measurements of urbanization are very crucial to capture the urbanization dynamics. Overall, a positive effect of urbanization on the HDI is expected, as urbanization is associated with higher employment, GDP, availability of infrastructure, provision of basic services, and lower poverty (Li et al., 2012; Khan et al., 2018). Thus, urbanization contributes to socio-economic development by promoting the state economy and increase the value of the HDI [Khan et al., 2019].

On the other hand, based on review of literature on determinant of the HDI (Arisman, 2018; Khan et al. 2019; Sangaji, 2016; Bhowmik, 2019), we expect that GDP growth rate has a positive effect on the HDI.<sup>129</sup> On the other hand, higher CO2 emissions, fertility rates, and the Gini index have a negative effect on the HDI. The higher rate of inflation reduces the purchasing power of money, makes investment less desirable, so it may reduce GDP and the HDI. However, the Phillips curve shows that high inflation is consistent with low rates of unemployment. This implies that inflations have a positive effect on economic growth. Therefore, inflations may have a positive or negative effect on the HDI. The FDI stimulates the labor market and economic growth, a high tax incentive environment. Therefore, a positive impact of FDI on the HDI is expected [Khan et al., 2019].

129 As per-capita GDP, life expectancy at birth, and adult literacy rate are considered to construct HDI, we did not consider these variables in the regression analysis.

4. REGRESSION RESULTS

Before we go to regression results, first we present the descriptive statistics of the variables. Table 1 presents the summary statistics of each variable used in the regression models. The coefficient of variation (CV) measures the dispersions of data points in a data series. HDI, Gini coefficients, fertility rate, percentage of the urban population, and population in the largest city have lower values of a CV, which indicates that little differences in their means, implying a more symmetrical distribution. However, it is not the case for inflation rates, total urban population, foreign direct investment, and GDP growth rate. Table 1 also presents the variance inflation factor (VIF) for the explanatory variables based on a simple OLS model.

Table 1: Descriptive statistics of panel data variables

Variable	No. of observation	Mean	Standard deviation	Minimum	Maximum	CV	VIF
Human development index (HDI)	4725	0.655	0.166	0.2	0.95	25.4	-
Percentage of urbanization (PU)	5230	53.86	23.39	5.42	100	43.43	2.96
Total urban population (TUP)	5227	1.66e+07	5.31e+07	4873	8.00e+08	319.88	1.52
Urban population growth (UPG)	5226	2.24	2.06	-7.18	17.76	92.31	2.57
Population in urban agglomerations of more than 1 million (PUAM)	3301	23.831	16.833	2.105	100	70.63	2.83
Population in the largest city (PLC)	4107	33.059	17.342	2.867	100	52.46	2.40
CO <sub>2</sub> emissions (CO <sub>2</sub> )	4347	0.281	0.243	0.005	2.12	86.54	1.35
Foreign direct investment (FDI)	4848	6.50	39.81	-58.32	1282.63	612.05	1.10
Fertility rate (FR)	5096	3.24	1.68	0.901	8.606	51.83	2.60
GDP growth rate (GDPG)	5004	2.11	6.33	-64.99	140.37	300.46	1.14
GINI index (GINI)	1359	39.22	9.40	23.7	65.8	23.97	1.55
Inflation rate (IR)	5004	38.41	496.61	-36.56	26765.9	1293.01	1.10

Source: Author.

Table 2 presents the raw correlation coefficients. The estimated values of correlation coefficients quantify the direction and strength of the linear association between the variables. The results show that the HDI has a positive association with the percentage of the urban population, the population in million-plus urban agglomerations, CO<sub>2</sub>, and foreign direct investment. In contrast, the values of the HDI are negatively correlated with urban population growth rate, fertility rate, populations in the largest city, Gini coefficients, and GDP growth rate.

Table 2: Correlation coefficient of the variables used in regression model

	HDI	PU	TUP	UPG	PUAM	PLC	CO <sub>2</sub>	FDI	FR	GDPG	GINI	IR
HDI	1.00											
PU	0.73	1.00										
TUP	0.03	-0.01	1.00									
UPG	-0.64	-0.57	0.04	1.00								
PUAM	0.29	0.52	0.05	-0.14	1.00							
PLC	-0.24	-0.14	-0.41	0.15	0.41	1.00						
CO <sub>2</sub>	0.10	0.06	0.23	-0.28	-0.08	-0.33	1.00					
FDI	0.11	0.07	-0.10	-0.07	-0.02	0.09	0.04	1.00				
FR	-0.84	-0.58	-0.15	0.71	-0.21	0.27	-0.32	-0.07	1.00			
GDPG	-0.10	-0.12	0.10	0.02	0.02	0.11	0.06	0.17	-0.01	1.00		
GINI	-0.41	-0.11	0.03	0.41	0.33	0.27	-0.22	-0.15	0.35	0.01	1.00	
IR	-0.05	0.02	0.04	-0.02	-0.01	-0.09	0.20	-0.05	-0.01	-0.19	0.04	1.00

Note: See Table 1 for variable definitions. The correlation coefficients are based on 945 observations.

Source: Author.

Except for fertility rates, there is no strong correlation between HDI and other explanatory variables. This lessens the probability that regression results are inconsistent and biased. Correlation coefficients together with variance inflation factors (VIF) (Table 1, the last column) recommend that multicollinearity is not present in regression analysis.

Table 3 presents the estimated random effect Tobit regression models of equation 3. The sigmas signify the variances of the two error terms  $\mu_i$  and  $\epsilon_{it}$ . Their relationship is explained by the variable rho, which informs us about the relevance of the panel data nature. When rho is zero, the panel-level variance component is unimportant, and the panel estimator is not different from the pooled estimator. As can be seen from Table 3, the panel data structure of the model has to be taken into account. The significant values of Wald chi<sup>2</sup> specify that for regression models 1-6 fit well; all coefficients in the model are different from zero. The higher values of log-likelihood for regression models 1-6, our regression estimations are good. The statistically significant values of likelihood-ratio tests for all the regression models reject the null hypothesis that there are no panel-levels effects.

The size of our country sample for estimations varies between 105 and 153, depending on the explanatory variables that are included in the regressions. Regression model 1 presents the full model, which includes all variables identified by the literature review. Regression models 2-6 report results for a parsimonious model, excluding controls that are not found

to be statistically significant in our data and to estimate the impact of particular independent variables on the dependent variable. In other words, regression models 2-6 are designed to capture the effect of each urbanization variables on the HDI separately.

The regression model 6 shows that FDI has a positive and statistically significant effect (at 1 % level) on the HDI. The coefficient 0.001 indicates that for a unit increase in FDI, there is a 0.001 point increase in the predicted value of HDI. On the other hand, CO2 emissions, fertility rate, GDP growth rate, Gini index, and inflation rate have a negative and statistically significant effect on the HDI. The sign of the estimated coefficients is matched with the expected sign. The impact of the Gini index, fertility rate, and Co2 emissions on the HDI support the findings of Shah (2016) and Arisman (2018). In the line of Khan et al. (2019), we also get a positive impact of FDI on the HDI. However, the negative impact of economic growth on the HDI does not support the findings of Khan et al. (2019). It is most of the developing countries in the world are having a higher growth rate but the rank in the HDI is very low, so only economic growth cannot increase the HDI value. For example, India has experienced a 7.08% GDP growth rate between 2000 and 2016 but India's rank in the HDI is 130. So if growth does not guarantee education and health, it cannot increase alone the HDI rank. Inflation rates have a negative and statistically significant effect on the HDI. This shows that higher inflation is bad for economic growth and it reduces the HDI values.

**Table 3: Random Effect Tobit Estimation Results for all countries (dependent variable: HDI)**

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Percentage of urbanization	0.00397*** (0.000395)	0.00492*** (0.000251)				
Urban population	0.00009** (4.25e-05)		0.0004*** (4.74e-05)			
Urban population growth	0.00272** (0.00120)			-0.0126*** (0.00154)		
Population in million plus urban agglomerations	0.00374*** (0.000759)				0.00882*** (0.000513)	
Population in the largest city	-0.000724 (0.000553)					-0.0008*** (0.00021)
CO2 emissions	-0.116*** (0.00938)	-0.142*** (0.00887)	-0.155*** (0.0104)	-0.148*** (0.0136)		-0.157*** (0.0062)
Foreign direct investment	0.000327** (0.000129)			0.000063 (5.87e-05)	0.000366** (0.000143)	0.000732*** (0.000104)
Fertility rate	-0.0375*** (0.00270)	-0.0401*** (0.00247)	-0.0671*** (0.00225)		-0.0486*** (0.00245)	-0.0662*** (0.00127)
GDP growth rate	-0.000622*** (0.000186)	-0.000497*** (0.000166)	-0.0007*** (0.00019)	-0.000421* (0.000256)	-0.000753*** (0.000220)	-0.00035*** (0.000103)
GINI index	-0.00115*** (0.000235)	-0.00112*** (0.000218)	-0.0013*** (0.000255)	-0.00254*** (0.000334)	-0.00146*** (0.000271)	
Inflation rate	-7.52e-07 (4.16e-06)	9.04e-07 (4.40e-06)	1.48e-08 (5.16e-06)	-1.10e-05 (6.80e-06)	-1.64e-05*** (5.07e-06)	
Constant	0.554*** (0.0317)	0.599*** (0.0227)	0.951*** (0.0138)	0.817*** (0.0188)	0.671*** (0.0227)	0.923*** (0.0111)
/sigma_u	0.0882***	0.0944***	0.0916***	0.1574***	0.11601***	0.0975***
/sigma_e	0.0194***	0.0207***	0.0243***	0.0321***	0.0245***	0.0295***
rho	0.9538	0.9539	0.9339	0.9601	0.9572	0.9162
Wald chi2	2563.8***	2427.6***	1528.4***	284.6***	1621.3***	3896.3***
Log likelihood	2124.7	2570.9	2408.24	2031.4	2140.7	6339.9
Likelihood-ratio test	195.9***	1978.03***	1978.1***	2291.7***	1679.3***	5997.9***
Observations	945	1,195	1,195	1,190	1,054	3,199
Number of country	105	153	153	152	107	144

Notes: Standard errors in parentheses, \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Source: Estimated using equation 3

Turning now to our main focus of interest, we observe that the percentage of urbanization and urban population have a positive and statistically significant effect on the HDI, while higher urban population growth rate has a mixed effect on it. Populations in million-plus agglomerations have a positive effect on HDI whereas the population in the largest city has a negative effect on the value of HDI.

Regression model 1 shows that a 1 unit increase in the percentage of urban population leads to a 0.004 point increase in the predicted values of HDI. Moreover, a 1 unit increase in total urban population associated with a 0.0001 point increase in the predicted value of HDI. To avoid collinearity of the urbanization variables, we obtain separate regression results for 5 independent variables used for measuring urbanization regression models 2 to 6. Regression models 2, 3, and 5 are consistent with results are obtained in the regression model1. Regression model 4 shows that the urban population growth rate has a negative effect on the HDI whereas regression model 1 shows that the urban population growth rate has a positive effect on the HDI. Therefore, the urban population growth rate has a mixed effect on the HDI. Regression model 5 indicates that the percentage of urban population living in million-plus agglomerations has a positive effect on the HDI. The coefficient 0.009 specifies that for a unit increase in the percentage of urban population living in million-plus agglomerations, there is a 0.009 point increase in the predicted value of the HDI. In contrast, regression model 6

shows that the percentage of urban population living in the largest city has a negative and statistically significant effect on the HDI. It implies that though bigger city sizes have a positive impact on the HDI there is a limit.

**Table 4: Marginal effects of the overall expected value of estimated random effects Tobit coefficients**

VARIABLES	Model 1	Model 2	Model 3	Model 4	Model 5	Model 6
Percentage of urbanization	0.348	0.408				
Urban population	0.004		0.0134			
Urban population growth	0.009			-0.036		
Population in million plus urban agglomerations	0.123				0.290	
Population in the largest city	-0.031					-0.045
CO <sub>2</sub> emissions	-0.049	-0.059	-0.065	-0.067		-0.068
Foreign direct investment	0.002			0.0006	0.002	0.004
Fertility rate	-0.164	-0.168	-0.279		-0.208	-0.381
GDP growth rate	-0.002	-0.002	-0.003	-0.002	-0.003	-0.001
GINI index	-0.070	-0.066	-0.079	-0.155	-0.088	
Inflation rate	0.000	0.000	0.000	-0.0004	-0.0005	

Source: Author.

Table 4 presents the marginal effects of the overall expected values of the estimated random effect Tobit coefficients. In regression model 1 shows that a one-unit increase in the percentage of urbanization (or total urban population) is associated with an increase of 0.348 (0.004) units on the HDI. Most importantly, regression model 5 shows that a one-unit escalation of the percentage of urban population living in million-plus agglomerations contributes to a 0.290% higher probability of an increase of the HDI. Among the other important independent variables (except urbanization variables) we find that FDI has a positive effect on the HDI. On the other hand, a higher value of the Gini index, CO<sub>2</sub> emissions, fertility rate, GDP growth rate, reduces the values of HDI. Regression model 1 shows that a one-unit increase of CO<sub>2</sub> emissions (or fertility rate) is associated with a decrease of 0.049 (or 0.164) units on the HDI.

However, regression models 1-6 consider all countries together. As different countries are in a different phase of urbanization, we run the regression models separately for high, upper-middle, lower-middle, and low-income countries as well. We only consider urbanization variables as lower data size of the other explanatory variables do not show robust results.

**Table 5: Random Effect Tobit Estimation Results (dependent variable: HDI)**

VARIABLES	All countries	High income countries	Upper middle income countries	Lower middle income countries	Low income countries
	Model 7	Model 8	Model 9	Model 10	Model 11
Percentage of urbanization	0.00779*** (0.000303)	0.00791*** (0.000547)	0.00628*** (0.000588)	0.00978*** (0.000701)	0.00202** (0.000872)
Urban population	0.000937** (0.000386)	0.00683*** (0.00230)	7.72e-06 (0.000460)	0.00619*** (0.000781)	0.130*** (0.0113)
Urban population growth (annual %)	-0.000644 (0.000574)	-0.000166 (0.00115)	0.00468*** (0.00113)	-0.00105 (0.00162)	-0.00478*** (0.000871)
Population in urban agglomerations of more than 1 million (% of total population)	0.00426*** (0.000578)	0.000915 (0.000979)	0.00564*** (0.00130)	0.00211 (0.00139)	0.00877*** (0.00133)
Population in the largest city (% of urban population)	-0.00181*** (0.000424)	-0.000795 (0.000923)	-0.00148 (0.00102)	0.00275*** (0.000939)	-0.00580*** (0.000716)
Constant	0.158*** (0.0224)	0.200*** (0.0514)	0.195*** (0.0427)	-0.0267 (0.0436)	0.410*** (0.0438)
Observations	3,159	966	860	808	525
Number of country	118	35	32	30	21

Notes: Standard errors in parentheses. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

Table 5 presents the estimated random effect Tobit estimation results where we consider only all the variables of urbanization together. The results are almost similar to the results presented in regression results 1-6 with little variations. The percentage of urban population has a positive and statistically significant effect on HDI for all countries irrespective of income differences. The total urban population has a positive effect on HDI for the regression results are obtained for all countries, high-income countries, lower-middle-income countries, and low-income countries. The effect in upper-middle-income countries is not statistically significant. The urban population growth rate does not have any effect on the HDI for all country-level, high-income countries, and lower-middle-income country's estimation. In contrast, it has a positive (or negative) effect on HDI for upper-middle-income countries (or low-income countries). The percentage of the population living in urban agglomerations of more than 1 million people has a positive effect on HDI except for high and lower-middle-income countries. The percentage of the urban population living in the largest city has

a positive effect on HDI in lower-middle-income countries while it has a negative effect on the results obtained for all countries level and low-income countries. However, it does not have any impact on HDI for high and upper middle-income countries.

**4.1 Robustness check**

As per theoretical explanations, the relationship between urbanization and the HDI (as GDP is already part of HDI) is the question of reverse causality. Other macroeconomic variables such as CO2 emissions are assumed to be endogenous, because causality may run in both directions—from CO2 emissions to HDI and vice versa. Therefore, regressors may be correlated with the error term. The country-specific effect representing time-invariant determinants of HDI may be correlated with the explanatory variables. To solve this problem we estimate the “system GMM” approach initially proposed by Arellano and Bover (1995) for dynamic panel estimation. The “system GMM” model also takes care of the autocorrelation problem which arises from the use of lagged dependent variables. In summary, the system GMM model better controls for the three sources of endogeneity, namely unobserved heterogeneity, simultaneity, and dynamic endogeneity.

Table 6 presents the estimated results. The panel sample comprises between 105 and 157 countries, depending on which regressors are included. We limit the number of instruments by including a maximum of two lags, to avoid rejection of the null for the validity of overidentifying restrictions. Regression model 12 presents results for the full model, including all regressors we consider. Other regression models report comparable estimates with a parsimonious set of controls. We use parsimonious models as they are simple models with great explanatory predictive power with the consideration of just the right amount of predictors needed to explain the best regression models. Regression models 12-15 consider the number of instruments less than the number of groups/countries. This avoids the problem of ‘too many instruments’ associated with the estimation. All tests for second-order autocorrelation and Hansen J-test are satisfactory. The null hypothesis of AR2 diagnostic tests for all regression models cannot be rejected at a 5 % or less statistically significant level. Therefore, our results have no caution of potential overfitting bias.

Regression results in Table 6 show that the percentage of urbanization, total urban population, urban population growth rate, the population in million-plus urban agglomerations, and FDI all have a positive statistically significant effect on the HDI. On the other hand, the population in the largest city of a country, CO2 emission, fertility rate, GDP growth rates, and Gini index have a statistically significant negative effect on the HDI. The results are consistent with the previous results which are obtained by using the Tobit model in Table 3. However, inflation rates do not have any statistically significant effect on the HDI in Table 6.

**Table 6: System GMM Estimation Results for all countries (dependent variable: HDI)**

VARIABLES	Model 12	Model13	Model 14	Model 15
Percentage of urbanization	0.001 (0.005)	0.015*** (0.002)		
Urban population	-0.0004 (0.0003)		0.007*** (0.003)	
Urban population growth	0.009 (0.008)	0.030*** (0.010)		
Population in million plus urban agglomerations	0.027** (0.012)			
Population in the largest city	-0.007 (0.011)		-0.007* (0.004)	
CO <sub>2</sub> emissions	-0.185*** (0.070)		-0.238*** (0.060)	
Foreign direct investment	0.0001 (0.0002)	0.00005* (0.00003)		
Fertility rate	0.007 (0.027)	0.001 (0.022)	-0.005 (0.012)	-0.060*** (0.016)
GDP growth rate	0.00003 (0.0002)			-0.0004*** (0.0002)
GINI index	0.001 (0.001)	-0.002 (0.001)		-0.008*** (0.001)
Inflation rate	-4.55e-06 (3.74e-06)			
Constant	0.211 (0.335)	-0.193 (0.185)	0.771*** (0.138)	1.184*** (0.077)
Observations	945	1328	3276	1331
Number of country	105	156	145	157
Number of instruments	91	79	48	126
AR1	0.21 0.837	2.47 0.014	1.86 0.063	-2.45 0.014
AR2	1.02 0.310	1.55 0.122	1.90 0.058	0.52 0.601
Hansen Statistic	47.13 0.998	64.40 0.754	53.67 0.128	70.35 1.000

Note: Estimation by System GMM (robust standard errors in parentheses). p-values for the null hypotheses of the usual diagnostic tests are reported in parentheses at the end of the table. \*\*\* p<0.01, \*\* p<0.05, \* p<0.1

## 5. DISCUSSION ON IMPACT OF URBANIZATION ON THE HDI

The estimated results show that, overall, the percentage of the urban population, total urban population, and percentage of urban population living in million-plus urban agglomerations have a positive effect on HDI. Moreover, it is suggested that urbanization is beneficial for improving the social and economic development of a country. Now the question arises on how urbanization improves HDI. The basic idea is that urbanization pulls resources from the predominantly agricultural sector to more advanced industrial and service sectors. This is part of economic development (Lewis, 1954). Therefore, the process of economic development not only accompanies economic structural change, but also contributes to a higher urbanization rate. It works with two forces: push from the country-side and pull from the city (Lewis, 1954; Fei and Ranis, 1964). The city offers greater specialization of labor (Smith, 1976), which leads to greater efficiency benefits (Marshall, 1890; Duranton, 2008). It is sourced from urban increasing returns (Krugman, 1991), which include sharing (e.g. local infrastructure), matching (e.g. employers and employees), and learning (e.g. new technologies) (Duranton & Puga, 2004). It also spurred the civic leadership to upgrade urban infrastructure and improve the spatial arrangement of towns and cities (Briggs, 1968; Hunt, 2004). Greater efficiency and rising prosperity are the outcomes of what is, on the whole, a virtuous circle [Turok, 2014]. Therefore, urbanization not only improves the income of a country but also the quality of life of its residents.

The results also show that a higher urban population growth rate and a higher percentage of the population residing in the largest city of a country have a negative effect on HDI. This indicates that when a city becomes very large or suffers from over-concentration of population, it challenges the provision of basic public services to the urban dwellers and increases pollution which impacts badly on human health mostly in developing countries. This clearly specifies that over-concentration or urbanization through the largest city harms the quality of life and reduces the value of HDI.

## 6. CONCLUSIONS AND POLICY IMPLICATIONS

The present paper links the urbanization with HDI. We consider 187 countries from the period of 1990-2017. The random effect Tobit panel data models are estimated for the analysis. Urbanization is measured by the total urban population, percentage of the urban population, urban population growth rate, percentage of the population living in million-plus urban agglomerations, and percentage of the population living in the largest city. In addition to urbanization, we also add other important variables such as CO<sub>2</sub> emissions, FDI, fertility rate, GDP growth rate, level of inequality (Gini index), and inflation rate to investigate the determinants of the HDI.

As different countries are experiencing different stages of urbanization, we also separate our analysis by high-income countries, upper-middle-income countries, lower-middle-income countries, and low-income countries. HDI data is collected from the UNDP and urbanization data is obtained from World Development Indicators provided by the World Bank.

All country-level analysis suggests that the percentage of urbanization, total urban population, and percentage of the population living in million-plus agglomerations have a positive and statistically significant effect on HDI when we run the regression along with controlling all other important variables. On the other hand, the percentage of urban population living in the largest city in a country has a negative effect on HDI. The urban population growth rate has a mixed effect on the HDI. In addition to that FDI has a positive effect on HDI, while higher CO<sub>2</sub> emissions, fertility rate, GDP growth rate, inequality, and inflation rate have a negative effect on it.

The results also are speread by country-level income differences. The percentage of urbanization has a positive effect on the HDI across countries categories by income differences. The impact of the total urban population on the HDI is also positive except for upper-middle-income countries. The urban population growth rate does not have any effect on all country level, high-income countries, and lower-middle-income countries estimations. The percentage of urban population living in million-plus agglomerations does not have any impact on the HDI for high income and lower-middle-income countries. The population living in the largest city of a country does not have any impact on the HDI for high-income countries and upper-middle-income countries.

Based on the results, we suggest that urbanization has a strong positive effect on HDI. The increase in the percentage of urban population is the most important indicator of urbanization to increase the HDI of a country. We need to promote balanced (lower population differences among the cities and towns) urbanization. This indicates that though million-plus cities advantageous for higher HDI, it is not the largest city of a country that is mostly over urbanized and overpopulated. We need to have sustainable urban development which includes the adequate provision of basic services such as urban roads, water, electricity, medical facilities, etc. Most importantly, developing countries like India are experiencing unplanned urbanization with insufficient provision of basic services. Therefore, to reap the maximum benefits of urbanization, we need to have sustainable and balanced (the lower difference in population size among the cities) urbanization, mostly, in developing countries. However, the impact of the HDI on urbanization is a topic for future research.

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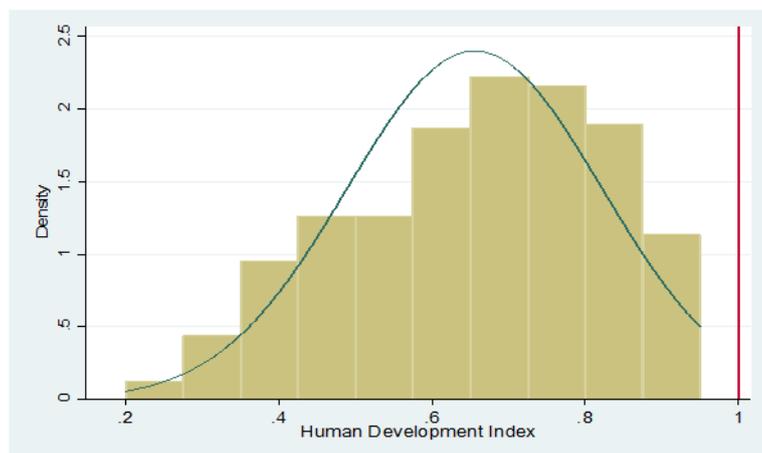
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APPENDIX

Figure 1



Source: Author.

Table 2: Variable definitions are given by the World Development Indicators

Variable	Definition	Source
CO2 emissions (kg per 2011 PPP \$ of GDP)	Carbon dioxide emissions are those stemming from the burning of fossil fuels and the manufacture of cement. They include carbon dioxide produced during consumption of solid, liquid, and gas fuels and gas flaring.	Carbon Dioxide Information Analysis Center, Environmental Sciences Division, Oak Ridge National Laboratory, Tennessee, United States.
Foreign direct investment, net inflows (% of GDP)	Foreign direct investment are the net inflows of investment to acquire a lasting management interest (10 percent or more of voting stock) in an enterprise operating in an economy other than that of the investor. It is the sum of equity capital, reinvestment of earnings, other long-term capital, and short-term capital as shown in the balance of payments. This series shows net inflows (new investment inflows less disinvestment) in the reporting economy from foreign investors, and is divided by GDP.	International Monetary Fund, International Financial Statistics and Balance of Payments databases, World Bank, International Debt Statistics, and World Bank and OECD GDP estimates.
Fertility rate, total (births per woman)	Total fertility rate represents the number of children that would be born to a woman if she were to live to the end of her childbearing years and bear children in accordance with age-specific fertility rates of the specified year.	(1) United Nations Population Division. World Population Prospects: 2019 Revision. (2) Census reports and other statistical publications from national statistical offices, (3) Eurostat: Demographic Statistics, (4) United Nations Statistical Division. Population and Vital Statistics Reprot (various years), (5) U.S. Census Bureau: International Database, and (6) Secretariat of the Pacific Community: Statistics and Demography Programme.
GDP per capita growth (annual %)	Annual percentage growth rate of GDP per capita based on constant local currency. Aggregates are based on constant 2010 U.S. dollars. GDP per capita is gross domestic product divided by midyear population. GDP at purchaser's prices is the sum of gross value added by all resident producers in the economy plus any product taxes and minus any subsidies not included in the value of the products. It is calculated without making deductions for depreciation of fabricated assets or for depletion and degradation of natural resources.	World Bank national accounts data, and OECD National Accounts data files.
GINI index (World Bank estimate)	Gini index measures the extent to which the distribution of income (or, in some cases, consumption expenditure) among individuals or households within an economy deviates from a perfectly equal distribution. A Lorenz curve plots the cumulative percentages of total income received against the cumulative number of recipients, starting with the poorest individual or household. The Gini index measures the area between the Lorenz curve and a hypothetical line of absolute equality, expressed as a percentage of the maximum area under the line. Thus a Gini	World Bank, Development Research Group. Data are based on primary household survey data obtained from government statistical agencies and World Bank country departments. For more information and methodology, please see PovcalNet ( <a href="http://iresearch.worldbank.org/PovcalNet/index.htm">http://iresearch.worldbank.org/PovcalNet/index.htm</a> ).

	index of 0 represents perfect equality, while an index of 100 implies perfect inequality.	
Inflation, GDP deflator (annual %)	Inflation as measured by the annual growth rate of the GDP implicit deflator shows the rate of price change in the economy as a whole. The GDP implicit deflator is the ratio of GDP in current local currency to GDP in constant local currency.	World Bank national accounts data, and OECD National Accounts data files.
Urban population (% of total population)	Urban population refers to people living in urban areas as defined by national statistical offices. The data are collected and smoothed by United Nations Population Division.	United Nations Population Division. World Urbanization Prospects: 2018 Revision.
Urban population	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects. Aggregation of urban and rural population may not add up to total population because of different country coverages.	World Bank staff estimates based on the United Nations Population Division's World Urbanization Prospects: 2018 Revision.
Urban population growth (annual %)	Urban population refers to people living in urban areas as defined by national statistical offices. It is calculated using World Bank population estimates and urban ratios from the United Nations World Urbanization Prospects.	World Bank staff estimates based on the United Nations Population Division's World Urbanization Prospects: 2018 Revision.
Population in urban agglomerations of more than 1 million (% of total population)	Population in urban agglomerations of more than one million is the percentage of a country's population living in metropolitan areas that in 2018 had a population of more than one million people.	United Nations, World Urbanization Prospects.
Population in the largest city (% of urban population)	Population in largest city is the percentage of a country's urban population living in that country's largest metropolitan area.	United Nations, World Urbanization Prospects.

Source: Author's compilation

**DETERMINANTS OF WELL-BEING IN THE TURKISH PROVINCES****Zeynep Elburz<sup>1</sup>, Karima Kourtit<sup>2</sup>, Peter Nijkamp<sup>2</sup>**<sup>1</sup>IZTECH, Turkey. <sup>2</sup>Open University, Heerlen, Netherlands**ABSTRACT**

In recent years, there has been a growing debate on insufficient perceptions of living conditions which relies only macro-economic dimensions. Turkish Statistical Institute conducted a study to measure and compare well-being of individuals and households on the province level and introduced the well-being index for provinces in 2015. Using 11 dimension and 41 indicators of objective and subjective criteria, the study aimed to monitor the well-being of people with all aspects. However, the study iterated only on national level and failed to measure, compare and monitor the wellbeing on province level. This study presents a new approach to well-being literature by creating a new well-being variable using age and family size related variables which have inverse U shape relations. We collect data from 81 provinces between 2012 and 2018 to understand determinants of well-being in Turkish provinces. We use income (GDP per capita), job (female employment), education (female university graduates), health (physician), access to services (road length), agglomeration (population density), governance (NGO), safety (homicide), feel of belonging (migration) indicators with panel data models. According to the results; female employment, female university graduates and share of population who lives in the same province they were born have positively effecting well-being. On the other hand, population density and number of physicians have negative effects. Interestingly, GDP per capita does not have any significant effect on well-being. It is also possible to conclude that time affect well-being positively.

## **Regular Session: RS10.5 - Regional development**

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/813420247>**

**Chair Gabriel Lyrio de Oliveira**

## SPATIAL CONCENTRATION OF ECONOMIC ACTIVITIES AND REGIONAL EXPORT VARIETY

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### ABSTRACT

This research aims to explore the influence of agglomeration forces on the product variety destined to international markets. For this purpose, the Brazil case study between 2002-2017 has been carried out. The hypothesis is that the Brazilian states (similar to NUTS2) that have the highest economic concentrations are those that export the greatest variety. The product variety that a state sells abroad is calculated by a Theil index prevention of the export's amount accounted by the Harmonized System (HS4) codes for international trade (Ministry of Industry Foreign Trade and Services, 2020). The independent variables are calculated to compound a spatial concentration index proposed by Ferrante et al. (2020) that measures the concentration of the event taking account its spatial distribution. To construct those concentration index for each state and year, the number of firms with more than 100 employees, and number of people with high education come from the Ministry of Labor (2020) and the information of Gross Value Added (GVA) of industry, services, and public administration, as well as data on population and GDP per capita are made available from the Brazilian Institute of Geography and Statistics (2020).

The dependent variable is modelled as a function of one-year lag independent variables through a generalized linear model (GLM), and observations are pooled across years and states. From the methodological perspective, this paper applies a novel index of spatial concentration able to take into account the geographical structure of the phenomenon under analysis. From the applied perspective, a deeper understanding of the underlying dynamic of trade flow generation, and of the impact of regions' dissimilarities on their capability of attracting consumers and firms, is fundamental in order to better orient regional development policies.

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## ESTIMATING THE LOCAL GOVERNMENT SPENDING MULTIPLIER FOR BRAZILIAN STATES: AN INPUT-OUTPUT AND A GENERAL EQUILIBRIUM ANALYSIS

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### ABSTRACT

The differences in growth rates and economic activity levels between regions within a country motivated the search for strategies to reduce regional disparities. At the initial stages of development, economic activity concentration positively affects national growth rates while raising regional inequality. However, after reaching a certain regional concentration level, increases in the latter would dampen national growth. The fiscal policy aimed at lagging regions configures as a regional policy for their development. Nonetheless, there is no consensus in the economic literature about fiscal policy's role, and there are still limited studies quantifying the multiplier effects at the local level, especially in developing countries. The global financial crisis of the late 2000s revitalized this debate, given the monetary policy's inability to counter the falling of economic levels. From a regional perspective, the heterogeneity in the transmission of a fiscal impulse causes varied effects between regions within a country due to differentials in productive structure and interdependence. In this context, the objective of this paper is to analyze the impacts of Federal Government spending on Brazilian regional GDP and economic growth. Thus, we seek to answer which policies would generate the highest multiplier effect on output. This objective will be achieved through a computable general equilibrium analysis (CGE) for the Brazilian economy, which will measure the impacts from both the aggregate and the regional perspectives. In this sense, this paper offers another perspective on the multiplier effect: at first, by calculating for each state its Federal Government Spending Multiplier; secondly, it decomposes the total multiplier in its intraregional effect and the interregional effect. As a preview of results, we found that the multiplier is higher in more impoverished areas and sensitive to trade openness. These states are more dependent on government spending in the composition of their and GRP and possess a less diversified productive structure. The pattern of the government spending multiplier is similar in all of our simulations, which reinforces our conclusions. Also, in the Input-Output modeling, the multiplier effect estimate is much higher for all regions with the absence of the price mechanism through the substitution channel. When evaluating how the government spending multiplier reacts to variations in substitution elasticity of imports, our results were consistent with other estimates in the literature: increases in import penetration (both from other regions of the country and the RoW, provokes the diminishing of the local multiplier and vice-versa. Nonetheless, when analyzing the sensitivity to the interregional import elasticity, our results suggest possible gainers with the interregional trade (mainly South and Center-West regions). Lastly, it provides evidence that there is no trade-off between mitigating regional disparities and fostering national growth. Our results may vary depending on how the government spending is funded, which we intend to incorporate in later analysis. In this sense, we contribute to the literature on the government spending multiplier at local levels, for a large emerging Market, providing estimates of the multiplier effect for Brazilian states, as the literature quantifying this impact is still limited, especially for underdeveloped economies.

## THE BRUMADINHO DAM RUPTURE DISASTER IN MINAS GERAIS (BRAZIL) AND THE PRODUCTIVITY: REGIONAL ECONOMIC IMPACTS USING A COMPUTABLE GENERAL EQUILIBRIUM APPROACH

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### ABSTRACT

On 25 January 2019, the Brazilian village of Brumadinho, in the mining-heavy state of Minas Gerais, was taken by the tailings of Córrego do Feijão's dam. This dam rupture is arguably one of the worst human and environmental disasters, leaving over 250 people dead, and spreading a large number of ore tailing into Paraopeba River and the surrounding area. The toxic waste of the mine dispersed towards the villages along the Doce River basin and reached the Atlantic coast. As a typical case of negative externalities, this type of disaster leaves behind large-scale environmental and economic damages at local but also regional levels. The share of the extractive sector in the Brazilian GDP is 2.5%, but Minas Gerais alone is responsible for 23.6% of that production. Characterised by an intensive use of capital and natural resources, the mining production is particularly oriented for international markets. From the economic point of view, public policies are urged in order to help with the regional recovery. This raises the question of what local and regional economic effects generated by the Brumadinho dam collapse are, but also how direct and indirect impacts are distributed among population arrangements. The objective of this study is to evaluate how pollution from this natural disaster affects the economy, whether driven by soil or water contamination, as it increases health problems and reduces the quality of inputs for several economic sectors. Consequently, there are changes in labour productivity, which translate into economic impacts. In this sense, the paper is intended to translate environmental effects into economic phenomenon in an attempt to identify where interdependencies lies on and provide insights to help formulate impact mitigation policy for the long-term. The occurrence of interdependencies in the absorption of negative impacts by the surrounding areas is likely. To that end, we apply a stylized computable general equilibrium (CGE) model for Brazil based on the comparative-static B-Maria model. B-Maria is a Brazilian Regional and Interregional Analysis model developed at NEREUS in the University of São Paulo. It contains detailed information of interregional monetary flows, whereby the origin and destiny of imports and exports of each state are identified. The version of this paper has been adapted for the case of Minas Gerais, the BMaria-MG model. BMaria-MG divides Brazil into four distinct regions: the municipality of Belo Horizonte, the rest of the populational arrangement of Belo Horizonte, the rest of Minas Gerais and the rest of Brazil. This interregional system is calibrated with data of 2015 and 22 productive sectors are specified in each region. The model is run using GEMPACK. Preliminary results indicate a small impact on GDP in all regions. This is due to the low significance of labour productivity in the sectors. Among all regions, the most affected is the rest of Minas Gerais. The largest negative impact is observed for the consumption of households. Despite the small effects at aggregate level, observed impacts are substantial and sector-specific in all regions.

## LONG-TERM EFFECTS OF CONDITIONAL CASH TRANSFERS ON CHILDREN: THE BRAZILIAN CASE

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### ABSTRACT

In this paper, we present some long-term effects of the largest Conditional Cash Transfers program in the world, and one of the pioneers, the Bolsa Familia Program (BFP). We focus on the effects on Schooling attained in early adulthood and Labor Market outcomes of our interest cohorts, i.e., individuals that were born in 1996, 1997 and 1998, and were more or less exposed to the BFP during their childhood.

The estimates were enabled by linking identified data from the Single Registry (Ministry of Social Development) from 2012 to 2017, with the Formal Labor Market (Ministry of Labor) from 2002 to 2017, and the BFP Payment Records (Ministry of Social Development) from 2004 to 2017.

The first source allows us to observe the family characteristics and composition in 2012, while our interest cohorts were still teenagers. The second source allows us to observe the Formal Labor Market performance of the parents of these individuals during their childhood, and, of course, the participation and earnings of our interest cohorts during their early adulthood. The third source fills the lack of SR data concerning the program's initial years and enables building the measures of program exposure during the individuals' childhood, since 2004.

In this Natural Experiment, the main identification strategy relies on a specific selection of the sample, considering only individuals from families registered in the SR during its strongest expansion period, between 2004 and 2006. Moreover, we were able to include a rich set of control variables, like the parents' Labor Market performance and schooling attained. We also rely on the program implementation rules, which states that the release of BFP resources for registered families is automatized and based on municipality quotas estimated by the government. In an alternative identification strategy, we consider an instrumental variable, an observed proxy for the municipality effort to register vulnerable families.

These strategies help to solve the potential selection bias of families to the SR, and consequently to the treatment. Nonetheless, since the program selects the most vulnerable families, the threats to the identification suggest that the estimated effects are lower bounds.

Our main results show positive long-term effects on Schooling, and on the Formal Labor Market participation, while mixed results are observed for Earnings. Heterogeneity tests suggest that the effects are stronger for boys, for smaller cities, and for families with never formally employed parents.

## **Special Session: SS19.2 - The spatial dimension of energy transition policies, practices and technologies**

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/84114610826>**

**Chair Andrea Caragliu**

## THE CONTRIBUTION OF ECONOMIC ACTIVITY AND ENERGY CONSUMPTION TO CO<sub>2</sub> EMISSIONS

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### ABSTRACT

The pollutants that contribute most to environmental degradation are carbon dioxide emissions and PM10 particulate matter. Greenhouse gas emissions have doubled between 1971 and 2015, with CO<sub>2</sub> representing more than two-thirds of greenhouse gas emissions. The objective of this research is to analyze to what extent excess CO<sub>2</sub> emissions are directly associated with energy consumption or are due to imperfections in the production processes of goods and services. To carry out this analysis, a microeconomic specification has been developed and applied in the period 1995-2015 on 6 countries of the European Union plus 14 countries of the rest of the world, whose total population is equivalent to 61 percent of the world population. The application has been carried out using econometric techniques including panel data and the results indicate that imperfections in production processes generally contribute to emissions to a greater extent than energy consumption, suggesting a duty to improve production processes.

### KEYWORDS

Emissions, Carbon dioxide, Energy consumption, Greenhouse gases, Production, Energy productivity.

### JEL CLASSIFICATION

D21, Q41, Q51.

### 1. INTRODUCTION

Since the last decade of the 20th century, regions and countries have emphasized the negative effects on the environment caused by the maintenance of energy consumption patterns that often lead to emissions of gases and other polluting particles, which are also associated with economic activity and economic growth. Carbon dioxide (CO<sub>2</sub>) in natural proportions is not harmful, but as a result of the combustion of fossil fuels, the concentration of this gas in the atmosphere has been increasing until it has become a greenhouse gas (GHG), which induces a greater absorption of infrared radiation that should escape from the earth but which ends up causing an increase in the temperature of the atmosphere and in the temperature of the earth's surface. The increase in the production of goods and services generates externalities, many of them negative, which add to the excesses in the use of environmental resources used to supply energy consumption and production. Many research results on the relationship between energy consumption and gross domestic product (GDP) indicate that energy consumption patterns have a positive impact on CO<sub>2</sub> emissions. CO<sub>2</sub> emissions are considered to be particularly responsible for global warming, as CO<sub>2</sub> is the most abundant greenhouse gas. Several World Bank reports claim that from 1971 to 2015 global greenhouse gas emissions have doubled, with CO<sub>2</sub> contributing 76 % of total greenhouse gas emissions. Other greenhouse gases, which not only affect health, but also promote environmental degradation are: i) carbon monoxide (CO), mainly associated with traffic and transportation; ii) sulfur dioxide (SO<sub>2</sub>), associated with the combustion of coal and petroleum products; iii) nitrogen oxides (NO<sub>x</sub>), associated with the combustion of fossil fuels; and iv) hydrocarbons (CH<sub>x</sub>), substances that contain only hydrogen and carbon but influence the formation of photochemical smog. Finally, lead (Pb) suspended or diluted in water and suspended particles called aerosols, which are particles of different sizes that influence the formation of sulfur smog, also highly polluting. Dust, fiber, soot, fumes, fog, mist and smog overload the environment in such a way that these particles end up affecting, to a greater or lesser extent, not only the health of people, but also the degradation of the environment. Among the most polluting aerosols, PM10 (Particulate Matter) are small solid or liquid particles of dust, ash, soot, metal particles, cement or pollen dispersed in the atmosphere. The size of PM10 particles is less than 10 microns. The daily limit value for the protection of human health is 50 micrograms per m<sup>3</sup> (µg/m<sup>3</sup>) of PM10, which must not be exceeded more than 7 times a year, with the average annual limit for the protection of human health being 20 µg/m<sup>3</sup>. Exceeding the permitted PM10 limit is very harmful to health and reveals a poorly developed production technology. The countries with the highest PM10 index are Pakistan, Bangladesh, Nigeria, Egypt, India, China, Saudi Arabia, United Arab Emirates and Kuwait, the latter related to fuel production and distribution. Table 1 shows the PM10 concentrations in the world's 44 agglomerations with more than 9 million inhabitants (megacities) and those exceeding the daily allowable limit, which are mostly Asian and African megacities, have been shaded.

**Table 1. Level of PM10 in the megacities of the world (2016)**

Agglomerations classified by population	Population (millions)	2016	Agglomerations classified by population	Population (millions)	2016
	PM10			PM10	
TOKYO-YOKOHAMA	35	37.126	BANGKOK	41	14.566
<b>CHONGQUING</b>	<b>77</b>	29.101	BUENOS AIRES	22	14.300
<b>JAKARTA</b>	<b>82</b>	28.019	<b>ISTANBUL</b>	<b>55</b>	13.855
<b>GUANGZHOU</b>	<b>56</b>	25.800	<b>TEHRAN</b>	<b>72</b>	13.500
<b>SHANGHAI</b>	<b>59</b>	25.700	<b>LAGOS</b>	<b>122</b>	13.400
SEOUL	31	25.600	<b>TIANJIN</b>	<b>103</b>	13.266
MEXICO	34	24.178	RIO JANEIRO	35	12.700
<b>DELHI</b>	<b>292</b>	23.500	<b>LAHORE</b>	<b>198</b>	12.500
<b>MUMBAI</b>	<b>104</b>	22.376	PARIS	14	11.950
<b>KARACHI</b>	<b>290</b>	22.100	KOLN-RUHR	22	11.215
NEW YORK	21	22.000	<b>CHENGDU</b>	<b>105</b>	11.001
<b>METRO-MANILA</b>	<b>118</b>	21.951	IZMIR	29	10.046
<b>BEIJING</b>	<b>92</b>	21.900	NAGOYA	30	10.027
SAO PAULO	45	21.100	<b>WUHAN</b>	<b>92</b>	10.020
<b>CAIRO</b>	<b>169</b>	20.384	<b>HARBIN</b>	<b>74</b>	9.874
LOS ANGELES	34	18.100	CHICAGO	25	9.800
OSAKA-KOBE	39	17.550	<b>JOHANNESBURG</b>	<b>85</b>	9.616
MOSKOW	40	17.000	KINSHASA	40	9.518
<b>KOLKATA</b>	<b>136</b>	15.835	<b>LIMA</b>	<b>58</b>	9.400
<b>DHAKA</b>	<b>134</b>	15.414	<b>CHENNAI</b>	<b>80</b>	9.182
SHENZHEN	42	15.250	<b>BANGALURU</b>	<b>96</b>	9.044
LONDON	17	15.211	BOGOTA	40	9.009

Shaded megacities indicate that they exceed the permissible limits of PM10.

Source: own elaboration based on data from the International Energy Agency 2019.

Air pollution is a phenomenon that is aggravated when population density is high. Population density is very high in countries such as Bangladesh, South Korea, India, Japan or Bahrain and, in the case of megacities, in Manila, Lagos, Delhi, Bangalore, Cairo, Dhaka or Tehran. It seems clear that it is at the local level that pollution control should be most decisive. For these reasons, its regulation is very important for the governments of countries and cities. From the Kyoto protocol (1997) to the climate report (IPCC, 2018) through the Paris agreements<sup>130</sup> (2015) and the Marrakech Climate Change Conference (2016), many countries have set themselves targets to reduce pollution and greenhouse gases. On the other hand, all these pollutants can also end up being a source of conflict between neighboring countries, regions and even between neighboring cities, due to the emission of toxic gases over less polluted areas. In volume, the most important pollutants are CO<sub>2</sub> emissions and PM10 particulate matter. In this research, only CO<sub>2</sub> emissions related to energy consumption and production processes of goods and services are analyzed.

The aim of this paper is to analyze to what extent CO<sub>2</sub> emissions are directly associated with energy consumption or imperfections in the production process of goods and services. The analysis is conducted across 20 countries over the period 1995-2015 with annual data from the International Energy Agency (2019). The countries in which the analysis is conducted represent 61% of the world's population in 2018 and belong to four continents. In the case of the European Union (EU), they include Ireland, France, Germany, Portugal and Spain. Iceland and the United Kingdom are also listed as European countries. The Asian countries analyzed in this research are: India, Indonesia, Saudi Arabia, Iran, Japan and China. Russia is also included. Some American countries are included, such as the United States, Brazil and Mexico. And the African countries included in this analysis are Morocco, South Africa and Nigeria. The five most important emerging countries considered in this analysis are included in the BRICS bloc.

The structure of this article is as follows: Section 2 deals with the background and literature Review. Section 3 contains the methodology and performs the modeling of the equations that attempt to explain the causal relationship between energy consumption and production and between CO<sub>2</sub> emissions and energy consumption. Section 4 analyzes the emissions. Section 5 contains the results obtained from the estimations of the equations obtained in the second section for the 20 countries in the sample. Section 6 contains the discussion of the results and, finally, section 7 contains the most relevant conclusions and policy implications of this research.

## 2. BACKGROUND AND LITERATURE REVIEW

The relationship between emissions and energy consumption, as well as the relationship between energy consumption and production, or production growth, has been widely analyzed since the pioneering work of Kraft and Kraft (1978), from which numerous researches on this topic are derived, but there is still no precise consensus on the relationship between energy consumption and economic growth. In this regard, two opposing positions can be identified: the first

130 United Nations Conference on Climate Change (Paris, December 2015) whose agreements were ratified and approved by the Parliament of the European Union on October 4, 2016. This European action on climate change has its background in articles 17, 18 and 19 of EU Directive 2009/28 / EC of the European Parliament and Council in April 23, 2009.

holds that changes in energy consumption have no clear effect on economic growth, and the second that there is some relationship between energy consumption and the level of production. There are enough studies that have attempted to empirically demonstrate this relationship in economies such as the United States (Abosedra and Baghestani, 1989), Gardner and Joutz (1996) and Soyatas, Sari and Ewing (2007); Canada (Ghali, 2004); Mexico (Caballero and Galindo, 2007) and Gómez (2010); Central American and Caribbean countries (Apergis and Payne, 2009). Studies in Asian countries have been conducted by Razzaqi, et al. (2011) and specifically in Bangladesh (Alam, et al., 2012); in China (Zhang and Cheng, 2009) for the period 1960-2007; in Taiwan (Cheng, 1997) for the period 1980-2007; in Pakistan (Siddiqui, 2004); in Iran (Zamani, 2007); in India (Mallick, 2009); in Turkey (Jobert and Karanfil, 2007) and Halicioglu (2009) for the period 1960-2005; Ang (2007a) examines the relationship between GDP, pollutant emissions and energy consumption in Malaysia between 1971 and 1999. In Africa, Belloumi (2009) examines the causal relationship between per capita energy consumption and per capita GDP in Tunisia for the period 1971-2004. In European countries, studies have been conducted in France (Ang, 2007b), Greece (Tsani, 2010), Russia (Zhang, 2011) and in Spain (Labandeira et al. 2017a, b). Medlock and Soligo (2001) have conducted analyses in 28 countries at different levels of development; Pao and Tsai (2010) have examined the relationships between CO<sub>2</sub> emissions, energy consumption and GDP in BRICS countries over the period 1990-2005; Mehrara (2007) has examined the causality between per capita energy consumption and per capita GDP through panel data on eleven oil exporting countries; Luzzati and Orsini (2009) study the relationship between energy consumption and per capita GDP in 113 countries for the period 1971-2004 and Farhani and Ben Rejeb (2012) conducted a study on 90 countries. Other research argues that increasing GDP increases pollution until the country reaches a certain per capita income, after which pollution starts to decrease (Hettige, Mani and Wheeler, 2000). In addition to all these authors, Srivivasan and Siddanth (2015) also found relationships between energy consumption and production level, which is not the case in the research of Yu and Choi (1992) and Altinay and Karagol (2004).

### 3. METHODOLOGY

Energy is a consumption good for consumers and, at the same time, a production factor for firms. We can assume an economy in equilibrium where there is a small number  $F$  of firms in imperfect competition, usually in oligopoly, in charge of supplying energy to a population of  $H$  consumers and to a large number  $N$  of firms producing consumer goods, which for simplicity we assume in perfect competition. We assume the absence of political or governmental interventions and call  $e_H$  the quantity of energy demanded by consumers as a good and  $c$  and  $R$  respectively the quantities of consumer goods and factors of production other than energy;  $p_e$ ,  $p_c$  and  $p_R$  are the respective unit prices. We assume that the unit price of energy ( $p_e$ ) is the same whatever the use of this energy. Energy used as a factor of production will be denoted as  $e_N$  if it plays the role of a factor of production in the  $N$  firms producing consumer goods  $c$  and when energy appears as a factor of production for the  $F$  firms supplying energy it will be denoted as  $e_F$ . We have assumed that the economy is in equilibrium and we also assume that the supply of energy is equal to the demand for energy, i.e., that the supply of energy provided by the  $F$  firms is demanded entirely as a good by the  $H$  consumers and as a factor of production by the  $N$  plus  $F$  firms in the economy. Denoting as  $e_S$  the amount of energy supplied by each of the  $F$  firms and, assuming that the agents are representative, the equilibrium in the internal energy market can be expressed in this form:

$$e_S \cdot F = e_H \cdot H + e_N \cdot N + e_F \cdot F \quad (1)$$

where the first member is the total energy supply and the second member is the total demand. We will simply denote as  $e$  the energy consumption in the market equilibrium, which is the energy consumption corresponding to the equality between energy supply and demand.

#### 3.1 Market structure.

We are assuming that the  $H$  consumers in the economy are a large number and are therefore competitive, i.e., the quantity of goods and energy demanded by each of them is very small relative to the overall quantities demanded in the market, so that each consumer individually cannot influence the market equilibrium price and are therefore price-accepting. The same is true for the  $N$  consumer-goods-producing firms, which we assume operate under perfect competition. But the  $F$  energy supplying firms are a small number of firms. The empirical application of the present theoretical model will be carried out on 20 countries in Europe, Asia, America and Africa, in each of which the number of energy supplying firms ranges from 2 (in Portugal) to 29 (in the United Kingdom). In general terms, therefore, these energy supply companies operate in imperfect competition, in an oligopoly regime, generally non-collusive. For the sake of simplicity, we assume that the product they offer is homogeneous: energy. In this sense, the simplest model to specify the operation of these companies is a Bertrand (1883)-type oligopoly, because its solution with homogeneous product is similar to that of perfect competition with few companies instead of infinite ones. Although it is an ideal model, there are some energy companies that compete, especially in the electricity market, according to the Bertrand oligopoly model. The Bertrand oligopoly model takes price as a strategic variable, i.e., companies compete on price. When the product is homogeneous, as in the case of energy, and under the assumption that all firms reach the same marginal cost in equilibrium, competition between firms ends up producing a price equal to the marginal cost, as in the case of perfect competition, even if there are only two firms in the market. Moreover, in equilibrium, zero profit for the firms ends up occurring, which is known as Bertrand's "paradox". To avoid the situation of zero profits, which does not usually occur in reality in the equilibrium of energy supply companies, we will also choose to analyze Cournot (1838)-type non-collusive competition in this type of companies. In applied studies of electricity markets, Cournot-type models are ubiquitous and are applied to a wide range of applications. The Cournot model takes quantities as the firm's strategy, i.e., firms compete on quantities, but not on prices as in Bertrand. The Cournot model is often well suited for application in the electric power market and are the

preferred choice when detailed modeling of technical characteristics, such as grid constraints, voltage stability, or start-up costs in the case of electric power, are needed. The impacts of congestion on prices and market power have also been analyzed with these models in several studies. Cournot models are easy to solve and provide, under the right conditions, a unique Nash equilibrium. An overview of the application of Cournot models in the analysis of market power issues can be found in Bushnell et al. (2008) and also in Palazuelos (2019) among others. Other applications of Cournot to energy markets, including the treatment of network problems in electricity supply, are discussed in Day et al. (2002) and Ventosa et al. (2005). However, following Klemperer and Meyer (1989), it is considered that the oligopolistic Supply Function Equilibria (*SFE*) model can represent power markets in a more realistic way than the Cournot model. *SFE* models assume that firms compete through continuous and fluid bidding in an oligopolistic market facing demand with uncertainty. And in the presence of uncertainty, firms take their supply function as a strategic variable. *SFE* models allow to find intermediate solutions located between Cournot and Bertrand and even collusion. These intermediate solutions occur in both equilibrium prices and quantities and are achieved by simply varying parametrically the hypothetical response of the supply function. The main drawbacks of supply function equilibrium models, as well as their derived models, are that they often have multiple equilibria, may have unstable solutions and require strong simplifications with respect to market and cost structures, all of which make *SFE* models difficult to compute, compared to Cournot models. Some authors such as Hu et al. (2004) conclude that, especially in the presence of congestion, the Cournot model is more efficient than the Supply Function Equilibrium (*SFE*) model. For all these reasons, in this paper we will alternatively use the Bertrand and Cournot models to explain the oligopolistic behavior of the *F* energy supply companies, in order to specify a relationship between energy consumption and the production of goods and services.

### 3.2 Consumers' energy demand:

Consumers maximize their utility conditional on their budget constraint. The utility function proposed for consumers, who choose between energy consumption ( $e_H$ ) and other consumer goods represented by a composite good ( $c$ ), is for simplicity of Cobb-Douglas type and has the following expression, for  $0 < \alpha < 1$ :

$$U(e_H, c) = e_H^\alpha c^{1-\alpha} \tag{2}$$

We assume that the prices of goods  $e_H$  and  $c$  do not vary with the quantity demanded by the consumer because, according to Mas-Colell et al. (1995), consumers are considered to be price-acceptors and cannot affect these prices because the quantity of energy ( $e_H$ ) and consumer goods ( $c$ ) demanded by each of them is insignificant in relation to the market, which implies that each consumer cannot influence it. Calling  $m$  the monetary disposable income per capita of the consumer, which we also assume constant in the short run, the behavior of the individual agents in each period will then be as follows:

$$\text{Max}\{U(e_H, c) = e_H^\alpha c^{1-\alpha}\} \text{ subject to: } e_H p_e + c p_c = m \tag{3}$$

Solving this maximization we obtain:  $m = \frac{p_e}{\alpha} e_H$ ; considering that this consumer is representative, in the absence of taxes we know that:  $H m = Y$  (monetary income or monetary *GDP* of the economy), i.e.:  $Y = \frac{p_e}{\alpha} H \cdot e_H$ . Therefore, the aggregate demand for energy by consumers, as a consumption good, will turn out to be:

$$H \cdot e_H = \frac{\alpha Y}{p_e} \tag{4}$$

### 3.3 Energy demand of firms producing consumer goods

In the economy there are  $N$  firms in perfect competition, firms that accept the price not being able to vary the price of  $c$  and that produce the consumer goods  $c$  maximizing profit. We assume that the goods  $c$  are, for simplicity, produced from a Cobb-Douglas type production function based on a series of production factors represented by a composite production factor ( $R$ ), plus energy ( $e_N$ ), which in this case functions as a production factor. That is:

$$c = A e_N^\beta R^{1-\beta} \tag{5}$$

with  $0 < \beta < 1$ .  $A$  is the coefficient of technical progress or technology which we assume to be neutral in the Hicks sense. The objective of each of these firms is to maximize profit  $B = p_c c - p_e e_N - p_R R$ . The demand for energy as a factor of production is a derived demand from profit maximization:

$$\text{Max} B = \text{Max} \left\{ p_c A e_N^\beta R^{1-\beta} - p_e e_N - p_R R \right\} \tag{6}$$

We assume that the markets for consumer goods  $c$  and factors  $R$  are in perfect competition, so that prices  $p_c$  and  $p_R$  appear as given.

**Bertrand case:** With respect to energy prices,  $p_e$ , in principle we assume that the  $F$  firms supplying energy to consumers and firms have non-collusive Bertrand (1883) type price competition among themselves, which implies that, although they form an oligopoly, their equilibrium is similar to that of perfect competition (for the  $F$  firms producing energy it must be satisfied:  $p_e = C'_{eF}$ ) since the product they offer (energy) is homogeneous. The derived energy demand is obtained by maximizing profit ( $B$ ) with respect to  $e_N$ :  $B'_{eN} = 0 = \beta \cdot p_c \cdot A \cdot e_N^{\beta-1} \cdot R^{1-\beta} - p_e$ , from where the energy demand of each firm is:  $e_N = \frac{\beta \cdot p_c \cdot c}{p_e}$ ; and for the  $N$  firms the demand will be:

$$e_N N = \frac{\beta \cdot (p_c \cdot c \cdot N)}{p_e} \tag{7}$$

**Cournot case:** Now, if we assume that the  $F$  firms producing and supplying energy operate as a non-collusive Cournot-type oligopoly, then the price of energy  $p_e$  is no longer given, nor is it equal to the marginal cost of energy, but depends

on the quantity of energy, according to the energy demand function:  $p_e = p_e(e_N)$ . This implies that the profit maximization from which the derived demand for energy as a factor of production is now extracted, is:

$$B'_{eN} = 0 = \beta p_c A e_N^{\beta-1} R^{1-\beta} - \left( \frac{dp_e}{de_N} e_N + p_e \right) = \beta p_c A e_N^{\beta-1} R^{1-\beta} - p_e \left( 1 - \frac{1}{\varepsilon} \right) = \beta p_c A e_N^{\beta-1} R^{1-\beta} - \frac{p_e}{\mu}$$

where  $\varepsilon$  is the elasticity of the derived energy demand faced by the firm and  $\mu$  the mark-up on the marginal costs of the energy supplying firm. From this maximization it follows that the amount of energy as a factor of production ( $e_N$ ) demanded by the firm is:  $e_N = \frac{\mu \cdot \beta \cdot p_c \cdot c}{p_e}$ ; and for the  $N$  firms the demand will result:

$$e_N N = \frac{\mu \cdot \beta \cdot (p_c \cdot c \cdot N)}{p_e} \tag{8}$$

### 3.4 Energy demand of energy supplying firms

The  $F$  firms that supply the good energy offered ( $e_S$ ) also use part of it as a factor of production ( $e_F$ ), according to a certain production function that for simplicity we also assume as a Cobb-Douglas type and whose arguments are energy as a production factor ( $e_F$ ) and the rest of production factors, represented by a composite factor  $R$ :

$$e_S = A e_F^\beta R^{1-\beta} \tag{9}$$

where  $e_S$  is the energy produced by each of the  $F$  companies and then supplied to the companies producing consumer goods and to consumers.

**Bertrand case:** The demand for energy is derived from the profit maximization by each of the  $F$  firms:  $Max B = Max \left( p_c A e_F^\beta R^{1-\beta} - p_e e_F - p_R R \right)$  whose result, considering that the price  $p_e$  is given by the Bertrand equilibrium, is:  $e_F = \frac{\beta \cdot p_c \cdot e_S}{p_e}$ ; and for the  $F$  firms the demand is:

$$e_F F = \frac{\beta \cdot (p_c \cdot e_S \cdot F)}{p_e} \tag{10}$$

Knowing that in an economy in equilibrium the income of sellers is equal to the expenditure of consumers and that the total annual nominal income of the economy ( $Y$ ) is the sum of the annual income of all firms:  $Y = (p_c c)N + (p_e e_S)F$ , where we know that the energy supplied by each firm ( $e_S$ ) is applied as a factor of production ( $e_N$ ) in the firms producing consumer goods, in addition to meeting the needs of consumers as a good ( $e_H$ ), the total derived demand for energy as a factor of production by the  $N + F$  firms, when the  $F$  firms operate a la Bertrand, by (7) and (10) will be:

$$N \cdot e_N + F \cdot e_F = \frac{\beta}{p_e} [(p_c c)N + (p_e e)F] = \frac{\beta}{p_e} Y$$

And the total energy demand ( $e_D$ ) of companies and consumers, taking into account (4), (7) and (10), will be:

$$e_D = H \cdot e_H + N \cdot e_N + F \cdot e_F = (\alpha + \beta) \frac{Y}{p_e} \tag{11}$$

where  $p_e$  is given. When the internal energy market is in equilibrium, the energy demand must be equal to the energy supply:  $e_D = e_S \cdot F = e$ , where  $e$  is the energy consumption in equilibrium.

**Cournot case:** Energy demand is derived from profit maximization by each of the  $F$  firms:  $Max B = Max \left( p_c A e_F^\beta R^{1-\beta} - p_e e_F - p_R R \right)$  but now the unit price of energy,  $p_e$ , is not given, but depends on the quantity of energy demanded as a factor of production:  $p_e = p_e(e_F)$ . The profit maximization from which the energy demand function is derived as a factor of production for each of the  $F$  supplying companies will now have the following expression:

$$B'_{eF} = 0 = A R^{1-\beta} \left( \frac{dp_e}{de_F} e_F^\beta + \beta e_F^{\beta-1} p_e \right) - \left( \frac{dp_e}{de_F} e_F + p_e \right) = \left[ A R^{1-\beta} e_F^{\beta-1} \left( \beta - \frac{1}{\varepsilon} \right) - \left( 1 - \frac{1}{\varepsilon} \right) \right] p_e$$

where  $\varepsilon$  is the elasticity of demand for energy as a factor of production and  $(1-1/\varepsilon)$  is  $1/\mu$ , where  $\mu$  is the same mark-up previously defined since we have assumed that the unit price of energy is the same whether it is a consumer good or a factor of production. Solving the maximization, the quantity demanded of energy as a production factor by each of the  $F$  companies is:  $e_F = [1 - \mu(1 - \beta)]e_S$ . Therefore, the quantity of energy demanded by all the  $F$  companies will be:

$$e_F F = [1 - \mu(1 - \beta)]e_S \cdot F \tag{12}$$

And the total energy demanded by the economy will be:  $e_D = H e_H + N e_N + F e_F$ . That is to say:

$$e_D = \frac{\alpha Y}{p_e} + \frac{\mu \cdot \beta \cdot (p_c \cdot c \cdot N)}{p_e} + [1 - \mu(1 - \beta)](e_S \cdot F) \tag{13}$$

Since the total income of the economy or money income is  $Y = (p_c c)N + (p_e e_S)F$ , we have that  $(p_c c)N = Y - (p_e e_S)F$  and substituting  $(p_c c)N$  in (13) we obtain the total energy demand:

$$e_D = \frac{(\alpha + \mu \cdot \beta)Y}{p_e} + (1 - \mu)(e_S \cdot F)$$

where the unit price of energy is not constant, but depends on the overall energy demand:  $p_e = p_e(e_D)$ . If we assume that the economy is energetically closed, i.e., consumers and firms receive energy only from the  $F$  supplying firms, then all the energy the energy produced by the supplying firms is distributed in this way:  $e_S \cdot F = e_F \cdot F + e_N \cdot N + e_H \cdot H$  where the first member is the total energy supply and the second member the total demand ( $e_D$ ). In equilibrium:  $e_S \cdot F = e_D = e$ , where  $e$  is the energy consumption when the energy market is in equilibrium. Substituting, we finally have that:

$$e = \frac{(\alpha + \mu \cdot \beta)Y}{\mu \cdot p_e} \tag{14}$$

where  $p_e$  is not constant. To value  $p_e$  at equilibrium, the energy supply must be analyzed.

### 3.5 Energy supply

We have assumed that each of the  $F$  energy supplying firms produce according to a Cobb-Douglas production function of the type:  $e_S = Ae_F^\beta R^{1-\beta}$ , with a cost function:  $C = p_e e_F + p_R R$ , where  $e_F$  is the endowment of energy as a factor of production,  $R$  involves the other factors of production other than energy but necessary to produce it,  $A$  is the coefficient of technical progress or technology and  $e_S$  the quantity of energy produced and supplied. To the Cobb-Douglas production function mentioned (9) corresponds a variable cost function dependent on  $e_S$ , which is obtained by minimizing the cost function  $C$  subject to the production function:

$$\text{Min}(C(e_F, R) = p_e e_F + p_R R) \text{ subject to: } e_S = Ae_F^\beta R^{1-\beta} \quad (15)$$

**Bertrand case:** Minimizing by Lagrange considering factor prices as given, a relationship is established between the two factors of production that allows to put each of them as a function of output  $e_S$ . Once these results have been substituted in the expression of the costs ( $C$ ), we can obtain the expression of the variable costs ( $Cv$ ) as a function of  $e_S$ , corresponding to the production function (9):

$$Cv = \left(\frac{p_e}{\beta}\right)^\beta \left(\frac{p_R}{1-\beta}\right)^{1-\beta} \frac{e_S}{A} \quad (16)$$

to which corresponds the following marginal cost function ( $C'$ ) with respect to  $e_S$ :

$$C'_{e_S} = \frac{1}{A} \left(\frac{p_e}{\beta}\right)^\beta \left(\frac{p_R}{1-\beta}\right)^{1-\beta} \quad (17)$$

Function that in this case turns out to be constant for the  $F$  firms, because it does not depend on the quantity of energy and the prices  $p_e$  and  $p_R$  are constant. When the  $F$  oligoplastic energy supplying companies maintain a Bertrand-type competition, competing on prices, in equilibrium they will equal the selling price of energy to the marginal cost ( $p_e = C'_{e_S}$ ) in a single market. Therefore, the market equilibrium can be expressed by equating price to marginal cost, from (11 and 17):

$$p_e = (\alpha + \beta) \frac{Y}{e} = \frac{1}{A} \left(\frac{p_e}{\beta}\right)^\beta \left(\frac{p_R}{1-\beta}\right)^{1-\beta} \quad (18)$$

from which we can obtain the total energy consumption in the market equilibrium (e):

$$e = (\alpha + \beta) \beta^\beta (1 - \beta)^{1-\beta} \frac{A \cdot p \cdot y}{p_e^\beta \cdot p_R^{1-\beta}} \quad (19)$$

equation in which monetary income  $Y$  has been broken down into its components, general price level  $p$  and real income  $y$ :  $Y = p \cdot y$ , where  $y$  is now income in real terms or  $GDP$  at constant prices. What is indicated in expression (19) is that energy consumption depends directly on real income and inversely on the price of energy and the prices of the other factors of production.

**Cournot case:** To perform the conditional minimization (15) with the idea of obtaining the variable cost function corresponding to the Cobb-Douglas production function,  $e_S = Ae_F^\beta R^{1-\beta}$ , we must use Lagrange's method taking into account that we assume the factor market  $R$  in perfect competition, i.e., we consider  $p_R$  as given. The same is not true for  $p_e$ , since  $p_e = p_e(e_F)$ . The Lagrangean function ( $\mathcal{L}$ ) of the problem is:

$$\mathcal{L}(e_F, R, \rho) = p_e \cdot e_F + p_R \cdot R + \rho \cdot (e_S - A \cdot e_F^\beta \cdot R^{1-\beta}). \text{ First-order conditions:}$$

$$\mathcal{L}'_{e_F} = \left(\frac{dp_e}{de_F} \cdot e_F + p_e\right) - \beta \cdot A \cdot e_F^{\beta-1} \cdot R^{1-\beta} \cdot \rho = 0$$

$$\mathcal{L}'_R = p_R - (1 - \beta) \cdot \lambda \cdot e_F^\beta \cdot R^{-\beta} \cdot \rho = 0$$

Considering again that  $1 - 1/\varepsilon = 1/\mu$ , where in this case  $\varepsilon$  is the elasticity of demand for energy as a factor of production for a firm in the group of  $F$  firms and  $\mu$  the mark-up that these firms put on marginal costs, equating the Lagrange multipliers ( $\rho$ ) of the two first-order conditions and substituting the results in the production function, we obtain the relationship between factors of production and output, i.e. between  $e_F$  and  $e_S$ , and between  $R$  and  $e_S$ . Substituting these relationships in the variable cost function to be minimized, we obtain the variable cost function of the firm as a function of  $e_S$ :

$$Cv = p_e e_F + p_R R = \frac{p_e}{A} \left[\frac{(1-\beta)p_e}{\mu \cdot \beta \cdot p_R}\right]^{\beta-1} e_S + \frac{p_R}{A} \left[\frac{(1-\beta)p_e}{\mu \cdot \beta \cdot p_R}\right]^\beta e_S \quad (20)$$

Denoting now  $X = \frac{1}{A} \left[\frac{1-\beta}{\mu \cdot \beta \cdot p_R}\right]^{\beta-1}$ , and as  $Z = \frac{p_R}{A} \left[\frac{1-\beta}{\mu \cdot \beta \cdot p_R}\right]^\beta$ , the marginal cost function will be:

$$C'_{e_S} = (X + Z) \cdot p_e^\beta \cdot \left[\frac{\mu \cdot (1-\beta) + \beta}{\mu}\right] \quad (21)$$

### 3.6 Equilibrium

We will now assume, just for simplicity, that the  $F$  supplying firms have identical marginal cost in equilibrium. This implies that if the  $F$  firms compete in Cournot style, where competition is in quantities, the amount of energy that ends up being offered to the market by each firm is identical for all firms. We will assume, also for simplicity that the mark-ups imposed on marginal costs by the  $F$  firms are identical ( $\mu$ ). Since the energy supply companies are operating under imperfect competition, the relationship between the selling price and the marginal cost is:  $p_e = \mu \cdot C'_e$ . Taking into account the value of from (21), the unit selling price of energy for each company will be:

$$p_e = [(X + Z)[\mu(1 - \beta) + \beta]]^{\frac{1}{1-\beta}} \quad (22)$$

In a non-collusive Cournot-type oligopoly this price is the same for all firms. But we know that the market equilibrium price is given by equation (14). That is:

$$p_e = \frac{(\alpha + \mu\beta)}{\mu \cdot e} Y \tag{23}$$

where  $e$  is the energy consumption in the market equilibrium. Equating the prices given by relations (22) and (23), we finally have that if in the oligopoly formed by the  $F$  firms, these compete in Cournot style, the energy consumption of the economy will then be:

$$e = \left(\frac{\alpha + \mu\beta}{\mu}\right) \left(\frac{1-\beta}{p_R}\right) (\mu\beta)^{\frac{\beta}{1-\beta}} \left[\frac{A}{\beta(1-\beta)(\mu-1)^2 + \mu}\right]^{\frac{1}{1-\beta}} p y \tag{24}$$

Where monetary income  $Y$  has been broken down into its two components: general price level ( $p$ ) and real income ( $y$ ). If a regression line could be fitted to the overall energy demand function faced by each firm then the mark-up on marginal costs imposed by each of the  $F$  firms competing in Cournot can be approximated as:  $\mu = \frac{F+3}{F+1}$ , where  $F$  is the number of firms composing the oligopoly, obviously for  $F > 1$ , because it is an oligopoly. If  $F = 1$  it would be a monopoly and the mark-up would then be  $\mu = 2$ . When  $\mu = 1$  we have Bertrand's solution, for which, the energy consumption will be:

$$e = (\alpha + \beta) \left(\frac{1-\beta}{p_R}\right) \beta^{\frac{\beta}{1-\beta}} A^{\frac{1}{1-\beta}} p y \tag{25}$$

It can be verified that energy consumption in equilibrium is higher when firms compete on prices (Bertrand), according to equation (25), than when they compete on quantities (Cournot), according to equation (24). Calling  $\lambda_0$  the term  $\left(\frac{\alpha + \mu\beta}{\mu}\right) (1 - \beta) (\mu\beta)^{\frac{\beta}{1-\beta}} \left[\frac{1}{\beta(1-\beta)(\mu-1)^2 + \mu}\right]^{\frac{1}{1-\beta}}$ , and taking natural logarithms in (24), but also considering (19) and (25) we can obtain a first explanatory linear expression of energy consumption in an economy; but when regressing the equation along a database, most probably the coefficient  $\lambda_0$  would be highly significant, manifesting the existence of omitted variables. One of them may be related to the population level ( $PO$ ) of the economy since it seems evident that higher population may correspond to higher energy consumption, so a more complete specification of equilibrium energy consumption to be regressed could be:

$$\log_e e = \lambda_0 + \lambda_2 \log_e A + \lambda \log_e y + \lambda_3 \log_e p + \lambda_4 \log_e p_e + \lambda_5 \log_e p_R + \lambda_1 \log_e P O + \varepsilon \tag{26}$$

where  $\varepsilon$  is a random disturbance.

### 3.7 Emissions

Energy production and consumption processes involve emissions of gases and particulates, but a good part of the emissions seem to come from heating and air conditioning of dwellings and buildings.

Therefore, we can assume that a certain percentage of the total pollutant emissions ( $Em$ ) are a by-product of energy consumption specifically dedicated to heating and cooling ( $e_{cr}$ ), so in principle we can express:

$$Em = \rho \cdot e^\gamma \cdot e_{cr}^{\gamma_1} \tag{27}$$

where  $\rho$ ,  $\gamma$  and  $\gamma_1$  are parameters. Some of the variables that explain the emissions caused by  $e_{cr}$  consumption may be related to environmental conditions, specifically variations in ambient temperature that affect heating and cooling consumption, as well as wind or rainfall, which can affect the dispersion of gas and particle emissions associated with energy production and consumption. From Joule (1850) it is known that the amount of heat required to raise or lower the temperature of a body of mass  $M$  is:  $Q = s \cdot M \cdot \Delta T$ , where  $Q$  is heat,  $s$  a constant called specific heat and  $\Delta T$  the temperature increase in Celsius degrees ( $^{\circ}C$ ); at the same time it is established that the accumulated heat energy ( $E$ ) is:  $E = J \cdot Q$ , where  $J$  is a universal constant called the mechanical equivalent of the kilocalorie. Therefore  $E = J \cdot s \cdot M \cdot \Delta T$  is the extra energy consumption caused by variations in ambient temperature. Since we have assumed that this consumption is basically due to heating and cooling ( $e_{cr}$ ), we can express that:  $e_{cr} = \theta \cdot J \cdot s \cdot M \cdot \Delta T$ , where  $\theta$  is a parameter reflecting a proportionality. Therefore, the expression (27) will now take the following form.

$$Em = \rho \cdot e^\gamma (\theta \cdot J \cdot s \cdot M \cdot \Delta T)^{\gamma_1} \tag{28}$$

Which indicates that emissions caused by energy consumption are amplified or reduced by the effect of environmental conditions. Taking natural logarithms in (28), concentrating the constant terms in  $\gamma_0$  and being  $\varepsilon$  a random disturbance, the equation to be estimated to explain emissions will finally have the following expression:

$$\log_e E m = \gamma_0 + \gamma \log_e e + \gamma_1 \log_e (M \cdot \Delta T) + \varepsilon \tag{29}$$

## 4. DATA AND EMPIRICAL RESULTS

As mentioned above, the objective of this research is to determine whether CO<sub>2</sub> emissions to the atmosphere are primarily due to energy consumption or imperfections in the countries' production process, or both, and in what proportion. To find out, equations (26) and (29) have been regressed over 20 countries during the period 1995-2015 with annual data. The 20 selected countries belong to consolidated economic blocs: on the European Union side are Ireland, France, Germany, Spain and Portugal. One non-EU European country are Iceland and United Kingdom. The BRICS countries include India, China, Russia, Brazil and South Africa; other Asian countries include Indonesia, Japan, Saudi Arabia and Iran; other American countries include the United States and Mexico; and finally there are other African countries in the sample, such as Nigeria and Morocco. The application has been carried out with data from the International Energy Agency (2019) and equations (26) and (29) have been adapted to perform the regressions according to the data. In order to have sufficient degrees of freedom, the prices of goods and factors, which, together with technology, have been included in the regression intercept, have been left out. In this way, equation (26), which explains energy consumption ( $e$ ), has been simplified, finally estimating the following equation:

$$\log_e e = \lambda_0 + \lambda \log_e y + \lambda_1 \log_e P O + \varepsilon \tag{30}$$

where  $\varepsilon$  is a random disturbance and  $e$  is the annual energy consumption<sup>131</sup> measured in thousands of tons of oil equivalent (ktoe<sup>132</sup>).  $PO$  is the population of the country measured in millions of inhabitants, and  $y$  is the real output of the economy measured at power parity purchasing in billions of constant 2010 US\$. Equation (29), which explains CO<sub>2</sub> emissions, will be estimated considering that the following considerations will be made regarding the term  $M \cdot \Delta T$ :  $\Delta T$  is the difference between the annual average maximum and minimum temperatures measured in Celsius degrees (°C) with respect to an ideal temperature, which in our case has been taken as 19 °C.  $M$  is the mass of the bodies to be heated or cooled. In this research,  $M$  has been taken for simplicity as the total population ( $PO$ ) of the country<sup>133</sup> measured in millions of inhabitants. And calling  $PO \cdot \Delta T$  as  $TPO$ , the equation (29) to be finally regressed will be:

$$\log_e Em = \gamma_0 + \gamma \log_e e + \gamma_1 \log_e(TPO) + \varepsilon \tag{31}$$

where  $\varepsilon$  is a random disturbance,  $e$  the annual energy consumption and  $Em$  the annual CO<sub>2</sub> emissions discharged by each economy.

To detect whether or not there is spatial dependence in energy consumption and emissions across the 20 countries in the sample, the I-test (Moran, 1950) was applied. The results in Table 2 show a slight spatial dependence in energy consumption and no spatial dependence in emissions. To verify whether the possible spatial dependence is due to dependence on the endogenous variables (lag dependence) or on the disturbances (error dependence), other tests based on the Lagrange multiplier applied to the residuals of an OLSQ regression have been used: Burrigge's (1980) LM(err) and robust RLM(err) tests, which measure the spatial dependence in error, and Anselin's (1998) LM(lag) and robust RLM(lag) tests, which measure the spatial dependence of the endogenous variables. None of these last four tests shows any evidence of spatial dependence in either energy consumption or emissions, possibly due to the dispersion of the countries selected in the sample. Table 2 shows the results of the estimations of the equation (30) -regressions I to XII- and of the equation (31) -regressions XIII to XIV- for half of the countries in the sample, plus the overall regression on the 20 countries with panel data (models XII and XIV).

**Table 2. Estimates of energy consumption and CO<sub>2</sub> emissions by country**

	UK	France	Spain	Portugal	Russia	India	Iran	Indonesia	China	Morocco	Global
<b>I</b>	<b>II</b>	<b>III</b>	<b>IV</b>	<b>V</b>	<b>VI</b>	<b>VII</b>	<b>VIII</b>	<b>IX</b>	<b>X</b>	<b>XI</b>	<b>XII</b>
<b>Met.</b>	<b>AR1</b>	<b>MCO</b>	<b>MCO</b>	<b>AR1</b>	<b>AR1</b>	<b>MCO</b>	<b>AR1</b>	<b>MCO</b>	<b>MCO</b>	<b>AR1</b>	<b>Panel Random Effects</b>
Ln e	<b>(Energy consumption)</b>										
Const	19.27 (23.6)	15.35 (11.5)	10.02 (2.87)	2.89 (1.00)	-26.1 (-1.0)	16.6 (2.53)	-1.22 (-1.3)	8.32 (3.67)	53.9 (1.37)	4.50 (1.55)	5.25 (3.48)
Ln y [λ]	0.43 (3.64)	0.96 (3.56)	1.55 (1.71)	0.95 (1.88)	0.40 (1.69)	0.88 (3.09)	0.38 (2.23)	0.56 (2.18)	1.03 (2.48)	0.82 (2.06)	0.53 (3.06)
Ln PO	-2.62 (-6.7)	-2.61 (-3.5)	-2.60 (-1.1)	0.67 (0.76)	6.52 (1.31)	-1.57 (-1.2)	2.41 (4.9)	-0.12 (-0.18)	-6.86 (-1.1)	0.16 (0.11)	0.35 (2.10)
DW	3.04	2.51	1.81	1.29	2.44	3.27	2.94	2.06	2.98	2.01	
R <sup>2</sup> -adj	0.81	0.73	0.70	0.61	0.48	0.98	0.99	0.76	0.94	0.97	0.56
Lagr. Mult.											21.5 pv: 0.004
Hausman											7.77 pv: 0.1
Moran's I		0.242	St. Dev.: 1.8021		p-value = 0.035 < 0.05			Small Global Spatial Dependence			
LMerr		1.4855			p-value = 0.223 > 0.05			No Spatial Error Dependence			
RLMerr		2.7872			p-value = 0.095 > 0.05			Non-robust Error Dependence			
LMlag		1.2872			p-value = 0.256 > 0.05			No Spatial Lag Dependence			
RLMlag		2.5890			p-value = 0.107 > 0.05			Non-robust Spatial Lag Dependence			

131 Total final consumption: residential energy consumption, transportation, industrial, services and primary sector, but energy consumption in transportation, industrial and primary sector are considered associated in this work to the "Economic Activity". Residential energy consumption and services are assumed as "Consumption".

132 1 ktoe = 11630000 kWh.

133 Strictly speaking, it would have been necessary to multiply for each country each inhabitant by its mass or by the average mass of the inhabitants but, assuming that on average the inhabitants of the countries have a similar mass, it was preferred to normalize the mass of each inhabitant to the unit.

	UK	France	Spain	Portugal	Russia	India	Iran	Indonesia	China	Morocco	Global
XIII	XIV	XV	XVI	XVII	XVIII	XIX	XX	XXI	XXII	XXIII	XXIV
Met.	MCO	MCO	AR1	MCO	AR1	MCO	MCO	AR1	AR1	MCO	Panel Between
Ln Em	<b>(Emissions)</b>										
Const	-15.4 (-5.3)	-14.4 (-1.4)	-5.60 (-1.9)	-3.08 (-0.54)	1.73 (0.47)	-10.1 (-7.1)	-5.50 (-3.4)	-13.7 (-14.06)	-11.3 (-6.8)	-6.10 (-7.7)	-6.62 (-5.8)
Ln e [y]	1.73 (8.04)	1.81 (2.03)	0.77 (2.67)	0.85 (1.93)	0.36 (1.51)	1.70 (10.2)	0.91 (2.64)	1.59 (8.23)	1.20 (23.0)	0.82 (5.52)	1.03 (6.40)
Ln TPO	0.14 (1.14)	-0.21 (-0.5)	0.36 (1.23)	-0.31 (-0.24)	0.09 (0.77)	-0.49 (-1.4)	0.11 (0.13)	0.08 (0.35)	0.31 (1.67)	0.36 (1.06)	0.71 (0.47)
DW	3.16	1.21	1.51	2.34	2.35	3.01	1.46	2.38	1.76	2.78	
R <sup>2</sup> -adj	0.94	0.67	0.65	0.66	0.50	0.99	0.98	0.97	0.99	0.99	0.90
Moran's I		-0.028	St. Dev.: 0.3421		p-value = 0.366 > 0.05			No Global Spatial Dependence			
LMerr		0.0204			p-value = 0.885 > 0.05			No Spatial Error Dependence			
RLMerr		0.6939			p-value = 0.404 > 0.05			Non-robust Error Dependence			
LMlag		0.3988			p-value = 0.527 > 0.05			No Spatial Lag Dependence			
RLMlag		1.0722			p-value = 0.301 > 0.05			Non-robust Spatial Lag Dependence			

Source: own elaboration. Note: t-ratios in brackets

From these regressions we extract the coefficients of  $\log_e y$  and of  $\log_e e$ , respectively coefficients  $\lambda$  and  $\gamma$  from equations (30) and (31). According to the estimates, these coefficients turn out to be significant at 99 % in general, except in regressions IV, V, VI and XVII where the significance of the estimators is somewhat lower. The regressions for the countries have been performed by ordinary least squares (OLS) method, correcting as far as possible for autocorrelation by assuming that the residuals follow a first-order autoregressive process (AR1), although in some of the estimates there is still temporal autocorrelation of the residuals. All regressions have high or acceptable R<sup>2</sup>-adjusted coefficients of determination. Table 2 does not report the regressions for the entire sample of countries, only for ten of them, but the remaining coefficients  $\lambda$  and  $\gamma$  not reported in Table 2 are reported below in columns IV and V of Table 5. Regression XII in Table 2 shows the panel estimate for the 20 countries in the sample over the 1995-2015 period in terms of the relationship between the log of energy consumption and the log of the real output (equation 30), with the best panel estimate being the Random Effects (Random Effects) estimate, since the p-value of the Lagrange multiplier test (Breuch and Pagan, 1980) is less than 0.05, which rejects the OLSQ-plains estimation, while the p-value of the Hausman (1978) test is greater than 0.05, which rejects the Fixed Effects estimation. As for the panel estimation of the logarithm relationship between CO<sub>2</sub> emissions and energy consumption (equation 31), the results indicate that the best panel regression is the Between Groups estimation, reported in regression XIV.

To verify whether the series involved in the regressions in Table 2 do not have unit roots, i.e., whether they are stationary, the Harris and Tzavalis (1999) test for panel data was used. The results of this test indicate that all the series involved are stationary, as can be seen in Table 3 in which the Rho parameters of the lagged variables are all less than unity. Given that they are all stationary, it is of interest to know whether there are causal relationships between the exogenous and endogenous variables of the two regressions in Table 2. For this purpose, the Granger causality test (1969) has been used, the results of which are shown in Table 3.

**Table 3. Stationarity and Granger causality between variables**

Stationarity Obs.: 100	Harris & Tzavalis	Panel	Endog	Explan.	Lagged Explan	Panel	R <sup>2</sup> -adj.	Granger Causality
$Y_t = \rho Y_{t-1} + \varepsilon_t$	<i>Rho</i>		Ln e	LnPO		RE	<b>0.5474</b>	
$\rho \text{Ln } e(-1)$	0.66 < 1	RE		Ln y	LnPO	RE	0.5503	PO → e
$\rho \text{Ln } \text{Em}(-1)$	0.85 < 1	FE			Ln y	RE	0.5495	y → e
$\rho \text{Ln } \text{TPO}(1)$	0.50 < 1	FE	Ln Em	Ln e		FE	<b>0.8105</b>	
$\rho \text{Ln } \text{PO}(1)$	0.87 < 1	FE		LnTPO	Ln e	FE	0.8106	e → Em
$\rho \text{Ln } y(1)$	0.74 < 1	RE			LnTPO	FE	0.8132	TPO → Em

Source: own elaboration. Note: FE (Fixed Effects); RE (Random Effects).

It can be seen from this table that there is Granger causality between real income (y) and population (PO) on energy consumption (e); and there is also Granger causality between the variable TPO (temperature multiplied by the population) and energy consumption (e) on the volume of emissions (Em), because the respective regressions with lagged explanatory variables imply a higher prediction of the endogenous variable.

The economic interpretation of the  $\lambda$  estimators is relevant, since:  $\lambda = \frac{\partial \log_e e}{\partial \log_e y} = \frac{\Delta e}{\Delta y} \cdot \frac{y}{e}$ , i.e., they are energy-income elasticities, from which we can know how much energy consumption varies when the country's production varies:

$$\frac{\Delta e}{\Delta y} = \lambda \cdot \frac{e}{y} \tag{32}$$

The term  $(e/y)$  is called energy intensity and is an indicator of the energy efficiency of each country. Columns III and IV of Table 4 show the countries in the sample ordered from lowest to highest energy intensity for 2015 data.

Table 4. CO<sub>2</sub> emissions, Energy Intensities and fossil energies (2015)

Emissions (Mt of CO <sub>2</sub> ) for each ktoe consumed (2015)		Energy Intensity: Tn of CO <sub>2</sub> per10000 US \$ produced (2015)		Fossil energy consumption (% of total)
I	II	III	IV	V
Nigeria	655	Nigeria	0.82	18.91
Iceland	718	Ireland	1.24	89.95
Brazil	1988	France	1.39	63.33
France	2266	Iceland	1.46	14.60
Indonesia	2734	Brazil	1.52	57.48
Portugal	2889	United Kingdom	1.57	86.34
Iran	3061	Spain	1.67	77.45
Spain	3099	Portugal	1.69	73.85
United Kingdom	3119	Indonesia	1.74	66.15
Russia	3210	Germany	2.09	81.60
U.S.A.	3263	Morocco	2.18	87.75
Germany	3315	Mexico	2.19	90.17
Ireland	3332	Japan	2.44	92.24
Morocco	3644	India	2.75	68.51
India	3668	U.S.A.	2.95	86.70
Saudi Arabia	3688	Saudi Arabia	3.41	99.99
Mexico	3689	Iran	4.31	98.94
Japan	3878	Russia	4.65	90.97
China	4650	China	5.00	87.50
South Africa	5835	South Africa	6.14	85.60

Source: own elaboration based on data from the International Energy Agency 2019

Lower energy intensity generally corresponds to higher energy efficiency. Columns I and II of the same table show the countries ordered by amounts emitted of CO<sub>2</sub> per ktoe of energy consumed, from lowest to highest emission. There seems to be a certain correlation between the two parts of the table and also between the massive use of fossil fuels (column V) in the last countries in column III and the higher proportion of renewable energy use in the first countries in this column. The evolution of energy intensity by blocks of countries in the sample from 1995 to 2015 can be seen in Figure 1. This figure shows that the lowest energy intensity is in the European countries and the highest in the BRICS countries. It can also be observed how energy intensity decreases over time in the four blocks of countries, probably due to the increase in efficiency in energy consumption, due to the progressive substitution of fossil energy for renewable energy.

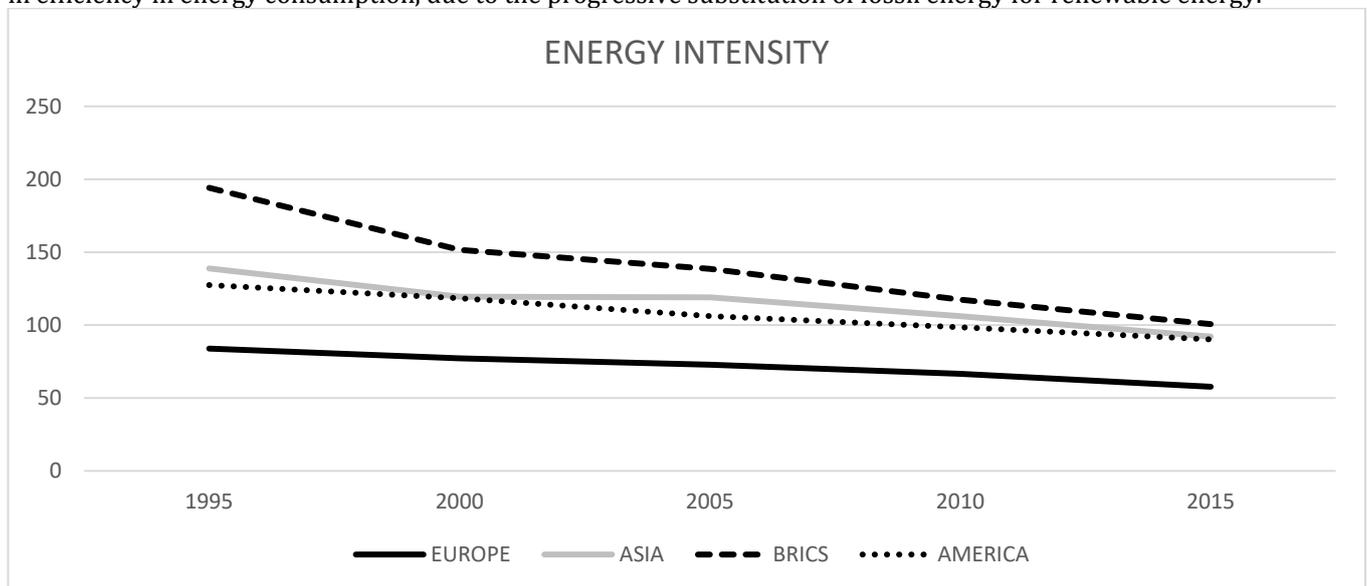


Figure 1. Evolution of the energy intensity by block of countries (1995- 2015)

Source: own elaboration based on data from the International Energy Agency 2019.

From equation (20) we can deduce that  $\gamma = \frac{\partial \log_e(Em)}{\partial \log_e e} = \frac{\Delta(Em)}{\Delta e} \cdot \frac{e}{Em}$ , from which we can infer how much emissions increase by energy consumption:

$$\frac{\Delta Em}{\Delta e} = \gamma \cdot \frac{Em}{e} \tag{33}$$

We want to know to what extent the increase in CO<sub>2</sub> emissions, when energy consumption increases, is greater or smaller than the increase in CO<sub>2</sub> emissions, when GDP increases. The term  $\lambda \cdot \gamma = \left(\frac{\partial \log_e e}{\partial \log_e y}\right) \left(\frac{\partial \log_e Em}{\partial \log_e e}\right) = \frac{\Delta Em}{\Delta y} \cdot \frac{y}{Em}$ , therefore, the increase in emissions when real income (real GDP) increases is:

$$\frac{\Delta Em}{\Delta y} = \lambda \cdot \gamma \cdot \frac{Em}{y} \tag{34}$$

**Table 5. Energy productivity and contribution to CO<sub>2</sub> emissions (2015)**

Countries	Average Energy Productivity (y/e) 2015. Billions US\$ ctes (2010) / ktoe	Marginal Energy Productivity (Δy/Δe) 2015	λ · γ	γ	CO <sub>2</sub> Emissions Tn of CO <sub>2</sub> per capita (2015)	Contribution to CO <sub>2</sub> emissions $\frac{\Delta Em}{\Delta y} - \frac{\Delta Em}{\Delta e}$
I	II	III	IV	V	VI	VII
Ireland	<b>0.026</b>	<b>0.096</b>	0.26	0.96	<b>7.29 &gt; 6.19</b>	0.028 < 0.165
UK	<b>0.019</b>	<b>0.045</b>	0.74	1.73	5.93	0.110
Spain	0.018	0.012	1.19	0.77	5.28	<b>0.195</b>
Portugal	0.017	0.017	0.80	0.85	4.53	0.132
Mexico	<b>0.0168</b>	<b>121.6</b>	0.0002	1.27	3.54	-0.004
Morocco	<b>0.0167</b>	<b>0.020</b>	0.67	0.82	1.54	0.142
France	0.0163	0.016	1.73	1.81	4.34	<b>0.200</b>
Japan	<b>0.01586</b>	<b>-0.015</b>	-0.47	0.47	<b>9.10 &gt; 6.19</b>	-0.115 < 0.165
Germany	<b>0.01583</b>	<b>-0.076</b>	-0.57	2.78	<b>8.72 &gt; 6.19</b>	-0.128 < 0.165
Indonesia	<b>0.0157</b>	<b>0.028</b>	0.87	1.59	1.72	0.145
India	0.014	0.014	1.49	1.70	1.48	<b>0.401</b>
Brazil	<b>0.012</b>	<b>5.0</b>	0.0028	1.14	2.15	-0.001
U.S.	0.011	0.011	1.02	1.02	<b>15.04 &gt; 6.19</b>	<b>0.297 &gt; 0.165</b>
Saudi Arabia	0.010	0.009	1.20	1.03	<b>16.36 &gt; 6.19</b>	<b>0.402 &gt; 0.165</b>
South Africa	<b>0.0095</b>	<b>-0.00008</b>	2.21	-0.02	<b>7.25 &gt; 6.19</b>	<b>1.350 &gt; 0.165</b>
China	0.0093	0.009	1.23	1.20	<b>6.54 &gt; 6.19</b>	<b>0.607 &gt; 0.165</b>
Nigeria	<b>0.0079</b>	<b>0.074</b>	0.28	2.83	0.40	0.021
Iran	<b>0.0071</b>	<b>0.018</b>	0.34	0.91	<b>6.79 &gt; 6.19</b>	0.143 < 0.165
Russia	<b>0.0070</b>	<b>0.016</b>	0.15	0.36	<b>9.97 &gt; 6.19</b>	0.067 < 0.165
Iceland	0.005	0.005	0.03	0.03	5.85	0.003
Efficiency of e: (y/e) ≥ (Δy/Δe) > 0			Averages:		6.19	0.165 (panel)

Source: own elaboration. Note: The shaded figures exceed the established criteria.

From (33) and (34) we can see which emits more, whether the production process of y or the energy consumption process (e), i.e., how much the difference is worth:  $\frac{\Delta Em}{\Delta y} - \frac{\Delta Em}{\Delta e}$ . The results, with 2015 data are shown in column VII of Table 5. When this difference is positive, the increase in production emits more CO<sub>2</sub> than the increase in energy consumption, which would indicate the need to reduce emissions caused by the production process.

**5. RESULTS AND DISCUSSION**

From the estimates for the 20 countries in the sample, of which for 10 of them are shown in Table 2, we obtain the corresponding estimators of λ and γ for each country, which are collected in columns IV and V of Table 5. Using expressions (33) and (34) with 2015 data we obtain the results in column VII. Considering the coefficients λ and γ obtained in estimations XII and XIV with panel data from Table 2 we obtain that the average difference  $\frac{\Delta Em}{\Delta y} - \frac{\Delta Em}{\Delta e}$  is 0.165 which shows that overall  $\frac{\Delta Em}{\Delta y} > \frac{\Delta Em}{\Delta e}$ . That is, as seen in column VII, what emissions increase when real GDP increases in general is more than what emissions increase when energy consumption increases. This implies that in the economies where this is the case, there are emitting production processes suggesting that an improvement in these production processes could cause emissions to decrease. There are only four countries in the sample, Mexico, Brazil, Japan and Germany, in which the increase in CO<sub>2</sub> emissions related to energy consumption are greater than those associated with economic activity, implying that the marginal productivity of energy is greater than one<sup>134</sup> (Brazil and Mexico) or that emissions decrease when production increases due to the Kuznets<sup>135</sup> effect (Germany and Japan). Countries whose difference is greater than the average provided by the panel data estimation (0.165) should improve their production processes. These countries are shaded in column VII of Table 5. Column VI shows the countries whose CO<sub>2</sub> emissions per capita are higher than the sample average (6.19 tons of CO<sub>2</sub> per capita), from which Ireland, Japan, Germany, Iran and Russia should reduce energy consumption while the United States, Saudi Arabia, South Africa and China should incorporate less polluting production processes, comparing the results of columns VI and VII. Columns II and III of Table 5 relate to the efficiency in the use of production factors, including energy, relative to 2015. Assuming that the production functions of the firms in the economy are homogeneous of degree one, as corresponds to the production functions (5), whose arguments are energy as a production factor (e<sub>N</sub>) plus a series of production factors (R), some of which we assume

134 If (ΔEm / Δe) > (ΔEm / Δy) then (1 / Δe) > (1 / Δy), that is: (Δy / Δe) > 1. See Table 5, column III.

135 From a high level of per capita income, emissions decrease as production increases.

fixed during 2015, then if we consider energy as a variable factor all production factors are efficiently used by the firm when production is between the technical optimum<sup>136</sup> and the technical maximum of a productivity function where energy acts as a variable factor. At that stretch the average productivity function of energy lies above the marginal productivity function of energy as a factor of production. Aggregating the productivity functions of the firms in the economy it can be deduced that the efficient use of all factors of production, including energy, is obtained when over the aggregate productivity function, the average productivity of energy (Table 5, column II) is equal to or greater than the marginal productivity of energy (Table 5, column III) the latter being non-negative:  $(y/e) \geq (\Delta y/\Delta e) \geq 0$ . Therefore the shaded results in columns II and III belong to countries that probably did not efficiently use energy as a factor of production in 2015. According to the results in Table 5, it can be assured under the assumption of aggregate production functions with constant returns to scale but decreasing returns to capital factor that, of the 20 countries analyzed only Spain, Portugal, France, India, the United States, Saudi Arabia, China and Iceland used energy efficiently in 2015 since, in relation to energy, their average productivities are higher than the marginal ones.

From the results obtained in the previous epigraph, the following considerations can be established corresponding to the situation reached in 2015 by the twenty countries analyzed: 1) In general, the increases in CO<sub>2</sub> emissions related to the productive processes of goods and services are greater than those associated with energy consumption:  $\Delta Em/\Delta y > \Delta Em/\Delta e$ . 2) Only the increase in CO<sub>2</sub> emissions associated with energy consumption are greater than those associated with the productive processes of goods and services ( $\Delta Em/\Delta e > \Delta Em/\Delta y$ ) in Germany, Japan, Brazil and Mexico. 3) The countries where the difference between the increases in CO<sub>2</sub> emissions related to the productive processes of goods and services are greater and the increases in CO<sub>2</sub> emissions associated with energy consumption turn out to be greater than the average ( $\Delta Em/\Delta y - \Delta Em/\Delta e > 0.165$ ), are: Spain, France, India, United States, Saudi Arabia, South Africa, and China. 4) The countries in the sample whose per capita CO<sub>2</sub> emissions are above the sample mean ( $Em/PO > 6.19 \text{ Tn CO}_2 / PO$ ), are: Ireland, Japan, Germany, United States, Saudi Arabia, China, Iran, and Russia. 5) The blocks of countries represented in the sample that use energy more efficiently, according to the inverse order of energy intensity are, in order from most efficient to least: Europe, America, Asia and BRICS. And 6) The countries that manage to user energy efficiently considered as a factor of production together with other factors, i.e., countries where the average energy productivity is greater than the marginal energy productivity [ $y/e \geq y'(e)$ ], are: Portugal, Spain, France, India, the United States, Saudi Arabia, China and Iceland.

According to these considerations established for 2015, the situation of the twenty countries in the sample with respect to the incentives they have or do not have to curb CO<sub>2</sub> emissions is shown in Table 6. From the results of Table 6 and the previous headings it can be seen that in 2015: 1) The United States, Saudi Arabia, China, Portugal, Iceland, Spain, France and India do not have sufficient incentives to reduce CO<sub>2</sub> emissions because energy use in these countries is already efficient. 2) Even so, the United States, Saudi Arabia, China, Spain, France and India must reduce CO<sub>2</sub> emissions from production even if energy use is already efficient. 3) But according to the results, South Africa should reduce CO<sub>2</sub> emissions from its production processes, because its current energy use is not efficient and it could improve efficiency by implementing innovations in the production processes of goods and services. 4) Undoubtedly Ireland, Russia, Japan, Germany, Iran, United Kingdom, Brazil, Morocco, Indonesia, Nigeria and Mexico must reduce CO<sub>2</sub> emissions from energy consumption.

**Table 6. CO<sub>2</sub> Emissions from Production and Energy Consumption (2015)**

	Emissions and energy efficiency (2015)	Countries
1	<u>Emissions per capita above the sample mean.</u> Energy could be more efficient if production emissions are halted.	<b>SOUTH AFRICA.</b>
2	<u>Emissions per capita above the sample mean.</u> Energy could be more efficient by curbing energy consumption emissions.	<b>IRELAND, JAPAN, IRAN, GERMANY, RUSSIA.</b>
3	<u>Emissions per capita above the sample mean.</u> Production emissions must be halted, but energy use is already efficient.	<b>US., SAUDI ARABIA, CHINA.</b>
4	Emissions from energy consumption must be stopped, but energy use is already efficient.	<b>PORTUGAL, ICELAND.</b>
5	Better production processes must be implemented, but energy use is already efficient.	<b>SPAIN, FRANCE, INDIA.</b>
6	Energy consumption must be halted.	<b>UK., MOROCCO, NIGERIA INDONESIA, BRAZIL, MEXICO</b>

Source: own elaboration.

To curb CO<sub>2</sub> emissions, the production processes of goods and services must be improved in order to reduce the emissions they produce, and emissions from energy consumption must be reduced, either by improving energy consumption processes or by reducing energy consumption. According to Table 6, the countries in rows 2, 4 and 6 should curb energy consumption, albeit with greater or lesser incentives to do so. In total there are 13 of the 20 countries in the sample.

## 6. CONCLUSIONS AND POLICY IMPLICATIONS

This research has proposed a microeconomic model that explains the supply and demand of energy, energy consumption and emissions produced by energy consumption and economic activity in the economic equilibrium. The objective of this

<sup>136</sup> Maximum of the average productivity function. Technical maximum is the maximum of the productivity function.

model is to find from the economic theory causal relationships between energy consumption and economic activity and between emissions and energy consumption. The emissions covered by this research are exclusively those of carbon dioxide, which was selected as the most abundant greenhouse gas and supposedly the most responsible for global warming and therefore of the possible long-term environmental degradation. The most important purpose of this research is to analyse what part of the total carbon dioxide emissions is associated with energy consumption and which part is associated with economic activity, regardless of energy consumption. The model has been applied econometrically on a sample of 20 countries in the period 1995-2015 with data from the International Energy Agency. Six of these countries belong to the European Union and the rest of the countries in the sample belong to Europe, Asia, America and Africa. The total population of these countries accounts for 61% of the world's population. The results of the application indicate that, in general, the process of carrying out economic activity, measured by gross domestic product in real terms, emits more carbon dioxide than the process of energy consumption. This seems to indicate the existence of certain imperfections in the productive processes of most of the countries in the sample. The results also indicate that Ireland, Japan, Germany, Iran and Russia should be able to reduce their energy consumption while the United States, Saudi Arabia, South Africa and China should incorporate less polluting production processes. The carbon dioxide emissions per capita of these nine countries are above the average of the sample. In relation to the productivity of energy in the production processes, only Spain, Portugal, France, India, the United States, Saudi Arabia, China and Iceland used energy efficiently in 2015, while only Portugal and Iceland, in addition to appearing efficient, did not exceed the average energy emissions per capita and the the difference between emissions caused by their production processes and those caused by their energy consumption does not exceed the sample average. Regarding the relationship between energy efficiency and the inverse of energy intensity, it can be ensured that during the period 1995-2015 together the European countries in the sample are those that show less energy intensity, and therefore probably more energy efficiency, followed of the American countries; then there are the Asian countries and finally the BRICS. The analysis and the results contained in this research could be useful for the correction of trends in some environmental degradation processes.

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## THE SPATIAL DIMENSIONS OF GREENHOUSE GAS REMOVAL TECHNOLOGIES TO ADDRESS CLIMATE CHANGE: A CRITICAL ASSESSMENT

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### ABSTRACT

The complex socio-technical challenges associated with meeting the goal of Paris agreement to limit global temperature increase to 1.5 °C create a policy and academic interest for the development of large-scale solutions to remove greenhouse gas (GHG) emissions from the atmosphere. These so-called GHG removal technologies (GGRT), also known as negative emissions technologies (NETs), represent a potential climate engineering method to remove GHGs from the atmosphere through enhancing and expanding existing natural (land or ocean) carbon sinks or creating new sinks and carbon sequestration options (IPCC, 2014; Royal Society, 2018). The environmental performance of GGRTs to date have been analysed using different methods such as material flow analysis and life cycle analysis (for a recent review, please see Goglio et al. (2020)). Life cycle analysis (LCA) is a standardized framework by ISO-14000 (ISO, 2006a, 2006b) and by the International Reference Life Cycle Data System (ILCD) handbook (European Commission, 2010) to assess potential environmental impacts and quantify resource use related to a product or a service their supply chain and entire life cycle of the product, “from cradle- to-grave” (Guinée et al., 2002). Using an inventory of inputs (resources required such as energy and materials) and outputs (products, waste and pollutants emitted) through all stages of the production cycle, it is considered as a powerful tool to assess the environmental performance of GGRTs (Klein et al., 2015; Plevin, 2017). A variant of LCA, consequential LCA (CLCA), takes into account the interdependencies between environmental performance of a technology/ product and the market dynamics. CLCA describes changes in physical flows and it predicts how environmental performance would evolve in response to market changes (e.g. increase or decrease in demand) within the system boundaries (Weidema, 2003). It consists of analysing substituted systems rather than just the actual system under study. Whilst capturing these feedback effects between a technology’s whole life cycle and economy are important, how these interactions evolve as a technology matures is largely ignored. Drawing from innovation studies and using a selection of GGRTs, the aim of this paper is to address this gap. More specifically, the objectives of this paper are three-fold: i) provide a brief description of the contribution of selected GGRTs to address climate change; ii) identify the supply chain of the selected GGRTs, and iii) offer a critical assessment of how supply chain and maturity of these technologies are characterised in CLCA approaches. Taking into account their differences in technology readiness levels, the analysis focus on the following GGRTs: Soil carbonation, enhanced weathering, bioenergy with carbon capture and storage (BECCs) and direct air capture.

**‘GONE WITH THE WIND’. ORGANISED CRIME AND THE GEOGRAPHY  
OF WIND AND SOLAR FARMS IN ITALY**

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**ABSTRACT**

The transition to low-carbon energy sources is considered as one of the key policies to tackle climate change and, to this aim, many European governments have been supporting the transition to renewable energy through subsidies. Growing anecdotal evidence suggests that the generosity of incentives has attracted the interests of corrupt politicians and criminal organisations, as the wind and solar energy sector offer attractive opportunities for mafias to benefit from public subsidies and to launder illegal money via legal business structures. Yet, no academic research has systematically explored the link between organised crime and the renewable energy sector at the local level. Our project aims to fill this gap. The analysis features innovative GIS data on the geo-location of wind and solar farms across Italy and on the local presence of mafia groups. Preliminary findings confirm how, in mafia-ridden regions, local criminal presence is strongly associated with a higher likelihood of hosting at least a plant.

## **Special Session: SS23 - Understanding the role of Renewable Energy in the Water, Agriculture, Energy Nexus in West and North Africa**

**16:00 - 17:15 Wednesday, 26th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88689482335>**

**Chair Mariama Camara**

## FINDINGS AND LESSONS OF THE PROGREEN RENEWABLE ENERGY ASSESSMENT IN BURKINA FASO

[Lin Da](#)

ProGREEN, Burkina Faso

### ABSTRACT

In Burkina Faso, communities and industries find many obstacles relating to insufficient supply and access to energy (i.e. 18.83% coverage in urban areas compared to 3.06% in rural areas). These obstacles are intricately linked to the agricultural sector and to water, health, social equity and the economy. Agriculture occupies more than 86% of the population with 34.4% of share in the GDP. Despite its importance in the economy, this sector faces challenges including low agricultural productivity linked to poor water control, poverty of arable land, low rate of use of improved varieties, etc. Approaching these challenges through an Energy, Water and Agriculture Nexus framing is essential for understanding the adaptation and resilience of the agricultural and other sectors in the face of global environment challenges and the energy transition. The Promoting Gains in Renewable Energy (ProGREEN) project with the collaboration of Burkinabe experts is carrying out an in-depth assessment of one facet of this framing, small-scale renewable energy (RE) systems in Burkina Faso. This evaluation aims to identify the factors enabling and constraining factors of the development of RE as well as their impacts on rural communities. The method adopted is based on a participatory approach starting from a literature review of renewable energy projects initiated in Burkina Faso, followed by interviews with project managers and interviews and group discussions with beneficiaries of these projects. In this presentation, I will detail the results of this assessment including how small-scale energy systems such as solar pumping and especially biodigesters support the different Sustainable Development Goals in Burkina Faso in particular through improving food security, community health, gender mainstreaming, job creation in rural areas etc. Enablers and barriers to the spread of renewable energy, notably the political and regulatory framework, the investment costs, the access to finance and the national norms and standards will also be presented.

## EXPLORING RENEWABLE ENERGY IN SENEGAL: THE PROGREN WEST AFRICA ASSESSMENT

[Khoudia Kane](#)

Direction des Financements verts et des Partenariats/Ministère de l'Environnement de l'Environnement et du Développement Durable, Senegal

### ABSTRACT

Access to energy plays an essential role in the growth and economic performance of Senegal, mainly through its key development sectors agriculture, industry and trade. Agriculture occupies a strategic place in national policy (development of the green economy, support food security, empowerment of young people and women, etc.). However, the sector faces many barriers linked to lack of energy access, poor quality supply, weakness of mechanization, inadequacy of harnessed water, insufficiency of fertile lands, difficulties in accessing improved and resistant varieties, weakness of the value chain, and others. To address these challenges, the government is investing in efforts to promote renewable energy access with the installation of large Photovoltaic (PV) on-grid plants. Decentralized off-grid renewable energy systems are also gaining greater interest. These off-grid operations have contributed significantly to our understandings of integrated systems, which are the focus of the Energy-Water-Agriculture Nexus approach. This framing examines not only access to clean and affordable energy in rural areas, but also looks at impacts of this on agricultural production, food security, income generation and the security of women and young people. In this context, the Promoting Gains in Renewable Energy (ProGREEN) project explores with a multidisciplinary team of Senegalese experts the main factors that revolve around the development of small-scale renewable energy systems as well as the impact of access to sustainable and affordable energy on the livelihoods of communities in rural and peri-urban areas. This presentation will provide the results of the ProGREEN assessment in Senegal, which demonstrates that the interactivity between access to energy (e. g. solar or bioenergy) and water control enhances economic growth in rural areas and substantially improves social equity, the quality of education, the performance of health services, the development of income-generating activities such as fish farming, gardening, the production of forest fruit plants, transformation of agricultural products, and more. The results also show the needs and difficulties encountered by the beneficiaries of the projects as well as the prospects to promote Renewable Energy access, especially in ways that benefit vulnerable groups.

## UNDERSTANDING SMALL-SCALE RENEWABLE ENERGY TRANSITIONS IN WEST AFRICA, THE PROGREEN PROJECT

[Mariama Camara](#)

START International, Burkina Faso

### ABSTRACT

Despite large untapped potential for renewable energy, a limited supply of affordable and reliable energy remains a persistent barrier to development in West Africa. Indeed, despite substantial investments in fossil fuels, the region has some of the lowest rates of electricity access in the world. Only about 42% of the total population is connected, and in the rural areas that rate is much lower at 8%. In addition, rural populations depend heavily on fuelwood for cooking and lighting. This energy vulnerability negatively impacts local economies and social development including health services, agricultural productivity and food security, control of water, agricultural value chains, youth and women empowerment, etc. Knowing the essential role energy plays for economic growth and performance and social equity in the region, countries are increasingly implementing efforts to attain international targets like the Paris agreement, as well as regional policy objectives such as the Regional Roadmap, ECOWAS Renewable Energy Policy (EREP), National Renewable Energy Action Plans (NREAPs), National Energy Efficiency Action Plans (NEEAPs), and National SE4ALL Action Agendas. The ECOWAS Centre for Renewable Energy and Energy Efficiency (ECREEE) was also created to support governments in developing and implementing their national engagement towards 2030. As concrete actions to meet this agenda and objectives, countries like Senegal and Burkina Faso installed large scale solar plants to increase the share of renewable energy in the national energy supply. To reach populations in remote areas, a focus has also been placed on the promotion of small-scale renewable energy with the hope of reaching vulnerable groups and bringing significant changes in the livelihoods of local communities. In this context, the Promoting Gains in Renewable Energy (ProGREEN) project has been undertaking an assessment of barriers and enablers to more widespread transitions to renewable energy in Burkina Faso and Senegal and of development impacts of such transitions. In this presentation, I will provide details on the ProGREEN project and an overview of the small-scale renewable energy transitions in both countries.

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# PARALLEL SESSIONS (10)

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## National Session: SS46 - Poverty and Local Economy Development in Ecuador



**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/86856640416>**

**Chair Patricio Aroca**

**DETERMINANTS OF MANUFACTURING MICRO FIRMS' PRODUCTIVITY  
IN ECUADOR. DO INDUSTRY AND CANTON WHERE THEY OPERATE  
MATTER?**

[Carolina Guevara](#)

Department of Quantitative Economics, Escuela Politécnica Nacional, Ecuador

**ABSTRACT**

This study aims to identify the productivity determinants of manufacturing micro firms, emphasizing on regional and industrial factors. A cross-classified multilevel model is employed using the Economic Census of 2010 from Ecuador. Results evidence that the heterogeneity of the total factor productivity of micro formal firms of the manufacturing sector is mainly due to differences across firms in 90.1%. The remaining variation of the TFP is explained to a larger extent by the industrial context (5.8%) than the geographical context (4.1%). Among firm characteristics, information and communication technologies, credit and training are important drivers of productivity. Despite of this, very few micro firms use internet, have credit access or engage in training in Ecuador. Moreover, micro firms benefit from agglomeration economies derived from specialization, diversity and density that they themselves generate.

## SUBNATIONAL POVERTY DYNAMICS IN DEVELOPING COUNTRIES: THE CASES OF ECUADOR AND URUGUAY

**Obaco Moises<sup>1</sup>, Nicola Pontarollo<sup>2</sup>, Rodrigo Mendieta<sup>3</sup>**

<sup>1</sup>Universidad Católica del Norte, Chile. <sup>2</sup>Department of Economics and Management University of Brescia, Italy. <sup>3</sup>GIER, Universidad de Cuenca, Ecuador

### ABSTRACT

This paper analyses subnational dynamics of a novel composite indicator, called Local Multidimensional Poverty Index (LMPI), accounting for multidimensional poverty at subnational level in Ecuador and Uruguay between the last two census, 1990 and 2010 and between 1996 and 2011, respectively. As a first step, using censuses microdata, we construct the LMPI at municipal level for both countries. Then, through a set of tools like probability transition matrix, Moran's I and Moran scatterplot, spatial probability transition matrix and spatial regressions, we explore the spatial and time dynamics of the LMPI. Results indicate that, compared to Ecuador, Uruguay is initially in a better position in terms of LMPI. However, Ecuador achieved a generalized reduction of LMPI during the period of analysis, reaching the levels of Uruguay. Probability transition matrices point to a convergence toward low levels of LMPI for both countries, while spatial probability transition matrices based on Moran scatterplots highlight a tendency toward clusters of municipalities with low levels of LMPI. Finally, divergence due to spatial spillovers is observed for Ecuador, while in Uruguay convergence is due to a leapfrogging phenomenon.

## POST-EARTHQUAKE SHORT-RUN LABOR INCOME SHIFTS. WHAT HAPPENS WITH THE DISTRIBUTION OF WAGES AFTER AN EARTHQUAKE?

[César Andrés Mendoza](#)<sup>1</sup>, [Benjamin Jara](#)<sup>2</sup>

<sup>1</sup>Universidad de Cuenca, Ecuador. <sup>2</sup>Gran Sasso Science Institute, Italy

### ABSTRACT

In this article we explore whether a strong earthquake (Manabí and Esmeraldas provinces, Ecuador, April 16th, 2016) had a distributional effect in labor income. We use survey micro-data and exploit the exogenous nature of the shock with an empirical strategy based on a combination of matching, difference in difference (DD) and quantile regression (QR) methods using three earthquake intensity measures (Peak Ground Acceleration, PGA; Peak Ground Velocity, PGV; and Modified Mercalli Intensity, MMI). We find a short-run distributional effect for the poorest workers in the most seismic areas. Compared to our control group, workers located in the lower income percentiles in the most affected zones earned more in the short run (between 17.6 and 20.3 percent in percentile 0.1, and 15.5 and 19.4 percent in percentile 0.2). Our results suggest that although some disasters could create opportunities for poorest workers, the assumption that proper public policies and support networks do exist is strong, and there is a need for specific policies to avoid gender gaps and help the most vulnerable workers in a disaster scenario.

**OIL ROYALTIES AND MULTIDIMENSIONAL POVERTY IN ECUADOR:  
HAVE THE EXTRACTION REGIONS IMPROVED THEIR LIVING  
STANDARDS?**

**Viviana Carriel<sup>1</sup>, César Andrés Mendoza<sup>2</sup>, Nicola Pontarrollo<sup>3</sup>, Rodrigo Mendieta<sup>2</sup>**

<sup>1</sup>Universidad Católica de Cuenca, Ecuador. <sup>2</sup>Universidad de Cuenca, Ecuador. <sup>3</sup>Department of Economics and Management University of Brescia, Italy

**ABSTRACT**

In this work we check for the causal effect of the introduction of a regulatory change on oil royalties happened in 2008 in Ecuador. This law established conditionalities on the transferences of money to extractive municipalities, that have to spend these resources in sectors such as education and public services, which should reduce unsatisfied basic need poverty. Our estimates, based on a difference in differences approach, are robust to different specifications and show a lack of positive effects in the improvement of education, provision of public services and poverty reduction. These results have various public policy implications related to the quality of local and national institutions, the way in which the oil resources are management and the population audit of way in which the local authorities spend this royalties.

## National Session: SS45.2 - Selected regional science topics in Mexico



**AMECIDER**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/84728052596>**

**Chair Serena Serrano Oswald**

## SUSTAINABLE COMMUNITY DEVELOPMENT THROUGH THE PERSPECTIVE OF A TYPE B COMPANY: YUCATAN, MEXICO CASE STUDY

Mayanin Asunción Sosa Alcaraz<sup>1</sup>, Adriel Elí Cáceres Ruiz<sup>2</sup>, Gustavo A. Monforte Méndez<sup>3</sup>, Andrés Pereyra Chan<sup>4</sup>

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### ABSTRACT

Currently, companies are changing from a concept of income generation just for their own benefit, to one where the generation of economic development promotes improvements in the quality of life and the environment of a community where these are located. These companies with a social purpose have stood out for using the force of the market to solve problems faced by humanity such as education, health, economic and environment. This type of companies that stand out have a B certification. Type B companies have a very clear mission of generating a long-term impact that contributes to development in urban and rural areas. The objective of this article is to present the experience of an organization that works with artisan warpers and represents an opportunity for the contribution of sustainable community development in Mayapan, Yucatan. For this research a literature review was conducted. The purpose of this literature review was to find concepts related to understand the empirical approach of a B company in regards to sustainability. Four thoroughly interviews were carried out to analyze how B companies have been able to respond to social, economic and environmental demands, in order to demonstrate their viability as a sustainable alternative, in a world where social and ecological problems predominate. The complexity of reality, detail and context of Cielo Hamacas as a case study was examined from a systemic perspective. The results revealed that there is still a lack of actions aimed at a good economic and social development of the group of community warpers. So, it is necessary to promote greater economic and education capacity of the stakeholders that participate in conjunction with this type of companies, since their culture and social level do not make them see themselves as main actors of their communities development. For this reason, the transition to a new sustainable rationality of doing business is essential. Regarding the environment, the B company has good practices, and these have been reflected in the work that leaders and artisans are doing to take care of their environment.

### KEYWORDS

Community development, Social enterprise, Socio-environmental impact, Sustainability, Type B enterprise.

### 1. INTRODUCTION

Community development has achieved a strategic scope in different nations and regions, acquiring an important role as a means of participation in the conduction of social and economic development, as well as a unifier of different actors to carry out plans to achieve social change (Pérez, 2016). This is developed on a medium and long-term time scale, it is not a program subject to a closed planning in time but to a process, understood with a pedagogical sense that aims to become an element of self-learning, of a citizenship school and democracy, with a vision of continuous transformation in the sense of improving the living conditions of citizens (Camacho, 2014).

Currently, both the government, civil organizations and some companies have designed and executed plans for community development with the aim of reducing poverty, generating production and income alternatives in order to promote comprehensive and sustainable development (Rosales, 2012). In our country public policies have only provided partial and short-term solutions to the socio-environmental problems that are experienced in the communities (Vázquez, 2010).

The social, economic and environmental crisis that humanity is experiencing, has made several people feel disillusioned that the financial profits generated by their companies have not been able to improve people's quality of life, address

social problems, improve conditions environmental, among others (Deloitte, 2018). This is why several companies have moved from a traditional model to one that can respond to social and environmental problems.

Today, many organizations are no longer evaluated on financial metrics; on the contrary, they are judged on the basis of their relationships with their workers, clients and communities, that is, on the impact they are generating on society (Deloitte, 2018). To achieve this, it is necessary to focus on the perspectives and evaluations of the reality of the region to identify the different meanings of the various actors who live the same situation, the main reason, as well as the social relations that are important, with the purpose of planning comprehensive, solid and long-term solutions that seek social, economic, cultural and environmental satisfaction, among others (Vázquez, 2010).

Businesses with a social purpose can also contribute to the community development of a region or country and positively impact rural communities. Therefore, the purpose of this article is to present the experience of a company with B certification for the contribution of community development in Yucatán, through a literature review to understand the empirical approach of a B company in regards to sustainability, and four thoroughly interviews that evaluates the three aspects of sustainability (social, economic, and environment). For this reason, it was necessary to know the experiences and perceptions of the artisan leaders, mayor and owner of the company; with the aim of analyzing how the company has contributed to the economic and human development of the weavers in the town of Mayapan.

## 2. LITERATURE REVIEW

### 2.1. Social enterprise

Alvarado, Auxiliadora and Agafanow (2016: 14) define a social enterprise as one whose mission is aimed at addressing social problems and meeting the needs of the population, through the provision of goods or services of general economic interest. They are financially sustainable entities and their profit margins are reinvested entirely or mostly in the production of goods or services for a disadvantaged population. Likewise, Deloitte (2018) mentions that it is an organization whose mission combines the growth of income and obtaining benefits with the need to respect and support its environment and the network of stakeholders.

Díaz, Marcuello and Marcuello (2012) indicate that the definition of social enterprise requires a multidimensional approach in which traditional elements of the enterprise and the social economy are related that affect the social objective, economic motivation and the management models. Similarly, the European Commission (2013) mentions that the main objective of a social enterprise is to achieve a social impact, beyond generating benefits for owners and shareholders. It operates in the market through the production of goods and services in an innovative and entrepreneurial way, which uses surpluses to achieve these social objectives, and it is managed by social entrepreneurs in a transparent and responsible manner. In the same way, it tries to help civil society and business organizations to increase their capacity to produce goods and services, or to serve their own beneficiaries (Valor, 2013).

The rise of different types of social enterprises requires a determined focus on building social capital through the participation of diverse stakeholders, creating a sense of mission and purpose throughout the organization, and devising strategies that address social expectations; which is related to reputation, relationships and the success or failure of a company (Deloitte, 2018).

The social enterprise sector in Mexico, known locally as the social economy, is relatively well established. Furthermore, the Mexican higher education system plays a key role in promoting social change; being one of the few countries that has a compulsory service component for students enrolled in higher education (British Council, 2016). However, the country lacks a consensual concept among different actors, and the use of synonyms is frequently. In this regard, the National Institute of Social Economy (2013) pointed out *that in practice it is very complex to have a worldwide definition of social enterprise, largely because the legal figures vary from one country to another and for different reasons, although it is not the same as cooperatives* (Cited in Conde, 2016).

Social enterprises have arisen long ago from a cooperative tradition; however, Mexico strongly advocates social entrepreneurs, innovation, and earned income strategies as solutions to social problems. In turn, more Mexican non-governmental organizations are changing to a hybrid business model to obtain financial sustainability through the creation of income streams (Wulleman and Hudon, 2015).

### 2.2. Type B company

Company B is an emerging phenomenon. It is known as hybrid company or companies with a purpose, the result of the convergence process among various actors that seek to use market instruments to build goods of public interest (Abramovay, Correa, Gatica and Van Hoof, 2013). A company B is one that is distinguished by two essential characteristics: a) it measures the social and environmental impacts of the entire company, using a rigorous evaluation that is Impact Evaluation B; and b) it is committed in its corporate constitution contract, in order to achieve positive impacts for society and for nature, while offering financial results to its shareholders (FOMIN, 2017). Impact evaluation

B measures the general impact of a business on all stakeholders (workers, suppliers, customers, community and environment), through an online platform (Troncoso, 2014).

This new business model is promoting the formation of an emerging sector or fourth sector that does not pretend to be another niche within the ecosystem, but to transform the conception of business success. The so-called fourth sector incorporates the private sector, regular participation in the markets; from the public sector, the nature associated with the generation of public value; and from the social sector, the orientation to its mission (FOMIN, 2014). This type of company is clear about its objectives, mission and vision, constantly contributing to build a new economy, where social and environmental issues correspond to the main axis and the way forward when making business decisions (Tapia and Zegers, 2014).

Being a B company is not determined by category, size or turnover; it is a type of company committed to generating change, considering consumers, workers, the community, investors and the environment in decision making (Bianchi, 2016). Likewise, they work together to achieve a unified goal: to redefine business success with the aim of companies competing not only to be the best in the world, but also the best for the world (Honeyman, 2015).

In the FOMIN report (2014), the triple impact that these companies pursue is:

1. Solve social and environmental problems with the products and services they sell, and also through their professional and environmental practices, their relationship with the community, suppliers and different stakeholders.
2. Pass a rigorous certification process that validates compliance with minimum performance standards, the exercise of its tasks with transparency, through the publication of its results and the impact of its social and environmental results.
3. Incorporate legal modifications to protect its mission or business purpose in which the public and private interest are combined.

B Companies matter because they are a global movement that seeks to redefine the concept of business success, so that society can enjoy shared and lasting prosperity. As a result, they have made progress in reducing poverty, building stronger communities, creating good workplaces, and restoring the environment for generations to come (Honeyman, 2015). In addition, being registered and certified as a B company is important to impact investors in the commitment of a corporation that creates social impact, as well as profits (Fierro, Miller and Johnson, 2016).

Today, there is a community of more than 3,000 certified B-companies in 70 countries and more than 130 industries focused on redefining business success. In Latin America, countries such as Chile, Colombia, Argentina, Brazil, Uruguay, Peru, Ecuador, Mexico and Paraguay have already joined this movement (Bautista y Cámara, 2018). In Mexico there are more than 50 B companies that cover different business sectors, whether consulting, restaurants, electronic commerce, product sales, media, and crowdfunding, among others.

### 2.3. Community development

To understand the concept of community development, it is first necessary to recognize what the notion of development and community refers to. Oteiza (1983) defines development as a process of social change based on a creative and participatory effort of the peoples themselves, and on the mobilization of the resources at their disposal, in order to eliminate poverty and marginalization, overcoming exploitation and internal or external socio-political domination and the continuous unfolding of the human personality through its own expression (Cited in del Moral, 1991: 153). Within this construction, the conception of the centrality of the subject that is claimed as the guiding principle of any development project is basic, so, in this approach what is important is people and not things; for a long time, the predominance of the economic vision of development has led to the forgetting of the human, cultural and environmental aspects that are now trying to recover (Carvajal, 2011: 30). Hence, Alguacil (2000) emphasizes the need to refer to the term as human development, sustainable development, local development, community development, among others; with the idea of highlighting those dimensions of development that are considered fundamental to be able to speak properly about it (Cited in Camacho, 2014: 207).

Regarding the concept of community, Marchioni (2002) mentions that it is a specific territory, with a specific population, resources and it has certain demands. In the same way, Ander-Egg (2005) points out that it is a group of people who inhabit a delimited geographical space, whose members are aware of belonging or identification with some local symbol and that they interact with each other intensely, operating communication networks, interests and mutual support, in order to achieve certain objectives, satisfy needs, solve problems or perform relevant social functions at the local level (Carvajal, 2011: 12).

Camacho (2014: 209) defines community development as an intervention method that incorporates all the agents that make up the community, establishing processes of participation and articulation between the population and the institutions that, enhancing a pedagogical process, and the participatory capacities of the actors and of the mediating

structures, it is then possible to pursue common and predetermined objectives to improve the socio-economic, social and cultural conditions of the communities, which the results can be evaluated. Likewise, Lopez and Cruz (2003: 60) point out that it is a process that combines the efforts of the inhabitants of a region, interest groups and the government to improve the economic, social and cultural conditions of the communities, through the diagnosis, plan, execution and evaluation of programs for this purpose. Finally, Nogueiras (1996) presents some characteristics that define community development: a) represents an educational process destined to achieve qualitative changes; b) a technique of social action, since it requires the intervention or collaboration of various agents; c) aimed at those communities that are in a situation of insufficient use of resources; d) a primary objective is to achieve social well-being and to improve the quality of life of the community; e) requires the voluntary, conscious and responsible participation of individuals in solving problems (Cited in Carvajal, 2011).

## 2.4. Sustainable development

Sustainable development or sustainability has two approaches. The first approach is ecological sustainability, which the authors Pearce and Turner define as ensuring that substitute products are accessible as non-renewable resources become physically scarce, and means ensuring that environmental impacts resulting from the use of these resources are kept within the support capacity of the earth to assimilate them (Foladori and Tommasino, 2000). In this approach, only the relationship between human beings and nature is discussed; social relationships are not included.

The second approach to sustainable development is social-economic sustainability. Social-economic sustainability is commonly considered an increase in population and poverty (when speaking of poverty, the authors also refer to hunger, health, lack of housing, drinking water, education, among others). These problems give a social inclination to sustainability. Poverty generates environmental problems because the poor do not have the resources for a sustainable productive strategy, or because the population growth that the poor promote implies a greater demand for resources and pressure on ecosystems (Foladori and Tommasino, 2000).

In this research, companies can use the Sustainable Development Goals (SDGs) as a general framework to shape, direct, communicate and inform about their strategies, goals and activities, which allows to capitalize on a series of benefits such as: 1) Identifying future business opportunities, and can offer innovative solutions and transformative change; 2) enhancing the value of business sustainability, the SDGs can reinforce economic incentives for businesses to use resources more efficiently as externalities become increasingly internalized; 3) strengthen relationships with stakeholders and stay up to date with policy development, companies that align their priorities with the SDGs, can strengthen their commitment to customers, employees and other stakeholders (SDG Compass, 2016).

## 2.5. Context characteristics: Mayapan

For this research, it was necessary to know the perspectives and experiences of the artisan leaders who have worked with the company, and for a convenience of the company, the Mayapan community was chosen. The municipality of Mayapan (located between parallels 20 ° 26 '- 20 ° 31' N and 89 ° 09 '- 89 ° 15' W) has a population of 3,700 inhabitants and 2,785 people over five years of age speaks the Maya language (INEGI, 2015). The main craft activity is hammock weaving. Furthermore, 89.80% of the total population suffers from poverty and the rest suffer from vulnerability due to social deprivation. On the issue of social backwardness and marginalization, it is classified as high and very high, respectively. In addition, the deprivation index is alarming in terms of access to social security and basic services in housing (H. Ayuntamiento Mayapan, 2015). Due to their levels of marginalization, the government agencies responsible for health and social development have applied various programs and projects to improve the social and economic conditions of the population, including the construction of roads and infrastructure for the community, alternative work options and programs focused on child nutrition and reproductive health (Robles, 2009).

## 3. METHODOLOGY

The unit of analysis for this research was a type B company that works with hammock weaving artisans in different communities and the population studied is the Mayapan community, its main activity is hammock weaving (H. Ayuntamiento Mayapán, 2015). Two methodological instruments were used, literature review and deep interviews. The sample was determined in a non-probabilistic way, the samples are not representative by the type of selection, they are informal or arbitrary (Pimienta, 2000). The different study actors for this research are described:

- An interview was conducted with two community artisan leaders from Mayapan and Chumayel.
- An interview was carried out with the general director of the company.
- An interview was conducted with the municipal mayor.

The reason for interviewing these actors was to learn about the company's perspectives and experiences towards sustainable community development through the hammock weaving activity. In addition, the interview with the owners was to find out their opinions of the impact they have generated in the community.

The information obtained was transcribed using a word processor. Subsequently, all the information was manually analyzed to examine similar and different opinions; where a classification and interpretation of the results was obtained. Then, we proceeded to create the aspects based on sustainable development in order to identify if the company contributes to the community development of the town. It should be noted, the economic aspect is within the category of social sustainability.

## 4. RESULTS

The results are presented for each of the three aspects of sustainable community development through the opinions of different actors who participated in the research.

### 4.1. Social and economic sustainability

It was observed some social and economic problems in the communities. This was according to the opinion of the municipal mayor:

*With regard to the social is the lack of employment; it had to be managed before the state government and some civil associations training people, such as temporary jobs (Mayor)*

Lack of employment is one of the social problems that can trigger other stronger complications in communities. Therefore, the company by providing a source of work to the artisans can reduce the difficulties in which they live and preserve an artisanal technique that has been transmitted from generation to generation. In this regard, the mayors mentioned the importance of hammock weaving crafts:

*It is of great importance, today there is not so much work in the field. So, the peasants are dedicated to making hammocks. Practically, in most of the houses of the town they are dedicated to making hammocks as a source of extra income. It is quite a lot because people live on it, but not in its entirety. This is due to the cost that it has, speaking by hand, people suddenly no longer want to continue concocting and they better go to work in the city because they earn more, women work as domestic servants and men as barns, bricklayers or porters. I feel that attention and resources must be given at the time to encourage artisans, because if we do not do it, this traditional practice will be lost little by little (Mayor).*

Faced with this situation, the social and economic impacts that one of the owners of the company has seen in the communities are:

*In the social part, the first study we carried out, showed us that the warpers feel more financially secure, finishing a hammock and there is an immediate and cash payment. They spend more time with the family because they do not have the need to go to work or to look for work elsewhere or to travel to the city. We are sponsoring the local baseball team, we started to create a sense of community. Also, our environmental actions begin to influence some leaders, there is one who no longer uses plastic bags and recycles. In the economic part, we make loans without interest so that artisans acquire equipment and tools, this helps them to be more efficient (Owner).*

In addition, the activity carried out by the company when employing warpers (especially women) is commendable and of the utmost importance for the ancestral warping knowledge to continue to be preserved. In addition, some artisans who were interviewed (45%) mentioned that they want to teach their children hammock weaving; likewise, a leader of artisans expressed himself as follows:

*It is important to teach warping to subsequent generations; for my part, I am going to teach my daughter to weave (Artisan leader).*

Mayor is happy with the work conducted by the company in the community, expressing how the company contributes: *They seek the participation of all: it involves society, it takes women and their coexistence very much into account. Above all, it provides sources of work. Also, company helps the community baseball team a lot. It helps us by paying fair prices to the artisan and giving them loans, which is something that would help a lot (Mayor).*

In turn, the owners of the company have observed a positive impact on the artisans of the different communities:

*We have improved in the standard of living and in educational matters, especially in the children of the warpers. Our impact is very focused on women; it is only invested in women because they spend and will spend in her family. In addition, we have leaders who finance a truck and end up paying for it.*

*From one study, it was perceived that the warpers feel more financially secure, finishing a hammock and there is an immediate and cash payment. They spend more time with the family because they do not have the need to go to work or to look for work elsewhere. We are sponsoring the local baseball team, we started to create a sense of community (Owner).*

Additionally, a large part of artisans do not allocate a portion of their income to savings, which is why few initiatives at the family or community level are difficult to achieve. But, they feel happy with the work they do and belonging to a group of artisans.

On the other hand, artisan leaders expressed how their well-being and that of their family has changed with the arrival of the company in the communities:

*In the family the economic income has improved. For artisans, it is a complement or help. In social welfare, not much has been done, there have not been scholarships or health campaigns, only missions have been carried out where women arrive and play with children (Artisan leader one)*

*Regular, when there is work there are changes. Even so, I am very satisfied with the changes that have taken place with the arrival of the company in the community (Artisan leader two).*

Also, the artisan leaders expressed what is needed for the company to improve:

*If there were more requests, that would help a lot (Artisan leader one).*

*Training for artisans, distribute a pantry and have the price of the hammock raised a little, so that the artisans feel more motivated to work (Artisan leader two).*

In a similar way, the company expressed their opinion about the improvement of their work.

*The company contributes to the 2030 Agenda because they work with 7 of the 17 sustainable development goals: 1. End of poverty: generating sources of employment in the most marginalized areas of the state; 4. Quality education; 5. Gender equality: gender equality is promoted, with special emphasis on women; 8. Decent work and economic growth: artisans work from home, offering favorable working conditions. With the leaders we promote economic development, since they are like small entrepreneurs; 10. Reduction of inequalities: holistic business model, transforming the artisan product into a product that can be massively consumed; 12. Responsible production and consumption: the only hammock company certified as Fair Trade and company B; 17. Alliances to achieve the objectives: there are alliances with local institutions, governments, health institutions and non-governmental organizations (Owner two).*

In the same way, the mayor expressed in what way the artisan activity contributes to sustainable development:

*Because through handicrafts people have capital or something to survive, even if it is little, but they seek to have one more resource to help the family.*

*I think that if our Yucatecan countryside, our smallholders, our artisans had the way to work in an organized way, to have resources and to have a market, we would be a municipality everywhere that we would not have to depend much on the income of others, since we would produce what we consume and we would give what we spend (Mayor).*

## 4.2. Environmental sustainability

There are some environmental problems faced by the community. For instance,

*Environmental problems have to do with urban solid waste, there is no culture of classifying garbage. We have the problem with our own culture and society that does not lend itself to working with the municipality, with more that we have a free collection service but people go to the periphery and leave their garbage bag; as a result such place is a source of infection that can expand (Mayor).*

In this regard, mayor has carried out garbage collection campaigns for people to clean their houses and their surroundings. Mayor expressed himself as follows:

*If society is not geared to the government, the change will be minimal. I think we should change that way of thinking and start with our young people, I feel that they are the base right now; If they change their way of thinking, the country can also change. But if we do not instill good values in him, we will continue the same (Mayor).*

The actions carried out by the company in favor of the environment, such as stopping the use of plastic bags, PET bottles and Styrofoam cups; have influenced community leaders to change their attitude towards caring for nature:

*I have seen how the company is taking care of the environment, like when they use biodegradable bags. Also, I always take my sabucan<sup>1</sup> to the store so they don't give me a plastic bag (Artisan leader one). I avoid wasting water and in the house I separate organic from inorganic waste. Also, the rest of the meals I use to feed my animals (Artisan leader two).*

In addition, the artisan leaders mentioned that most artisans avoid wasting water, recycle PET and cardboard, reuse an object, and use the rest of the food for animals and plants. On the other hand, the owner talked about what the environmental impacts of the company's future projects would be:

*Our processes are very friendly to the environment, since no water or any pollutant is used. We try to use the least amount of non-recyclable products in our final product. In addition, we are looking at the possibility of a Leed Certification for the new factory. With the new plant that was built, it is intended to reforest the areas where trees were removed for the construction of the factory, with the help of some environmental foundations. As well as getting rid of the use of plastics and using solar panels (Owner).*

In general, most of the people are concerned about caring for the environment and consider, they consider that the hammock warping activity does not contaminate very much the environment because they reuse the scraps of yarn that are left over from the warp, to make candles or to make moorings.

## 5. DISCUSSION

Community development has the objective of improving the social, economic, cultural and environmental conditions of a population. Currently, it is viewed as a way to sensitize and motivate people to participate in solving their problems (Lopez and Cruz, 2003). This is consistent with the purpose of a Type B and social enterprise, which is to generate an impact that benefits stakeholders by solving social and environmental problems so that society can enjoy shared and more lasting prosperity (Honeyman 2015; European Commission, 2013). From this study, it was observed some needs in the community such as lack of employment, low level of education, vulnerability of women, low access to health services and problems with garbage.

It can be seen that community development aims to improve economic, social and cultural conditions through different actors (organizations, government, companies and society) for a better quality of life of the community and the empowerment of the inhabitants. An example is the type B company as a member of the Fair Trade Federation, committed to the economic and human development of the artisan communities in the region. This company promotes the empowerment of women as heads of families and also as entrepreneurs and an instrument of change in their communities. They have a business model with a holistic component that provides fair jobs and helps to improve living conditions.

Vázquez (2010) emphasizes that proposals to achieve community development must be based on local perceptions in order to plan comprehensive, solid and permanent solutions based on the determination of the causes of problems, and their consequences in different areas of life community; the actors must be involved and able to transform current conditions; and the participatory construction of long-term strategies that seek to satisfy material, cultural, spiritual, recreational, and environmental needs, among others.

However, the company needs to have a significant impact on the economic side. This is because the warpers feel that the payment for hammock warping is very little; therefore, they do not cover their health, basic services and expenses. Arvizu and Borbón (2017) point out that the community where a social enterprise is installed plays an important role, since its purpose is to increase the utility and benefit of those involved in the process to create a spatial and cultural link, in a way that a joint value creation is generated between the different groups that make up the company and an equitable distribution of such maximization.

In a FOMIN report (2014) emphasizes that the purpose of type B companies is to create a favorable environment for solving social and environmental problems. This could be seen in the impact that the company has had on job satisfaction issues, the communication with the leader and the unity that exists among the artisans is favorable. Above all, in responding to a problem that affects most communities, which is the lack of employment.

On the environmental side, the company has shown interest in this issue. The actions carried out in favor of the environment such as stop using plastic bags and use biodegradable bags to deliver hammocks, zero disposable products, as well as the use of a water purifier. This has influenced the way of thinking of some artisans and they have adopted some conservation practices that they carry out from home. In this regard, Honeyman (2015) indicates that supporting the environment can help retain both artisanal and professional talent, as well as establish more lasting relationships with its suppliers and increase trust with consumers.

Business, for better or for worse, is one of the most powerful forces on the planet. When companies are positive they promote collaboration, innovation and mutual well-being, and help people to live more vibrant and fulfilling lives. When they are negative, they can lead to significant social and environmental damage (Honeyman, 2015). Alonso (2013) mentions that to achieve a change in communities, it is necessary to assume people as subjects capable of achieving the change they need on their own. This implies promoting symmetrical links between people and human groups, that is, fostering union and meeting, so that this translates into a better quality of life (Cited in Pérez, 2016).

## 6. CONCLUSIONS

Companies with type B certification represent an alternative to solve the economic, social and environmental problems that society is currently experiencing; as well as support to achieve sustainable community development. But, it must be taken into account that certification is a change of mentality to redirect businesses towards the concern for the well-being of people and the environment, that is, increasingly sustainable.

The company's activities towards achieving sustainable community development in the Mayapan community are still incipient. Actions are needed to achieve good economic development, to improve the quality of life and to generate changes in the perception of caring for the environment in community artisans. Also, it is important that the company

establish short and medium term goals; in turn, observe that these results are aimed at achieving a significant impact on the social, economic and environmental aspects of the Mayapan community.

In the economic aspect, an analysis is required for the possibility of making changes in the income received by the warpers, since the majority are not satisfied with it, and it is not enough for basic and health services. Once the above is resolved, the social impact may increase. In the environmental aspect, it is necessary to raise awareness of how to manage the garbage. Finally, type B companies can contribute to sustainable community development, influencing a systemic and paradigm change at the local level and making it possible to scale globally.

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**THE ROLE OF PUBLIC MANAGEMENT IN THE PROMOTION OF INTELLIGENT TOURIST DESTINATION: THE CHALLENGE FOR COZUMEL, QUINTANA ROO, MEXICO**

**Alex Adiel Cano Herrera, Crucita Aurora Ken**

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**ABSTRACT**

The smart tourist destination (STD) model has become a tool with advantages to analyze the role of public management of tourist destinations. This is because the model highlights the situation of sustainability of the tourist sector, its adaptation to the digitization and the progress towards connectivity. The STD model, in addition to promoting the development of the destination, it endorses inclusiveness and other dimensions, such as benefits to the local population and the role played by public management in its establishment. Through a compilation of documents such as plans, programs and regulations, we analyze the STD model and dimensions as applied in the tourist island of Cozumel, Quintana Roo, Mexico. This study intends to capture the current panorama of the smart model, at the federal, state and municipal levels in Cozumel. This allows us to point out the challenges that this island faces as a tourist destination in its route to becoming a STD. Above all, we measure the performance of public management in achieving this objective. We perceive that the challenges for the public administration is great due to the absence of a plan to promote, expand and to include the population at large, through actions that lead to the island's classification as a STD.

## GENDER BASED POLITICAL VIOLENCE AGAINST WOMEN IN MEXICO: A MULTIDISCIPLINARY RESEARCH MODEL PROPOSAL

Serena Eréndira Serrano Oswald

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### ABSTRACT

Gender Based Political Violence against Women is one of the main forms of political discrimination. It violently affects women, obstructing social justice for all and hindering parity democracy. In Mexico, the Constitution and the legal framework has been greatly reformed over the past two decades in order to enable women to fully exercise their political rights and have formal power in the political arena. Results are visible, if we consider that Mexico went from having 14 to 49 per cent of female representation in federal chambers from 1995 until 2018. In April 2020, the federal law of Gender Based Political Violence against Women was approved.

On September 7th, 2020 and until June 6th, 2021, in the midst of the Covid-19 pandemic, the biggest and most complex electoral process in Mexico began. IT will be the first electoral process under the federal law sanctioning Gender Based Political Violence against Women. It includes 95 million registered voters with 21,368 elected positions in dispute and elections on almost half of the states that make up the republic. For the first time in history, gender parity has been established by a strict quota system at municipal, state and federal level. This has exacerbated all forms of political violence, political violence against women and gender based political violence against women.

Gender Based Political Violence against Women is one of the least researched emerging topics in the social sciences, and it is mostly absent in regional science debates. It is relevant to consider that the 2017-18 electoral process was the most violent in Mexican history (in terms of total aggressions and homicides), narcopolitics have become a defining feature of Mexican politics, and the present Covid-19 crisis has exacerbated long-lasting inequalities and intersectional violence. It follows an in-depth study of Gender Based Political Violence against Women in Mexican history, encompassing a research team of over twenty academics primarily developed and led by the presenting author. The paper seeks to discuss a triangulated multidisciplinary research methodology proposal, with quantitative and qualitative indicators, to research the prevalence and impact of Gender Based Political Violence against Women in the 2020-21 electoral process with a transversal social justice and regional lens, presenting some preliminary research findings.

## **Regular Session: RS02.4 - Infrastructure, transportation and accessibility**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/84223142845>**

**Chair Jean-Claude Thill**

## THE SYSTEM OF SEAPORTS IN THE SOUTHERN AFRICAN CONE: HINTERLANDS AND SHIPPERS CHOICES

Jean-Claude Thill

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### ABSTRACT

Ports have historically been critical points articulating shipping and commercial activities between countries and regions. Their importance today is no less than it was centuries ago, but it may have morphed to some extent. Today, ports should not be regarded as isolated assets, but as nodes on shipping networks that may stretch over long distances, across oceans and supporting the global trade activities of territories. Africa, and Southern Africa in particular, has attracted the attention of the international business community as a frontier with great opportunities. Infrastructure is known to be rather deficient and widely believed to hold back the economic potential of the region. Transportation infrastructure has been a particularly weak in this respect. In this paper, we study the port system of the Southern African Cone. We aim to identify the hinterland of ports of the region for the purpose of export to another world region. Focus is on the capacity to handle containerized freight in particular. The analysis includes the econometric modeling of port choices by shippers seeking to export from the region. The model is estimated on data reflecting current logistical operations and trade realities. Factors include ports infrastructure elements, landside transportation systems, oceanside connectivities, and barriers associated with the crossing of national borders. A disaggregated choice model is used to this effect. Results underscore the core drivers of port choice in the region and are intended to serve as a decision-support tool to evaluate the possible responses of the freight transportation systems of the region to alternative future investment scenarios and enhancements of the level of service on a geographically disaggregated basis.

**SUBWAY EXPANSION, JOBS ACCESSIBILITY IMPROVEMENTS AND HOME VALUE APPRECIATION IN FOUR GLOBAL CITIES: CONSIDERING BOTH LOCAL AND NETWORK EFFECTS**

**Adriano Borges Costa, Camila Ramos, Siqi Zheng**

MIT Center for Real Estate, USA

**ABSTRACT**

We explore the potential of incorporating accessibility analysis in studying the impact of subway expansions on the real estate market. We first demonstrate that using increases in accessibility to firms as a continuous treatment variable instead of its binary alternative, the station-dummy approach, yields better goodness-of-fit in a quasi-experimental econometric analysis. We show that the dummy treatment variable consistently reported overestimated coefficients of impact for new subway stations. Furthermore, accessibility measures allow the exploration of impacts beyond the local effects around new subway stations, shedding light on network impact that has been largely overlooked in the literature. To provide greater external validity to our results, we apply the same analysis to the cities of Santiago (Chile), São Paulo (Brazil), Singapore, and Barcelona (Spain) and explore the common results. We argue that the integration of urban economics and transportation analysis can bring innovation to the empirical approach commonly adopted in the literature, and the use of accessibility measures in causal empirical studies on transportation impacts can produce more robust and comprehensive results and capture the nuanced spatial heterogeneity effects.

## EMISSIONS IMPACT OF PORT ACTIVITIES ON AIR QUALITY AND PUBLIC HEALTH: EVIDENCE AND IMPLICATIONS FOR ENVIRONMENTAL JUSTICE

[Yeonkyeong Park](#)

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### ABSTRACT

Over the past decade, many studies have explored various spatial dimensions of long-term emission impacts by pollutants and discovered associations to public health. However, there has been lack of scholarly attention on the environmental justice in those studies. Using the case of the Port Authority of New York and New Jersey, this paper aims to identify the spatial footprints of long-term emissions from port industrial activities on the ambient air quality of near-port communities, their expected outcomes on the public health, and implications for environmental justice.

Assuming a general higher preference to a cleaner environment for a higher quality of life, it is hypothesized that the residents living around the port areas of New York and New Jersey are those whose income levels are below average compared to other neighborhoods. Ports, as public infrastructure, are accountable for upholding principles of environmental justice and to protect marginalized and vulnerable groups of people for their fundamental right to live in a clean and healthy environment. While emission contributions vary by pollutants and locations within the states, PANYNJ's biggest contribution in local air pollution comes from its nitrogen dioxide emission in the Union county, NJ, accounting for 16 percent of the entire local air emissions in the New York and New Jersey area. Hypothetically, it is explained by the port truck operations from the three biggest terminals within the Union county. However, can the inference be scientifically proven? How can the trajectory of long-term emissions be spatially illustrated? What are the implications for the health outcomes of local communities? What does the spatial distribution of long-term port emission explain about environmental justice?

In terms of its research methodology, the paper conducts spatial analyses to test the hypotheses using the following multiple maps: 1) air pollution concentration map, 2) socioeconomic demographic map, and 3) respiratory diseases map. Data is combined from three sources: the C-PORT model, a web-based screening tool to estimate the long-term near-port air quality by four main air pollutants (NO<sub>x</sub>, PM<sub>2.5</sub>, SO<sub>2</sub>, CO) in census tracts scale, socio-economic data for near-port residents in New York and New Jersey from the U.S. Census Bureau of 2019, respiratory illnesses from the Centers for Disease Control and Prevention (CDC) for Chronic Obstructive Pulmonary Disease (COPD) prevalence. By spatially joining the three datasets, the paper attempts to validate the hypotheses on the port emission impact of air quality and public health of the near port residents.

Contributions from the study will include recommendations for local environmental policies specifically targeting the identified pollutant sources matched to the demographic profile and respiratory diseases to stir up more local dialogues between municipalities and communities. Furthermore, the study contributes to port hinterland studies which have been neglected in a scholarly context, by providing evidence of ports industrial risks and environmental justice across countries, and suggesting future guidelines for the developing countries with similar motivations. Lastly, the research will give a preliminary result for larger research questions on the sustainability of freight movements for both local communities and economic development.

## **Regular Session: RS16.2 - Tourism**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/89003478979>**

**Chair Leila Kebir**

## DO MOBILE DEVICES RENEW URBAN TOURISM PRACTICES? THE CASE OF THE CHAMPS ELYSEES IN PARIS

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### ABSTRACT

The digital revolution and what are called E-tourism modify urban tourist behaviors. With a computer and an internet connection, booking a room or building a tourism circuit is now easy to do by internet before the departure. But mobile devices can also be used in tourism during the tourism trip and inside the destination. What is called M-tourism is different from e-tourism. Indeed, mobile devices might allow changing behavior in-situ, i.e. in the destination. The changes induced by the increasing and widespread use of mobile device for tourism purpose affect these behaviors in a more important manner during their stay. M-tourism allows for last-minute booking for accommodation but also for different activities (museum, restauration, etc.). It can allow to changing instantly access, itinerary in the destination. It can also change the experience of the destination when tourism stakeholders are developing some new applications that are providing for instance geo-localization, augmented reality, etc. They also allow tourists for sharing experiences through social media (Munar and Jacobsen, 2014). The growing use of digital technologies offers many opportunities for innovation to build the destination of tomorrow, a smart destination (Gretzel et al., 2015), that is a destination in which the tourism experience will be central, and where the actors of the offer will be many, some of them even new to the tourism activity. The aim is to investigate, how mobile devices are used and how they eventually change urban tourism practices, taking into account a French case, the Champs Elysees in Paris. We have identified if the tourists own a smartphone, for what purpose M-tourism is used in-situ (transportation, hotel booking, restauration, meteo, activities, etc.). What other tools are used to prepare the trip (TV, mouth of word, touristic guide, etc.), what kind of mobile applications have been downloaded for what type of services (geolocation, trip, practical information, user reviews, etc.), if they are using augmented reality. The aim of the survey is also to identify if tourists but also inhabitants share photography or other information via mobile applications and what kind of information. For that purpose, a survey was conducted during May and June 2018 on the Champs Elysées in Paris. This paper starts by presenting the main digital technologies used in tourism and the way they may modify tourist's behavior and practices. It then presents the case of the Champs Elysées.

## SPATIAL MOBILITY AND CRUISE PASSENGERS' EXPENDITURE: AN INVESTIGATION USING GPS TECHNOLOGY

[Mauro Ferrante](#)<sup>1</sup>, [Caterina Sciortino](#)<sup>2</sup>, [Stefano De Cantis](#)<sup>2</sup>, [Szilvia Gyimóthy](#)<sup>3</sup>

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### ABSTRACT

This paper aims at analyzing the relationship between tourists' spatial behaviour and expenditure at the destination by means of an integration of traditional questionnaire-based survey and GPS technology. The complex information derived from GPS tracking device are analyzed through the implementation of various algorithm in order to synthesize key-characteristics of the itinerary undertaken. As a case study cruise passengers' behaviour in the city of Copenhagen are analyzed thanks to the availability of information collected in 2018 and 2019. The relationship among cruise passengers' expenditure at the destination, socio-demographic characteristics and mobility is analyzed through logistic regression models. The results show the relevance of spatial behaviour on expenditure. More in particular, stop activities are strongly associated with expenditure. Consequently, an analysis of stop locations is performed in order to highlight locations in which is likely that most of the expenditure is concentrated. The proposed approach is of relevance both from the methodological perspective, related to the analysis and synthesis of complex information derived from GPS tracking data, and from the applied point of view, with reference to destination marketing and management implications.

## COVID-19 AND THE SILENCE IN THE STREET: REGIONAL ECONOMIC IMPACTS OF A BRAZIL WITHOUT CARNIVAL

**Cláudio Eurico Seibert Fernandes da Silva<sup>1</sup>, Thaís Diniz Oliveira<sup>2</sup>, Rayan Wolf<sup>3</sup>, Fernando Salgueiro Perobelli<sup>1</sup>, Victor Eduardo de Mello Valério<sup>4</sup>**

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### ABSTRACT

The outbreak of pathogenic viruses and their interactions with humans and animals have resulted in severe acute respiratory syndromes over time. The emergence and rapid spread of Corona virus disease (COVID-19) has posed a major public health and governance challenges worldwide. The new SARSCoV-2 infection was first reported in Wuhan (China) but quickly reached a global pandemic status due to its high transmissibility characteristic. The COVID-19 pandemic has led to numerous sanitary restrictions that affected both the economy and individuals. The primary measure commonly adopted to prevent the transmission of the virus involves social distancing. The tourism sector has been by far the hardest hit, with postponements and cancellations of previously scheduled travels and public events in an attempt to avoid large gatherings of people. The negative effects on tourism activities are set to persist more than those on other economic activities since recovery will require a massive vaccination. In developing economies like Brazil, the total supply of tourism activities results from a mix of formal and informal activities and workers, which help shield important economic and social indicators. This research aims to estimate the regional economic impact of a Brazil without Carnival due to COVID-19 in 2021. Carnival is the most important and well-known tourist event in Brazil. This popular cultural celebration occurs annually and attracts people from different regions, promoting various economic gains from taxes collection and employment creation, for instance. The last Carnival before the first case of COVID-19 generated approximately US\$1.5 billion from tourism activities such as restaurants, accommodation, transportation, artistic and leisure activities, and travel agencies. Those are the activities supposedly most affected by the silence of the streets during Carnival this year. The analysis is focused on the six main Carnival states, namely Rio de Janeiro, São Paulo, Bahia, Minas Gerais, Pernambuco and Ceará. Using an unprecedented interregional input-output modelling for the population arrangements of each state, we simulated the contraction in touristic demand of each region under scrutiny to estimate the effects of cancelling Carnival. To account for such contraction, we use the relative share of each tourism activity in total earnings from Carnival 2020. With the method of total hypothetical extraction, we also identify the underlying relevance of the value chain linked to carnival tourism in creating both formal and informal jobs. The implications of this employment variation differ among the regions. Preliminary results show that more than 190 thousand jobs would have been created in Brazil if Carnival had not been cancelled in those states. Moreover, the government could have collected approximately US\$102 million of taxes. This Carnival chain represents, on average, 18.6% of job creation in these states. Given the substantial economic relevance of Carnival, public policies should encourage similar touristic events in the post-COVID context as a measure to stimulate both sectoral and overall economic recovery through employment generation and taxes collection.

## **Regular Session: RS18.4 - Resilience and Risk Management**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/83755733224>**

**Chair Abdellatif Khattabi**

## ANALYSIS OF DROUGHTS AND THEIR IMPACTS ON THE NATURAL AND SOCIO-ECONOMIC ENVIRONMENTS OF THE RURAL COMMUNITY OF EL FAID

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### ABSTRACT

The rural commune of El Faïd, which is part of the Souss region, has experienced alternating wet and dry periods. This evolution will certainly have negative impacts on the natural resources of the commune (Forests, water resources, soil,...), as well as on the socio-economic activities (Agriculture, breeding, ...). These climate trends are an important element for the assessment of the impact of climate change. The objective of the present work is to analyze precipitation data in order to characterize dry periods in the municipality and their succession over time. The analysis of rainfall data covers a period of 38 years (1981-2018) by calculating the values of the Standardized Precipitation Index (SPI) on an annual basis. The precipitation data used are taken from CHRIPS (Climate Hazards Group Infra Red Precipitation With Station Data). The results obtained show rainfall variability with a succession of dry periods and wet periods with a dominance of dry years. Indeed, there were several successive years of significant and moderate droughts during the periods 1981-1986, and during the period 1990-2008, with a severe drought year in 2001. Diachronic vegetation index analysis showed a variation on vegetation density and a survey among farmers has provided substantial vulnerability of the agriculture sector.

## A PROBABILISTIC ASSESSMENT OF ECONOMIC IMPACTS CAUSED BY EARTHQUAKES BY USING SEISMIC RISK MODELS AND SPATIAL CGE MODELING

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### ABSTRACT

This paper presents a probabilistic approach to estimating economic losses caused by the propagation of catastrophe-induced disruptions through the economy of an entire country and its regions. Our proposal connects a spatial Computable General Equilibrium model (CGE) with a probabilistic model for seismic risk assessment both robust and well-known models, used worldwide in their respective fields. We use a spatial CGE model based on a bottom-up approach to describe economic relations that consider the geographic location of the economic components and to propagate losses caused by earthquakes throughout the economy. The seismic risk model is used to estimate the physical loss of all economic components during a seismic event and the frequency with which it occurs. We estimate the physical losses not only for a particular event but also for a vast collection of events that collectively describe the entire seismic hazard of a country. To integrate the models, the assumption is that physical losses are directly proportional to the reduction of capital stocks that make up the assets inventory of an economy. Our approach allow us to present for the first time a set of probabilistic risk indicators regarding losses of production, employment, GDP, gross regional product, export volume, inflation, tariff revenue, among others, due to earthquakes. All indicators are computed by using a systematic probabilistic approach, which considers a vast collection of earthquakes, each of which has a particular frequency of occurrence. We illustrate this novel approach with an example developed for Chile. Results reveal that the Average Annual Loss (AAL) of production, GDP and export volume in Chile are 583, 305 and 62 million dollars, while the employment AAL is 7,786 workers. We also present for the first time the loss exceedance curves of production, employment, exports and for other different components of the Chilean economy at country and regional levels caused by the earthquake hazard.

### KEYWORDS

Economic impacts, CGE modelling, disaster risk management indirect impacts, seismic risk.

### 1. INTRODUCTION

We have witnessed recent catastrophic events that have made evident the economic implications and new features brought by disaster occurrence. The 2004 Indian Ocean earthquake and tsunami, hurricane Katrina in 2005, the 2010 Haiti earthquake, and the 2011 Japan earthquake and tsunami highlighted the importance of matters as disaster risk governance, reconstruction strategies, vulnerability of the economy of developing countries, the multinational disaster aspects and how disasters can cascade. The importance of accounting for indirect losses in risk is crucial and becomes larger as the supply-chain complexity increases in the age of globalization shown even in occasions, losses larger than those produced by physical damage (GFDRR 2014). However, it is not easy to account for the economic consequences of earthquakes with historical information alone, because these catastrophic events are infrequent, so relevant information is scarce, and it is not always easy to distinguish between direct and indirect losses.

Catastrophe modeling of physical damage caused by earthquakes is today a well-developed technique, to the point that it is possible to estimate, in a probabilistic manner, the seismic risk of individual assets (Marulanda et al., 2013) as infrastructure, buildings, contents, machinery, equipment, etc. Modeling of indirect losses, in comparison, lags far behind, mainly due to the difficulties in empirically translating property damage into indirect losses and due to the lack of adequate models that relate these two kinds of losses. Usually, indirect losses are estimated roughly as a percentage of physical losses, establishing this percent with empirical information obtained from a very limited historic database of events occurred around the world; this is clearly unsatisfactory.

However, there is a well-developed literature on the economic impact of natural and man-made disasters, whose most recent advances have been compiled by Okuyama and Rose (2019). On one hand, efforts have been focused on improving and extending the quantitative models used for disaster impact analysis, such as cyber-attacks, extreme weather events, earthquakes, flooding, climate change, and terrorist attacks, amongst others. On the other hand, researchers have devised

tools to directly estimate economic damages and/or losses based on some physical data of natural hazards, or to evaluate, for instance, the changes in economic activities with a set of satellite data on annual difference in nighttime light intensity. In spite of the existence of this large and rich analytical framework to study the impact of disasters into the economy, efforts have concentrated in the analysis of individual, without appropriate consideration of their frequency of occurrence. But frequency of occurrence matters. Clearly, decisions and policy would be very different if one knew that the economic impacts of a certain size are to be expected, on average, once every 100 years or once every 1000 years. Further, it would seem that little attention has been given to linking physical damage to infrastructure or economic components with higher-order economic losses.

In view of this, we present here a probabilistic approach to the estimation of higher-order losses that takes into account that: 1) natural events –earthquakes in our case– take place as a stochastic process in time; 2) frequency of occurrence of events matters for measuring risk; and 3) there are links between the level of physical damage to economic components and the reduction of capital stock. In our approach, we start with a Computable General Equilibrium (CGE) model of the economy, specified as a fully integrated interregional system. This model describes the economic interactions among regions and industrial sectors, and is in equilibrium under a certain level of inputs, outputs and prices. Then, an earthquake happens, and produces physical damage (direct losses) to the economic components associated with the available capital stock (e.g. buildings, factories and infrastructure) of the affected portion of the region; these losses are estimated with conventional seismic risk techniques (Cardona et al., 2012). Direct losses, in turn, produce partial reductions in some inputs to the CGE model, namely regional-sectorial capital stocks, which attains a new equilibrium after proper adjustments, reaching new levels of outputs and prices. The result is that the occurrence of the earthquake produces direct losses plus other types of indirect losses that result from the propagation of the reduction of available primary factors through the economy described by our CGE model. As in the case of conventional seismic risk models, the analysis is then repeated for a vast set of earthquakes (44,350 events for our case of study) with known occurrence frequencies, that collectively describe the hazard of the region under study. Results for all earthquakes allow for various probabilistic risk metrics to be computed, now including the effect of indirect losses as well.

This work is the first effort to join, in a systematic way, the probabilistic seismic risk and the CGE modeling frameworks, both robust and well-known models used worldwide in their respective fields. CGE models are used widely for studying and simulating economic effects within an economy, given the occurrence of different types of shocks, such as economic policies, taxes, financial crises, terrorist attacks, natural disasters, etc. We make use of a special type of CGE models, known as spatial CGE models (Haddad 2009), which have the ability to take into account the geographic location of economic agents and endowments.

Our modeling approach is fully probabilistic on the earthquake occurrence side, but for now is deterministic on the CGE side. We assume that the physical damage produces a proportional reduction on the value of the capital stock of components hit by the earthquake, which initially causes a direct reduction on production and later propagates into the economy in ways dictated by the interactions contained in the CGE model.

Besides dealing with the estimation of indirect monetary losses, our approach allows for a better glance of the likely consequences of the earthquake occurrence into the full economy. As we will see, the richness of the CGE modelling allows for carrying out risk assessment referred to different economic variables, such as employment, GDP, GRP, wages, tariff revenue, consumer price index, export volume, and so on. Furthermore, we have observed the capacity of the CGE model to catch positive economic impacts of earthquakes on certain sectors and regions, through substitution effects. The new methodology is applied to Chile, a country that is frequently affected by large earthquakes and with one of the most dynamic economies of Latin America, economy that in addition shows remarkable regional disparities. These characteristics make Chile an ideal place to exemplify our approach.

## 2. SEISMIC RISK MODEL

First, the seismic risk model contains an exposure database (ERN-AL 2010) that includes all assets at risk that are relevant for the analysis. In our case, the relevant assets are buildings, factories, infrastructure and, in general, all assets that provide input of some kind to the economic model. In other words, all assets whose damage might have a potential impact in the economic flows. Each asset must be identified by its location, seismic vulnerability characteristics and, particularly relevant for our present purposes, the economic sector to which it belongs. Exposure database can be built from cadastral and local data or by using proxy methodologies as suggested by Gunasekera et al., (2015), Aubrecht & León Torres (2016) that harnesses global geo-referenced datasets and census data.

At random instants, with all assets intact, and following a Poisson process, the economic equilibrium is perturbed by the occurrence of an earthquake with known focal characteristics (magnitude, hypocentral location, orientation of the rupture plane), which in turn will produce a spatial random field of intensities (peak ground acceleration, spectral values). In contemporary seismic risk models, this information is provided by its hazard component (Esteva 1967), (Ordaz et al., 2014). This component provides a potentially very large event set, each one associated to an annual frequency of occurrence and to one or more intensity random fields. Therefore, the hazard component provides information about how frequently different kinds of earthquakes take place and gives probabilistic indications of the intensities it produces. In principle, the hazard component should contain information about occurrence frequencies and intensity distributions of all earthquakes that could take place in the future. In other words, the event set must be collectively exhaustive. For the case of Chile, we have used a seismic hazard model developed by consulting company ERN (Salgado-Gálvez 2018).

Once a hypothetical earthquake has taken place and its intensities are known –or, more precisely, the probability distributions of the intensities are known-, the seismic risk model (Ordaz et al., 2000) provides tools to assess, in probabilistic terms, the level of direct losses suffered by each one of the assets contained in the exposure database; this part of the model is usually referred to as the loss component. The level of damage sustained by an asset depends on its location, the size of the intensity and its vulnerability characteristics. Thus, once a hypothetical event has taken place, we have means to determine the probability distribution of the losses sustained by each one of the assets at risk. For this issue, we computed a set of functions, called vulnerability functions (ERN-AL 2010) that characterize the seismic vulnerability of any asset.

In general, and in view of the lower geographical resolution of the CGE models compared to that of the seismic risk models, a loss aggregation is required in order to sum all the losses that correspond to the same economic sector at the same economic region. Since the losses at the various assets are not numbers but correlated random variables, the aggregation process is not trivial, because of the correlation among losses for the same event. We will not discuss in detail how this aggregation process is handled; we just call the readers’ attention to this complexity.

Therefore, as it can be noticed, the seismic risk model is used in our approach to determine two important pieces of information for each one of the members of the event set: 1) the probability distributions of the losses incurred by assets belonging to all economic sectors and regions, that is, the severity of the direct losses; and 2) the annual frequency with which that particular loss scenario takes place. We will see later how this information is used in the overall risk calculations.

### 3. CGE MODELLING

We use the BMCH model, a fully operational spatial CGE model for Chile. The model uses an approach similar to Peter et al., (1996), Haddad (1999), Haddad & Hewings (2005) to incorporate the interregional economic structure. We use an absorption matrix as the basis to calibrate the CGE model, together with a set of elasticities borrowed from the econometric literature applied for Chile. This database allows capturing economy-wide effects through an intricate plot of input-output relations. Table 1 shows the regions and economic sectors that constitute our model.

**Table 1: List of regions and sectors used for Chile**

Code	Name of the region	Code	Name of the economic sector
R1	Region of Arica and Parinacota	S1	Agricultural-forestry and fishing
R2	Region of Tarapacá	S2	Mining
R3	Region of Antofagasta	S3	Manufacturing industry
R4	Region of Atacama	S4	Electricity, gas and waste management
R5	Region of Coquimbo	S5	Construction
R6	Region of Valparaiso	S6	Commerce, hotels and restaurants
R7	Metropolitan Region of Santiago	S7	Transport, communications and information services
R8	Region of Libertador General Bernardo O'Higgins	S8	Financial intermediation
R9	Region of Maule	S9	Real state and housing services
R10	Region of Biobío	S10	Business services
R11	Region of La Araucanía	S11	Personal services
R12	Region of Los Ríos	S12	Public administration
R13	Region of Los Lagos		
R14	Region of Aysén Del General Carlos Ibáñez del Campo		
R15	Region of Magallanes and Chilean Antarctic		

The current version of the BMCH model recognizes the economic structures of the 15 Chilean regions. Results are based on a bottom-up approach – i.e. national results are obtained from the aggregation of regional results. The model identifies 12 production/investment sectors in each region producing 12 commodities, a representative household in each region, regional governments and a Central government, and a single foreign area that trades with each domestic region. Two local primary factors are used in the production process, according to regional endowments (capital and labor). Special groups of equations define government finances, accumulation relations, and regional labor markets. The BMCH model qualifies as a Johansen-type model in that the solutions are obtained by solving the system of linearized equations of the model, following the Australian tradition. A typical result shows the percentage change in the set of endogenous variables, after a policy is carried out, compared to their values in the absence of such policy, in a given environment. Interregional linkages play an important role in the functioning mechanisms of the model. These linkages are driven by trade relations (commodity flows), and factor mobility (capital and labor migration). In the first case, interregional trade flows are incorporated; interregional input-output relations are required to calibrate the model, and interregional trade elasticities play an important role (Haddad 2009).

When an earthquake takes place it produces direct losses, whose probability distributions were determined with the seismic risk model described succinctly in the previous subsection. Once aggregated, the direct losses by sector and by region are entered into the CGE model as “shocks” to the capital stock component of the sector/region combination. These shocks are nothing more than exogenous capital stock reductions, which are usually calculated as the ratio between physical loss and the total cost of the capital stock. When entering the set of shocks to the CGE model, the equilibrium conditions of the model are lost, so that we need to run the CGE model again in order to reach a new equilibrium that reflects how the economy adjusts to the received shock. The new equilibrium condition is obtained with a new value-set of the endogenous variables, which are the results of the model.

A CGE model can be made of hundreds or even thousands of variables (exogenous and endogenous); each one of them can provide us with a different type of result, either of economic or social interest. The richness of the CGE model in terms of the amount of results is extraordinary, allowing for the possibility of developing a broad range of analyses. Initially, we will focus on the variables that quantify the total production of the industries; later, however, we will analyze other, non-economic types of losses.

We will define the *production loss* of sector  $i$  in the spatial region  $j$ ,  $L_{pij}$ , as the difference between the production before and after the earthquake, for the same sector/region. In other words, as a consequence of the decreased capital stock in certain sectors and regions, hit by the earthquake, the economy attains a new equilibrium in which the production at that sector/region is smaller (or higher...) after the earthquake than before. We regard this difference as a production loss, and this will be our initial measure of indirect losses, although we will later explore the use of results related to other variables.

At this initial phase of our research, the behavioral parameters and structural coefficients of the CGE model, that is, the parameters and coefficients required to establish the relations between exogenous and endogenous economic variables, are considered deterministic. In spite of this, the outputs of the CGE model – the indirect losses – are not numbers, but random variables, because some of the inputs were also random variables. We do not distract the attention of the reader with details on how the probability distributions of the CGE model outputs are determined. For the time being, it suffices to say that it is possible – although computationally challenging – to obtain the probability distributions of all relevant CGE model outputs, either at the sector/region level or for any required aggregation.

At this point, we are able to compute, for each event of the event set, probabilistic direct and indirect losses. In the following section we will illustrate the way in which the most common risk measures can be obtained with the results presented so far.

#### 4. RISK ASSESSMENT

The most common risk measures, both in the disaster risk management world as well as in the insurance sector, are: 1) the average annual loss; and 2) the loss exceedance curve, which indicates the average frequency with which given values of loss would be exceeded. We will focus only for illustration purposes, on the total direct and indirect losses. The total losses are, of course, the sum of the losses for all assets, in the case of the direct losses, and for all sectors and regions, for the case of the indirect losses.

For instance, the  $k$ -th event of the event set produces probabilistic direct and indirect losses  $Ld_k$  and  $Lp_k$ , respectively. Then, the corresponding average annual loss,  $AAL_d$  would be given by:

$$AAL_d = \sum_{k=1}^{Events} E(Ld_k) F_k \tag{1}$$

$$AAL_p = \sum_{k=1}^{Events} E(Lp_k) F_k \tag{2}$$

where  $E(.)$  denotes expected value and  $F_k$  is the annual frequency of occurrence of event  $k$ .  $AAL_d$  is a quantity that is routinely computed in conventional risk analyses;  $AAL_p$  is introduced in this paper.

The loss exceedance curves,  $v_d(.)$  and  $v_p(.)$  of direct and indirect loss, respectively, are computed with the following expressions:

$$v_d(l) = \sum_{k=1}^{Events} Pr(Ld_k > l) F_k \tag{3}$$

$$v_p(l) = \sum_{k=1}^{Events} Pr(Lp_k > l) F_k \tag{4}$$

where  $Pr(Ld_k > l)$  and  $Pr(Lp_k > l)$  are, respectively, the probabilities of direct and indirect losses exceeding a given value,  $l$ .

##### 4.1 New complementary risk indicator

The procedure for the computation of the probabilistic risk measures regarding employment, GRP, consumer price index, export volume and any other economic variable of the CGE model, is exactly the same but for the corresponding economic variable instead of that of production one. In the case of positive economic effects, the procedure for the computation is again the same, with the difference that, in this case, we only account for the positive effects that each earthquake triggers in the CGE model.

The risk calculations shown in this paper have been carried out with program DIRAS2020, developed at the Instituto de Ingeniería, UNAM. This piece of software has been specifically created to join and process the information coming from a conventional seismic risk model and a spatial CGE model.

##### 4.2 Calibration of the model

Empirical validation of catastrophe models is, by definition, a difficult task. Fortunately, catastrophes are relatively rare events (otherwise, they would not be catastrophes) so observed values of losses are never a sample big enough to allow for empirical validation. Even if we had observed losses for a long time, cities change, construction materials change as well, so the loss information of events that took place more than a few decades ago is not very useful. In a way, the reason

to start developing catastrophe models, back in the 1990s, was precisely the need to compensate for this data shortage. So direct validation of the models, in the sense of empirically establishing the exceedance frequency of losses of various sizes, is never possible.

Nevertheless, efforts are made to carry out partial validations of different kinds. First, the rate of occurrence of earthquakes of various magnitudes, as well as their spatial distribution, is estimated from appropriate earthquake catalogs and knowledge of the regional tectonic setting; this guarantees that the model for future occurrences will not be introducing too many or too few events, and also that the spatial distribution of future, hypothetical events, will be coherent with the observed distribution and coherent also with geological science.

Additional validations are made regarding the relation between earthquake source characteristics (magnitude, hypocentral location, rupture plane orientation, etc) and the ground acceleration field produced by the event. This guarantees that, on average, the observed ground accelerations and the accelerations predicted for future events will be unbiased.

In some cases, it is possible to compare the real losses produced by an event with those computed with the model for a synthetic event of similar characteristics. We present an example of this comparison with the Maule earthquake of 2010 (section 5.3), finding that the modelled losses are coherent with those observed. In some cases, several loss-producing events can be used in this validation phase but, in our case, the last big event before the Maule earthquake took place in 1985, which was considered to be too far away in the past. Although it is no possible to use for validation proposes, in results sections we have included the losses obtained for simulations of the 1985 Valparaiso and the 1960 Valdivia Earthquakes in order to estimate what would be the economic consequences if those earthquakes took place today.

## 5. HAND-ON CASE OF STUDY

As we have mentioned before, this is the first time in which a robust, probabilistic and systematic connection between entire seismic risk and large-scale economic models has been attempted. Therefore, we have not been able to collect all data required to carry out a full joint calibration of the models, in particular the proportional relation between the reductions of the capital stock and the direct losses in non-residential buildings. In this sense, our example should be considered a proof-of-concept rather than a final product. In spite of this, we believe that the results obtained in this example are quite reasonable and can be used to gauge the power of the approach, within, of course, its assumptions and limitations. In what follows we will present the main results of our example, highlighting some of the most interesting findings.

Table 2 presents general descriptors of the Chilean economy and some of the more aggregated results of our analysis. Direct losses computed refers exclusively to non-residential buildings. The reason for this restriction is that we are trying to model damages only in capital stocks used in the production process, in the sense that their physical disruption is susceptible of being propagated in the economy of the country.

### 5.1 General results

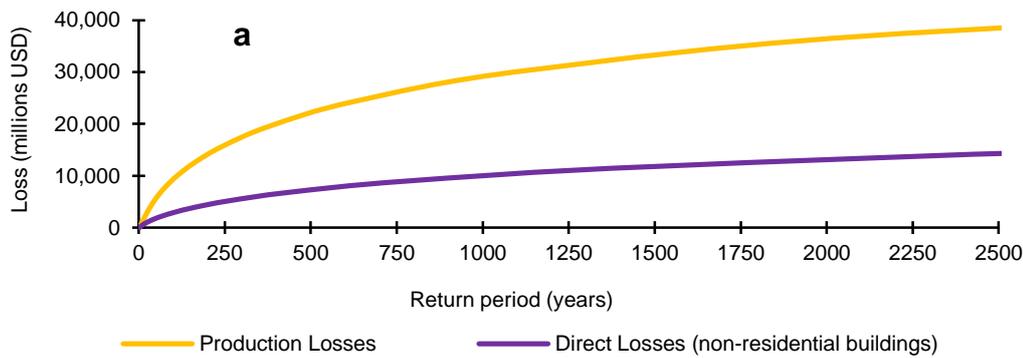
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**Table 2: general value of the Chilean economy (2014) and main aggregated results**

Item	Total Value	Average annual loss
Total value of non-residential buildings	103,720 million USD	302 million USD
Total value of yearly production	442,805 million USD	583 million USD
GDP	251,020 million USD	305 million USD
Total employment in Chile	6,671,072 workers	7,786 workers
Total export volume	83,102 million USD	62 million USD

We will express seismic risk, due to direct or indirect losses, in terms of a few standard risk metrics. We will use the average annual loss (Methods, equations 1-2) and the loss exceedance curve (LEC; Methods, equations 3-4). Let us start presenting the results at the country level.

Figure 1 shows the loss exceedance curve of Chile's direct and production losses. It must be noted that we are representing the LEC with the return period (the inverse of the exceedance rate) in the horizontal axis and the loss values in the vertical axis. The LEC for physical losses is a common metric within the risk assessment world; however, the LEC for production losses is introduced for the first time in this paper. The production loss associated to 250 years of return period for Chile was estimated in 15,870 million dollars (3.58% of the total yearly production) while direct losses were 5,025 million dollars, that is 4.9% of the total value of non-residential buildings. For 1,000 years of return period, the production and direct losses were 28,760 and 9,835 million dollars, respectively.

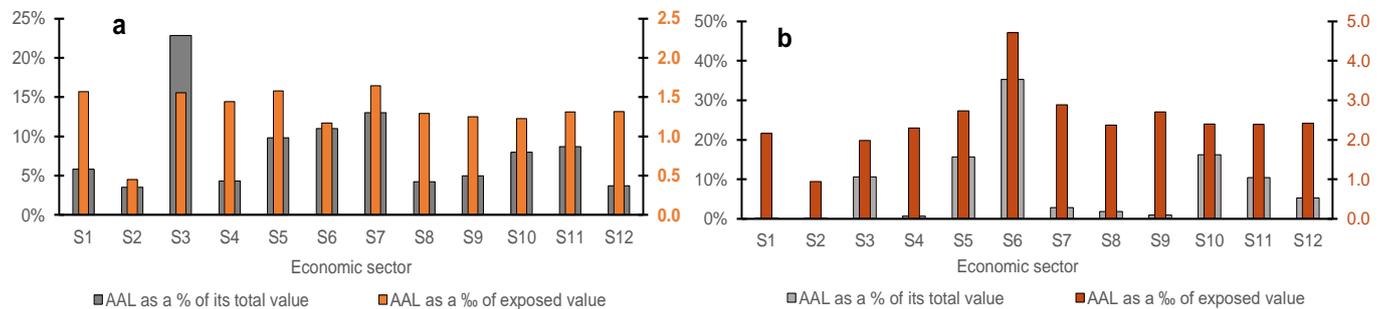


**Figure 1: Loss Exceedance curves of direct and production losses.**

It is shown the LECs expressed in million dollars. Direct losses refer exclusively to non-residential buildings of the country

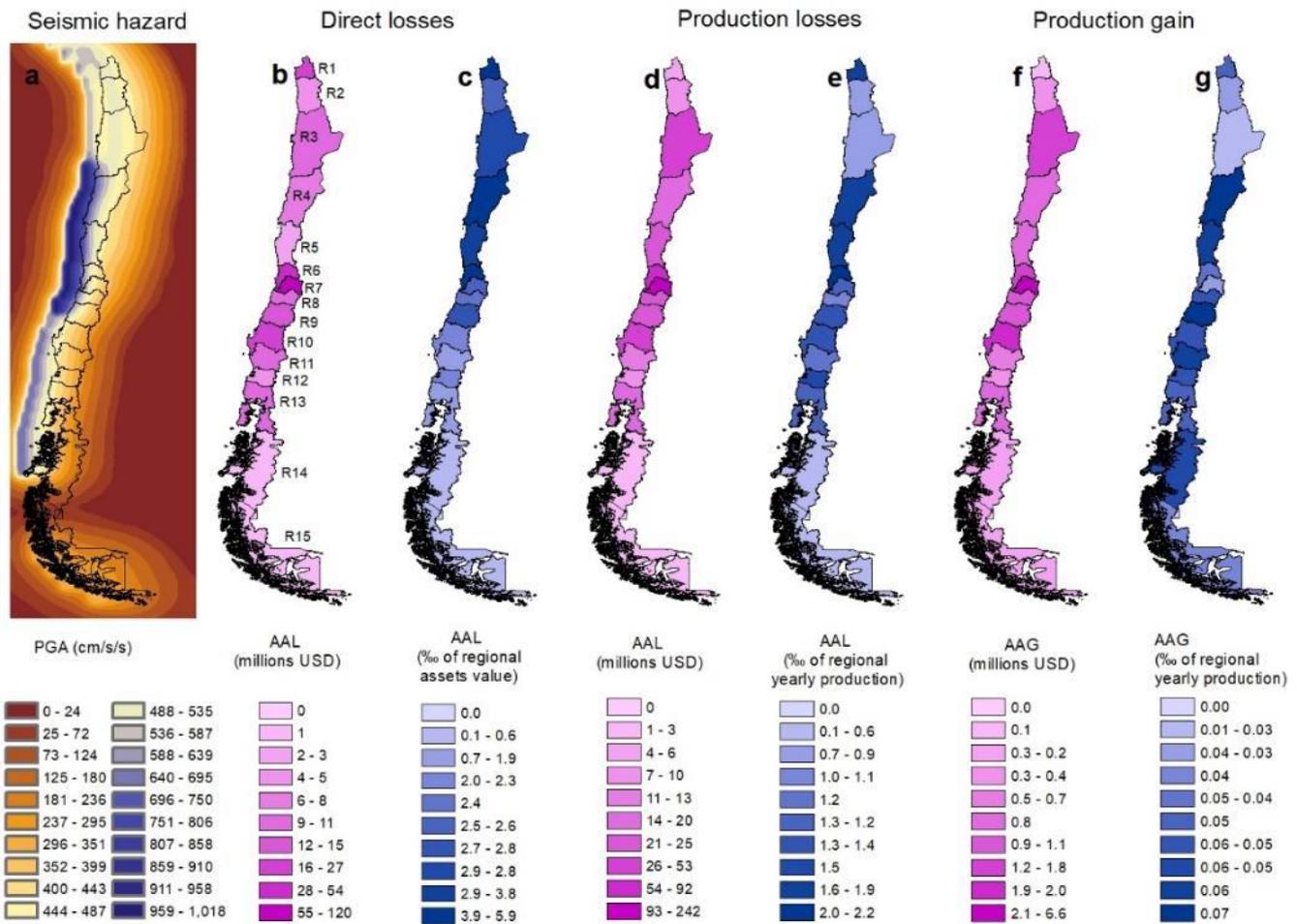
In the case of the AAL for the whole country, that of direct losses has been estimated as 302 million dollars, which is 0.29% of the total value of non-residential buildings. In turn, the AAL of production losses reaches 583 million dollars, that is, 0.132% of the total yearly production of the country.

Figure 2 shows the AAL for Chile grouped by economic sector, both for direct and production losses. We present the AAL results: 1) as a percentage of its total value, in order to see the influence of each sector in the total AAL; and 2) as a fraction (per thousand) of its exposed sectorial value of assets and yearly production, respectively, in order to see how risky each sector is. Clearly, we can see in Figure 2 that both the AAL distribution by sector and the risk rank of economic sectors are different for direct and indirect losses. Similarly, Figure 3 depicts the AAL by region of the country for both types of losses, together with an indication of the seismic hazard level, expressed in terms of the peak ground acceleration (PGA). Figure 3 shows for instance that regional risk indicators of direct losses are not proportional to their corresponding ones of production loss. We have found that the riskiest region (highest value of relative AAL) in terms of direct losses are Region of Atacama (R4) while in terms of production losses the riskiest is Region of Valparaiso (R6). This clearly demonstrates the importance of taking into account the high-order economic losses since, while there are regions most physically affected by the earthquake hazard, there are other regions that suffer the largest effects in terms of loss of production.



**Figure 2: Average annual loss for Chile by economic sector**

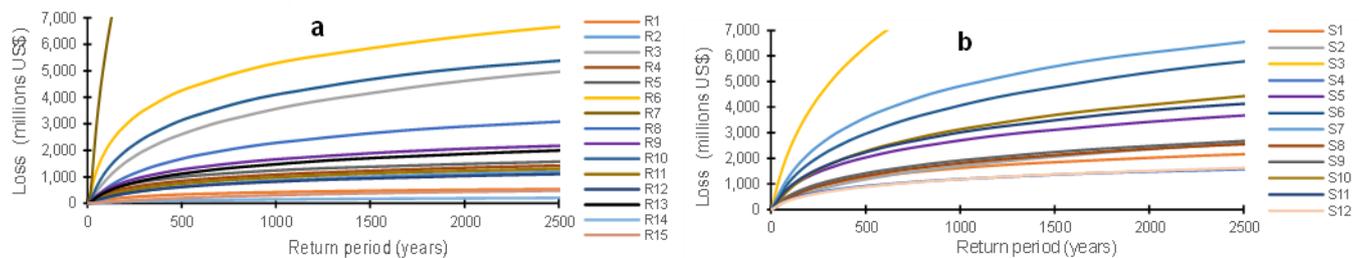
Panel a shows the production AAL as a percentage of its total value (gray) and as a fraction (per thousand) of its sectorial yearly production (orange). Panel b shows the direct AAL as a percentage of its total value (grey) and as a fraction (per thousand) of the corresponding sectorial value of non-residential buildings (red)



**Figure 3: Distribution of AAL in Chile**

Panel a shows the seismic hazard for Chile, expressed in terms of the peak ground acceleration (PGA) associated to 475 years of return period. The average annual loss due to physical damage of non-residential buildings (direct losses) by region is shown in panel b in millions of USD and in panel c as a fraction (per thousand) of its regional exposed value. The average annual loss in production by region is shown in panel d in millions of USD and in panel e as a fraction (per thousand) of the corresponding regional annual production. Finally, panels f and g present the annual average gain (AAG) of production by region in millions of USD and as a fraction (per thousand) of the corresponding regional annual production

Our approach also allows us to obtain the LEC of production for individual regions or economic sectors, as shown in Figure 4. The Metropolitan Region of Santiago, R7, presents the highest losses in absolute terms. For example, for a return period of 250 years, region R7 shows a loss of 10,674 million dollars, which is 5.45% of its total yearly production. In the case of economic sectors, manufacturing industry, S3, presents the highest losses in the country in absolute terms, and, transport, communications and information services, S7, the highest losses in in relative terms to its sectorial production, for any return period.



**Figure 4: Production loss exceedance curve of Chile by region**

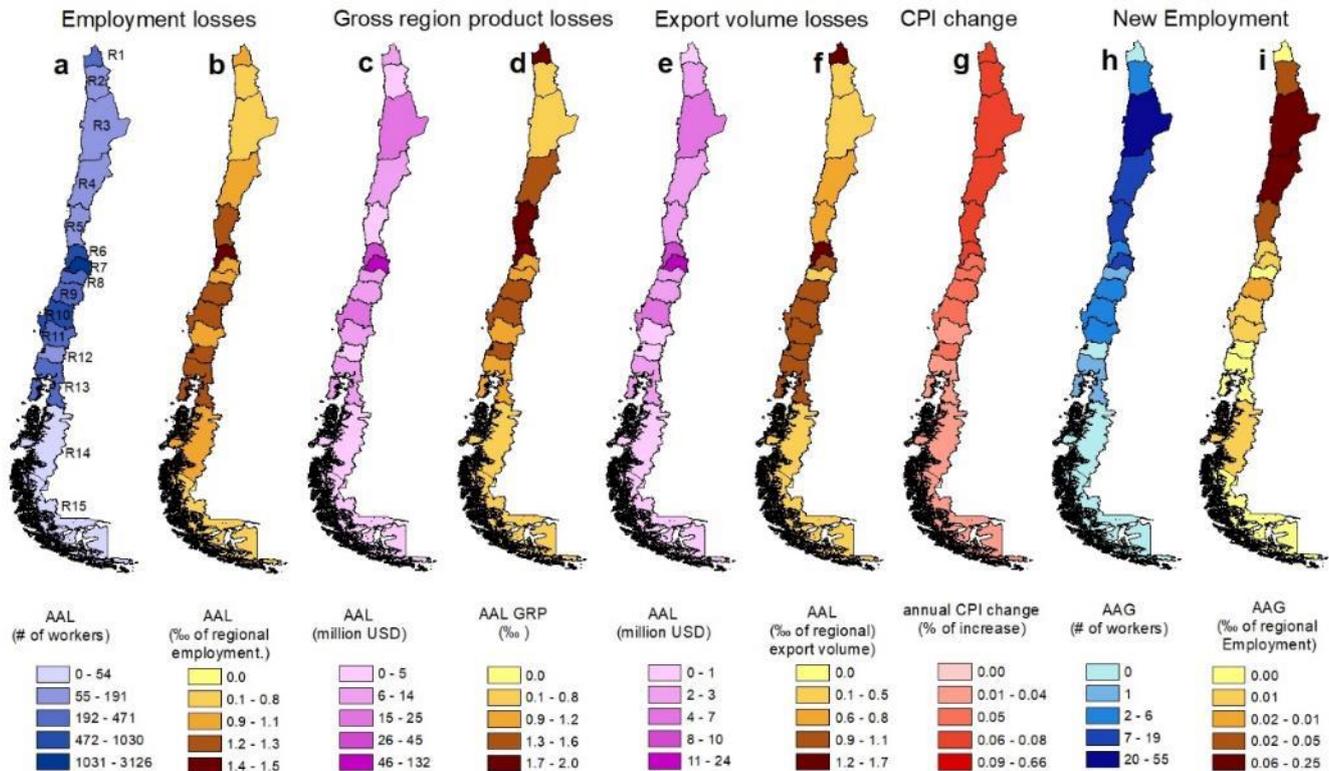
Panel a by region of the country, Panel b by economic sector.

**5.2 New risk indicators**

The richness of CGE modelling regarding the amount of interesting output variables, each one of them reflecting a different aspect of the economy, allows for the computation of many interesting and useful risk measures. Besides calculating the risk measures in terms of production loss, it is possible to compute risk measures for losses of

employment, GDP, GRP, tariff revenue, consumer price index, export volume, among others. These novel indicators can be useful for seismic risk management, as they provide a way to measure the losses in various aspects of an economy facing earthquake hazard.

For instance, the employment AAL and the employment loss associated to 250 years of return period for Chile are 7,786 and 237,165 workers. In the case of AAL in GDP and the loss associated to a return period of 250 years due to seismic hazard, losses have been estimated in 305 and 9,415 million dollars, those are, 0.122% and 3.77% of the total Chilean GDP. GDP loss do not include direct losses (physical damage). Figure 5 exemplifies some of the results obtained in term of the AAL for several economics variables.



**Figure 5: New risk indicator for Chile**

Panel a and panel b show the average annual loss (AAL) of employment by region of Chile in number of workers and as a fraction (per thousand) of the corresponding regional employment. Panel c and panel d show the AAL of gross regional product in millions dollars and in relative terms. Panel e and panel f show the AAL of export volume by region in million dollars and as a fraction (per thousand) of the regional export volume. Panel g shows the average annual change of the consumer price index by region of Chile. Panel h and i show the average annual gain of employment by region in number of workers and as a fraction (per thousand) of the regional employment.

Because of an earthquake, economic losses usually occur; however, in certain regions one or various economic sectors can have positive effects, like production increases given the decrease of production in other regions. In fact, we are able to measure, using the same indicators, the positive effects in the same components of the economy for which we calculated the negative impacts. These novel probabilistic indicators of positive effects can be also useful for a better understanding and management of the seismic risk. Similar to economic losses, positive effects are captured for a vast collection of events that collectively describe the seismic hazard of the country. Figures 3 and 5 in the most-right panels present a couple of examples of the positive results obtained. By now, we are not considering recovery and reconstruction processes of the lost capital stock, reason why, on average, positive effects are much smaller than the negative effects and mainly due to substitution effects.

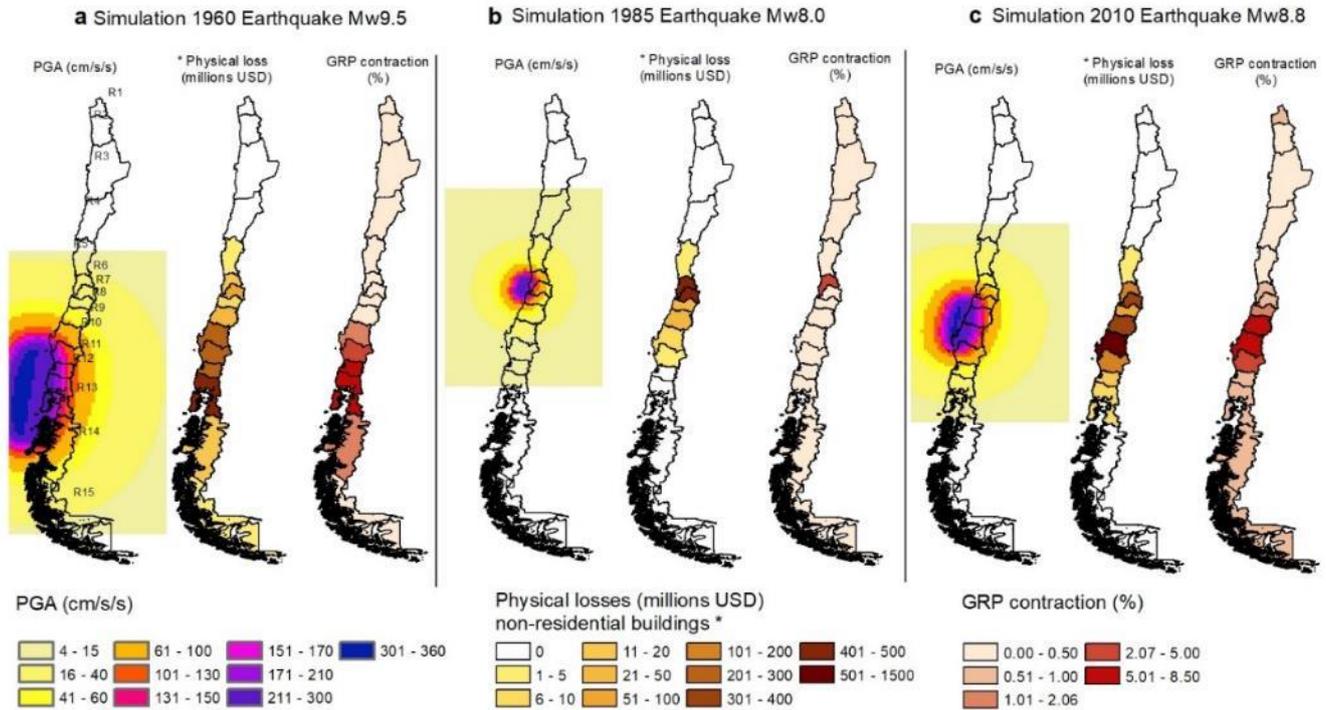
### 5.3 By-scenario analysis and calibration of the model

Production losses, employment losses, CPI changes, and so on, can also be computed for any particular stochastic earthquake coherent with a seismic hazard model for the region over study. Figure 6 presents the direct losses and GRP reductions estimated for simulations of three large earthquakes occurred in Chile. Earthquake. For instance, we found that for the 2010 Maule Earthquake, the maximum price increase take places in Region of Biobío (R10), with a 1.9% and would cause an average production loss of 1.7% of the total yearly production of Chile.

By-scenario loss analysis is also useful to calibrate y/o validate catastrophe models, when information of real losses of recent events are available. In our case, official information of direct and indirect losses of 2010 Maule Earthquake are available.

According to estimations of the Central Bank of Chile, The Maule 2010 Earthquake caused a 3% of losses in the total net capital stock of Chilean economy, 3.2% in the residential buildings and 2.6% in non-residential infrastructure (Banco de

Chile 2010). Our model estimate direct losses in non-residential buildings of 2.5% of its total value. Furthermore, Chilean Government (Gobierno de Chile 2010), estimated a GDP decrease of 7,600 million dollars for the next four years after the 2010 Maule Earthquake. Our simulation for this event estimates a yearly GDP contraction of 1.65%, which is coherent with the official estimation assuming that the first year after the earthquake, at least, half of the total 7,600 million loss will take place, it is, a 1.74% GPD contraction (Total Chilean GPD 2010: 218,500 million dollars).



**Figure 6: Physical losses and GRP contraction caused in Chile by three simulated earthquakes**

Each panel present the PGA intensity field generated by the earthquake and both the physical losses in non-residential buildings and the Gross Regional Product (GRP) contraction caused the earthquake. Panels a, b and c show results for simulated earthquakes similar to 1960 Mw9.5 Valdivia Earthquake, 1985 Mw8.0 Valparaiso Earthquake and for 2010 Mw8.8 Maule Earthquake.

## 6. CONCLUSION

Our approach has shown how the Computable General Equilibrium model and the probabilistic model for seismic risk assessment are able to work together, allowing for a robust and systematic probabilistic glance of the consequences of the earthquake disturbance into the full economy. We were able to successfully deal with the production losses, exemplifying our methodology with the computation of the standard risk metrics respect to production losses, that is, the average annual production loss and the production loss exceedance curve, both at country and regional levels, and computed by considering a vast collection of earthquakes, with known annual occurrence frequencies, that collectively describe the entire seismic hazard of a country. We also have shown how our approach can go beyond production losses and, harnessing the richness of the CGE modelling, we have computed the standard risk metrics for different economic variables, such as losses of employment, GDP, GRP, export volume and consumer price index. We believe that these new risk measures are useful and complement well the usual risk indicators of physical damage, and can contribute for a better integral disaster risk management as well as in designing financial hedging instruments for governments and the insurance industry. Our model captures not only the negatives consequence of earthquakes but also some positive effects on the economy proposing new probabilistic measures of these gains. Our methodology is not exclusive for earthquakes and can be easily extended to other natural disaster as flooding, hurricanes, drought, etc.

For the case of Chile, we find that the average annual loss (AAL) and the production loss associated to a return period of 250 years, for the whole country, were 0.132% and 3.58% of its total yearly production, respectively. From the authors' experience, these results look reasonable in comparison with the direct economic losses obtained (0.29% of the total value as AAL of non-residential buildings). We also find that the employment AAL in Chile is 7,786 workers and the AAL in the GDP and export volume are 305 and 62 million dollars, corresponding to 0.122% of the GDP and 0.08% of the annual export volume, respectively. Metropolitan Region of Santiago concentrates ~41% of the total production AAL while Region of Valparaiso is the riskiest, with a regional production AAL of 0.22%.

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## HEALTH INTERVENTIONS IN A POOR REGION AND RESILIENCE IN THE PRESENCE OF A PANDEMIC

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### ABSTRACT

We focus on a poor region and analyze the connections between health interventions undertaken by a regional authority (RA) and this region's resilience in the presence of a pandemic such as Covid-19. First, we show how a health intervention by the RA stochastically impacts an appropriately defined health indicator for this region. Second, we compute the probability that the health status of this region's population falls below a minimum acceptable level in the presence of the health intervention. Third we solve an optimization problem in which the RA maximizes the likelihood that the health status of this region's population stays above a minimum acceptable level at a given economic cost. Finally, we discuss the nexus between a health intervention, our region's health status, and its resilience by presenting two applications of our theoretical framework.

### KEYWORDS

Cost, Pandemic, Regional Health Indicator, Resilience, Uncertainty

### JEL Codes

R11, I18

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## 1. INTRODUCTION

### 1.1. Preliminaries

In early December 2019, a physician by the name of Li Wenliang from the city of Wuhan in China commented in a group chat that he had observed a series of patients demonstrating signs of an ailment that was similar to severe acute respiratory syndrome (SARS). As pointed out by Lango (2020), this ailment was then reported to the World Health Organization (WHO) country office in China on 31 December 2019. On 12 January 2020, Chinese scientists published the genome of the virus and the WHO asked a team in Berlin, Germany to use the information provided to develop a diagnostic test to identify any active infection. This was developed a few days later. The work of Chaplin (2020) and that of many others tells us that the cause of the SARS-like ailment that subsequently became known as Covid-19 was a novel coronavirus, specifically, the SARS-CoV-2. On 30 January 2020, Covid-19 was declared by the WHO to be a Public Health Emergency of International Concern (PHEIC). The first case of Covid-19 stemming from local person-to-person spread in the United States (U.S.) was confirmed in mid-February 2020. On 11 March 2020, the WHO declared COVID-19 a pandemic.

It is important to recognize that the *regional* impacts of Covid-19 thus far have been very different. For instance, China and Italy, the two nations in which the adverse impacts of Covid-19 were felt very strongly early on in the spread of the coronavirus---see Perez-Pena (2020)---are now doing much better as far as the management of the virus is concerned. In contrast, Londono (2020) tells us that initially little affected nations such as Brazil are now seeing some of the worst outbreaks of the virus. Even within a single nation such as the U.S., there are substantial regional differences. Northeastern states such as Connecticut, New Jersey, and New York were all initially hit hard by Covid-19 but now have few new cases or deaths (Anonymous, 2020). In contrast and as noted by Findell *et al.* (2020), states such as Arizona, Florida, and Texas that were relatively unaffected by Covid-19 during the early days of the outbreak in the U.S. are now seeing large increases in both new cases and deaths.

Given the clear regional dissimilarities in the impacts of Covid-19, it is pertinent to explore what regional scientists have written about the connections between the health and the well-being of regions. We now discuss this topic briefly.

## 1.2. Literature review

Eibich and Ziebarth (2014) use hierarchical Bayes models to analyze spatial health effects in Germany. They show that more than twenty years after the reunification of Germany, there exists a clear spatial east-west health pattern that equals an age impact on health of up to five life-years for a 40-year old individual. Dorfman and Mandich (2016) use a Bayesian estimation strategy to study migration for amenities by “later-life migrants.” Their analysis shows that there is a positive association between access to healthcare and the migration decisions of older individuals.

Looking at the Massachusetts healthcare reform of 2006, Alm and Enami (2017) ask whether governmental subsidies to low-income persons influences them to move to a state with better health subsidies. Their analysis reveals that the reform did not lead to a “global effect” meaning that there was no movement of low-income persons across all cities in Massachusetts. Even so, there was a “local effect” meaning that there was a noteworthy movement of low-income persons into the border cities of Massachusetts. Goodman and Smith (2018) study the regional location of health professionals by examining 373 metropolitan statistical areas (MSAs). They show that spatial agglomerations raise factor productivity and therefore the rents paid and the wages earned by health professionals.

Moving on to natural disasters, Skoufias *et al.* (2017) construct damage indices for individual districts in Indonesia and show how these indices can be used for budgetary planning. For instance, they contend that *ex ante* or before the occurrence of a natural disaster, these indices can be used to ascertain the size of the annual fiscal transfers that will need to be made from the central government to the affected subnational governments. Looking at the impact of natural disasters on the growth of population densities across U.S. counties in 1960-2000, Wang (2019) finds no significant adverse long-term growth effects.

The last four decades have given rise to a burgeoning literature on the topic of the nexuses between the concept of *resilience* and the well-being of a region. The modern or post-World War II usage of the term resilience in the academic literature is due to the prominent but now deceased ecologist Buzz Holling (1973). The Holling resilience of an ecological-economic or a socioeconomic system is “the capacity of [this] system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks” (Walker *et al.*, 2004).<sup>137</sup> The ways in which the notion of resilience has been studied in the regional science literature and some of the problems stemming from this kind of study have been discussed in detail by Batabyal (2020) and by Batabyal and Kourtit (2020).<sup>138</sup>

That said, we would now like to emphasize two points. First, the extant regional science literature has studied the connections between a region’s health and its well-being in a variety of ways. Second, this literature has also shed light on how alternate policies and a region’s functioning affects and is affected by its resilience. Even so, our central claim is that to the best of our knowledge, there are *no* theoretical studies in regional science that analyze how a pandemic such as Covid-19 influences a poor region’s welfare and how policies adopted to combat the ill effects of the pandemic influence this same region’s resilience. Given this lacuna in the literature, we now discuss our main objective in this paper.<sup>139</sup>

## 1.3. Our objective

We concentrate on an economically disadvantaged region and analyze the links between health interventions undertaken by a regional authority (RA) and this region’s resilience in the presence of a pandemic such as Covid-19. Consistent with the work of Paul-Sen Gupta *et al.* (2007), Adler and Newman (2002), and Choksi (2018), we take it as given that the population of an economically disadvantaged region also has poor health. In this setting, we first demonstrate how to connect the RA’s health intervention or action<sup>140</sup> to the evolution of a suitably defined regional health indicator in an environment of uncertainty. Second, we compute the probability that the health status of this region’s population falls below a minimum acceptable level in the presence of a health intervention. Third, we solve an optimization problem in which the RA maximizes the likelihood that the health status of this region’s population stays above a minimum acceptable level at a given economic cost. Finally, we discuss the nexus between a health intervention, our region’s health status, and its resilience by presenting two applications of our theoretical framework.

The remainder of this paper is organized as follows. Section 2 describes the theoretical model of an economically disadvantaged region that is adapted from Batabyal *et al.* (2003). Section 3 shows how to link the RA’s health intervention

137 In the remainder of this paper, we shall drop references to Buzz Holling’s name when we talk about resilience. The reader should understand that even though there are two senses in which the term resilience is used in the ecology literature---see Batabyal (2020) and Batabyal and Kourtit (2020)---all mentions of resilience in this paper are to the Holling interpretation of this term.

138 See Di Caro (2018) and Ezcurra and Rios (2019) for a discussion of related issues.

139 This objective is consistent with the perspective of Bailly and Gibson (2017, p. 58) who note that “[r]egional scientists have certainly contributed to discussions on [health care] but there is clearly still work to be done.”

140 In the remainder of this paper, we use the terms “action” and “health intervention” interchangeably.

to the behavior of an appositely defined regional health indicator in an environment of uncertainty. Section 4 calculates the probability that the health status of this region's population falls below a minimum acceptable level in the presence of the health intervention. Section 5 solves an optimization problem in which the RA maximizes the likelihood that the health status of this region's population stays above a minimum acceptable level at a given economic cost. Section 6 discusses the nexus between the RA's health intervention and this region's resilience by presenting two applications of our theoretical framework. Finally, section 7 concludes and then discusses two ways in which the research delineated in this paper might be extended.

## 2. THE THEORETICAL FRAMEWORK

Consider a poor region in a particular country. An example of such a region in a poor (wealthy) country would be Chhattisgarh (Mississippi) in India (the United States). In practice, it is common to find one or more health indicators that provide a researcher with information about the health status of those residing in this region. So, for instance, if the region under consideration is New York State in the U.S. then we know that there exist "The New York State Community Health Indicator Reports (CHIRS)" that are annually updated to consolidate and provide information regarding health indicators in the so called County Health Assessment Indicators (CHAI) for all communities in New York.<sup>141</sup> The CHIRS dashboard tracks about 350 indicators organized by 15 health topics and hence an analyst can easily obtain information about the incidence of, for instance, cancer, cardiovascular disease, and communicable diseases.

Similarly, if we were to focus on what the WHO calls the "European region," then we could use information published by this organization in the "Core Health Indicators" to monitor progress towards the attainment of specific health targets in the 53 member states of the WHO European region.<sup>142</sup> Finally, the Ministry of Health and Family Welfare in India, in cooperation with the World Bank, publishes information about different health indices for states in India.<sup>143</sup>

Since we are interested in studying the effects of a pandemic such as Covid-19 on the health of people living in our economically disadvantaged region, suppose that a relevant health indicator ( $H$ ) which tells us the proportion of the regional population with *no* respiratory disease, has a stable, steady-state value denoted by  $H_0$ . When the stochastically arriving coronavirus begins to spread in our region, *ceteris paribus*, the virus tends to *lower* the value of the health indicator ( $H$ ) to some fraction below  $H_0$ . Note that this lowering of the indicator means that the proportion of the regional population that now has a respiratory ailment of some sort has *risen*.

To combat this insalubrious state of affairs, an appropriate regional authority (RA) takes action ( $A$ ) to raise the value of the indicator from  $H_0$  to  $H_0 + \beta A$ , where  $\beta > 0$  is a parameter. Taking action is costly and therefore we suppose that the cost of taking action  $A$  is given by the cost function  $c(A)$ . We assume this cost function is both strictly increasing and strictly convex. In terms of the derivatives of the cost function, we have  $c'(A) > 0$  and  $c''(A) > 0$ .

Examples of an action  $A$  taken by the RA include, but are not limited to, a lockdown, a mandatory mask wearing requirement, an increased level of testing, a decision to quarantine visitors and those testing positive for Covid-19, and contact tracing. The action  $A$  can be viewed as a single action or it can also be viewed as a set of actions. When viewed as a set, we would let  $A_i$  denote the *ith* possible action,  $N$  denote the total number of actions that may be taken by the RA, and the composite action  $A$  would be, for instance, a linear combination of the individual actions. Mathematically, we would then have  $A = \sum_{i=1}^N \alpha_i A_i$  where the weights  $\alpha_i \in (0, 1)$  would denote the relative importance the RA assigns to each of the individual actions.<sup>144</sup> We now demonstrate how to connect the RA's action  $A$  to the behavior of our regional health indicator  $H$  in an environment of uncertainty.

## 3. LINK BETWEEN AN ACTION AND THE HEALTH INDICATOR

At any time  $t$ , let  $Z(t) = \{H(t) - H_0 - \beta A\}$  denote the deviation in the value of our health indicator from the steady-state value  $H_0$  when the RA's action or control variable is  $A$ . To account for the point that a pandemic such as Covid-19 almost certainly affects the value of the health indicator  $H$  stochastically, we model the evolution of the  $Z(t)$  deviations with a stochastic differential equation.<sup>145</sup>

The next question concerns what kind of stochastic differential equation we ought to use to model the  $Z(t)$  deviations. Here, we are guided by two considerations. First, because there is no evidence to suggest otherwise, we assume that a

141 Go to <https://www.health.ny.gov/statistics/chac/indicators/> for more information about these indicators. Accessed on 5 August 2020.

142 Go to <https://www.euro.who.int/en/data-and-evidence/evidence-resources/core-health-indicators-in-the-who-european-region> for more information. Accessed on 5 August 2020.

143143 Go to [https://smartnet.niua.org/sites/default/files/resources/healthy-states-progressive-india-report\\_0.pdf](https://smartnet.niua.org/sites/default/files/resources/healthy-states-progressive-india-report_0.pdf) for more details. Accessed on 11 August 2020.

144 In what follows, in order to avoid algebraic clutter and to keep the mathematical analysis tractable, we shall proceed with the assumption that the action  $A$  is a single action and not a set of actions. That said, the reader should understand that an analysis of the "set of actions" case would proceed in a manner that is very similar to what we illustrate in the subsequent sections of this paper.

145 Here  $Z$  denotes the deviation random variable and  $z$  denotes a particular realization of this random variable.

linear approximation around the steady-state is valid. Second, because of the way in which we have defined the deviation random variable, we expect this variable to display some degree of mean reversion over time. Putting these two considerations together, we contend that it is reasonable to model the evolution of  $Z(t)$  with the Ornstein-Uhlenbeck process.<sup>146</sup> This means that  $Z(t)$  satisfies the linear stochastic differential equation

$$dZ = -\zeta Zdt + \sigma dW, \tag{1}$$

where  $\zeta > 0$  is the speed of reversion,  $\sigma > 0$  is the variance parameter, and  $dW$  is the increment of a standard Brownian motion or Wiener process.

We wish to analyze the steady-state behavior of the deviation in the value of our health indicator from the steady state value  $H_0$ . From Proposition 5.1 in Karlin and Taylor (1981, p. 219), it follows that the steady-state probability distribution function of  $Z(t)$  is given by

$$f_{SS}(z) = \sqrt{\frac{\zeta}{\pi\sigma^2}} \exp\left(\frac{-\zeta z^2}{\sigma^2}\right). \tag{2}$$

When we study nutritional health indicators, particularly those for children, we find that the notion of a “Minimum Acceptable Diet (MAD)” is one of eight core indicators developed by the WHO. Other similar indicators include the related concepts of “minimum dietary diversity (MDD)” and “minimum meal frequency (MMF).” In fact, the MAD indicator itself is a composite indicator that is constructed by using the MDD and the MMF indicators.<sup>147</sup> In addition, Xing and Batabyal (2019) tell us that in the natural resource and environmental economics literature, it is now understood that when uncertainty and irreversibility are issues in natural resource management, the management function ought to pay attention to the notion of a “safe minimum standard (SMS).” The idea here is to manage an ecological-economic system<sup>148</sup> so that this system’s ability to provide humans with a flow of ecosystem services does not fall below a particular level, namely, the SMS.

This discussion suggests that it would be reasonable for our RA to focus on some *minimally* acceptable value of the health indicator  $H$  when pondering how this authority might combat the onset of a pandemic such as Covid-19 in our poor region. Since  $H(t)$  tells us the proportion of the population in our region that has *no* respiratory disease at time  $t$ , concentrating on a minimum value of  $H$  is equivalent to taking an action  $A$  so that the fraction of people in our region with no respiratory disease does *not* fall below this minimum acceptable threshold. Let us denote this threshold by  $H_M$ . Note that the threshold does *not* depend on time. By making  $H_M$  be time-independent, we are seeking to capture the idea that when combating a pandemic such as Covid-19 in a region where the population has poor health, the choice of the *threshold* proportion of the population in our region that has no respiratory disease ought not to depend on how virulent the pandemic is at any particular point in time. Our next task is to compute the probability that the health status of this region’s population falls below the minimum acceptable level  $H_M$  in the presence of the health intervention.

#### 4. A LIKELIHOOD FUNCTION

To compute the above probability, let

$$f(h)dh = \text{Prob}\{\text{steady} - \text{state health status value} \in (h, dh)\}. \tag{3}$$

The probability on the right-hand-side (RHS) of equation (3) can also be written as

$$f(h)dh = \text{Prob}\{\text{steady} - \text{state deviation value} \in (h - H_0 - \beta A, h - H_0 - \beta A + dh)\}. \tag{4}$$

Now, using equation (2), the probability on the RHS of equation (4) can be simplified. This simplification gives

$$f(h) = \sqrt{\frac{\zeta}{\pi\sigma^2}} \exp\left\{\left(\frac{-\zeta}{\sigma^2}\right) (h - H_0 - \beta A)^2\right\}. \tag{5}$$

Note that equation (5) provides us with an explicit way of calculating the probability density of the deviation from the raised health indicator value  $H_0 + \beta A$ . We are now in a position to state and then solve an optimization problem in which the RA maximizes the likelihood that the health status of this region’s population stays above the minimum acceptable level  $H_M$  at a given economic cost  $c(A)$ .

#### 5. AN OPTIMIZATION PROBLEM

The RA chooses the control (action)  $A$ , incurs cost  $c(A)$ , and maximizes the probability that the health status of our region’s population stays above the minimum acceptable threshold  $H_M$ . The reader will note that this is an unconventional objective function in the sense that it is partly focused on public health and partly on economic considerations. We say this because the probability part of the objective function is a public health criterion whereas the cost part is clearly an economic yardstick.

Using equation (5) and the cost function  $c(A)$ , mathematically, our RA solves

146 See Karlin and Taylor (1981, pp. 170-173) or Taylor and Karlin (1998, pp. 524-534) for more on the Ornstein-Uhlenbeck process.

147 Go to <https://index.nutrition.tufts.edu/data4diets/indicator/minimum-acceptable-diet-mad> for more details. Accessed on 6 August 2020.

148 Examples of ecological-economic systems include fisheries, forests, and rangelands.

$$\max_{\{A\}} \int_{H_M}^{\infty} \left[ \sqrt{\frac{\zeta}{\pi\sigma^2}} \exp \left\{ \left( \frac{-\zeta}{\sigma^2} \right) (h - H_0 - \beta A)^2 \right\} \right] dh - c(A). \tag{6}$$

Let us now make the substitution  $k = h - H_0 - \beta A$ . Using this substitution, the RA's maximization problem in (6) can be written as

$$\max_{\{A\}} \int_{H_M - H_0 - \beta A}^{\infty} \left[ \sqrt{\frac{\zeta}{\pi\sigma^2}} \exp \left\{ \frac{-\zeta k^2}{\sigma^2} \right\} \right] dk - c(A). \tag{7}$$

Differentiating the maximand in (7) with respect to the control variable  $A$ , the first-order necessary condition for an optimum is

$$\beta \left[ \sqrt{\frac{\zeta}{\pi\sigma^2}} \exp \left\{ \left( \frac{-\zeta}{\sigma^2} \right) (H_M - H_0 - \beta A)^2 \right\} \right] = c'(A), \tag{8}$$

and the second-order sufficiency condition is

$$\sqrt{\frac{\zeta}{\pi\sigma^2}} \exp \left\{ \left( \frac{-\zeta}{\pi\sigma^2} \right) (H_M - H_0 - \beta A)^2 \right\} \left\{ \left( \frac{2\beta^2\zeta}{\sigma^2} \right) (H_M - H_0 - \beta A) \right\} - c''(A) \leq 0. \tag{9}$$

The first-order necessary condition in equation (8) tells us that optimality requires the RA to choose the action  $A$  so that the marginal economic cost to the poor region from the use of this action designed to fight the pandemic's ill effects (the RHS of equation (8)) is equal to the marginal increase in the likelihood that the health status of our region's population will be above the minimum acceptable level  $H_M$ . We now proceed to show how our analysis thus far can be used to figure out the resilience of the region under study and to demonstrate the connection between the RA's action and the resilience of this region.

### 6. A HEALTH INTERVENTION AND REGIONAL RESILIENCE

Let  $A^*$  be the solution to equation (8). To find a closed-form expression for  $A^*$  and to compute our region's resilience in the face of a pandemic, it will be necessary to impose more structure on the problem by positing explicit values for  $(H_0, H_M)$  and by working with a specific functional form for the cost function  $c(A)$ . Before we do this, let us emphasize two points. First, we shall focus on two applications of our analysis thus far. In both applications, we shall make use of a key finding in the extant literature---see Paul-Sen Gupta *et al.* (2007), Adler and Newman (2002), and Choksi (2018)---that the residents of economically disadvantaged regions also tend to have poor health. This means that the population of the region we are studying is unhealthy as far as the proportion of the population that has one or more respiratory diseases is concerned. Second, in the first (second) application, the region under study is more (less) healthy. We model this feature by supposing that  $H_0 = 0.6$  (0.5) in the first (second) application. In words, when  $H_0 = 0.6$  in the first application, when a pandemic such as Covid-19 hits this region, 60 percent of the region's population has no respiratory ailments of any kind and hence 40 percent do have one or more respiratory ailments. Similarly, when  $H_0 = 0.5$  in the second application, upon the onset of Covid-19, 50 percent of the regional population has no respiratory ailments and therefore 50 percent of this population is afflicted with some kind of respiratory disease.

Note that since we are conducting two "thought experiments" for the *same* underlying regional population, in the following two applications, the initial value of the steady-state level of the health indicator  $H_0$  is different. That said, the purpose of the RA's health intervention is to act forcefully to improve the health status of the relatively unhealthy regional population. As such, in both the following applications, we suppose that the RA's goal is to determine a stationary or constant value of the action  $A$  to maximize the likelihood that the health status of our region's population is above the minimum acceptable threshold or  $H_M = 0.8$  at minimum cost. Finally, the cost of taking action  $A$  is represented by the exponential cost function.

#### 6.1. Application 1: More healthy regional population

Suppose that the cost function  $c(A) = \exp(A)$ . Clearly, this means that  $c'(A) = \exp(A)$ . Let us now substitute  $c'(A) = \exp(A)$  in equation (8). After several steps of algebra, equation (8) can be simplified to give

$$\beta \sqrt{\frac{\zeta}{\pi\sigma^2}} \exp \left\{ \left( \frac{2\zeta H_0 H_M - \zeta H_M^2 - \zeta H_0^2}{\sigma^2} \right) + \left( \frac{2\beta\zeta H_M A - \beta^2\zeta A^2 - 2\beta\zeta H_0 A}{\sigma^2} \right) \right\} = \exp(A). \tag{10}$$

Taking the natural logarithm of both sides of equation (10) and then rewriting the resulting expression gives us a quadratic equation in the control variable  $A$ . That equation is

$$\left[ \frac{\beta^2\zeta}{\sigma^2} \right] A^2 + \left[ \frac{2\beta\zeta H_0 + \sigma^2 - 2\beta\zeta H_M}{\sigma^2} \right] A + \left[ \left\{ \frac{\zeta H_M^2 + \zeta H_0^2 - 2\zeta H_0 H_M}{\sigma^2} - \log \left( \beta \sqrt{\frac{\zeta}{\pi\sigma^2}} \right) \right\} \right] = 0. \tag{11}$$

Inspecting equation (11), if we denote the coefficient of  $A^2$  by  $\Gamma$ , the coefficient of  $A$  by  $\Delta$ , and the constant term by  $E$ , then the solutions to equation (11) are given by

$$A_i^* = \frac{-\Delta \pm \sqrt{\Delta^2 - 4\Gamma E}}{2\Gamma}, i = 1, 2, \tag{12}$$

with  $\Delta^2 \geq 4\Gamma E$  for obvious reasons. Which of these two values<sup>149</sup> of the action  $A$  makes most sense for the optimization problem that we are analyzing depends on the parameters of the stochastic differential equation describing the evolution of the  $Z(t)$  deviations and on the exogenously given health indicators levels  $H_0$  and  $H_M$ . We already know that in this first application,  $H_0 = 0.6$  and  $H_M = 0.8$ . Therefore, to illustrate the working of our model, suppose that  $\beta = \zeta = 2$ , and  $\sigma^2 = 4$ . In this case, tedious but straightforward computations show that the quadratic equation in (11) has two real roots given by  $A_1^* = 0.1191$  and  $A_2^* = -0.1691$ . To see which of these two solutions maximizes the objective function in equation (7), we substitute the above two candidate maximizers into equation (7) and then perform the necessary computations.<sup>150</sup> This tells us that when  $\beta = \zeta = \sigma^2 = 2$ ,  $H_0 = 0.6$ , and  $H_M = 0.8$ ,  $A_1^* = 0.1191$  maximizes the RA's objective function.

To see the link between the RA's maximization problem and the notion of resilience that we have discussed in section 1.2, recall that the resilience of a socioeconomic system is "the capacity of [this] system to absorb disturbance and reorganize while undergoing change so as to still retain essentially the same function, structure, identity, and feedbacks" (Walker *et al.*, 2004). The socioeconomic system that we have been studying is the poor region and our specific focus has been on the health status of the population in this poor region. The disturbance alluded to in the definition above is the onset of a pandemic such as the Covid-19. So, when will our poor region be able to withstand the Covid-19 induced disturbance and still retain its function, structure, identity, and feedbacks? This will happen if, as a result of the RA's health intervention, the health status of our region's population is *above* the minimum acceptable threshold  $H_M = 0.8$ . However, since we are analyzing a stochastic environment, we *cannot* be sure about whether the RA will succeed in enhancing the regional population's health status to at least  $H_M = 0.8$ . That said, in the stochastic environment that we are studying, we can compute the *probability* that the RA's health intervention will improve the regional population's health status to at least  $H_M=0.8$ . This probability is given by the integral in the first part of the maximand in equation (7). Using  $A_1^* = 0.1191$  and the other parameter and indicator values given in the preceding paragraph, we can evaluate this integral and determine that the probability we seek is 0.5215.

In words, the probability that the RA's action will succeed in maintaining the health status of the population in our poor region above the threshold  $H_M = 0.8$  is 52.15 percent. Put differently, the likelihood that our poor region will be resilient when faced with an adverse stochastic shock from the Covid-19 pandemic is 52.15 percent. Since our analysis is long-run in nature, consistent with the previous work of Batabyal (1999) and Batabyal and Beladi (1999), we can think of the resilience of our poor region as a probability and, more specifically, as the probability 0.5215. This way of thinking about resilience has two distinct advantages. First, since it is a probability, resilience is bounded from above and below. Second, it is integrally tied to our RA's health intervention and this is as it should be because we are studying a socioeconomic or social-ecological<sup>151</sup> system whose behavior in the presence of a pandemic is governed partly by natural and partly by human forces. We now proceed to discuss the second application of this paper.

## 6.2. Application 2: Less healthy regional population

In this instance,  $H_0 = 0.5$ . This means that only 50 percent of our poor region's population has no respiratory ailments and hence 50 percent do when a pandemic such as Covid-19 strikes the region. This is the sense in which the regional population now is *less* healthy than the case studied in section 6.1. The cost function and the remaining parameter and threshold values are all as in section 6.1. Therefore, we have  $c(A) = \exp(A)$ ,  $\beta = \zeta = \sigma^2 = 2$ , and  $H_M = 0.8$ . Also, the methodology we employ in this section is identical to that employed in section 6.1.

Let us plug the various values given in the preceding paragraph into equation (11) and then solve the resulting quadratic equation in the RA's control variable  $A$ . This gives us two real roots and they are  $A_1^* = 0.116$  and  $A_2^* = -0.066$ . Next, let us substitute these two candidate maximizers into equation (7). After performing the necessary computations using the method delineated in section 6.1, we infer that when  $\beta = \zeta = \sigma^2 = 2$ ,  $H_0 = 0.5$ , and  $H_M = 0.8$ ,  $A_1^* = 0.116$  maximizes the RA's objective function.

As in section 6.1, to see the link between the RA's maximization problem and the notion of resilience, let us compute the *probability* that the RA's health intervention will improve the regional population's health status to at least  $H_M=0.8$ . This probability is given by the integral in the first part of the maximand in equation (7). Using  $A_1^* = 0.116$  and the other parameter and indicator values given in the preceding paragraph, we can evaluate the relevant integral and conclude that the probability we seek is 0.4617. In words, the probability that the RA's action will succeed in maintaining the health status of the population in our poor region above the threshold  $H_M = 0.8$  is 46.17 percent. In accordance with the

149 It is understood that there will only be one value if  $\Delta^2 = 4\Gamma E$ .

150 We used the tables in Beyer (1991, p. 486) and the complementary error function calculator given in <https://keisan.casio.com/exec/system/1180573449> to perform the necessary computations. Accessed on 11 August 2020.

151 See Walker *et al.* (2004) for additional details on this point.

reasoning employed in section 6.1, we contend that the resilience of our economically disadvantaged region is also given by the probability 0.4617.

As an intuitive check on one of our key findings, note that when confronted with a relatively healthy (unhealthy) population, it should be easier (harder) for the RA to improve the health status of the population to the desired threshold of  $H_M = 0.8$ . However, since we are analyzing a stochastic environment, this means that the probability of being successful when the RA uses action  $A$  should be higher (lower) when working with a relatively healthy (unhealthy) population. This is indeed what happens in the two applications that we have presented. Specifically, in the more healthy population case analyzed in section 6.1, the RA's probability of being successful is 0.5214 which is clearly *larger* than the corresponding probability of 0.4617 which arises when the RA works with the less healthy regional population. This completes our discussion of health interventions in a poor region and resilience in the presence of a pandemic.

## 7. CONCLUSIONS

In this paper, we concentrated on a poor region and studied the connections between health interventions undertaken by a regional authority (RA) and this region's resilience in the presence of a pandemic such as Covid-19. First, we showed how a health intervention by the RA stochastically affected an appositely defined health indicator for this region. Second, we computed the probability that the health status of this region's population would fall below a minimum acceptable level in the presence of the health intervention. Third, we solved an optimization problem in which the RA maximized the likelihood that the health status of this region's population would stay above a minimum acceptable level at a given economic cost. Finally, we discussed the nexuses between our region's health status and its resilience by presenting two applications of our theoretical framework.

The analysis conducted in this paper can be extended in a number of different directions. In what follows, we suggest two possible extensions. First, it would be useful to study a scenario in which the minimum acceptable health threshold  $H_M$  is not exogenously specified but determined endogenously in an appropriately specified model. Second, it would also be instructive to study a scenario in which it is not possible---or possible only at great cost---for a RA to reverse the adverse impacts of one or more respiratory ailments suffered by the people living in the region under study. Studies of health interventions that incorporate these aspects of the problem into the analysis will provide additional insights into the nexuses between optimal health interventions and the resilience of economically disadvantaged regions.

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## THE PERSISTENT EFFECTS OF NATURAL DISASTERS ON OPIOID DEATHS

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### ABSTRACT

Catastrophic natural disasters have been increasing worldwide in recent decades, among which floods and coastal storms (e.g., cyclones, hurricanes) have been recognized as the most consequential in terms of economic and human tolls. The two types have been responsible for the most economic losses and human impacts in the United States as well. Up to date, the research has focused on understanding disaster vulnerability measured by the number of fatalities at the onset of the event. Much less is known about the long-term health implications of disasters. Disasters can have health implications and potentially result in deaths in the long term potentially due to the debilitating consequences of post-traumatic stress disorder, as well as the overall decline in general mental or behavioral and physical health. Moreover, languishing health problems could lead to other more serious issues such as substance abuse and dependence and possible drug-related fatalities. This is a concern considering especially the already dire US opioids crisis coupled with the preponderant scientific consensus that climate change will likely increase the frequency and severity of extreme weather events in the future.

In this paper, we focus on understanding how individuals' exposure to extreme disaster events may linger over time and contribute to drug-related mortality in the United States. We also explore how federal disaster response specifically addressing the immediate needs of households in terms of temporary housing (e.g., shelters, hotels) accommodation and quick repair of homes, short-term counseling and legal services could mitigate substance-related fatalities of disasters.

Results of our county-level analysis covering the entire US over the period 1970-2016 suggest a significant rise in drug overdose mortality in areas experiencing damaging flooding events. Interestingly, our results indicate that impacts of floods on deaths (as opposed to opioids abuse, which may have started immediately after the disaster) start to emerge two years after the incident and linger over the long-term, with a significant rise in death rates seen even 9 years after the catastrophic disaster experience. Meanwhile, we also find that increased support for housing and other household needs made available by the Federal Emergency Management Agency (FEMA) in the aftermath of disasters is important in terms of reducing opioid-related mortality.

Our results are important and have significant policy implications both for the disaster risk and ongoing opioid crisis management.

## **Regular Session: RS10.6 - Regional development**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/81342024716>**

**Chair Monica Cardozo**

## TRADE REFORM, SECTORAL SPILLOVERS, AND POVERTY REDUCTION: EVIDENCE FOR GUINEA-BISSAU

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### ABSTRACT

Guinea-Bissau has been facing socioeconomic development challenges since it became in the late 1970s. The challenges concerns reconciling import tariff and export taxes reductions to promote national economy integration and to use resources from trade gains to fight against extreme poverty. This study uses a dynamic recursive micro-simulated computable general equilibrium model to analysis the macro-micro level long-term outcomes of two trade reforms scenarios in this least developing country, which are imports tariffs and export taxes cuts. We observe that negative import tariffs shocks adversely affected the overall output, investment, and government consumption. Although real product does not decrease at the end of simulations period, the small recovery over time is not enough to counteract the initial negative effects, since the accumulated result is negative. Conversely, export taxes reductions positively affect macroeconomic aggregates and sectoral level performances, as well as rural and urban households' income, with stronger impacts for poorer ones. Our results suggest the relevance of accumulated wealth in mitigate long-term poverty as it plays an important role in households' income gains and hence in their long-term consumption.

### KEYWORDS

Trade liberalization. Household poverty. Guinea-Bissau. CGE modeling.

### JEL Classification

C68; F13; F61

### 1 INTRODUCTION

Guinea-Bissau is one of the former Portuguese colonies in Africa, which became independent in 1973. It borders to the North with the Republic of Senegal, East and the South with the Republic of Guinea, and to the West by the Atlantic Ocean. The country's total population is approximately 2 million, of which 60% lives in rural areas and 40% in small urban cities. Guinea-Bissau is one of poorest country worldwide. For instance, in 2017, its Human Development Index (HDI) stands at 0.420, with 67% of the population considered poor or extremely poor. The average life expectancy at birth is 55 years (48.9 for women and 53.1 form men), with the infant mortality rate of 92 per 1000 born (World Bank Development Indicators - WBDI, 2018).

The country economy is supported by a variety of sectors and products. However, this is a typical example of a small and undeveloped agriculture-based-economy, in which only a few products play an important role for gross domestic product (GDP) of US\$ 100 million in 2017. In the total of 68% of the population over 15 years employed, 61% correspond to employment in the agricultural sector, 5.8% industrial employment and 34.1% employment in the services sector (ILO, 2017).

Employment opportunities reflect each sector production capacity in which agriculture represents 53 % of the total added value, the industrial sector 12% and the services sectors 35 % (WBDI, 2018). Agricultural most relevant products include the production of sorghum, maize, rice, sorghum, cashew nuts, and others. Cashew nuts became the main production and export product since 1990s when increasing demand from Asian countries, such as India and Singapore, boosted activities related to chestnuts. As the country does not export intermediate and capital goods, 99 percent of exports of Guinea-Bissau are mostly raw materials, of which the share of cashew nuts reach 90 percent.

To face the challenges of fighting persistent poverty, governments have relied on trade policies to improve the households' conditions as well as to find ways to increase budget to fund their development policies. The first trade measure was an initiative to the economy openness in mid-1986, having been cemented with the country's entry into the WTO (World Trade Organization) in 1995 and the consequent participation in the Doha Round, formally known as Doha Development Agenda (henceforth DDA), in 2001.

However, as the government agreed to reduce the import tariffs during the DDA, it also adopts the so-called exportable taxes to increase its revenue. This policy consists of a percentage of taxes set on export products. Such percentage is determined once a year during high harvest seasons between April and June and remains invariant for the remaining 9 months. Each product is taxable according to its sector classification and therefore its share on total output. The government charges higher export taxes to the agricultural products, represented primarily by cashews. Tax less products from other sectors allows disintegrating the export grid. However, exporters increase complains about the high taxes charged by arguing that the government has committed in the DDA to reduce import taxes, while failing to relieve

national exports. To mitigate these complaints, in May 2019, the government adopted a compensatory policy, reducing exports taxes by 2.5 percent.

The purpose of this study is to provide macro and micro level evidence of current trade reforms in Guinea-Bissau. The study is based on two development policies: the import tariff reduction agreement signed in DDA, that government effectively put into practice in 2007, and the government decree to reduce export taxes by 2.5 percent in 2019, as to mitigate the above exporters complaints, deepen economic openness, and explore the country's comparative advantages. We seek to answer the following questions: Is the agreement formalized in the DDA capable of promoting the performance of the economy of a small poor country like Guinea-Bissau? Are there gains from trade liberalization? If so, who earns or lost more? Do imports tariffs and exports taxes cuts have the same effects on rural and urban households living standard?

This study aims to analyze the DDA long-term impacts on socioeconomic outcomes, We analyze both the exports taxes and imports tariffs reductions proposal formalized in the Doha agreement on the economy of Guinea-Bissau and their implications for development, particularly discussing their effects on macroeconomic aggregates and household's income and consumption and more generally on poverty.

Our study fits in the context of the growing economic literature that analyzes impacts of trade liberalization on socioeconomic outcomes (see, for example, Davies et al.1994; Krishna and Mitra, 1998; Diao, Somwaru and Roe, 2001; Beghin, Roland-Holst and der Mensbrugge, 2002), particularly those evaluating the long-run effects of trade reforms on the households living conditions in developing countries (Chitiga, 2000; Cockburn, 2001; Mabugu, R. 2001; Chitiga, Kandiero and Mabugu, 2005; Chitiga and Mabugu, 2008; Cockburn, Decaluwé and Robichaud, 2008; Annabi et al.; 2005a,b).

We focus on analyzing the long-term effects of trade reforms for rural and urban households with different conditions, that is, poor and not so poor. Understanding the effects of such policies is important for several reasons for the country to find socioeconomic development options. First, economic policies might affect these households differently once they are exposed to the different challenges and opportunities arising from trade liberalization. These opportunities involve the diversification of consumption and job opportunities that openness can bring up. Suppose that a political measure ultimately resulted in the economic activity improvement. Suppose further that this improvement was due by faster production growth in the industrial sectors than in any other sector. *Ceteris paribus*, employment of (skilled) urban workers is expected to grow faster than employment of rural workers. This can increase the income of the former more quickly and then leading to income gap. So, by concentrating on different rural and urban households with different initial conditions, we will be able to provide instructive evidence for the elaboration of public policies consistent with the reality of each household.

Second, this study differs from those that simulate joint policy effects for regions or economic blocs (e.g., see Achterbosch *et al.*, 2004). In such studies, the country-specific characteristics and their potential effects may be not well captured, or they are ignored. However, the generalizations of the conclusions based on the simulated data could eventually fail when the block-based evaluations suffer greatly from the effects of the entities. For instance, besides striking difference in the size of economies, Sub-Saharan Africa has several countries, each with its own agricultural culture. Some have chestnuts-based economies and others have economies entirely based on cotton and therefore their interests must be in line with the characteristics of their economies, which suffer differently from the consequences of liberalization agreements. By focusing on one country, this study has the advantage of considering the national strategic interests and the effects of trade policies on different economic outcomes.

Third, we deal with an axis that has been the central focus of the government, which is to encourage trade on agricultural products, and \$ billions have been spent as better the condition of national production as well as the households' standard of living that suffer from extreme poverty. Fourth, evidence shows that trade impacts macroeconomic activities, and resources from a growing economy could be used to fund policies to fight against poverty (e.g., Bhagwati, Panagariya, and Srinivasan, 1998), but no empirical studies have been done for Guinean economics so far. As to fill this empirical gap, we apply a micro-simulated dynamic CGE model for Guinea-Bissau economy using 2014 updated SAM. For the best of our knowledge, this is the first CGE model for this economy.

Finally, although developing countries have increased participation in world trade, which has changed from 33 percent in 2000 to 48 percent in 2017, has contributed to a reduction in half the world's poverty, according to the World Bank (World Bank Report, 2018), it is still unclear how households in Guinea-Bissau with a monocultural economy will benefit from the trade liberalization. Evidence from our study therefore may guide current integration policies as well as to design development policies to fight against the prevailing extreme poverty.

The rest of the study is structured as follows: Section 2 shows the general characteristic of economy Guinea-Bissau. Section 3 provides a brief incursion into the applied related literature. Next section presents the methodology, including the database, while Section 5 discusses the results of the policy scenarios. Section 6 concludes the discussions.

## 2. OVERVIEW OF GUINEA-BISSAU ECONOMY AND MACROECONOMIC CONTEXT OF TRADE

The Guinea-Bissau economy is supported by a variety of sectors and products. Fishing is one of the most important economic activities, with the sale of industrial fishing licenses for the European Union and China been one of the main sources of government revenue. Since the economic openness in the mid-1980s this country has experienced significant economic growth and it is currently 20 times greater than it was in the 1970s, with GDP around US\$ 100 million (FCFA 50 billion). Private final consumption expenditure represents the largest cumulative share among GDP components (Table 1).

**Table 1 – Macro aggregates (% of GDP)**

Variable	1970-1989	1980-1989	1990-1999	2000-2009	2010-2017
Households consumption	95.476	85.623	91.948	87.637	89.106
Government consumption	26.710	11.854	8.1882	12.548	9.920
Investment	11.724	38.353	21.189	10.241	8.794
External balance	(33.910)	(5.831)	(21.325)	(10.427)	(7.820)
Total	100.00	100.00	100.00	100.00	100.00

Source: Authors' calculations. World Development Indicators: World Bank data, 2018.

Free trade practices were initiated in mid-1986 with the adoption of structural adjustment measures aimed at carrying out internal reforms that allow the country's international integration. The 1990s represented a decade of intensification of the process of integration into international markets. During this period, the country joined the West Africa Economic and Monetary Union (WAEMU) in 1997 and signed several unilateral and multilateral agreements, including its accession to the World Trade Organization, World Bank and the International Monetary Fund in 1995 (CATEIA ET AL., 2018).

Since then the political measures both in the economic as well as in the social area have been taken in partnerships with these institutions. But despite major advances in several sectors, socioeconomic indicators suggest that Guinea-Bissau is one of the poorest countries in the world, because of the relatively low performance of its economy that reflects the backwardness of its low-growth productive sectors.

Several factors could explain these results, but analysts converge on the argument that the lack of reform in the public sector has hampered the implementation of development programs, since the modern assessment criteria, such as accountability, are often loose (Cateia et al., 2018). However, such reforms have never been easy to implement. For instance, after initiating state reforms including the establishment of the multi-party system in 1994, the country faced an 11-month civil war that began on June 7, 1998, which wiped out more than 1/3 of its economy. And, before even recovering from war episodes, political instability occurred, culminating in a coup d'état that disbanded the President of the Republic in 2003. The national reconciliation start following the attempt by international organism and sub-regional partners to promote dialogue between the parties, and it enabled the holding of the second presidential election in 2005 (see GUINÉ-BISSAU, 2010).

In 2001, the first National Poverty Reduction Paper (I NPRSP) was established, which was only implemented in 2004. An IMF report at the time (IMF Country Report, 2007, p.5), however, notes that the country's high level of instability did not permit it to focus government initiatives on the search for ways and means to tackle the challenges of the country's development, which resulted in the failure of this plan. That failure is officially pegged to the cashew nuts price fall in 30 percent in 2009.

The country has experienced moments of political stability that have benefited economic activities practice. The challenges it has faced have been to carry out reforms of the public administration, to restructure the productive system and to formulate economic policies consistent with its comparative advantages. The actions taken by governments along with their international partners are also intended to combat mainly rural poverty, because most extremely poor people live in rural areas and the basis of their livelihood comes from the agricultural sector (BOUBACAR-SID ET AL., 2007). Thus, in 2011, the II NPRSP was designed to promote inclusive growth and reduction of social inequalities, although their operating mechanism was less tied to the performance of a sector (CATEIA ET AL., 2018).

In short, the Guinean economy can be characterized as follows: first, it is an economy that depends crucially on the performance of cashew nut production, which represents 98% of export earnings and about 17% of government revenues (GUINEA-BISSAU, 2010). More than 85% of the population is directly involved in cashew nut production process whose planting occupies approximately 6% of the national territory. That is, an area of almost 210,000 hectares, and on average each Guinean produces more than 53 kg of cashew nut a year, that is, an average of more than 90,100 tons produced annually in the country (CATEIA ET AL., 2018). Second, it is an economy with infrastructure base that suffers with the chronic degradation problem since, according to Guinea-Bissau (2010, p.01), both roads and port facilities have received little maintenance or improvement since 1975 and continue to suffer from the effects of the civil war that took place in 1998/99.

The DDA is a reform program to prevent and correct distortions in the world agricultural markets and it was expected to contribute to current socioeconomic indicator and boost Guinea-Bissau trade. The distortions stem from excessive agricultural subsidies by developed country governments, which have spent billions of dollars each year to support their agricultural sectors (World Trade Organization Documents - WTO, 2001).

The subsidies to the agriculture products impact developing country because there is a competition effect associated to the fact that they allow the production from developed countries to be offered at prices below the production cost. Farmers in developing country may lost their market share and invest less to improve the production chain. At the macro level, the poor countries like Guinea-Bissau may remain as food importers. Conversely, tariffs applied by poor nations also distort agricultural products markets, so it is recommended that they should be reduced.

However, although important trade new guidelines were established in 2001, there was no agreement on bandwidth and exact threshold for subsidies, not even for the level of tariff cuts. The broad acceptance of reducing such burdens was achieved in the General Council Decision 579, known as July 2004 Package, where it was proposed higher cuts in higher subsidies and tariffs from answerable countries. For Guinea-Bissau, whose performance of the aggregate macroeconomics depends on the agricultural sector, the agreement was signed with some enthusiasm.

### 3. RELATED LITERATURE

The conventional economic theory argues that fewer trade restrictions can accelerate the development of poor countries (Bhagwati 1965). This is because trade liberalization can reduce trade cost (Portugal-Perez and Wilson 2012) and increase exports (Iwanow and Kirkpatrick 2007; Coşar and Fajgelbaum 2016). The resources obtained through positive trade balance can be used for various development purposes, such as to fight against poverty (Ju, Wu, and Li 2010). Policymakers are then advised to adopt trade facilitating measures. They seem to be doing that, since the expansion of world trade by 146 per cent between 1960 and 2017 would have been their response in using such available facilitating mechanisms, thus a clear example of why open economies is preferable (WTO 2015).

Trade liberalization can also affect the development of a country because it impacts national comparative advantages (Bernard *et al.*, 1999; Bernard and Wagner, 2001). For instance, in the Melitz (see Melitz, 2003) trade-type model, trade shock, which induces competition among firms for scarce labor, causes real wages to be increased by relatively more productive firms. Such firms can enter export markets and thus be able to expand production. Therefore, promoting productivity growth is one way of increasing the export opportunity while trade liberalization can increase the firms' growth productivity. Therefore, trade and productivity affect each other, and both can be affected by the same factors (Melitz *et al.*, 2008; Helpman *et al.*, 2008).

The present study fits into the context of economic literature that assesses socioeconomic impacts of trade liberalization (Dutt *et al.* 2009; Amiti and Cameron 2012), essentially those for developing economies using CGE approach, such as Chitinga and Mabugu (2008) study for South Africa. The experiment of this literature consists of designing various economic opening policies scenarios and verifying which one contributes to the improvement of the households welfare, in terms of income and consumption gains, or in terms of income inequality reduction, using the usual inequality measures, such as the Gini Index.

The theory seeks to capture the short, medium or long-term outcomes of these scenarios by establishing a series of causal relationships provided by the open framework of a consistent CGE model. Although its short and medium-term effects depend on the context, in the long run, trade liberalization is expected to contribute to economic growth and the reduction of income inequality. Possible negative short-term impacts are related to the delay in contracts renegotiation and, more generally, to relative price readjustments. In such a situation, economic theory predicts that cuts in a country's tariffs, for example, tend to trigger relative price changes unfavorable to its economy (WTO 2001).

This is the result explained by the inverse relationship between demand and price. The domestic demand for imports, for example, is a function of the price of the imported good in the domestic market and this price is the sum of the international price and the tariff that acts as an addition to the cost of transportation. Thus, the reduction in the tariff will lead to a decrease in the domestic price of the imported goods (see Rutherford and Paltsev, 1999), which increases the demand for imports. For countries that export only a small proportion of their production, demanding more imports can generate negative external savings and an increase in foreign indebtedness.

By analyzing the effect of the openness because of the increase in the number of foreign competitors caused by the reduction of tariffs arising from trade agreements, Bittencourt *et al.* (2008), find that, for Brazil, unilateral liberalization generated a real trade-off between aggregate welfare gains and losses for low-income households in urban areas. Therefore, according to Kis-Katos and Sparrow (2015), short and medium-term implications of trade liberalization in labor market are context-specific. They depend on several factors such as the previous protection structure to regional market access as well as the degree of market flexibility (see also BITTENCOURT 2004; GOLDBERG and PAVCNİK 2005; AMITI and KONINGS 2007; CHIQUIAR 2008, LEE and WIE 2015).

However, as domestic production is carried out by combining inputs from different sources, basically national and imported, the decrease in import prices means that economic activities are using more imported goods as intermediate inputs in the production process. If taxes, endowments and offer prices remain unchanged, the firm's production will increase, as well as its profit. The firm will hire workers and, consequently, income and household consumption will rise. The increase in demand for total production will increase the offer price and the firm will also win. Industries should increase their production if the weight of the foreign commodity in the composite good is greater than the weight of the domestic one. If this is case, the sector should demand more workers and capital.

The increased demand for primary factors is expected to increase its price, assuming that each factor is remunerated according to its marginal productivity. But what types of workers can benefit most from trade liberalization is an issue under investigation. What is expected is that the increase in household income and the decrease in prices of imported goods will increase household consumption. Therefore, for developing countries, trade liberalization might be a feasible way that leads to the redistribution of wealth and increases aggregate welfare in long-term.

There is growing body of empirical literature analyzing the effect of trade liberalization through negative import tariff shocks. For instance, in their study for Ethiopia, Kebede, Aredo and Fekadu (2012) noted that liberalization resulted in a decline in economy output as well as in poverty in the short term, but it has benefited more farming agriculture sector. They also observed an increase in import volume while exports slightly decrease. In the same direction, Chitinga *et al.* (2005) for Zimbabwe find also strong evidence of general decreasing in poverty and inequality due to trade liberalization. Several studies, however, find ambiguous results of trade reform including Decaluwé *et al.* (2008) and Aka (2006) for Benin and Ivory Coast, respectively. In particular, Nwafor *et al.* (2007) for Nigeria show a weak short term but a strong long-term increase in poverty resulting from trade liberalization. This contrasts the Annabi *et al.* (2005) findings. Using a dynamic CGE model for Senegal, they show that, in the long-term, trade liberalization increases capital accumulation, leading to significant increases in welfare and decreases in poverty, although the effects are greatest for urban and non-

poor households. Durongkaveroj (2014) applies the same methodology to simulate free trade policy effects on the Thailand economy, and they showed that removing tariffs increases the national prosperity. Meanwhile, export taxes work as an important source of government revenue in many developing countries, particularly those with agricultural-based economies like Guinea-Bissau<sup>152</sup>. In fact, many countries incorporate export taxes as an important element of their trade policy and use them as a strategic industrial policy strategy, as well as to overcome domestic economic crises (Ruta and Venables, 2012). According to Solleder (2013), the rise of export taxes relative to other trade policy measures may be explained by a lack of discipline on export taxes in the WTO law. GATT in its article XI stipulates only that export should not be subject to quantitative restrictions, but does not determine any obligation on the maximum level of export taxes defined, which makes countries take advantage of this loophole by using these taxes as restrictions on exports of raw materials. Ruta and Venables (2012) argue that mutual gains from trade are possible upon coordinated policy reforms. Several studies provide empirical evidence of these gains, including Grossman (1980) and Staiger and Alan (2010), who show that both negative shocks in import tariffs and export taxes bring long-term gains to households.

**4. METHODOLOGY**

We use PEP (*Partnership for Economic Policy*) recursive dynamic CGE model. This is a detailed model, making it impossible to provide here a full description of its theoretical structure. We refer interested reader to Decaluwé, Lemelin, Robichaud and Maisonnave (henceforward DLRM, 2012). The foundations of this model stems from neoclassical microeconomic assumptions in the tradition of Dervis, De Melo and Robinson (1982) that have used an analytical framework developed almost a century ago by Leon Walras (Devarajan and Rodrik, 1989; Davies and Torvik, 1994; Devarajan and Robinson, 2002 ).

We describe productive activities and agent's demand in an interconnected environment, that is, a national open economy to international trade. The model's agents are firms, households, government, and the rest-of-the-world, however, only firms and households optimize.

There is a representative firm operating in a perfectly competitive environment and each firm in an industry *j* maximizes profits ( $XS_{j,i,t}$ ) - Eq.1,

$$XS_{j,i,t} = \frac{XST_{j,t}}{(B_j^{XT})^{1+\sigma_j^{XT}}} \left[ \frac{P_{j,i,t}}{B_{j,i}^{XT} PT_{j,t}} \right]^{\sigma_j^{XT}} \tag{1}$$

subject to its production technology constraints (Eq.2),

$$XST_{j,t} = B_j^{XT} \left[ \sum_i B_{j,i}^{XT} XT_{j,i,t} \rho_j^{XT} \right]^{\frac{1}{\rho_j^{XT}}} \tag{2}$$

taking the prices of factors, goods, and services as given. Where, at time *t*,  $XST_{j,t}$  is the total aggregate output;  $P_{j,i,t}$  is the basic price of industry *j*'s production of commodity *i* ;  $PT_{j,t}$  is the basic price of industry *j*'s output;  $B_j^{XT}$  is the scale parameter;  $\sigma_j^{XT}$  is the elasticity of transformation,  $0 < \sigma_j^{XT} < \infty$ ; and  $\rho_j^{XT}$  is the elasticity of substitution,  $\rho_j^{XT} = \frac{1+\sigma_j^{XT}}{\sigma_j^{XT}}$ ,  $1 < \rho_j^{XT} < \infty$ .

As results, the production technology provides clear understanding of the firm optimizing production process. Firm combines intermediate inputs and value added in fixed shares to produce the sectoral output of each productive activity. There is strict complementary in inputs use that we model through the Leontief production function.

Each industry's value added consists of transformation of composite labor and composite capital. There are 12 types of worker, 6 skilled and 6 unskilled, and one type of capital, a land and capital add up, used as primary inputs, with the requirement that each factor receive the value of its marginal product. As both labor and capital can replace each other, and a constant elasticity of substitution (CES) specification is adopted to model this substitution.

The households maximizing the utility function by choosing between domestic and composite commodities is carried out in a combined system of CES/LES preferences. At the highest level, the utility generated by the consumption of these commodities is maximized using this function.

Consistently, there are 12 types of households, 6 urban and 6 rural, demanding local and imported commodities. It is assumed that they have Stone-Geary utility function from which derives the Linear Expenditure System (LES). A characteristic of this function is that there is a minimum level of consumption of each commodity (so-called subsistence consumption), which may be zero for some commodities. Demand equations are derived from each type household *h* maximizing utility function for each commodity *i* subject to the budget constraints, so that:

$$PC_{i,t} C_{i,h,t} = PC_{i,t} C_{i,h,t}^{MIN} + \gamma_{i,h}^{LES} (CTH_{h,t} - \sum_{ij} PC_{ij,t} C_{ij,h,t}^{MIN}) \tag{3}$$

where, at time *t*,  $PC_{i,t}$  is the purchaser price of composite commodity *i* (including all taxes and margins);  $C_{i,h,t}$  is the consumption of commodity *i* by type *h* households;  $C_{i,h,t}^{MIN}$  is the minimum consumption of commodity *i* by type *h* households;  $\gamma_{i,h}^{LES}$  is the marginal share of commodity *i* in type *h* household consumption budget; and  $CTH_{h,t}$  is the consumption budget of type *h* households.

Investors are responsible for creating capital goods in each sector of the national economy. This representation resembles that of the production technology of firms, but with subtle difference. Here investment demand includes both

<sup>152</sup> However, The Lerner Symmetry Theorem (Lerner, 1936) states that, under some conditions, import tariffs and export tax have the same effect on the economy. See Casas (1991) and Costinot and Werning (2017) for more qualification on this theorem.

gross fixed capital formation and changes in inventories. It is assumed that the quantity demanded of each commodity for investment purposes is the sum of the quantity demanded for private investment and for public investment, and that, for a given amount of investment expenditures, this demand is inversely related to its purchaser price.

Firms use transport, and retail and wholesale trade services to lead commodities to the final consumer. The commodities services are paid. Usually, the payment is made in terms of marginal rates that are applied to the value of domestic production and imports to determine the quantities of this margin services necessary to distribute goods to potential demanders, local or foreigners.

Although government does not maximize any function, its introduction into the model enriches further analysis, since it receives tax transfers, but also makes expenditures. The government demand in this model is identified from SAM values. As investment demand, for a given current expenditure budget, the quantity demanded by government of each commodity varies inversely with its price.

Next, we present producer supplies functions and international trade. The underlying assumption of Guinea-Bissau's economy is that it is a small open economy to foreign trade, implying that the world price of traded goods (imports and exports) is exogenous. Trade relations with the rest-of-the-world is set through specification of domestic consumer's behavior with respect to the different supply sources and domestic producers' supply behavior. The supply side comprises two things: first, the transformation of the composite product into the supply of final products, and second, the supply of each product to destination markets.

The first case has already been treated by Equations (1) and (2). The second ensures that every product of each industry is shared out among domestic or export markets. However, the production directed to consumer of Guinea-Bissau is somewhat different from that for exports. We use a CET (constant elasticity of transformation) aggregator function to represent this imperfect substitution, showing how readily the production of an industry can be redirected from Guinea-Bissau to export market and vice-versa.

Relative supply functions ( $EX_{j,i,t}$ ) are derived from the first-order conditions of profit maximizing problem subject to the product of each industry, yielding Equation (4)

$$EX_{j,i,t} = \left[ \frac{\beta_{j,i}^X PE_{i,t}}{\beta_{j,i}^X PL_{i,t}} \right]^{\sigma_{j,i}^X} DS_{j,i,t} \tag{4}$$

where, at time  $t$ ,  $PE_{i,t}$  is the price received for exported commodity  $i$  (excluding export taxes);  $PL_{i,t}$  is the price of local commodity  $i$  (excluding all taxes on products);  $DS_{j,i,t}$  is the supply of commodity  $i$  by industry  $j$  to the domestic market;  $\beta_{j,i}^X$  and  $\sigma_{j,i}^X$  are the scale parameter and elasticity of transformation (CET - exports and local sales), respectively, for each  $0 < \sigma_{j,i}^X < \infty$  and  $\rho_{j,i}^X = \frac{1+\sigma_{j,i}^X}{\sigma_{j,i}^X}$ .

Buyer's behavior is derived symmetrically by assuming that local products are imperfect substitutes for imports, or that goods are differentiated with respect to their origin. Commodities demanded on the domestic market are composite goods, combinations of locally produced commodity demanded locally and imports. Then a CES aggregator function is used to represent the imperfect substitutability between the two with sector-specific scale parameter.

Our model is very rich in price information. It has at least 25 types of prices, including wages and other production costs. Prices and price indexes are defined according to the hypotheses and functional forms already declared. This means that, in aggregations, the price of an aggregate variable is a weighted sum of the prices of its components. For instance, the commodities purchased on the domestic market are composites. The price of the composite commodity is a weighted sum of the price paid for domestically produced and imported goods.

It is worth noting that, in the aggregations of Leontief-type function, the weights are invariant to relative price change. The model's price indexes include the GDP deflator and the consumer price index, the former being the Fisher index and the latter is the Laspeyres one.

With the agents, the supply and demand for production, as well as the price structure' blocks, we will now verify theoretical model micro-consistency, i.e., the market equilibrium condition. A market is in equilibrium when there is neither demand nor supply excess, i.e., demand must be equal to supply. For instance, market clearing for export market means that supply of Guinea-Bissau commodities to the external market should be exactly equal to the demand of the rest-of-the world for those exports. This notion of equilibrium is verified for all markets including factor and services markets.

This is usual structure of a static CGE model. We include the dynamic module in this structure. In this, we are free from the task of distinguishing between the short and long term. The immediate implication is that we let investment to adjust, rather than being fixed, and allow the model to recursive and dynamically incorporate investment and endogenous accumulation of capital, as well as the savings dynamics and the accumulation of wealth over time.

The evolution of capital stock is modeled through the investment demand functions, where the volume of new type capital allocated to business-sector industry is proportional to the existing stock of capital. The proportion varies according to the ratio of the rental rate to the user cost of that capital (Tobin's  $q$ ) and the rate of depreciation (DLRM, 2012). The level of investment demand is used in capital accumulation rule equation (Eq.5):

$$KD_{k,j,t+1} = KD_{k,j,t}(1 - \delta_{k,j}) + IND_{k,j,t} \tag{5}$$

where, at time  $t$ , the stock of capital in industry  $i$  in period  $t+1$  ( $KD_{k,j,t+1}$ ) is equal to the stock of the preceding period ( $KD_{k,j,t}$ ), minus depreciation of capital ( $\delta_{k,j}$ ), plus the volume of new capital investment in the preceding period ( $IND_{k,j,t}$ ).

#### 4.1 Data and simulation scenarios

We use an updated 2014 Social Accounting Matrix (SAM) of Guinea-Bissau originally built by Cabral (2015) from International Food Policy Research Institute (IFPRI)<sup>153</sup>. This matrix has 22 sectors, 2 production factors, and 6 accounts: factor, institutions, activity, domestically sold commodity, export commodity, and accumulation. Each account represents the agent’s relationships determining the dynamics of the economy in the period in question.

The calibration process requires additional data, such as trade and production elasticities, household consumption elasticities, interest rate, and population growth rate. While the latter two are from the World Bank, the production, trade, and substitution elasticities have not yet been estimated for Guinea-Bissau. We consider it possible to resort to the already estimated elasticities for Tanzania, which is an economy with the production technology very similar to Guinea-Bissau<sup>154</sup>.

For the micro-simulation purpose, we use the 2014 official minimum wage to disaggregate households in six urban and six rural types (Table 2) and then emerge the resulting shares with every rows and columns in the SAM as to obtain a new level of consumption and income for every household, generating an updated SAM for the current minimum wage base year.

**Table 2 – Household disaggregation by minimum wage**

Household 1	H1	≤ 1 minimum wage	50,000*	0.018
Household 2	H2	≤ 2 minimal wages	100,000	0.036
Household 3	H3	≤ 4 minimal wages	200,000	0.072
Household 4	H4	≤ 6 minimal wages	600,000	0.218
Household 5	H5	≤ 8 minimal wages	800,000	0.290
Household 6	H6	≤ 10 minimal wages	1,000,000	0.363

Source: Authors elaboration. \*:50,000 is the current official minimum wage.

The main general observation for households is that we respect the initial classification that there are two types of workers (skilled and unskilled) and two types of households (urban and rural). Therefore, in terms of the treatment of the labor market, all urban households offer skilled labor, while their rural counterparts offer unskilled labor. The reason for disaggregating workers in several types is that it allows to visualize which sector demands more the labor offered by poor households, for example. We could observe that, for a given total supply of factors, the agricultural sectors demand more unskilled labor from the rural environment, while the industrial and service sectors demand more skilled labor.

The trade liberalization policy is simulated based on two scenarios. The first scenario is a uniform 100% import tariffs reduction for importer sectors. The scenario 2 consists to perform the shock based on the export taxes cuts. It refers to mentioned government's response in 2019 to the exporters claims that the export tax charge is too high. The government reduced taxes for exported products by 2.5 percent in April 2019. Therefore, our shock size in this scenario is based on this value across all exporter sectors.

#### 4.2 Model closure

For household, we assume that disposable income after savings and transfers to other agents is entirely dedicated to household consumption and that household savings are a linear function of disposable income. For the government side, we represent income taxes as a linear function of the total income of households and firms. This specification makes it possible to differentiate the marginal rate of taxation from the average rate when a nonzero intercept is determined, a specification as much as useful for fiscal policy modeling.

The model also specifies several constants and variables to grow at the same rate of population growth. The constants are the follows: households and firms’ income tax function intercepts, intercept of the household transfers to government function, transfers from government, and from the rest of the world. Exogenous variables are labor supply; government current expenditures; current account balance; minimum consumption of commodities in the LES demand equations; changes in inventories; and public investment by category and by public sector industry.

### 5. RESULTS AND DISCUSSIONS

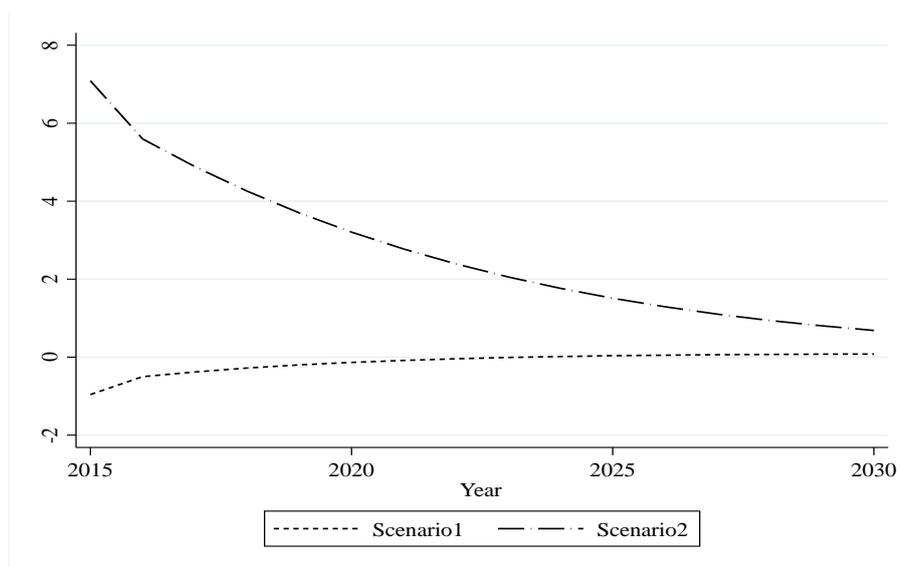
We present simultaneously the results of scenarios 1 and 2, which represent unilateral decision to cut down imports tariff to product from abroad and exports taxes policy, respectively. It is worth emphasizing that these results represent percentage deviations from the BAU scenario.

#### 5.1 Macroeconomic results

The effects of the trade liberalization on GDP depend on effective performed the shock. First, the uniform cuts in sector import tariffs has a negative impact on GDP, especially in the immediate period after the shock (Figure 1). We observe that this result was due to the increase in imports, which were incentives for the fall in the import goods price (Table 3).

153 The Social Accounting Matrix of Guinea-Bissau is obtained by request. Interested parties can access: <http://www.agrodep.org/dataset/2007-social-accounting-matrix-sam-guinea-bissau>.

154 We perform sensitivity analysis of most of the parameters used for our model. We realize that there was no change in the signals in the sensitivity test. The results have not changed so much when we change the values of the free parameters.



**Figure 1 – GAP compared to BAU scenario for real GDP**

Source: Author elaboration, Model's results.

In fact, a unilateral import tariff reduction generated deviation in relative prices that favored imported products relative to national exports, with a clear increase in export prices. In contrast, export taxes cut led to a drop in the export price, facilitating the placement of the national product on the world market. This policy circumvented the exogeneity of the world price by directly adjusting the exports price. Such adjustments had two implications. First, they led to an increase in aggregate exports and a consequent improvement in the trade balance. Second, the inflow of funds via improved external accounts favors the creation of investments in the country. We saw that reductions in export taxes would not have sustained a lasting growth in GDP if the demand for investments had not increased. It is the amount of aggregate investments made that sustain GDP over time, whose long-term stability is due to capital depreciation.

**Table 3 - Aggregate macroeconomic variables at the end of simulation**

Variable	Scenario 1	Scenario 2
Imports	5.100	-6.500
Exports	-5.270	0.515
Investment	-0.692	6.317
Government Consumption	-2.620	-3.427
Export price	0.570	-2.308
Import price	-5.200	3.631

Source: Author elaboration, Model's results.

A common feature of our result is that both policies to cut import tariffs and export taxes contributed to reduce government consumption at the end of the simulation. This result is not surprising, since the government's revenue depends on both imports and exports the burden. However, we must observe that reducing export taxes generates a greater drop in government consumption, possibly due to the weight of these taxes on government revenue, which is 17% percent, instead of 3% of the import tariffs.

### 5.2 Sectoral results and labor market

In this section, we discuss sectoral and labor market results from two policy scenarios. Sector-level results are in terms of the sector's aggregate output, while the labor market ones are represented in terms of employment by each type of worker, rural and urban (Table 4), and for type of skill set, skilled and unskilled (Table 5)

Two lessons can be drawn from Table 4. First, that imports tariff cuts negatively affect the service sectors is what industry output results reveal. Second, the production of cashew nuts has been negatively affected by import tariff reduction policy. This helps to explain the GDP result obtained, that is, it is the behavior of cashew nut production that justifies, for example, why the positive response in some agricultural sector production to the import tariff negative shock did not translate into an increase in aggregate real GDP.

Meanwhile, as the government reduces current exports taxes, the positive effects on the level of economic activity are underpinned by the growth in production of the majority economy's sectors. Thus, the impacts of export taxes reductions are more forceful in the sense that only three sectors (millet, construction, and other industries) responded negatively to the fall in export taxes, while the remaining 19 sectors of the economy benefited from this policy.

This result is associated with the performance of the export sector, whose effect of folding favored the production of the national sectors. In other words, the increase in world demand due to the lower FOB price generated growth in exports,

which translated into positive economic growth. Over time, this growth in aggregate product was sustained by an increase in investment demand, resulting in increased production in national sectors including those that do not export.

**Table 4 - Scenario 2: GAP compared to BAU scenario for industry output**

Sector	Scenario 1	Scenario 2
Millet	4.070	-0.062
Sorghum	0.180	0.037
Maize	0.170	0.037
Rice	0.366	0.026
Fonio	0.140	0.036
Cotton	0.380	0.012
Other agriculture	0.454	0.026
Cashew nut	-0.980	0.046
Breeding and hunt.	-0.006	0.036
Forestry	0.102	0.028
Fishery products	0.241	0.115
Mining industries	0.138	0.005
Food products	0.935	0.002
Other industries	0.205	-0.062
Electricity and water	-0.025	0.002
Construction	-0.500	-0.123
Trading and repair	0.045	0.000
Hotels and rest.	-0.627	0.054
Transport and communication	0.072	0.005
Financial services	-0.025	0.002
Real state Serv.	-1.077	0.072
Public administration	-0.557	0.026

Source: Author elaboration, Model's results.

In addition, the results suggest the potential of current policy to promote diversification in the economy. In fact, we observe that in each period the amount of investment of the sectors grows in the same direction as the growth of capital accumulation and that sectors producing capital goods have also experienced growth in their production. This signals that the policy of reducing taxes on exports may be important for the government to start creating instruments that encourage investments in non-traditional sectors, which are those not directly linked to agriculture.

In term of its impact on labor market, trade liberalization by uniform import tariffs cuts increase the employment of both skilled and unskilled workers, but the skilled ones increased faster. This policy benefited more the poorest workers in both categories, with a cumulative percentage deviation ranging from 0.690 to 2.347 for the unskilled worker and from 1.129 to 1.322 for the skilled worker earning up to two minimal wages.

**Table 5 - Unskilled and skilled employment at the end of simulation**

Worker	USK1	USK2	USK3	USK4	USK5	USK6	SK1	SK2	SK3	SK4	SK5	SK6
<b>Panel A: Unskilled and skilled employment at the end of simulation</b>												
Worker	USK1	USK2	USK3	USK4	USK5	USK6	SK1	SK2	SK3	SK4	SK5	SK6
Scenario1	2.347	0.690	0.622	0.467	0.455	0.465	1.322	1.129	0.968	0.721	0.581	0.566
Scenario2	7.768	1.929	1.654	1.286	1.158	1.052	2.634	2.195	1.882	1.464	1.317	1.197

Source: Author elaboration, Model's results.

Although their benefits are different among workers by category and type, export taxes shocks affect positively aggregate employment. There is an increased in intra and inter-category employment. For instance, the difference in the percentage of employment between an unskilled worker earning up to one minimum wage (USK1) and another same type of worker but earning up to 10 minimal wages (USK6) is 4.137 percent. For the same type of skilled workers, this difference is 0.336 percent in favor of one who receives up to one minimum wage.

In short, in response to the export tax shocks, employment of unskilled labor increases by up to 5 percent more than skilled labor one. Next, we examine whether this employment gain among less skilled workers can translate into more income and consumption opportunities, which potentially may suggest some distributive effect of this trade policy.

### 5.3 Results at household level

A general inspection of the results reported in Table 6 suggests that, ceteris paribus, import tariffs cut has positive impacts on rural and urban household incomes. Households with higher wages earn substantially higher incomes than those with lower minimal wages in both rural and urban environment. In other words, in the shock of import tariff cuts, households with the highest income that benefit most, both in rural and urban areas. However, with the same initial wage, negative shocks in import tariffs increase rural household incomes more than urban household ones. The incomes gap between rural and urban households earning up to one minimum wage is 0.019 percent, while the income gap between rural and urban household earning up to 10 minimal wages is 0.327, both in favor of rural household.

Table - Unskilled and skilled employment at the end of simulation.

Impacts of export tax reductions on household incomes are more direct. Like import tariff shocks, both uniform and sector level export tax cuts increased rural and urban households' incomes. Tax cuts in the cashew nut sector accounted for most of the gains, with a percentage deviation ranging from 0.445 to 0.623 percent for rural households receiving one and ten minimal wages, respectively. In general, export tax cuts policy increased more household incomes negative import tariffs shocks one. The export scenario benefits more households with lower income. This is due to the performance of the sectors after each shock, since in the export taxes scenario the agricultural sectors are most benefited and, as they employ many households in the lowest income categories, the increase in their production increased the demand for employment and consequently income of such households.

**Table 6 - GAP compared to BAU scenario for household income and consumption**

Panel A: Rural and urban household income at the end of simulation												
Household	HR1	HR2	HR3	HR4	HR5	HR6	HU1	HU2	HU3	HU4	HU5	HU6
Scenario 1	1.422	1.824	1.912	1.945	1.978	1.993	1.403	1.840	1.939	1.973	2.013	1.672
Scenario 2	2.049	2.625	2.754	2.800	2.847	2.872	1.955	2.559	2.698	2.747	2.799	2.825

Panel B: Rural and urban household consumption at the end of simulation												
Household	HR1	HR2	HR3	HR4	HR5	HR6	HU1	HU2	HU3	HU4	HU5	HU6
Scenario 1	0.083	0.483	0.570	0.603	0.634	0.653	0.064	0.496	0.596	0.633	0.668	0.689
Scenario 2	1.195	0.617	0.488	0.442	0.394	0.370	1.290	0.684	0.545	0.495	0.443	0.417

Source: Author elaboration, Model's results.

Considering the dynamic structure of the present model, households whose income is growing faster after the shock will accumulate greater wealth along the growth trajectory. At the end of the simulation period, they will be in better situations than in their initial positions before the policies implementation. As a result, the export promotion policy instruments that are being used for the country's socioeconomic development or, more specifically, for poverty alleviation, should be deepened, since the result shows the improvement of the condition of the poorest households, mainly in rural areas, after the shock is delivered.

Uniform tariff reductions increase rural household consumption by 0.019 percent more than urban households receiving up to a minimum wage (HR1 and HU1). For households in the middle range of income distribution, that is, those who receive up to 4 minimum wages (HR3 and HU3), the consumption difference is 0.027 in favor of the rural household.

Rural household consumption increases more with uniform export tax cuts than consumption achieved with uniform import tariff reductions. For instance, uniform export tax shocks increase by 0.627 percent more the consumption of rural households receiving up to a minimum wage (HR1) than shocks in import tariffs. The difference in consumption of urban households verified after each shock is more pronounced. Uniform export tax cuts accounted for increasing urban household consumption receiving up to a minimum wage (HU1) by 1.290 percent, while imports tariff cuts did so with a percentage of 0.064 percent, that is, the former policy increase the poorest households consumption by 1.226 percent more than the latter one. However, as we move to the household receiving higher initial wages, we see that the difference of the two results regarding to consumption drops significantly.

This is consistent with the result previously analyzed. The consumption of the rural household in the lower tail of the distribution range is increasing more than the consumption of any household because their income has increased more than the income of any household after the shock of export taxes. This policy positively impacted household consumption more than the policy based on cutting import tariffs, because it had a more intense impact on the income than the results achieved by the last policy.

Meanwhile, the export tax reduction policy has benefited relatively less the sectors that employ higher-income workers. Household income in this range then grew less as did consumption. Thus, the smallest difference in the results obtained from consumption of households that receive higher wages obtained through the two policies also reflects the more intense sectoral impact achieved by these policies.

These trade policies scenarios corroborate the findings of Moreira and Correia (1998), Amiti and Cameron (2012), as it shows gains through economic liberalization. However, while these authors observed the short-term gains from trade policy due to increased factor reallocation, we found that the household wealth accumulation over time was responsible for increased consumption of rural and urban households in Guinea-Bissau due to tariff and tax reductions-, and, thus, was responsible for increasing their welfare. This study also collaborates with Brighth (2017) studies for Ghana, Ferreira and Rossi (2001) and Figini and Santarelli (2006) studies for Brazil and developing countries.

As it emphasizes capital accumulation as a key variable for long-term welfare gains, our study also is in accordance with recent growing body of literature analyzing the effect of trade reforms including Kebede, Aredo and Fekadu (2012), Annabi *et al* (2005), Chitinga *et al*. (2005), Decaluwé *et al* (2008), Aka (2006) and Nwafor *et al*. (2007), Durongkaveroj (2014), Porto (2008), and Menezes-Filho and Muendler (2007).

In their study for Brazil, Bittencourt, Larson, and Kraybill (2008) show through a CGE model that tariff reduction policy resulted in equivalent welfare gains of 0.7% for both low-income and middle income rural households, but resulted in a loss in the same proportion for the low-income urban household, and has no impact on the middle-income urban one. This study is important since it shows that there is no equivalence between distributive concerns, emphasized by the standard trade theory, and poverty concerns. This is the line that supports the rationale behind the comparison we make

of our results for all simulations, that is, to show whether there are gains in welfare and occurrence of inequality after the policies have been implemented.

We also observe that all current policies may mitigate income inequalities in the country, since the projected inequality percentages (0.58% in BAU) are above those obtained after each shock. As a result of negative import tariff and export taxes shocks, the Gini index reduced respectively for 0.57 and 0.53%, respectively, signaling the potential of trade reform to reduce long-term income inequality. In their studies for Colombia, Attanasio et al, (2004) found similar results, albeit in the short term.

## 6. CONCLUSIONS

This study analyzed the effects of Doha Round and recent government policy to incentive national exports on the Guinean economy. The purpose is to deepen the understanding of how the country's economy reacts to tariff shocks. By using a dynamic recursive computable general equilibrium model, we evaluate the impacts of such shocks on macroeconomic aggregate and household level outcomes.

The simulations were carried out through two policy scenarios, namely import tariffs and export taxes reduction. Trade reform through complete import tariff cuts negatively affected the overall economy product in the early years. We observe that CDP results had been influenced by relative price changes, that increase imports vis-à-vis the exports. In the absence of a macro compensatory variable that adjusts as to balance the initial negative impacts, we saw that not even the GDP values were negatives, but government revenue as well as its consumption also decreased.

Conversely, export taxes policy has immediate, positive, and persistent impacts on macro aggregate and sector output. The endogenous export price change favored exports increase, investment, and the diversification of national production. We observe that the way in which the government directs its trade policy as to promote the country's comparative advantages will be important in determining household welfare outcomes. Current trade scenarios provoke an increase in demand for poorest workers labor in both rural and urban settings, however, import tariff reductions increase more de employment of urban-skilled worker, while the export taxes reductions increase more employment of unskilled rural household. These results led the capital accumulation favoring the poorest households, as they increase more the income and consumption of those households receiving least initial minimal wage.

What is reported so far suggests the importance of trade liberalization as a feasible option the governments can fulfill to potentialize the country comparative advantage as well as to improve the households' living conditions, both in urban and rural areas. The potential gains observed lead us to suggest that diversification of the export basket and the robust insertion in the national economy can be achieved by relieving the current restrictions on trade. Staggering the reduction in tax rates and tariffs for sectors with comparative advantages would strengthen the development of these sectors, as they will be forced to compete with others producing similar products. Naturally, although this implies the exclusion of those sectors that will not be able to participate in competitive international markets, conscious free trade will bring gains even for the poorest household in rural areas. This is because the sectors that survive economic opening will produce more, invest more, and employ more workers of different levels of qualification.

We emphasize, however, that the promotion of trade liberalization may not achieve the desired results in a small economy like this one with a low level of productivity. Institutional reforms that eliminate internal restrictions on production will be desirable. The country will be able to exploit its condition of relative backwardness by investing in human capital, since economic openness naturally implies the existence of national and international firms demanding qualified workers. Thus, once the country's ability to exploit its comparative advantages is guaranteed, the human capital availability with different skills will enhance the diversification of the economy that our results suggest.

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## TRADE WITH CHINA: TRADE BASKET AND ECONOMIC GROWTH IN LATIN AMERICA

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### ABSTRACT

The Latin American (LATAM)-China trade relationship is based on the exchange of Latin American commodities for manufactured goods from China. This paper aims to analyze the impact of the composition of the LATAM-China trade basket on the economic growth of Latin American countries. Based on a Cobb-Douglas production function, productivity is expressed as a function of exports to China, imports from China, China's share of overall U.S. imports, and other control variables. Exports destined for China are disaggregated into: (1) commodities, (2) low-tech manufactures and, (3) medium and high-tech manufactures while imports from China were broken down into: (1) consumer goods, (2) intermediate goods and, (3) capital goods. Non-exporting GDP to China is used as the dependent variable to remove the effect of exports on the national accounts. Regression analysis techniques are applied with panel data on 23 Latin American countries for the period 2002 - 2017. Considering the structural differences between countries in the region, the exercises are applied in two separate panels, one corresponding to South American countries (SA) and the second to Mexico, Central American and Caribbean countries (MCC). The results indicate that: (1) exports destined to China and imports from China exert negative and positive effects, respectively, on LATAM economic growth. The negative effects of exports to China are attributed to the commodity sector and low-tech manufactures while the positive effects of imports correspond to the three types of imported goods. The effects according to the composition of the trade basket are heterogeneous between SA and MCC, (2) the competition effect with China generates negative effects on SA's economic growth. The Latin American region needs to concentrate efforts to increase the share of medium and high technology manufactures in its export basket, in order to face the changes in international trade patterns both as a trading partner and as a competitor.

### KEYWORDS

China; composition of the trade basket; economic growth; Latin America

### 1. INTRODUCTION

The Latin America-China trade relationship has intensified since the formalization of China's entrance in the World Trade Organization (WTO) in November 2001. Between 2002 and 2017, Latin American exports destined for China increased from \$75.8 million USD to \$884.6 million USD while imports from China grew from \$142.9 million USD to \$1,552.8 million USD (constant prices, base year 2009) (UN COMTRADE, 2019).

The effects of exports and imports on economic growth via productivity are linked to the composition of the trade basket. Based on the ELG approach, the technological content of exported goods is a determining factor. According to Lall (2000), Dreger and Herzer (2013) and Arteaga, Cardozo and Diniz (2020), commodities and low-tech manufactures are basic and homogeneous goods, which offer a limited scope for the development and innovation of new products; consequently, these sectors are not effective in generating spillover effects. On the contrary, medium and high technology manufactures have greater potential to induce innovation processes and the capacity to promote spillover effects to the remaining of the industrial sectors (Hatzichronoglou 1997; Lall 2000).

Regarding the ILG hypothesis, the effects of imports on economic growth are captured according to the final usage of the imported goods. Kim, Lim and Park (2007) indicate that imports of consumer goods stimulate the competitiveness between local and foreign goods, inducing productivity improvements in local production. Keller (1997) explains that imports of intermediate goods and capital goods boost productivity through the transfer of foreign technology to local production units. However, Balassa (1978) and Priede (2012) warn that imports can generate a substitution effect of local production for imported goods.

On average, 79.4% of Latin American exports to China are made up of commodities, followed by medium and high technology manufactured goods (10.7%) and lastly low technology manufactured goods. In addition, on average, 41.2% of imports from China correspond to intermediate goods, 31.9% to consumer goods and the rest to capital goods. The current literature (Feal, 2015; Vianna, 2016; Murakami and Hernandez, 2018; Hou, 2019; Timini and Sanchez-Albornoz, 2019; Arteaga et al., 2020) analyzes the impact of trade with China on Latin America's economic growth considering aggregate exports and imports; an analysis considering the composition of the Latin America-China trade basket is needed.

On the other hand, Jenkins (2010), Jenkins and Barbosa (2012) and Ray and Gallagher (2015) explain that the supply of manufactured goods from China in the international market have generated market losses for Latin American goods. Arteaga et al. (2020) show that the substitution effect of Latin American imports for Chinese imports in the US inhibit the economic growth of South American countries.

The objective of this paper is to analyze the impact of the composition of the Latin America-China trade basket on economic growth via productivity of Latin American countries. In addition, it analyzes the effect of China's penetration of the US market on the economic growth of Latin American countries. In accordance with Feder (1983), Greenaway and Sapsford (1994), Feal (2015) and Arteaga et al. (2020), non-export-to-China GDP is used as the dependent variable in order to remove from GDP the contribution of exports destined for China to the national accounts. This analysis is performed for the period after China's entry to the WTO, 2002 - 2017. Regression analysis techniques are applied with panel data on 23 Latin American countries. In accordance with the differences in productive structures between Latin American sub-regions pointed out by Ocampo (2012), Rosales and Herreros (2013), Bernal (2015) and Arteaga et al. (2020), the present study applies the analysis for two subgroups of countries, the first corresponds to South American countries and the second to Mexico, Central American and Caribbean countries.

This paper is organized as follows: this section corresponds to the introduction; section 2 contains theoretical aspects about the composition of trade basket and economic growth. The next section shows the characteristics of the LATAM-China trade basket. The fourth section presents the methodology, while the fifth section shows the results. The last section concludes the paper.

## 2. COMPOSITION OF THE TRADE BASKET: THEORETICAL ASPECTS

According to Crespo-Cuaresma and Wörz (2005), Herzer, Nowak-Lehmann and Siliverstovs (2006) and Arteaga et al. (2020) the effects of exports on the productivity levels of an economy depend on the technological composition or degree of complexity of the exported goods. This paper considers the criteria of Lall (2000), under this classification exports are disaggregated into three major groups: primary products and natural resource-based manufactures (also called commodities), low-technology manufactures and medium and high-technology manufactures. Table 1 describes the main characteristics of these goods.

**Table 1 - Classification by technological composition of goods traded according to Lall (2000)**

Classification	Examples	Main characteristics	Main means of competitiveness in the international market
Primary products	Fresh fruit, meat, rice, cocoa, tea, coffee, wood, coal, crude petroleum, gas, etc.	Homogeneous products with low technological content and intensive in natural resources. Low-income elasticity. Products vulnerable to shocks in international commodity prices.	Abundance of natural resources.
Resource based manufactures	Prepared meat/fruit, beverages, wood products, vegetable oils, etc.		
Low technology manufactures	Textile fabrics, clothing, headgear, footwear, pottery, simple metal parts/structures, furniture, jewelry, toys, plastic products, etc.	Homogeneous products with low technological content and labor intensive. Low income elasticity.	Market prices.
Medium technology manufactures	Passenger vehicles and parts, commercial vehicles, synthetic fibers, chemicals and paints, fertilizers, engines, motors, industrial machinery, etc.	Products with high technological content. Their production requires specialized labor. Products linked to Research and Development (R&D)* activities. High income elasticity.	Product differentiation and value-added. Market prices.
High technology manufactures	Office/data processing/telecommunications equipment, TVs, pharmaceuticals, aerospace, optical/measuring instruments, etc.		

Note: \* According to Lall (2000), in the medium and high-tech manufacturing sector, operations are also installed in labor-intensive production units located in low-wage countries. Source: Own elaboration based on Lall (2000).

On the other hand, the literature discusses the effects of imports on the economy according to their final use. A country imports goods to use them as consumer goods or as factors of production (intermediate goods and capital goods). Thus, the classification by Broad Economic Categories (BEC) (United Nations, 2002) is the most appropriate for studying the effects of imported goods on the economy. Table 2 describes the main characteristics of these goods.

**Table 2 - Classification by Broad Economic Categories (BEC) of traded goods according to United Nations (2002)**

Classification	Components	Examples	Final consumption	Main characteristics
Consumer goods	Food and beverages, transport equipment, durable goods, semi-durable goods and non-durable goods.	Milk, fruit, textiles, jewelry, motorcycles, bicycles, vehicles, etc.	Household consumption	These types of products can be commodities, low technology manufactures or medium and high technology. These goods may originate from countries specialized in

Classification	Components	Examples	Final consumption	Main characteristics
Intermediate goods	Food and beverages, industrial supplies, fuels and lubricants, parts and accessories of capital goods.	Wheat, grains and seeds, petroleum, valves and tubes, machine tools, resistors, transistors, etc.	Production factor	commodities or highly industrialized countries.
Capital goods	Equipment, machinery and transport equipment.	Steam boilers, tractors, electrical instruments and apparatus, freight vehicles, railroad systems, etc.	Production factor	They correspond to medium and high technology manufactures from highly industrialized countries with a high level of Research and Development (R&D) activities.

Source: United Nations (2002).

Kasahara and Rodrigue (2008) explain that the adoption and imitation of imported technologies improves the efficiency of production units. For their part, Lee (1994), and Halpern, Koren and Szeidl (2015) point out that increases in efficiency and productivity levels in local economies can materialize through the importation of cheaper intermediate and capital goods.

### 3. LATAM-CHINA TRADE BASKET

Between 2002 and 2017, South American countries were responsible for 92.3% of Latin American exports destined for China and 52.18% of Latin American imports from China. Mexico, Central America and Caribbean countries accounted for the rest of the volumes traded with China.

Figures 1 and 2 show details of the composition of the Latin America-China trade basket. The box plots in Figure 1 show the share distribution in total exports to China by type of good and by Latin American sub-region. In the South American countries, primary products and natural resource-based manufactures account for at least 70% of total exports, thus this subregion's export basket to China is specialized in commodities. Figure 1 also shows that Barbados and Costa Rica stand out for concentrating more than 75% of exports to China in low-technology manufactures and with medium and high-technology manufactures, respectively. However, considering the subregion made up of Mexico, Central America and the Caribbean, commodities account for an average of 67.2% of exports to China; therefore, the export basket destined for China in this subregion is also concentrated in commodities.

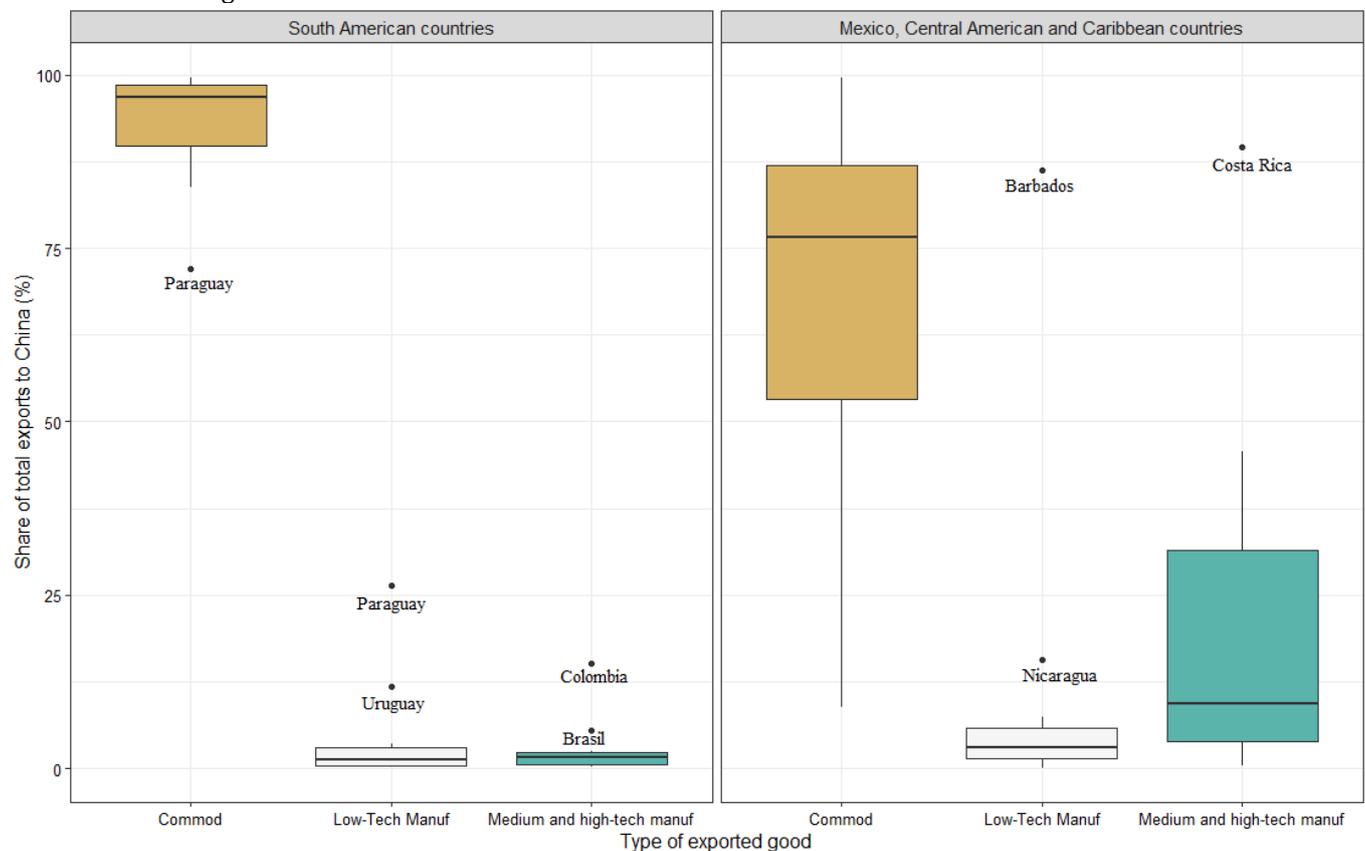
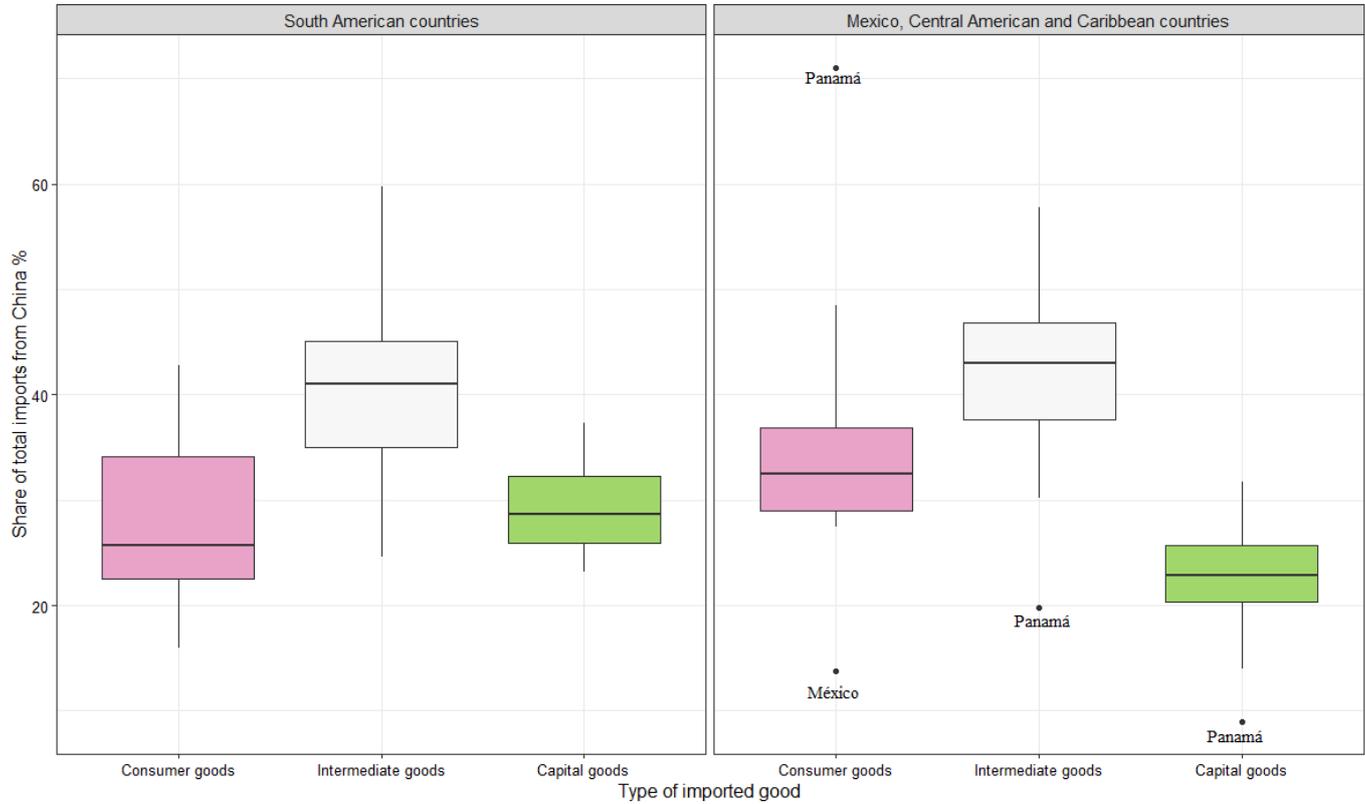


Figure 1 - Share distribution in total exports to China by type of good according to Lall (2000), and by Latin American sub-region, period 2002 - 2017

Source: Own elaboration based on Lall (2000) and UN COMTRADE (2019).

The box plots in Figure 2 show the share distribution in total imports from China by type of good according to United Nations (2002), and by Latin American sub-region. In South American countries, imports of intermediate goods account for 45.3% of imports from China, while in Mexico, Central America and the Caribbean this percentage is 40.8%. In the second sub-region, Mexico stands out for having the lowest share of consumer goods in its total imports from China (13.7%), while in Panama at least 70% of imports are made up of consumer goods.



**Figure 2 – Share distribution in total imports from China by type of good according to United Nations (2002), and by Latin American sub-region, period 2002 - 2017.**

Source: Own elaboration based on United Nations (2002) and UN COMTRADE (2019).

**4. METHODOLOGY**

We follow the theoretical model applied by Arteaga et al. (2020) and incorporate imports from China within the set of explanatory variables.<sup>155</sup> For each country *i* at time *t*, non-export-to-China GDP (NonEC\_GDP) is explained by the following variables. Labor stock (*L*), net capital of imports of capital goods from China (NonIC\_K),<sup>156</sup> terms of trade (TERMS), China's share of overall U.S. imports (SHAREUSA). Exports to China are segregated according to the Lall (2000) classification: primary products and natural resource-based manufactures (COMMODO), low-technology manufactures (LT) as well as medium and high-technology manufactures (MHT). Lastly, imports from China are grouped according to the United Nations (2002) classification: consumer goods (CONS), intermediate goods (INTER) and capital goods (CAPG). Via national accounting identity, exports destined for China are a component of GDP, therefore, based on Feder (1983), Greenaway and Sapsford (1994), Feal (2015) and Arteaga et al. (2020), the most appropriate proxy variable for economic growth is non-export-to-China GDP (NonEC\_GDP).<sup>157</sup> On the other hand, the capital stock (*K*) includes imported capital goods (European Commission et al., 2009), therefore, it is more appropriate to exclude from capital the capital goods imported from China (BCAP), this operation results in the variable NonIC\_K.

$$\ln(\text{NonEC\_GDP}_{it}) = \lambda_1 \ln(L_{it}) + \lambda_2 \ln(\text{NonIC\_K}_{it}) + \lambda_3 \ln(\text{TERMS}_{it}) + \lambda_4 \ln(\text{SHAREUSA}_t) + \lambda_5 \ln(\text{COMMODO}_{it}) + \lambda_6 \ln(\text{LT}_{it}) + \lambda_7 \ln(\text{MHT}_{it}) + \lambda_8 \ln(\text{CONS}_{it}) + \lambda_9 \ln(\text{INTER}_{it}) + \lambda_{10} \ln(\text{CAPG}_{it}) \quad (1)$$

*i* = 1, ..., *N*; *t* = 1, ..., *T*

Following Leybourne (1995), Banerjee and Russel (2005), Dreger and Herzer (2013), Feal (2015) and Arteaga et al. (2020) the labor effect can be treated as an individual effect conditional on time  $\alpha_{1i}T_t$ . On the other hand, the country fixed effect ( $\lambda_{0i}$ ) and the idiosyncratic error ( $\epsilon_{it}$ ) are included. Equation 2 results in these adjustments:

$$\ln(\text{NonEC\_GDP}_{it}) = \sum_{i=1}^N \lambda_{0i} D_i + \sum_{i=1}^N \alpha_{1i} D_i T_t + \lambda_2 \ln(\text{NonIC\_K}_{it}) + \lambda_3 \ln(\text{TERMS}_{it}) + \lambda_4 \ln(\text{SHAREUSA}_t) + \lambda_5 \ln(\text{COMMODO}_{it}) + \lambda_6 \ln(\text{LT}_{it}) + \lambda_7 \ln(\text{MHT}_{it}) + \lambda_8 \ln(\text{CONS}_{it}) + \lambda_9 \ln(\text{INTER}_{it}) + \lambda_{10} \ln(\text{CAPG}_{it}) + \epsilon_{it} \quad (2)$$

*i* = 1, ..., *N*; *t* = 1, ..., *T*

<sup>155</sup> The work of Arteaga et al. (2020) presents details of the development of the model structure.

<sup>156</sup> NonIC\_K = Capital (*K*) minus imports of capital goods from China (BCAP).

<sup>157</sup> NonEC\_GDP = GDP minus exports to China

The data sources for the variables were CEPAL-STAT for GDP, World Bank for capital (K) and terms of trade (TERMS), and UN-COMTRADE for the variables related to exports to China, imports from China and U.S. imports from China and overall U.S. imports. The variable NonEC\_GDP is GDP minus exports to China. NonIC\_K is Capital (K) minus capital goods from China (CAPG). The ratio between U.S. imports from China and overall U.S. imports expresses the share of China in U.S. imports (SHAREUSA). All variables except TERMS and SHAREUSA are expressed in constant dollars (base year 2009). Annual information is available for 23 Latin American countries: Argentina, Barbados, Bolivia, Brazil, Chile, Colombia, Costa Rica, Cuba, Dominican Republic, Ecuador, El Salvador, Guatemala, Guyana, Honduras, Jamaica, Mexico, Nicaragua, Panama, Paraguay, Peru, Trinidad and Tobago, Uruguay and Venezuela for the period 2001 - 2017. The variables NonEC\_GDP, TERMS and CONS have unit root in levels; however, all variables are integrated of order 1. To avoid spurious relationships, equation 3 results from applying first differences to equation 2.<sup>158</sup>

$$\Delta \ln(\text{NonEC\_GDP}_{it}) = \alpha_{1i} + \lambda_2 \Delta \ln(\text{NonIC\_K}_{it}) + \lambda_3 \Delta \ln(\text{TERMS}_{it}) + \lambda_4 \Delta \ln(\text{SHAREUSA}_t) + \lambda_5 \Delta \ln(\text{COMMOD}_{it}) + \lambda_6 \Delta \ln(\text{LT}_{it}) + \lambda_7 \Delta \ln(\text{MHT}_{it}) + \lambda_8 \Delta \ln(\text{CONS}_{it}) + \lambda_9 \Delta \ln(\text{INTER}_{it}) + \lambda_{10} \Delta \ln(\text{CAPG}_{it}) + \varepsilon_{it} \quad (3)$$

$i = 1, \dots, 23; t = 1, \dots, 16$

In equation 3, the coefficients  $\lambda_{ki}$  explain the elasticity of non-export-to-China GDP with respect to the explanatory variables. The estimations are performed through regression analysis with panel data. The panel formed by 23 Latin American countries (LA panel) for the period 2002 - 2017 is divided into two subgroups of countries according to the differences in export structures pointed out by Gallagher and Porzecanski (2008), Jenkins (2010), Correa (2012), Ocampo (2012), Rosales and Herreros (2013), Bernal (2015), Anderson and Strutt (2016) and Arteaga et al. (2020). The first subgroup is made up of South American countries (panel SA) whose overall export basket tends to be primary exporter. The second is made up of Mexico, Central American and Caribbean countries (MCC panel), these countries have managed to position technological content manufactures in their export baskets. For the SA panel, corrections must be made for time dependence and heteroscedasticity, while for the MCC panel, corrections must be made for heteroscedasticity and serial correlation. The panel-corrected standard error estimator (PCSE) method is used to make these corrections.<sup>159</sup>

## 5. RESULTS AND DISCUSSIONS

Table 3 shows the effects of the composition of the Latin America-China trade basket on the economic growth of Latin American countries. Column 1 indicates the effects for South American countries (SA Panel) and column 2 for Mexico, Central American and Caribbean countries (MCC Panel).

The results show that capital exerts positive effects in both subregions; however, the effect is greater in South American countries. On the other hand, the terms of trade generate positive effects in Mexico, Central American countries and the Caribbean. A possible explanation for the behavior of this last variable is obtained from Jenkins, Dussel and Mesquita (2007) and Rosales and Kuwayama (2012). These authors indicate that the increase in commodity prices and the decrease in manufacturing prices induced by China's entry into the WTO caused a deterioration in the terms of trade in Mexico, Central American and Caribbean countries, since their global exports have a significant volume of manufactured goods. These conditions generated negative effects on the balance of payments. Once non-export-to China GDP contains exports to other trading partners, the results of this paper show that a 1% improvement in the terms of trade in Mexico, Central American and Caribbean countries stimulates the growth of non-exporting GDP to China by approximately 0.20%, a value higher than the contribution given by capital.

Table 3 also indicates that China's share of global imports from the United States have no effect on the economic growth of Mexico, Central American and Caribbean countries and negative effects in South American countries; these results coincide with those found by Arteaga et al. (2020). Among the possible reasons is that the export portfolio of South American countries is concentrated in few products. In this condition, South American countries tend to be more vulnerable to changes in trade patterns, the negative effects of which can reach production destined for local consumption via a decrease in productivity.

Column 1 shows that, in South American countries, exports to China of low-technology manufactures generate negative effects on economic growth via productivity. With respect to imports from China, consumer and capital goods exert positive effects, however, the most notable impact corresponds to consumer goods. Also, column 1 shows evidence of negative effects produced by imports of intermediate goods from China. Column 2 shows that, in the group of countries comprising Mexico, Central America and the Caribbean, commodity exports have negative effects on economic growth via productivity, while imports of intermediate goods have positive effects.

158 Note: for all variables except SHAREUSA, the Harris-Tsavalis [HT] (1999) unit root test for panel data was used because it is the most appropriate for very small t-values. On the other hand, the variable SHAREUSA is a time series that does not vary between countries, therefore, for this variable the Augmented Dickey-Fuller (ADF) test was used.

159 The Generalized Least Squares method is also used in panels with non-spherical errors, however, according to Beck and Katz (1995), this method is suitable when the average contemporaneous correlation is greater than 0.75 and T is at least twice N. In the SA and MCC panels, the average values of contemporaneous correlation are less than 0.75.

**Table 3. Effects of the composition of the LATAM - China trade basket on economic growth of Latin American countries**

<b>Dependent variable: non-export-to-China GDP (NonEC_GDP)</b>				
Independent variables:		SA panel		MCC panel
		1		2
Constant		0.0414 <i>0.0010</i>	***	0.0320 <i>0.0000</i>
Net capital of imports of capital goods from China (NonIC_K)		0.2829 <i>0.0000</i>	***	0.1546 <i>0.0000</i>
Terms of trade (TERMS)		0.1062 <i>0.1030</i>		0.1993 <i>0.0000</i>
China's share of overall U.S. imports (SHAREUSA)		-0.3132 <i>0.0100</i>	**	-0.0928 <i>0.1560</i>
Exports to China of:	commodities (COMMOD)	-0.0044 <i>0.6300</i>		-0.0049 <i>0.0480</i>
	low-technology manufactures (LT)	-0.0165 <i>0.0190</i>	**	0.0002 <i>0.9070</i>
	medium and high-technology manufactures (MHT)	0.0026 <i>0.6310</i>		0.0006 <i>0.6940</i>
Imports from China of:	consumer goods (CONS)	0.1663 <i>0.0000</i>	***	0.0132 <i>0.3100</i>
	intermediate goods (INTER)	-0.0864 <i>0.0520</i>	*	0.0264 <i>0.0430</i>
	capital goods (CAPG)	0.0522 <i>0.0820</i>	*	-0.0099 <i>0.4490</i>
Model		Random Effects		Random Effects
Corrections		DC, HET		HET, AUTOCOR
Number of countries		11		12
Period		16		16
Number of observations		176		192
R-squared		0.7092		0.3825

Note: All variables are expressed in first differences of logarithms. As a robustness test, regression was performed on the panel of 23 countries using a Dummy variable with a value equal to 1 for MCC countries and zero for the rest, the significance results coincide with those shown in Table 3. DC = contemporaneous dependence, HET = Heteroscedasticity, AUTOCOR = Autocorrelation. Superscripts \*\*\*, \*\*, and \* indicate 1%, 5%, and 10% significance level, respectively.

The empirical evidence found in this paper on the effects of commodity exports and low-tech manufactures on economic growth via productivity in Latin America is consistent with the arguments of Lall (2000), and Oreiro and Feijó (2010). These sectors are lacking in the generation of spillover effects due to the fact that they are basic products with low technological content. As shown in Figure 1, in Latin America, exports to China are concentrated in few products, generally homogeneous and of low value added, therefore, it is possible that the expansion of exports to China is diverting and capturing resources from sectors of production of goods with higher technological content as warned by Sachs and Warner (2001), Herzer et al. (2006) and Arteaga et al. (2020). In the case of Mexico, Central America and the Caribbean, the export basket destined for China is specialized in commodities; however, the overall export pattern of this sub-region is oriented towards manufacturing. It is possible that the expansion of commodity exports to China is inducing a reorientation of the export pattern of these countries, as noted by Oreiro and Feijó (2010), Devadason et al. (2017) and Arteaga et al. (2020).

Regarding the effects of imports, the positive effects found confirm the theoretical contributions of Keller (1997), Kim et al. (2007), and Kasahara and Rodrigue (2008). However, in South American countries there is evidence of negative effects of intermediate goods, as noted by Balassa (1978) and Priede (2012).

## 6. CONCLUSIONS

China's entry into the World Trade Organization (WTO) in 2001 deepened Latin America-China trade, based on the exchange of commodities for manufactured goods. Evidenced by Latin American sub-regions and by type of good traded with China shows heterogeneous effects of these transactions on Latin American economic growth.

In South American countries, exports of low-technology manufactures and imports of intermediate goods produce negative effects on economic growth via productivity, which seems to indicate that trade with China follows a process of deterioration of productivity levels in the rest of the sectors of the economy and substitution of local production by imported goods from China. On the other hand, in this same subregion, imports of consumer goods and capital goods produce positive effects, with the former having a greater effect than the latter. The large volumes of soybeans, copper, iron and oil exported by Latin America to China come from South American countries; this sub-region benefited from the commodities boom after 2001 and some countries had trade surpluses with China. It is possible that the income received from the expansion of commodity exports to China was channeled into the supply of consumer goods from China and that these goods generated at least one of the following two effects: first, these goods stimulated the competitiveness of local production. Second, the acquisition of cheaper imported goods induced the growth of demand for other locally

produced goods, redirecting resources to sectors where aggregate demand grew, i.e., the expansion of demand for consumer goods imported from China had a complementary effect with local goods.

In Mexico, Central America and the Caribbean, commodity exports to China have negative effects on economic growth via productivity. One possible explanation is that the expansion of aggregate demand for commodities is inhibiting the growth of higher value-added sectors, since the overall export basket of this sub-region has a significant manufacturing content. On the other hand, imports of intermediate goods from China generate positive effects either by acquiring cheaper goods or by transferring technical progress to production units.

The results indicate that exports to China are not generating positive externalities to the rest of the sectors of the economy, since they are of low technological complexity and concentrated in few products; in fact, the evidence of negative effects indicates that these exports generate stagnation in sectors that do not export to China. However, imports from China, characterized by being more diversified and with higher value added, catalyze economic growth in Latin America, with greater intensity in South American countries. The sources of the positive effects vary among sub-regions, in South American countries these effects are attributed to consumer and capital goods and in Mexico, Central American and Caribbean countries to intermediate goods. On the other hand, the competitive nature of China in the U.S. market generates losses in the economic growth of South American countries.

To mitigate the negative effect attributed to exports to China and China's participation in the U.S. market, it is necessary to stimulate the manufacture and export of products with greater technological complexity, especially medium and high technology manufactures that generate the diffusion of technical progress and innovation to the rest of the sectors of the economy, diversify the export portfolio and verify the multilateral agreements with China that inhibit exports of higher value-added goods.

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**Special Session: SS01 - Alternatives for  
integrating development with infrastructure  
provision in the global South**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/84114610826>**

**Chair Manisha Jain**

## COMPETITION FOR ILLICIT PAYMENTS ON ROAD NETWORKS OF WEST AFRICA 1988-2016

[Glenn Rogers](#)

Independent Advisor, France

### ABSTRACT

At a regional scale across multiple countries in West Africa there is a spatial market for illicit payments (IP)s along roadways that is distinct from the market for any specific commodity traded. Efforts over five decades to promote intra-African trade from the Mano River Union in 1973 to the 2019 African Continental Free Trade Area have had slower success than anticipated. In part this is due to non-tariff barriers related to IPs demanded at roadblocks by soldiers, police, political party authorities, private collection agents and customs officials. The dynamics of this IP market play a crucial role in creating the spatial structure of economic activity, conflict, trafficking and migration pressure in West Africa.

In 1997 I pessimistically concluded in conference presentations and an unpublished working paper that given road infrastructure at the time and without increased competition in the IP market, even if legal taxes are eliminated, transport losses are reduced and producer efficiency is increased dramatically through rural development programs, IPs on a regional basis would increase to choke off expected development benefits. This paper re-examines this question using my 1990s framing and empirical results in combination with more recent findings of others on competition in this regional IP market.

This is the first time findings are compared from empirical analyses based on two micro-datasets of IPs for 1988-1997 and 2012-2016 developed with support from US Agency for International Development (USAID) country programs. Improvements in data collection and digital archiving that make IP time-series data publicly available has enabled more analyses and refinement of empirical hypothesis testing. The manifestations of competition in IP markets are examined using characteristics of three distinct scenarios: 1. independent monopolists, 2. joint monopolists and 3. competitive agents. Evidence of changes in these basic manifestations over time and space are used as an indication of shifts in competition in the IP market. Related institutional contextual understanding draws from decades of work of many analysts on the political economy of IPs, how they constrain regional integration, governance for broader anti-corruption efforts and costs IPs impose on commodity-specific crop and livestock trade.

Since the 1990s researchers and policy makers have continued to highlight the persistence of bribery in West Africa. Foltz & Li (2020) reiterated my 1997 call for corrupted officials to face increasingly competitive markets as a necessary condition to reduce the socio-economic costs of IPs. Over recent decades there has been an evolution in governance and an increase in the number of alternative transport routes. These changes have the potential to lower total IPs or reduce volatility in the economic welfare costs they impose. But we still know little about the actual impact of more competition for IPs, the topic of this paper and needed future research.

## REGIONAL DEVELOPMENT IMPLICATIONS OF IMPROVED CENTRAL TO SOUTH ASIA TRANSPORT DEVELOPMENT: SUMMARY OF RECENT ANALYSIS BY THE WORLD BANK

[Nathan Hutson](#)

University of North Texas, USA

### ABSTRACT

Background: Regional integration of the economies of Central and South Asia has long been stymied by the lack of transport connectivity. Path dependent development of the railroad infrastructure, in particular, has created a situation where the economies of the former Soviet Central Asian states have negligible trade flows with South Asia despite the formers' large resource supplies and the latter's massive consumer market. In addition, the decades-long instability of Afghanistan, which serves as the principle gateway linking Central and South Asia has inhibited infrastructure investment to improve connections. In the last few years, the planned construction of the Mazar-e-Sharif to Herat railway has served as the beginning of a larger project for regional connectivity. The government of Afghanistan has coordinated with the World Bank to engineer a series of rail connections to Pakistan, including the new container port of Gwadar and dry ports of Baramcha and Spin Boldak. Given the considerable investment risk, a team from the World Bank has evaluated existing and potential cargo flows with the goal of determining which of these linkages would be economically justifiable. In addition, this analysis illustrates which regions of Central and South Asia would be most impacted by a reorientation of existing supply chains. This paper illustrates the key results of this analysis, showing which gaps in the transport network continue to persist, which options exist for new routes, and the logistical and political challenges of pushing forward with infrastructure investment prior to the time when Afghanistan is fully stable. Methodology and Data: Base data is extracted from publicly available sources such as UN-Comtrade as well as from interviews with current shippers and potential future mineral producers. Additional insight on gaps in predicted versus actual trade are identified using a revealed comparative advantage (RCA) analysis using data from World Integrated Trade Solutions (WITS). RCA is used to compare Central Asian States' existing trade relationship with South Asia compared to their relations with Russia and China – two states with which trade relationships are already well developed. Preliminary Findings: Initial findings show that while existing Central Asia-South Asia flows are inadequate to recoup the substantial investment, a reduction in transport costs could allow a significant share of exports to South Asia that currently originate in China and Southeast Asia to relocate to Central Asia – thereby reorienting regional supply chains and enhancing regional integration. Mineral projects within Afghanistan also have the potential to bolster total tonnage and improve revenue adequacy over time. While investment risk persists, improved trade relationships can aid Afghanistan's incorporation into the global trade system. A major test is in ensuring that Afghanistan receives economic development beyond transit rents. Coupling inland port development with rail gauge change locations is seen as a critical element creating an environment for job creation and value-added services.

**INTEGRATING SPATIAL DEVELOPMENT WITH INFRASTRUCTURE  
PROVISION: A CONCEPTUAL FRAMEWORK AND ITS APPLICATION TO  
INDIA**

**Manisha Jain<sup>1</sup>, Artem Korzhenevych<sup>1</sup>, Jörg Knieling<sup>2</sup>**

<sup>1</sup>Leibniz Institute of Ecological Urban and Regional Development, Germany. <sup>2</sup>HafenCity University, Germany

**ABSTRACT**

In recent years, scholars of urban studies have advocated strategic spatial planning as a way to better integrate infrastructure provision with spatial development in the Global South, especially given escalation in large-scale development projects under neoliberalism. Although strategies to create transport corridor are prevalent in the global South, there is a lack of empirical research to evaluate these initiatives, in particular whether they have realized their general goal of reducing regional disparities. The current paper describes a multi-method approach involving spatial and non-spatial analysis to investigate spatial disparity along a proposed corridor and examine its integration within the existing settlement structure. The analytical framework is tested on India's Delhi-Mumbai Industrial Corridor. A rationale is developed to enable a critical view of corridor policies as strategies for development in the global South.

## RURAL TO URBAN TRANSFORMATION IN INDIA AS CENSUS TOWNS: RURAL-URBAN DICHOTOMY REVISITED

[Manisha Jain](#)<sup>1</sup>, [Artem Korzhenevych](#)<sup>1</sup>, [Jörg Knieling](#)<sup>2</sup>

<sup>1</sup>Leibniz Institute of Ecological Urban and Regional Development, Germany. <sup>2</sup>HafenCity University, Germany

### ABSTRACT

The urbanization process in the Global South is characterized by the blurring of the boundaries between urban and rural areas and the lack of institutional capacity, which have made the process highly unsustainable. In India, an example of such development is the rapid growth of “census towns”. These settlements are not acknowledged as urban by the state, but they play an important role in accommodating population growth.

The current discourse on urbanization calls for new approaches to capture the peculiarities of growth in the global South. This paper takes the National Capital Territory of Delhi as a case study and adopts a mix of methods (field survey, ordinary least squares regression and geographically weighted regression) to highlight the emerging gradient of urbanization within official rural areas.

The article first examines the population and municipal status dynamics, location and economic characteristics of census towns as well as their migratory and commuting patterns. The status and costs of providing basic amenities and social infrastructure are then analyzed. The paper emphasizes the contribution of contemporary theories that explain the growth of census towns and the role of secondary and primary data in capturing their characteristics. Taking advantage of the economic potential of India's urbanization as census towns will require the following: (i) the enforcement of reforms to empower Gram Panchayat for spatial planning and growth regulation; (ii) the discontinuation of subsidized infrastructure provision and charging development tax; and (iii) investment in decentralized infrastructure for more accountable and more efficient delivery of basic amenities.

**Special Session: SS38.1 - Resilience and  
peripheral areas: development patterns and  
policies in the borderlines**

**17:30 - 18:45 Wednesday, 26th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88689482335>**

**Chair Gabriela Carmen Pascariu**

## INNOVATION-DISRUPTED SPATIAL EQUILIBRIUM: INSIGHTS FROM THE ISRAELI EXPERIENCE

**Raphael Bar-El<sup>1,2</sup>, Liran Maymoni<sup>1,2</sup>**

<sup>1</sup>Ben-Gurion University, Israel. <sup>2</sup>Sapir Academic College, Israel

### ABSTRACT

The emergence of innovation as a major engine of development challenges regional economic balances due to the strong concentration of high-tech activities in central metropolitan regions. Besides the positive influence of innovation on national growth, there is a regional market failure, leading to a disruption of peripheral regions' efforts to integrate into the national and global economy. We hypothesize that labour supply in the periphery responds by adapting to new requirements, while labour demand (through high-tech activities or start-ups) responds to changes in labour supply but also tends to concentrate in central regions. We expect that public policy can create a new equilibrium in the labour market, reducing the periphery-centre socio-economic gap.

We use Israel as a case study, given that it is a major leader in innovation but concentrates these activities in the metropolitan centre. We propose and test a conceptual approach using secondary data on the changes in the labour market.

The analysis of the Israeli experience leads to several preliminary conclusions:

1. Labour supply in the periphery shows a tendency to adapt to the new conditions, with increases in quality and quantity, which contradicts arguments about periphery desertion.
2. Labour demand in the periphery reacts to innovation new opportunities and to public policy measures and leads to changes in the domestic economic structures.
3. Yet, labour demand does not fully accommodate changes in labour supply, apparently as a result of insufficient or inappropriate policy measures.
4. A consequence of the insufficient balance between labour supply and demand is the persistence of periphery-centre gaps in unemployment and income.
5. An intensive research effort is needed in order to identify the policy measures that would lead to a better labour market balance.

## RESILIENCE, DEVELOPMENT REGIONS AND LOCAL REVENUE COLLECTION LEVELS IN ROMANIA

Octavian Moldovan, Bogdana Neamtu

Department of Public Administration and Management, Faculty of Political, Administrative and Communication Sciences, "Babeş-Bolyai University", Cluj-Napoca, Romania

### ABSTRACT

This paper explores if location in a development region influences local revenue collection levels (public revenue mobilization conceptualized as the ratio between the amounts collected at the local budget during one year divided by the amounts that were supposed to be collected during that budgetary year) in the case of Romania. As such, the revenue collection levels of 3227 (almost all) Romanian territorial-administrative units are analyzed for the 2008 to 2011 budgetary years according to the eight development regions (NUTS 2 level) created and maintained since 1998 in order to facilitate regional development, progress towards European Union accession and manage post-accession funding. The data analysis consists of descriptive and exploratory techniques (such as Tukey Boxplots, central tendency analyses and One Way ANOVA with Post Hoc).

The research provides corroborated evidence that Romanian development regions have a statistically significant effect on the levels of revenue collection at the local level. The results show that local administrative institutions from the North-West (with collection levels between 85.54% and 90.61%), West (with collection levels between 81.69% and 87.55%) and Bucharest (with collection levels between 84.27% and 88.29%) development regions constantly attained higher levels of local revenue mobilization between 2008 and 2011, while the North-East (with collection levels between 74.43% and 82.25%), South (with collection levels between 73.88% and 83.43%) and South-East (with collection levels between 78.68% and 81.89%) regions under-performed in regard to local revenue collection/mobilization. No clear pattern seems to emerge in the case of the remaining two regions (Center and South West) as they constitute an intermediary level between the aforementioned two categories.

Policy implications, especially for sustainable development, are discussed both in for the current administrative framework and in view of a potential administrative re-organization.

## THE RELEVANCE OF SMART CITIES IN ASSESSING URBAN LABOR MARKET RESILIENCE. A POST-TRANSITION ECONOMY SPECIFICITY

Dan Lupu, Liviu Geroge Maha, Daniela Elena Viorica

Alexandru Ioan Cuza University of Iasi, Romania

### ABSTRACT

Resilience is a well-established concept that is used to assess whether a system has the capacity to respond to a variety of challenges. One of the dimensions of resilience is the labor market ability to overcome the perturbations imposed by internal and external shocks and improve its capacity to respond to it. The cities' characteristics in terms of infrastructure, demographics, socio-cultural, governance, mobility, standards of living in general, as characteristics that describe key features of a smart city, can significantly influence the resilience of the urban labor market. From this perspective, a focus on explaining spatial variations in labor market resilience by analyzing the performance of urban areas is relevant in a geographical context of economic growth and development policies. This paper aims to assess the urban labor market resilience, the urban labor market resilience capacity and the relationship between the two, for the European Union's metropolitan areas from Eastern Europe. Also, the paper will follow the idea that this relationship is less significant for the borderline metropolitan region than for the most central ones. In building the resilience capacity index, we explored the extent to which key features of smart cities contribute to the evaluation of the resilience capacity of the urban labor market. The urban labor market resilience will be evaluated by building an aggregate indicator, using variables that measure specific characteristics of a labor market for post-transition economies. A profiling of the metropolitan areas with different degree of labor market resilience will be identified, using key features that define a smart city, in order to understand the extent of spatial variation in terms of urban labor market resilience. A spatial analysis using a visualization tool, namely a self-organizing map, will be employed to assess the regional disparities between borderline and non-borderline metropolitan regions. Analyzing the urban labor market resilience for a post-transition economy is considering the specificities of its labor market: the ongoing restructuring of the economy; the unemployment, especially for youth and female employment; massive migration of the workforce towards the Western developed countries. This approach can help investigating the possibility if a city with the key characteristics of a smart city can better cope with labor market shocks in a young market economy.

# Wednesday, 26 May 2021

## Special Academic Session (SAS)

07:55 -17:15 GMT+1, Wednesday, May 26, 2021

**Do we need new data, models and planning for the post-pandemic city?**

**Room: Dakhla**

<https://us02web.zoom.us/j/88500705804>

**Organizers:** Peter Batey, Guney Celbis, Kingsley Haynes, Karima Kourtit, Peter Nijkamp and Neil Reid

*The Regional Science Academy*



### Aim & Scope

The past decade saw the emergence of connected intelligent infrastructures used for facing growing urbanization challenges. These networks of integrated computerized systems began collecting and transmitting urban data in real time, leading to automated and/or supervised interventions aimed to facilitate the lives of the individuals in cities. As part of the general concept of a “Smart City,” real-time data management and analysis has been used to streamline the distribution of energy, waste management, management of traffic congestion, and environmental protection among many other examples. One major purpose of the fast and efficient collection and analysis of city data is to anticipate urban challenges and intervene preemptively.

As the world was just entering a new stage characterized by urban communication networks powered by the Internet of Things infrastructures, the Covid-19 pandemic broke out. Monitoring population density to assess transmission risks and the place-based management of health services based on spatial information on COVID-19 cases have emerged as essential policy-relevant measures. The collection and rapid analysis of data related to the spatial accessibility to health services became an essential task for organizing the effective allocation of healthcare resources. Retuning intelligent transportation systems and developing heat maps identifying hotspots of are already recognized as imperative. This being said, privacy concerns and accessibility to data are vibrant discussion topics alongside with the technical aspects of the collection and processing of information.

What will be the aspects of the new types of data that we need with regards to the new urban life characterized by the pandemic? How will the lasting effects of the pandemic on urban life be represented and tracked digitally? How will this new data be translated into planning the post-pandemic city? This TRSA session will initiate a scientific discussion on how urban data will shape our lives after the pandemic.

**07:55 - 08:00 | Welcome**

**Peter Batey**, President, *The Regional Science Academy* (TRSA)

**The Regional Science Academy (TRSA) Lecture Series: “The Voice of Regional Science”**

**08:00-09:30 | SIGNATURES OF REGIONAL SCIENCE I**

**Chair: Jaewon Lim**

- 1) **The contribution of behavioral economics to post pandemic regional science**  
**Daniel Czamanski**
- 2) **Data issues during COVID-19 in developing countries**  
**Budy Resosudarmo**
- 3) **Microsimulation for mobility patterns based on digital twins in the context of a pandemic**  
**Henk Scholten**

09:30-10:00 | Break

10:00-12:00 | SIGNATURES OF REGIONAL SCIENCE II

Chair: John Carruthers

- 4) Integration of economics with epidemics using the spatial structure  
[Tomaz Dentinho](#)
- 5) Do we need new data, models and planning for the post-pandemic city?  
[Hans Westlund](#)
- 6) The contribution of digital technology to the resilience of cities and territories in Morocco in the face of COVID-19  
[Abdelaziz Adidi](#)
- 7) More timely, more granular - progress and bottlenecks in measurement  
[Alexander Lembcke](#)

12:00-13:00 | Break

13:00-14:30 | SIGNATURES OF REGIONAL SCIENCE III

Chair: Geoffrey Hewings

- 8) Collaboration between beekeepers in rural areas and farmers in the surrounding of urban area in southern Morocco during the COVID-19 pandemic  
[Mostafa Lamrani Alaoui](#)
- 9) Pandemic Recovery Index, commercial real estate markets under conditions of persistent work-from-home arrangements  
[Terry Clower](#)
- 10) The city after Covid-19: a discussion of some research needs  
[Amit Batabyal](#)

14:30-15:00 | Break

15:00-16:30 | SIGNATURES OF REGIONAL SCIENCE IV

Chair: Peter Nijkamp, Vice-President of TRSA

**Great Minds in Regional Science**

[Denise Pumain](#) on Wolfgang Weidlich and his scholarship.

[Roberto Camagni](#) on Adam Smith and his scholarship.

16:30-17:15 | SIGNATURES OF REGIONAL SCIENCE V

Chair: Laurie Schintler

- 11) Spatial transmission of the economic impacts of COVID-19 through international trade  
[Adam Rose](#)
- 12) Citizen Science for smart cities: a post-corona perspective 'Should I Stay or Should I Go?'  
[Saskia Sassen](#) and [Karima Kourtit](#)

**Thursday, 27 May 2021**

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# PARALLEL SESSIONS (11)

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## National Session: SS52 - Regional Science in Lebanon



**09:30 - 10:45 Thursday, 27th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/85253483318>**

**Chair Nadim Farajalla**

## CLUSTERS OF CULTURAL AND CREATIVE INDUSTRIES: EMPIRICAL EVIDENCE FOR CATALONIA

Lina Maddah<sup>1</sup>, Josep-Maria Arauzo-Carod<sup>1</sup>, Fernando LÓpez Hernandez<sup>2</sup>

<sup>1</sup>Universitat Rovira i Virgili, Spain. <sup>2</sup>Universidad Politécnica de Cartagena, Spain

### ABSTRACT

Creative clusters are increasingly being recognized as vital tools in the promotion of a city's competitiveness, innovation, urban development, and growth in developed countries. This paper studies the geography of Cultural and Creative Industries (CCIs) in Barcelona (Spain) for the years 2009 and 2017.

Although several studies have made contributions on CCIs clustering, there exists a need to understand how clusters change, grow or decline and what processes influence their geographical concentration and knowledge embeddedness, with a variety of theoretical efforts and empirical means. This is an initial attempt to identify CCIs clusters' evolution over a period of time, to understand their lifecycle and progression. Though the benefits of clusters have been asserted in preceding literature, this paper attempts to fill an existing gap in understanding those patterns for CCIs by exploiting Kulldorff's scan statistics methodology using SaTScan as an additional input to existing work on "third-generation methods" for identifying significant industrial agglomeration.

Our findings indicate that CCIs are not haphazardly located, as they tend to cluster in and around Barcelona's prime districts. The evolution of the clusters over nine years reveals distinct patterns of clustering among the twelve sub-sectors of CCIs. The mature clusters in Barcelona's core tend toward greater growth and have enhanced transformation capabilities. The clustering patterns reflect that the maturity of an existing cluster or the emergence of a new one is not a "coincidence" and can be rather explained by understanding the local environment and the related variety among CCIs at the subsector level. This reinforces existing arguments that locations with older but related industries have a higher likelihood of forming a cluster. With this being said, the findings confirm two major economic claims (1) Jacob's claim on the development of new work on the basis of old work as a 'branching' process that is fundamental to the way that economic growth happens in cities (2) Schumpeter's claim on how economies evolve through the process of new innovation and path interdependence, not only dependence (depending on the knowledge base of the CCI subsector). Furthermore, clusters' evolution findings reveal linkages to knowledge flows within and outside the cluster, suggesting that knowledge embeddedness can either widen the spatial boundary of a cluster or narrow it down. Also, the role of institutions and local policies is highlighted and is assumed to modulate the sustaining and emerging clusters in the core of FUAB. Our results can guide CCIs cluster policy, taking into account the specificity of each sub-sector. In addition, they can direct place-based development strategies and creative urban planning and restructuring within a polycentric context.

## MAPPING AND ASSESSING WATER RESOURCES RELATED INTERACTIONS IN THE BEKAA, LEBANON

**Rana El Hajj, Jasmine El Kareh, Nadim Farajalla, Abed Halim Hajj Chehadeh**

Issam Fares Institute for Public Policy and International Affairs at the American University of Beirut, Lebanon

### ABSTRACT

Water resources can serve as both a source of tension and conflict, or as a tool for cooperation and partnership. Successful interactions over shared water resources can help build confidence between involved parties, foster cooperation in managing other resources and could even be a path for dialogue and negotiation. In Lebanon, the increasing scarcity of water resources and the fragile state of water governance has worsened water-related interactions among stakeholders. The Bekaa, whose resident population has nearly doubled due to the Syrian refugee influx, is perceived to represent a microcosm of the challenges facing the water sector in Lebanon. By examining the nature of new and existing pressures on water-related interactions among stakeholders in the Bekaa, this study aimed to assist development organizations working in the water sector to identify priority areas prone to conflict. This is done to ensure that cumulative efforts effectively contribute towards abating existing pressures and improve governance of the sector in the Bekaa. In order to achieve this aim, the research sought to identify and map stakeholders involved in the water sector in the Bekaa; determine the state of water resource related interactions among the identified stakeholders; identify and analyze different factors that contribute to the negative interactions in the Bekaa; and identify hotspots or areas in the Bekaa that are predisposed to water-based conflict. Factors contributing to water-related conflict in the Bekaa were categorized into three main groups: socioeconomic and demographic; institutional; and physical and geographic. The most negatively and frequently mentioned factors were considered areas of concern that must be addressed and were found to be, in decreasing order of importance: refugee influx; water quality; untreated wastewater; water availability; and implementation of Law 221. Seventeen towns/villages in the Bekaa were identified as having the highest predisposition to conflict based on the previously mentioned factors. This was done while taking into account two demographic factors: the first included local population density alone, while the second added to the first refugee populations. The main recommendations drawn out from this study include improving communication with local communities on water and wastewater related issues in relation to informal settlements; easing tensions by enhancing wastewater treatment capacity through developing integrated solutions relying on the reuse of wastewater; and assist in capacity-building of municipalities, enabling them to take over some functions and responsibilities regarding the management of the water sector to help achieve better decentralization.

**IMPACT OF CLIMATE CHANGE ON RURAL LIVELIHOODS IN LEBANON****Leya Zgheib, Nadim Farajalla, Mira Zaghbour, Karim Korban**

Issam Fares Institute for Public Policy and International Affairs, Lebanon

**ABSTRACT**

Lebanon has been enduring multiple crises for the past 18 months that have had economic, political, and social repercussions all over the country threatening the livelihood of many. The agricultural sector not only suffers from these economic threats but is also subject to the impacts of climate change and natural disasters. Farmers have been highly affected by climate variability as well as the current economic crisis and will need to implement adaptation measures to sustain their production and secure income generation year-round to ensure their food security. Building on the World Food Program's efforts to expand activities that promote food security and livelihoods for refugees and host communities in Lebanon, this study aimed to generate evidence on the impact of climate change and climate variability on food security and rural livelihoods. The WFP Consolidated Livelihoods Exercise for Analyzing Resilience (CLEAR) was used to identify, design, and implement pilot interventions to test new approaches and generate lessons learned to help upscale UN's World Food Programme's (WFP) agriculture and climate related activities in Lebanon. The study adapted and applied the WFP-developed CLEAR methodology relying on extensive desk-research and stakeholder consultations at the national and sub-national levels. CLEAR has three distinct analysis steps: (1) Mapping of livelihood zones; (2) Developing a resilience index based on poverty, food security, climate sensitivity of crops and livelihood diversity; and (3) Assessing the impact of future climate risks on livelihoods and food security. The livelihood zoning conducted for this study resulted in the division of Lebanon into 19 different livelihood zones focused on eight main agricultural sources of livelihoods. Those zones were divided into three main categories based on agricultural land density. Three out of four zones relying heavily on agriculture showed a low resilience index regarding impacts of climate change on livelihoods. Zones with low agricultural land density had mixed results with a high resilience index for the four highly urban zones. The other two zones in which scarce agriculture land comprises of deciduous fruit trees and field crops displayed a low to moderate resilience index. Five of the zones with moderate agricultural density displayed a low to moderate resilience index, while the remaining four zones had a moderate resilience index. The main recommendations for implementing effective adaptation to climate change revolve around a comprehensive and dynamic policy approach covering a range issues, from helping farmers understand risk profiles to the establishment of efficient capacity-building programs and pilot projects that facilitate response strategies. More systemic changes in resource allocation need to be considered, such as targeted diversification of production systems and livelihoods and working towards increased climate change adaptation action.

## CLIMATE CHANGE VULNERABILITY ASSESSMENTS: THE CASE OF BATROUN AND TYRE

Celine El Khoury, Rana El Hajj, Nadim Farajalla

Issam Fares Institute for Public Policy and International Affairs - American University of Beirut, Lebanon

### ABSTRACT

According to the Intergovernmental Panel on Climate Change, low-lying coastal zones are at a particularly high risk of severe harm due to climatic hazards and various vulnerabilities. Climate change vulnerability assessment is a critical exercise for defining climate change risks and developing climate change adaptation options that are context specific, which could be accounted for in city development plans.

In Lebanon, vulnerability assessments to climate change have rarely addressed the city scale due to its complexity and lack of data at such a scale. The understanding of the vulnerabilities to climate change impacts and risks on local and city scale in Lebanon is still limited, obstructing the mainstreaming of climate change adaptation into city planning and governance.

This study adapts and applies an integrated approach, mixing both bottom-up and top-down methodologies initially developed by GIZ et al. (2017), in Lebanese coastal cities, Batroun and Tyre. First, vulnerable sectors were identified in a stakeholder consultation meeting. Next, an impact chain was developed for each sector to select potential impacts, and vulnerability components. The approach used a simplified formula which defines  $Vulnerability = Exposure + Sensitivity - Adaptive\ capacity$ . For each component, a set of indicators were identified to ultimately compute the vulnerability index of each sector. The developed impact chain and associated indicators were validated by experts in an expert consultation meeting. Data collected for each selected indicator was normalized into a 0 to 1 scheme, whereby 0 is optimal and 1 is critical.

Our research has shown that, in both Tyre and Batroun, the most vulnerable sectors were tourism, water resources, infrastructure and fisheries. The tourism sector scored 0.66 and 0.61; the water resources sector scored 0.54 and 0.52; the infrastructure sector 0.57 and 0.52; while the fisheries sector scored 0.53 and 0.47 for Batroun and Tyre, respectively. The score of the tourism sector for both cities is considered as 'rather negative' while the other sectors' are seen as 'neutral'. In all sectors, the adaptive capacity component, specifically governance, is the one that impacted the vulnerability of sectors the most. This highlights the need and role of local and national Lebanese governments in integrating sound adaptation actions while also enforcing existing policies. Key institutions and authorities should build their know-how and capacities to enforce and update environmental laws. Laws should tackle accountability and participation practices to guarantee sustainable management of natural, financial and social capacities.

## National Session: SS51.3 - Sustainable Regional Development in China



**09:30 - 10:45 Thursday, 27th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/83942885151>**

**Chair Lily Kiminami**

## DIGITAL ECONOMY AND REGIONAL INDUSTRIAL UPGRADE: EVIDENCE FROM THE YANGTZE RIVER DELTA

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### ABSTRACT

Developing the digital economy and forming the new impetus of regional industrial upgrade are the significant strategies of China. It is of great theoretical and practical importance to figure out the relationship between them, as well as quantitatively analyze the related process. This study takes the Yangtze River Delta, which is China's pioneer region of developing digital economy, as the research scenario. The main work and possible innovations of this study include: (1) From both the meso and micro levels, it reveals the mechanism that how to realize industrial upgrade with promoting digital economy. (2) The paper puts forward the theoretical hypothesis that there might be three paths, on which would help digital economy accelerate the industrial upgrading: technological upgrading, factor-input-structure upgrading and product market upgrading. In addition, we conducted an empirical test using a multi-step multiple mediator model, and the results support the three assumptions above. (3) Comparing to previous research, the paper takes the response mechanism of regional development as one of the variables, solving the endogeneity problem, which is high-efficiency enterprises more tend to use digital technology. The results show that the development of digital economy is an important driving force of industrial upgrading in Yangtze River Delta. Furthermore, the regional response mechanism and market response mechanism triggered by digital economy have an attention-worthy impact on regional industrial upgrade.

**URBAN BUILT ENVIRONMENT QUALITY AND ECONOMIC DEVELOPMENT: AN EXAMINATION WITH BIG DATA ON 50 CHINESE CITIES**

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**ABSTRACT**

The quality of urban life has been considered as an important factor in determining the attractiveness of cities and the flow of human capital and other resources. While Edward Glaeser argued for aesthetics and physical setting as a critical urban amenity (Glaeser et al., 2001), yet empirical examination of its role is still not enough. To fill in the gap, this study employs newly-available big data on urban built environment in 50 most-populated Chinese cities and produces fine-grained evaluation on their quality, which was hardly measurable with conventional urban data. More specifically, we utilize street view images provided by online mapping services to evaluate the quality and aesthetics of urban buildings and utilize building footprint data to evaluate the comfortableness of urban space. An R package is developed for this purpose, which will also be introduced. With such unprecedented information on urban built environment, we aim to examine its role on urban economic development and answer questions like whether high built environment quality drives urban economic development. The work is on-going and will be reported in the conference.

**REFERENCE**

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## **Regular Session: RS02.6 - Infrastructure, transportation and accessibility**

**09:30 - 10:45 Thursday, 27th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/87555502007>**

**Chair Hideki Fukui**

## MANAGING MULTIPLE AIRPORT REGIONS VIA PERIMETER RULES: AN EMPIRICAL ANALYSIS

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### ABSTRACT

We examine the effects of perimeter rules, which set limits on the distance of nonstop flights to and from a given airport, on the traffic performance of carriers operating at airports within Multiple Airport Regions (MARs). We use a difference-in-differences strategy with propensity score matching and weighting methods by taking advantage of the repeal of the Wright Amendment at Dallas Love Field in October 2014. The estimation results for the Dallas and Washington MARs suggest that (1) the perimeter rules do seem to have a negative impact of air traffic; but (2) the rules do not necessarily incur negative effects on airfare competition; and (3) the repeal of the rules does not necessarily lead to increases in economic welfare: negative side effects such as higher congestion should be anticipated.

### KEYWORDS

Difference-in-Differences, Multiple Airport Regions, Perimeter rule, Propensity Score Analysis Methods

### 1. INTRODUCTION AND BACKGROUND

Perimeter rules set upper limits on the distances of nonstop flights at airports in Multiple Airport Regions (MARs), in which several closely located major airports are operated. This research empirically assesses the welfare effects of perimeter rules, which is based on the US experience, is the first to explicitly examine the effects of perimeter rules on airport congestion.

The operational interactions and allocation of air traffic between airports are major challenges for airport management, especially in MARs. To control congestion and optimize the use of airports in the given MARs, some airports have set limits on nonstop flights. In the US, LaGuardia Airport in New York, Reagan National Airport in Washington DC, and Dallas Love Field Airport in Dallas have been under the perimeter rules.

### 2. PREVIOUS STUDIES

Despite the well-intended motives, the perimeter rules have been criticized. Indeed, previous studies (Le, 2018; Pukar, 2019; TRB, 1999; US GAO, 2012) suggest that the perimeter rules lead to fewer flights, reduced competition, and higher fares.

Among these studies, Le (2018) and Pukar (2020) are valuable contributions to the literature because these provide quantitative evidence that supports the criticism of perimeter rules which has been based only on descriptive and qualitative analyses. However, both Le (2018) and Pukar (2020) have several limitations that should be improved. Especially, these studies do not assess whether the perimeter rules have contributed to controlling airport congestion.

### 3. DATA AND MODEL

To examine the effects of perimeter rules on air traffic, airfares, and airport congestion, this paper uses a difference-in-differences strategy with propensity score matching and weighting methods by taking advantage of the repeal of the Wright Amendment at Dallas Love Field in October 2014. The treatment group comprises routes from airports in the Dallas and Washington DC MARs where airports are owned and operated by the same authority and one of its airports has/had perimeter restrictions. The control group consists of routes from airports in the Chicago and Houston MARs because the airports in these MARs are owned and operated by the same authority and have never been under the restrictions of perimeter rule.

The data are carrier-route level quarterly unbalanced panel data that are constructed from the US DOT's T100D, On-Time Performance Data, and DB1B for the period from October 2010 to September 2018.

The basic estimation model is given by Eq. (1):

$$Y_{iodt} = \theta_t + \alpha POST_t + \sum_p \beta_p APT_p + \sum_p \gamma_p (POST_t * APT_p) + X_{iodt} \delta + C_{iod} + U_{iodt} \quad (1)$$

Where  $p = 1 \dots 4$  (DAL, DFW, DCA, IAD)

The subscripts  $i$ ,  $o$ ,  $d$ , and  $t$  denote carrier, origin, destination, and quarter. The dependent variable,  $Y_{iodt}$ , is either the numbers of (a) flights (logged) or (b) passenger (logged) or (c) average departure delay (minutes) or (d) average airfare deflated by CPI (logged). The estimation model includes a dummy for the period after the Wright Amendment was repealed ( $POST_t$ ), origin airport dummies ( $APT_p$ ), an interaction term between these two dummies ( $POST_t * APT_p$ ), and controls ( $X_{iodt}$ ). To mitigate the endogeneity problem, propensity score matching/weighting methods, lagged endogenous variables, and IV method are used.

**Table 1 Variable balance across the treatment and comparison groups: Standardized differences between two groups**

Sample type	(1) Passenger dataset			(2) Airfare dataset			(3) Delay dataset		
	Original	Weighted	Matched	Original	Weighted	Matched	Original	Weighted	Matched
	Standardized differences			Standardized differences			Standardized differences		
Slot controlled airport dummy	0.862	0.034	0.047	0.731	-0.055	0	0.576	-0.075	0.041
Number of effective competitors per route (t-1)	-0.463	0.001	0.035	-	-	-	-0.477	0.009	-0.004
Southwest's presence dummy (t-1)	0.061	-0.009	0.036	0.232	0.068	-0.035	0.128	-0.002	0.049
Distance (miles) (log-transformed)	-0.200	-0.074	-0.126	0.019	-0.058	-0.022	0.048	-0.015	-0.029
Quarterly average population size of the two endpoint states of the given route (log-transformed)	-0.115	-0.147	0.015	0.085	-0.134	0.099	0.199	-0.115	0.045
Quarterly average per capita personal income of the two endpoint states of the given route (deflated by the CPI-U) (log-transformed)	0.116	-0.062	0.001	0.051	-0.062	0.007	0.013	-0.007	-0.007
Quarterly average kerosene price deflated by the CPI (log-transformed)	0.060	0.012	-0.001	-0.020	-0.006	-0.001	0.060	0.009	0.010
Quarterly total number of performed flights calculated on a carrier-route basis (log-transformed)	-	-	-	-	-	-	0.128	-0.086	0.043
Quarterly total number of performed flights calculated on a carrier-route basis (log-transformed) (t-1)	-	-	-	-	-	-	0.146	-0.077	0.050
Observations	54492	54492	34568	29693	29693	19770	31861	31861	19942

Table 1 shows the balance of each variable between the treatment and control groups in the original, weighted, and matched samples for the passenger, airfare, and delay datasets, respectively. Table 1 suggests that many variables in the original sample would likely be unacceptable for the difference-in-differences analysis without weighting or matching. However, the propensity score weighting and matching improve the covariate imbalance of most variables. Most variables appear to be adequately balanced, which suggests that the propensity score is properly specified.

Controls,  $X_{iодt}$ , include the following variables: (1) slot-controlled airport dummy, which is 1 if at least the origin or destination is slot-controlled airport and 0 otherwise; (2) number of effective competitors (i.e., the inverse of the Herfindahl-Hirschman index), calculated by using each carrier's number of flights on a route/quarter basis (Source: US DOT, T100D); (3) Southwest's presence dummy, which is 1 if Southwest Airlines is present at the origin or destination of the given route and 0 otherwise (Source: US DOT, T100D & DB1B); (4) log-transformed route distance (miles) (Source: US DOT, T100D & DB1B); (5) log-transformed quarterly average population size of the endpoint states of the given route (Source: US BEA, SQINC1); (6) log-transformed quarterly average per capita personal income at the endpoint states of the given route (adjusted by the CPI-U) (Source: US BEA, SQINC1; US DOL, Consumer Price Index - All Urban Consumers); (7) quarterly average of monthly kerosene price (adjusted by the CPI-U) (Source: US EIA, US Kerosene Wholesale/Resale Price by Refiners (Dollars per Gallon); US DOL, Consumer Price Index - All Urban Consumers).

**4. ESTIMATION RESULTS**

Table 2 presents descriptive statistics for our datasets. Tables 3 through 5 report the estimation results using each dataset.

The estimation results partially support the findings of previous studies: the perimeter rule at Dallas MAR has led to fewer flights, reduced competition, and higher fares. Indeed, the repeal of the perimeter rule at the Dallas MAR resulted in the increase of flights and passengers (more than 100 percent) and the decrease of airfares (about 6 to 7 percent) on routes from Dalla Love Field Airport. However, at the same time, the results suggest that the average departure delay minutes on routes from Dallas MAR's two airports became longer about 3.8 to 6.7 minutes compared with the control group.

Interestingly, the estimation results for the Washington DC MAR suggest not only negative but also positive effects of the perimeter rules. On the one hand, the results suggest that the perimeter rule at Reagan National did neither lead to the passenger shift from National to Dulles nor the increase of passengers using the airports. However, the results suggest that the perimeter rule has a positive effect on controlling airport congestion: although the average departure delay minutes on routes from the Washington DC MAR's two airports increased about 1.8 to 4.6 minutes, the estimated increase in the delay minutes is 31 to 56 percent shorter compared to the routes from the Dallas MAR. In addition, the results suggest that even under the perimeter rule, competition at the Washington DC MAR is effective in reducing airfares on routes from Dulles (about 10 to 11 percent) and potentially from Reagan National (about 5 percent).

**Table 2 Descriptive statistics**

Panel A: Passenger dataset	Mean	SD	Min	Max
<b>Sample type: Original</b>				
$Y_{iодt}$ : Quarterly total number of passengers calculated on a carrier-route basis (log-transformed)	8.196	2.0870	0	12.467
REPEAL: Wright Amendment repeal dummy (repealed on October 13, 2014)	0.536	0.499	0	1
POST*O_DAL: Interaction between DAL origin dummy and REPEAL	0.0177	0.132	0	1
POST*O_DFW: Interaction between DFW origin dummy and REPEAL	0.0932	0.291	0	1
POST*O_DCA: Interaction between DCA origin dummy and REPEAL	0.0626	0.242	0	1
POST*O_IAD: Interaction between IAD origin dummy and REPEAL	0.0592	0.236	0	1

Panel A: Passenger dataset Sample type: Original	Mean	SD	Min	Max
Slot controlled airport dummy: 1 if origin or destination is slot controlled	0.158	0.365	0	1
Number of effective competitors per route calculated on a route-quarter basis (t-1)	2.261	1.274	1	11.215
Southwest's presence dummy: 1 if Southwest is present at origin or destination or both (t-1)	0.0559	0.230	0	1
Distance (miles) (log-transformed)	6.287	0.776	2.398	8.480
Quarterly average population size of the two endpoint states of the given route (log-transformed)	16.364	0.449	15.283	17.347
Quarterly average per capita personal income of the two endpoint states of the given route (deflated by the CPI-U) (log-transformed)	9.903	0.0850	9.681	10.198
Quarterly average kerosene price deflated by the CPI (log-transformed)	-0.0583	0.348	-0.699	0.358
Observations	54492			
Panel B: Airfare dataset Sample type: Original	Mean	SD	Min	Max
$Y_{i,odt}$ : Passenger weighted quarterly average fare calculated on a carrier-route basis (log-transformed)	5.366	0.249	4.431	6.341
<i>REPEAL</i> : Wright Amendment repeal dummy (repealed on October 13, 2014)	0.492	0.500	0	1
<i>POST*O_DAL</i> : Interaction between <i>DAL</i> origin dummy and <i>REPEAL</i>	0.0254	0.157	0	1
<i>POST*O_DFW</i> : Interaction between <i>DFW</i> origin dummy and <i>REPEAL</i>	0.103	0.304	0	1
<i>POST*O_DCA</i> : Interaction between <i>DCA</i> origin dummy and <i>REPEAL</i>	0.0589	0.235	0	1
<i>POST*O_IAD</i> : Interaction between <i>IAD</i> origin dummy and <i>REPEAL</i>	0.0386	0.193	0	1
Slot controlled airport dummy: 1 if origin or destination is slot controlled.	0.144	0.352	0	1
Southwest's presence dummy: 1 if Southwest is present at origin or destination or both (t-1)	0.723	0.447	0	1
Distance (miles) (log-transformed)	6.445	0.725	4.205	8.490
Quarterly average population size of the two endpoints of the given route (log-transformed)	16.434	0.458	15.284	17.347
Quarterly average per capita personal income of the two endpoints of the given route (deflated by the CPI-U) (log-transformed)	9.898	0.0855	9.681	10.198
Quarterly average kerosene price deflated by the CPI (log-transformed)	-0.0209	0.341	-0.699	0.358
Observations	29693			
Panel C: Delay dataset Sample type: Original	Mean	SD	Min	Max
$Y_{i,odt}$ : Quarterly average time of departure delays (min.) calculated on a carrier-route basis - Early departure show negative numbers	11.763	13.502	-19	1170
<i>REPEAL</i> : Wright Amendment repeal dummy (repealed on October 13, 2014)	0.5259	0.499	0	1
<i>POST*O_DAL</i> : Interaction between <i>DAL</i> origin dummy and <i>REPEAL</i>	0.0262	0.160	0	1
<i>POST*O_DFW</i> : Interaction between <i>DFW</i> origin dummy and <i>REPEAL</i>	0.0986	0.298	0	1
<i>POST*O_DCA</i> : Interaction between <i>DCA</i> origin dummy and <i>REPEAL</i>	0.0369	0.189	0	1
<i>POST*O_IAD</i> : Interaction between <i>IAD</i> origin dummy and <i>REPEAL</i>	0.0298	0.170	0	1
Quarterly total number of performed flights calculated on a carrier-route basis (log-transformed)	4.824	1.371	0	7.507
Slot controlled airport dummy: 1 if origin or destination is slot controlled	0.0859	0.280	0	1
Number of effective competitors per route calculated on a route-quarter basis (t-1)	2.139	1.211	1	10.667
Southwest's presence dummy: 1 if Southwest is present at origin or destination or both (t-1)	0.0726	0.259	0	1
Observations	31861			

**Table 3 Estimation results for the passenger dataset (fixed effects estimation)**

Dependent variable: Quarterly total number of passengers calculated on a carrier-route basis (log-transformed)	Passenger dataset		
Sample type	(1) Original	(2) Weighted	(3) Matched
<i>REPEAL</i> : Wright Amendment repeal dummy (repealed on October 13, 2014)	0.0556 (0.517)	-0.168 (0.566)	-0.193 (0.653)
<i>POST*O_DAL</i> : Interaction between <i>DAL</i> origin dummy and <i>REPEAL</i>	1.283** (0.439)	1.479** (0.491)	1.271** (0.445)
<i>POST*O_DFW</i> : Interaction between <i>DFW</i> origin dummy and <i>REPEAL</i>	-0.00347 (0.0687)	-0.0168 (0.0691)	-0.0285 (0.0702)
<i>POST*O_DCA</i> : Interaction between <i>DCA</i> origin dummy and <i>REPEAL</i>	0.247** (0.0823)	0.218** (0.0816)	0.141 (0.225)
<i>POST*O_IAD</i> : Interaction between <i>IAD</i> origin dummy and <i>REPEAL</i>	0.0232 (0.0942)	-0.00393 (0.0993)	0.0246 (0.0991)
Slot controlled airport dummy: 1 if origin or destination is slot controlled	0.170 (0.410)	0.172 (0.403)	0.357 (0.396)
Number of effective competitors per route calculated on a route-quarter basis (t-1)	0.0167 (0.0168)	-0.00180 (0.0231)	0.00599 (0.0238)
Southwest's presence dummy: 1 if Southwest is present at origin or destination or both (t-1)	0.0884 (0.0633)	0.110 (0.0630)	0.0891 (0.0747)
Distance (miles) (log-transformed)	-4.976 (10.24)	-0.781 (8.324)	1.959 (7.868)
Quarterly average population size of the two endpoint states of the given route (log-transformed)	0.0643 (1.131)	-0.284 (1.087)	0.184 (1.230)
Quarterly average per capita personal income of the two endpoint states of the given route (deflated by the CPI-U) (log-transformed)	4.299*** (0.884)	3.939*** (0.961)	5.125*** (1.012)
Quarterly average kerosene price deflated by the CPI (log-transformed)	0.518 (1.251)	-0.238 (1.358)	0.0851 (1.576)
Observations	54492		
Year fixed effects	✓	✓	✓

Dependent variable: Quarterly total number of passengers calculated on a carrier-route basis (log-transformed)	Passenger dataset		
Quarter fixed effects	✓	✓	✓
Year specific quarter fixed effects	✓	✓	✓

**Table 4 Estimation results for the airfare dataset (fixed effects estimation)**

Dependent variable: Passenger weighted quarterly average fare calculated on a carrier-route basis (log-transformed)	Airfare dataset		
Sample type	(1) Original	(2) Weighted	(3) Matched
<i>REPEAL</i> : Wright Amendment repeal dummy (repealed on October 13, 2014)	0.0186* (0.00733)	0.0202** (0.00780)	0.0236** (0.00853)
<i>POST*O_DAL</i> : Interaction between <i>DAL</i> origin dummy and <i>REPEAL</i>	-0.0666*** (0.0155)	-0.0743*** (0.0157)	-0.0657*** (0.0159)
<i>POST*O_DFW</i> : Interaction between <i>DFW</i> origin dummy and <i>REPEAL</i>	-0.0159 (0.0111)	-0.0158 (0.0117)	-0.0120 (0.0115)
<i>POST*O_DCA</i> : Interaction between <i>DCA</i> origin dummy and <i>REPEAL</i>	-0.0521*** (0.0134)	-0.0518*** (0.0137)	-0.0120 (0.0193)
<i>POST*O_IAD</i> : Interaction between <i>IAD</i> origin dummy and <i>REPEAL</i>	-0.114*** (0.0160)	-0.116*** (0.0163)	-0.102*** (0.0163)
Slot controlled airport dummy: 1 if origin or destination is slot controlled.	0.0511 (0.0504)	0.0710 (0.0649)	0.0224 (0.0264)
Southwest's presence dummy: 1 if Southwest is present at origin or destination or both (t-1)	-0.105*** (0.0162)	-0.0984*** (0.0176)	-0.0972*** (0.0235)
Distance (miles) (log-transformed)	2.930 (3.876)	5.002 (3.661)	5.323 (3.969)
Quarterly average population size of the two endpoints of the given route (log-transformed)	0.211 (0.166)	0.440* (0.179)	0.378 (0.193)
Quarterly average per capita personal income of the two endpoints of the given route (deflated by the CPI-U) (log-transformed)	-0.797*** (0.132)	-0.740*** (0.153)	-0.930*** (0.160)
Quarterly average kerosene price deflated by the CPI (log-transformed)	0.0247 (0.0147)	0.0280 (0.0160)	0.0544** (0.0188)
Observations	29693	29693	19770
Year fixed effects	✓	✓	✓
Quarter fixed effects	✓	✓	✓
Year specific quarter fixed effects	✓	✓	✓

**Table 5 Estimation results for the delay dataset (IV fixed effects estimation)**

Dependent variable: Quarterly average time of departure delays (min.) calculated on a carrier-route basis - Early departures show negative numbers	Delay dataset		
Sample type	(1) Original	(2) Weighted	(3) Matched
<i>REPEAL</i> : Wright Amendment repeal dummy (repealed on October 13, 2014)	-3.532*** (0.872)	-4.357*** (1.045)	-3.004** (0.964)
<i>POST*O_DAL</i> : Interaction between <i>DAL</i> origin dummy and <i>REPEAL</i>	5.202*** (1.509)	6.735* (2.733)	5.547** (1.732)
<i>POST*O_DFW</i> : Interaction between <i>DFW</i> origin dummy and <i>REPEAL</i>	3.812*** (0.585)	4.527*** (0.999)	4.113*** (0.722)
<i>POST*O_DCA</i> : Interaction between <i>DCA</i> origin dummy and <i>REPEAL</i>	3.883** (1.272)	3.311* (1.638)	4.580* (2.158)
<i>POST*O_IAD</i> : Interaction between <i>IAD</i> origin dummy and <i>REPEAL</i>	1.251 (0.849)	0.874 (1.180)	1.830* (0.908)
Slot controlled airport dummy: 1 if origin or destination is slot controlled	0.0403 (1.658)	0.704 (3.317)	2.022 (4.167)
Number of effective competitors per route calculated on a route-quarter basis (t-1)	0.554* (0.231)	0.618 (0.391)	0.907* (0.417)
Southwest's presence dummy: 1 if Southwest is present at origin or destination or both (t-1)	-0.281 (0.974)	-1.482 (1.419)	-1.490 (1.557)
Quarterly total number of performed flights calculated on a carrier-route basis (log-transformed)	6.675** (2.171)	10.61* (4.665)	6.872* (2.807)
Observations	31861	31861	19942
Year fixed effects	✓	✓	✓
Quarter fixed effects	✓	✓	✓
Year specific quarter fixed effects	✓	✓	✓
Instrumental variable			
Quarterly average per capita personal income of the two endpoints of the given route (deflated by the CPI-U) (log-transformed)	3.702*** (0.764)	2.567** (0.837)	2.929*** (0.7107)
F-statistic	23.455	9.408	16.984

**5. CONCLUSION**

Overall, our analysis suggests that the repeal of the perimeter rules does not necessarily lead to increases in economic welfare: negative side effects such as higher congestion should be anticipated. As previous studies suggest, the perimeter rule does seem to have a negative impact on air traffic. However, the results of our analysis suggest that the perimeter rules can serve as tools to manage airport congestion without incurring negative effects on airfare competition. Future

studies should explore improved designs of the perimeter rules, which minimize their negative effect on air traffic and competition, and maximize their potential as tools to manage airport congestion in MARS.

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## MEASURING TRANSIT-ORIENTED DEVELOPMENT DEGREE BASED ON THE RAILWAY TRANSIT NETWORK PERFORMANCE CONSIDERING POPULATION AND FACILITY DISTRIBUTION

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### ABSTRACT

To respond to urban challenges such as car dependence, air pollution, urban sprawl, and congestion, transit-oriented development (TOD) is increasingly recognized and interested. TOD can effectively reduce car dependence by attracting people to attend activities near public transport. While previous studies are rich in the neighborhood- and station-level TOD, very few studies focused on a universal measurement of the city- and regional-level TOD, which can be used to make efficient TOD planning in different cities regarding railway transit network performance in connecting population and facilities. Therefore, this research aims to measure the TOD degree of the city- and area-level in terms of the travel time reduction benefit from a railway network in 40 cities worldwide considering the linkage of population, facilities.

First, the TOD degree is defined using the linkage index of city- and area-level, which indicates the gap between the ideal and current condition in terms of travel time or the number of facilities. To calculate the linkage index, we define three speed settings by changing the speed of the network: (1) travel by using only the road network, (2) travel by current road and railway networks (current condition), and (3) travel by road and railway with railway speed (ideal condition). Calculating the linkage by comparing the current and ideal situation can help understand how far the current network performance is from the ideal condition. We assume two travel patterns for measuring the linkage index: population to population (long-distance travel) and population to facility (short-distance travel). Then, these linkage indexes of 40 cities are calculated using data collected from OpenStreetMap, including road data, railway data, and facility data. Finally, the relationship between linkage index and city characteristics such as population distribution, transit system, and facility distribution is investigated to determine the reasons for differences in TOD degree.

The major conclusions include the followings: On the city-level, (1) the railway systems of European cities have a high linkage index than some cities in developing countries, whether in long or short distance travel, due to relatively well-developed railway infrastructures; (2) railway and station density have a positive relationship with the linkage index, but differences in linkage index are observed between cities with the same infrastructure level; (3) this difference indicates the importance of efficient connections in railway systems between distributions of population and facilities. On the area-level, the spatial differences of the linkage index are clearly displayed. This research enhances the understanding of the TOD degree and provides benchmark points that contribute to decision-making processes regarding the TOD development.

## MEASURING THE EVOLUTION OF REGIONAL VALUE CHAINS IN NORTHEAST ASIA USING A CROSS-BORDER INTERREGIONAL INPUT-OUTPUT MODEL

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### ABSTRACT

The recent Regional Comprehensive Economic Partnership (RCEP) Agreement signed by 15 East Asian countries in 2020 marks the first time that China, Japan and South Korea (CJK) have gathered together under a single trade agreement. As the world's largest regional free trade agreement, RCEP is expected to accelerate the development of regional value chain of CJK as well as regional economic integration of Northeast Asia. International IO table has been considered a very useful source of data for analysis of production network or value chain (VC). VC trade is separated into regional value chain (RVC) trade – involving only regional production partners – and global value chain (GVC) trade – involving also extra-regional partner countries. This paper adopts input-output decomposition techniques to analyze the evolution of production networks in CJK over the period 2005-2015 from a RVC perspective. The main objective of this study is to find out what are the locational patterns of trade in value-added in Northeast Asia and how are these patterns changing over time. In this paper, the area is composed of 7 regions of China, 4 regions of South Korea, and 9 regions of Japan, while each region having ten industrial sectors. The primary data sources are the Transnational Interregional Input-Output Table for CJK, 2005, constructed by the Institute of Developing Economies, JETRO. Then, the updated cross-border interregional input-output table of 2015 is calculated based on the Eora Input-Output Database, China regional Input-Output Table and Korea regional Input-Output Table of 2015. Based on recent IO-based GVC indicators, this study tries to provide a more detailed image of a certain region's (not only a country's) positions and degrees of participation in international production networks and measure the comparative advantage at the regional level rather than the national level. This cross-border interregional IO model is expected to find out (a) the evolution of interdependencies in regional trade and production networks between 20 regions in CJK through a matrix of cross-border transfers of intermediate goods by origin and destination, (b) value-added distributions and their evolution across the sample region, and (c) how a region's value-added is induced by its partner region's final demand.

## SCHOOL INTEGRATION AND EDUCATION OUTCOMES IN INDONESIA: GLOBAL INFORMATION SYSTEM, MICRO SIMULATION AND CGE ANALYSIS

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### ABSTRACT

Indonesia estimated age population at the primary and secondary education levels are reaching 70 million, and spread over more than 500 districts / cities. In 2020/2021 the number of elementary school graduates decreased by 200 thousand students compared to 2016/2017. In the same period, the number of junior high school graduates fell by 40 thousand. We investigate possibility of school integration in Indonesia to improve access to education using Global Information System (GIS), Micro Simulation and Computable General Equilibrium (CGE). We utilize many different data sources, including school location; National Socioeconomic Survey (SUSENAS); and Village Potential (PODES) for the year 2011, 2014, and 2018. Schools Integration is unitin three levels of education into one environment, so that primary school (SD), Junior High School (SMP), and Senior High School (SMU) can be implemented in the same location. Although there is no junior high school and senior high school on a village, but it more likely has primary school. Our findings indicate the integration brings closer the distance to the school by these school age students. At least three school integration benefits are identified: the existence of integration can solve the problem of school supply, in this case the distance is too far to get to school. The second benefit of school integration is the efficiency of the cost of running the school. The next benefit is the ultimate goal of education policy, namely to reduce inequality in access to education and increase the average length of education through increasing school enrollment rates in disadvantaged and isolated areas. Papua Island and Kalimantan Island are the islands that benefit from the largest change in distance compared to other island averages. School integration can lead to a reduction in the distance to schools on the island of Kalimantan by up to 40 km with an average reduction of the distance to the nearest school by 20 km. This is bigger for Papua Island, which can save up to 64 km of mileage with an average mileage of 50 km. Micro simulation suggest school integration related to increase the level of education of children in Papua Province by 0.06 years, the largest compared to other regions, followed by Southeast Sulawesi, Bengkulu, Aceh, North Maluku and Maluku Provinces. The education of children in Central Java and South Sumatra Provinces will increase by 0.01 years if integrated schools are implemented. Furthermore, our early finding exhibits school integration could lead to total savings in school operational budgets is estimated at 2.42 trillion rupiahs per year compared to if three separate schools were formed. Savings on school integration options include no need to acquire new land for school land, savings in maintenance costs and service subscriptions. Finally, CGE simulates school integration could improve Indonesia economic growth in the long run through labor productivity improvement. However, school integration may not be effective for areas on scattered small islands due to limited transportation links between islands even though the distance is getting closer to school integration.

## **Regular Session: RS20 - Biodiversity, ecosystems and ecosystem services**

**09:30 - 10:45 Thursday, 27th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/81262412877>**

**Chair Stefania Tonin**

## ASSESSMENT AND VALUATION OF ECOSYSTEM SERVICES AT A WATERSHED LEVEL- THE CASE OF BEHT IN THE MIDDLE ATLAS OF MOROCCO

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### ABSTRACT

The upstream Oued Beht watershed covers an area of approximately 1,810 km<sup>2</sup> and it is home to the best natural ecosystems of the central Middle Atlas Mountains. It provides a large number of ecosystem goods services, namely: wood, aromatic and medicinal plants, fodder, and a large variety of other services such as: recreation, water and soil conservation, carbon storage, etc. However, these ecosystem goods and services are considered gifts of nature offered for free and therefore suffer from irrational exploitation by a large number of people with multiple and divergent interests. Associating monetary values to these goods and services will contribute to the sensitization of their importance to human wellbeing. Several valuation methods can be used to assess their values. This assessment will contribute to take into account the ecosystem services during decision-making processes and for consequence the preservation of the natural ecosystems. In this study, we try to assess various goods and services at the river basin level using revealed preferences or stated preferences evaluation methods. This evaluation aims at supporting and redirecting the objectives set for the watershed development to be in conformity with the requirements of sustainable management.

## VALUING MARINE BIODIVERSITY AND ECOSYSTEM SERVICES: A CONTINGENT VALUATION STUDY IN ITALY

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### ABSTRACT

Marine biodiversity provides valuable benefits to human beings, some of those easily recognized, such as the provision of food, some much less well known, such as climate regulation; yet people lack a direct experience of their economic values since no relevant market exists. This study reports the results of a contingent valuation study to estimate the public's willingness to pay (WTP) to improve biodiversity in some rare coralligenous habitats in the Venetian North Adriatic Sea, called Tegnùe.

Coralligenous habitat constitutes one of the most important 'hot spot' of species diversity in the Mediterranean, notoriously affected by a loss of biodiversity as a consequence of human activities such as over-fishing and pollution, sediment deposition, recreational fishing and trawling, diving. A major threat is the increasing frequency of Abandoned, Lost or otherwise Discarded Fishing Gears (ALDFG) at sea. We surveyed a sample of 4000 Italian people and we found that WTP for interventions aimed to improving biodiversity through removal and restoration operations in the area is distinctly higher than the WTP for the preservation and prevention of further biodiversity loss. Our findings suggest that respondents perceive prevention and control activities as disentangled from restoration, the benefit of which can be clearly recognizable in their time horizon, while the benefits of preservation and prevention are perceived as much more ambiguous and less controllable. This study is particularly important because it proves that the aggregate benefits related to the improvement of biodiversity as a result of restoration and conservation activities are significantly higher in comparison to the estimated costs of these activities. Following the real activities undertaken during the project, the investigation, restoration, and removal costs incurred in cleaning up 20 Km<sup>2</sup> were estimated to be approximately €191,000. Thus, if we suppose that there are similar environmental conditions in all of the sites of the Adriatic Sea, the total cleaning up cost will be around €500,000, while the total benefits can be estimated as €97 million, assuming a discount rate of 5%, a number of families equal to 2,057,227 and a duration of the benefits equal to three years.

## PRACTICAL VALUATION OF ECOSYSTEM SERVICES FOR LOCAL STAKEHOLDERS: ECONOMIC VALUATION CONSIDERING LOCAL EXPLICIT DATA

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### ABSTRACT

For the achievement of 2030 SDGs agenda and conservation of ecosystem accordingly, it is important to assess the value of ecosystem and its services. In light of this, some initiatives such as Millennium Ecosystem Assessment (MA), The Economics of Ecosystem and Biodiversity (TEEB), Wealth Accounting and Value of Ecosystem Services (WAVES), Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), and Ecosystem Services Partnership (ESP) are launched to develop measures for valuation of ecosystem services (ES), and researches are ongoing worldwide to evaluate ES. Although researchers expect that the results to be used in various decision-making related to business and policies, some studies have pointed out that the valuation results are not fully utilized for the decision-making. So-called “information gap” issue is pointed out and, some reasons for the gap are raised. Among this, some studies questioned that local specific factors are not fully captured in the valuation. This means that in most valuation cases, national statistics are mainly used for the valuations, and local on-site information such as geographical conditions and information/data on residents are not sufficiently reflected in them. This makes the use of the results difficult for local stakeholders. In addition, most of ES valuations assess potential value instead of actual value which beneficiaries currently and actually receive from ecosystem. Some studies consider beneficiaries of ES, but ES valuations and tools that identify the beneficiaries of a given ES in a spatially explicit way are still minor. The economic valuation is regarded as a prerequisite for better decision-making, and some valuation results are already incorporated in various decision-making processes. In order to enhance the usefulness of ES valuation the number of beneficiaries of ES that link with economic valuation is crucial particularly for ecosystem conservation policies and management practices in a specific area. Additionally, local-specific information such as the number of beneficiaries can close the gap between valuation studies and decision-making regarding ecosystem conservation practices.

The purpose of this study is to obtain the valuation that is practically useful for policy decision-makings particularly for local policymakers. More specifically, we chose water storage service of forest ecosystem as a valuation object, and assess the value of the ES in monetary term. The valuation is combined with information on beneficiaries. By spatial analysis with geographical information system (GIS), we estimate the number of households influenced by deforestation of upstream forest caused by the construction of solar power plants. We use a case of Satetsu-gawa River basin in Ichinoseki-City, Japan. In this study, we firstly estimate the area of forest deforested due to construction of six solar power plants in Satetu-gawa River basin. Then the areas and the number of households located downstream of the river are also estimated. The households in downstream area can be regarded as beneficiaries of the services in the river basin. Finally, the value of each type of ES in monetary term is assessed using information on beneficiaries.

### KEYWORDS

Beneficiaries; Economic valuation; Forest ecosystem services; Spatial information; River basin;

### 1. INTRODUCTION

Conservation of ecosystem and its services is included in the SDGs targets: targets 14 and 15. For the achievement of 2030 SDGs agenda and the conservation of ecosystem, it is important to assess its value (Costanza et al., 1997; Su and Peng, 2018). In light of this, some initiatives such as Millennium Ecosystem Assessment (MA), Intergovernmental Panel on Biodiversity and Ecosystem Services (IPBES), The Economics of Ecosystem and Biodiversity (TEEB), Ecosystem Service Partnership (ESP), and Wealth Accounting and Value of Ecosystem Services (WAVES) are launched to assess ecosystem services (ES) and develop its measures. In the academic field, researches are ongoing worldwide to evaluate ES (Costanza et al., 2017), and they hope that the results to be used to influence on business and policy decision-making (Laurans et al., 2013). However, some studies have pointed out that the valuation results are not fully utilized for the decision-making (Laurans et al., 2013; Rieb et al., 2017; Ruckelshaus et al., 2015), and so-called “information gap” issue is raised (Keishish and Salles, 2021; Barton et al, 2018; Levrel et al., 2017). Many reasons for the gap are raised by previous studies; researchers are not interested in the use of the valuation (Olander et al., 2017; Laurans and Mermet, 2014; Spash and Vatn, 2006), a degree of accuracy does not meet users’ demand (Villa et al., 2017), the explanation of constraints in the valuation is not sufficient (Schaefer et al., 2015), the contribution of valuation studies for policy decision-making is limited (Palmer, 2012) and local information is not reflected in the valuation (Pandeya et al., 2016; Nelson et al., 2009).

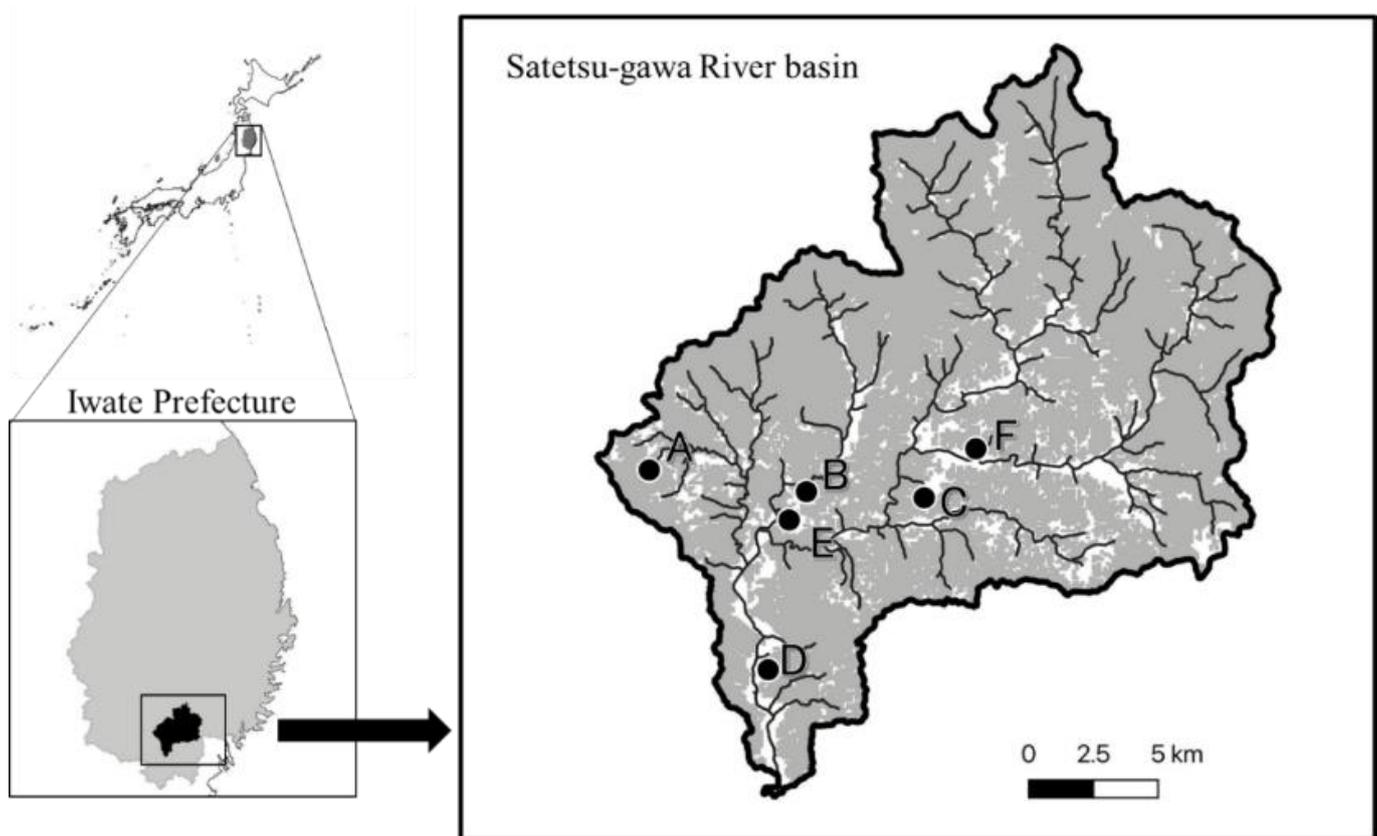
Waite et al. (2015) identified enabling conditions for informing decision-making: a clear policy question, strategic choice of study area, strong stakeholder engagement, effective communications, access to decision makers, and transparency in reporting results. Olander et al., (2017) pointed out that the factors for the gap fall mainly into two primary groups; the failure to develop transparent and unambiguous linkages between ecosystem changes and outcomes, and the methods applied to the valuation do not answer relevant policy and management questions. In addition, they also raised the question regarding local specific factors, which are not fully captured in the valuation. This means that in most valuation cases, national/regional statistics are mainly used for the valuations, and local on-site information such as geographical conditions and information/data on residents are not fully reflected in them. This makes the use of results difficult for local stakeholders. Pandeya et al. (2016) also deals with local vs regional approaches and insisted that “most existing frameworks are focused at regional scales and there is limited focus at local scale valuation.” (Pandeya et al., 2016, p.254). Villa et al. (2017) pointed out that most of ES valuations assess potential value instead of actual value which beneficiaries currently and actually receive from ecosystem and they include the location of beneficiaries into the valuation. Some other studies consider beneficiaries of ES (Schirpke et al., 2014; Bagstad et al., 2014; Garcia-Nieto et al., 2013; Syrbe & Walz, 2012). However, ES valuations and tools that identify the beneficiaries of a given ES in a spatially explicit way are still minor (Rieb et al., 2017). All above studies except Schirpke et al. (2014) do not actually estimate the number of beneficiaries of services provided from specific ecosystems. Even Schirpke et al. (2014) simply estimate the number of beneficiaries and do not link with economic valuation. The economic valuation is regarded as a prerequisite for better decision-making (Laurans et al. 2013; Daily et al., 2009), and some valuation results are already incorporated in various decision-making processes (Gowan, 2006; Navrud, 2001). In order to further enhance the usefulness of ES economic valuation, the economic valuation that link with the number of beneficiaries of ES is crucial particularly for ecosystem conservation policy and management practices in a specific area. Additionally, the number of beneficiaries as local-specific information can close the gap between valuation studies and decision-making regarding ecosystem conservation practices.

The purpose of this study is to obtain the valuation that is practically useful for policy decision-makings particularly for local policymakers. More specifically, we chose water storage service of forest ecosystem as a valuation object, and assess the value of the ES in monetary term. In this study, we define practical valuation as valuation that can close the information gap, and we combine the valuation with information on beneficiaries so that it can be practical. Specifically, we use a case of Satetsu-gawa River basin in Ichinoseki City, Japan. By geographical analysis with geographical information system (GIS), we firstly estimate the number of households benefitted by upstream forest ecosystems, and estimate the area of forest deforested due to construction of six solar power plants in Satetu-gawa River basin. Then the areas and the number of households located downstream of the river are also estimated. The households in downstream area can be regarded as beneficiaries of the services in the river basin. Finally, the value of the ES in monetary term is estimated using information on beneficiaries.

## 2. METHODS

### 2.1 Overview of Study Site

Ichinoseki, which is our study site is a middle-class city in Iwate Prefecture and located 450 km away to north from Tokyo. It has about 121 thousand population and 43046 households (as of 2015) and its area accounts to 1256 km<sup>2</sup>. Average temperature in Ichinoseki in 2020 was 12.4 degree C with maximum 37.8 and minimum -7.6 degree C. Average precipitation and snowfall were 1306 mm, and 17 cm respectively in 2020. Kitakami-gawa River which is one of the main rivers in Northern Japan flows into the city, and our study site, Satetsu-gawa River, is a tributary of Kitakami-gawa River (Figure 1). Satetsu-gawa River is located in south part of Iwate prefecture and flows into former Daito, Higashiyama and Kawasaki municipalities, which was merged with Ichinoseki. The length of the river is about 44.6 km. In Figure 1, black lines, gray areas and black points indicate river channel, forest area, and sites of solar power plants, respectively. In July 2002, a typhoon raged and brought great damage to the Satetsu-gawa River basin with 743 above-floor and 222 under-floor inundation, with 529 hectares of inundation area. Since then, flood is one of the major concerns in this area.



**Figure 1: Location of Satetsu-gawa River basin and six solar power plants**

In 2012, the Feed in Tariff scheme of renewable electric power is introduced in Japan, and the number of solar power plants has rapidly increased since then. A part of the plants was constructed by deforesting existing forest, and this holds on Satetsu-gawa River basin. In the river basin, additional flood prevention measures are requested, on the other hand, six solar power plants have been installed so far, all of them are constructed by deforesting. Therefore, we chose Satetsu-gawa River basin as study site. In addition, from analytical point of view, the reasons for selecting Satetsu-gawa River are; (1) there are multiple solar power plants and they are located remotely each other in the river basin, (2) the whole river basin is in Ichinoseki City, that makes the connection of statistical data and geographical data easy, (3) we already have forest registration data in Iwate Prefecture and have conducted analysis on forest in the Prefecture including Ichinoseki City.

## 2.2 Geographic analysis

In the analysis, we identify the area which is affected by reduction in water storage service of forest ecosystem caused by the construction of six solar power plants in Satetsu-gawa River basin, and hereafter we call the area affected area. To identify the affected area, we firstly assume that forests provide water storage service only to the area that is lower elevation than the forests in river basin and to the residents who live the area and can be seen as beneficiaries of forest water storage service. Under the assumption, we estimate the affected area and calculate the number of households as beneficiaries by each small river basin which is a sub-compartment of the whole river basin.

Since this study focuses on lost forest ecosystem services, specifically water storage service, due to the construction of solar power plants, it is important whether or not the power plants were constructed by deforestation. However, judging whether the deforestation was made for the purpose of constructing a power plant is controversial in terms of following two criteria (1) whether deforestation is made for the construction of a power plant, (2) when the forest was deforested. Regarding the former issue, there is no objective and rational criteria for determining whether deforestation is conducted for the purpose of constructing a solar power plant. Of course, if the forest was cleared just before the construction of the plant, it can be regarded as deforestation for the construction of the plant, but even in this case, how far should we go back to the past in order to judge deforestation for the plant construction? For instance, since our analysis applies 2012 forest registration data in the year of 2012, even forests that had been cleared land by 2012, it may have been for the purpose of installing a solar power plant which is related to the latter issue. The point is, it is quite difficult to set clear criteria for distinguishing deforestation for the purpose of solar power plant construction. Therefore, in this study, we assume that if there are forest registration data at the construction site, the site is deforested. Forest registration data is created only for the land that was previously managed as forest. Based on this, we think it is appropriate to regard the existence of the forest registration data on the site as a modification from the forest. As a result, all of the six power plants in Satetsu-gawa River basin meet the conditions that the construction sites have forest registration data. In this study, these six solar power plants, which are indicated A to F in Figure 1, are used as the cases.

**Table 1: Data used for the analysis**

Item	Type of data	Year	Source	Reference
Elevation level	10 m mesh	-	Website of Geospatial Information Agency	<a href="https://fgd.gsi.go.jp/download/menu.php">https://fgd.gsi.go.jp/download/menu.php</a>
Number of households	250 m mesh	2015	Japanese population census	<a href="https://www.e-stat.go.jp/">https://www.e-stat.go.jp/</a>
Forest registration data	Polygon	2012	Provided by Forest Agency and Iwate Prefecture	
Location of solar power plants	Point	2020	Website of Electrical Japan INC.	<a href="http://agora.ex.nii.ac.jp/earthquake/201103-eastjapan/energy/electrical-japan/">http://agora.ex.nii.ac.jp/earthquake/201103-eastjapan/energy/electrical-japan/</a>

As shown in Table 1, in this study, used data are Digital Elevation Model (DEM) as mesh elevation data, forest registration data, mesh data on land use, and zoned area for land use. We also use mesh data on the number of households which is originally from the Japanese Population Census to estimate the number of beneficiaries. Firstly, the area of Satetsu-gawa River basin is strictly estimated and polygons of the river basin is created from DEM by geographical information system (GIS). The polygons are subdivided by small river basin, and these sub-polygons are basic unit of our analysis. Under the above process, we also create water channel network data to identify river flow in the river basin. Affected area is defined as sub-polygons that overlap the flow path of the river and that are lower than the sub-polygon where a solar power plant is located. A point on the river which is the closest to a solar power plant and a sub-polygon that include the point (hereafter, plant sub-polygon) is identified by visual inspection. We calculate elevation level, and area by each sub-polygon. DEM is used to estimate elevation level of the sub-polygon, and sub-polygons that are lower than a plant sub-polygon are identified. These sub-polygons are regarded as affected area of the construction of a solar power plant. Finally, the sum of the area of these sub-polygons is estimated as total area of affected area, and the number of households is also calculated. These figures are seen as affected area and the number of people influenced by the deforestation caused by the construction of solar power plants. In other words, these people are regarded as former beneficiaries of lost forest ecosystem services. In the analysis, Arc GIS for Desktop 10.6 and Spatial Analyst are applied to river basin analysis, and QGIS 3.6 is applied for other analysis.

**2.3 Economic valuation**

Using results of geographical analysis, we also estimate the values of water storage service of forest ecosystem lost by the construction of solar power plants in Satetsu-gawa river basin. The unit value of water storage service is based on a previous study conducted by my colleagues (Fujii et al., 2017) which identified an equation to estimate a unit value of forest ES. In the study, they firstly assessed the total value of forest ecosystem using contingent valuation (CV) and estimated the unit value of forest water storage service. A questionnaire survey for CV was conducted in November 2015. On average, approximately 0.3% of the population of each prefecture is covered. After dropping non-responses or protest responses for the CVM questions and other insufficient answers, 192,704 observations from all 47 prefectures in Japan remained. From these observations, following regression equation for willingness to pay (WTP) is identified.

$$WTP = 2610.18 + 0.00015 * \text{income} - 354.57 * \text{woman rate} - 19.79 * \text{age} - 457.73 * \text{natural forest rate} + 788.72 * \text{broadleaf rate} - 5.75 * \text{forest age} + \epsilon \tag{1}$$

Age: age of respondent

Income: income of respondent

Woman rate: woman rate of the municipality where valued forest is located

Natural forest rate: natural forest rate of valued forest,

Broadleaf rate: broadleaf rate of valued forest

Forest age: average forest age of valued forest

Based on the equation, we insert variables for Ichinoseki-City where Satetsu-gawa River is located to estimate the unit value of forest ecosystem in the river basin. The result showed that the unit value of forest ecosystem in Ichinoseki was 2658 JPY per hectare per household. Secondly, as the above unit value includes all types of forest ecosystem service, the value of water storage service should be extracted. To do this, we also conducted choice experiment (CE) to estimate weights for each ES. The ES we chose for the estimation of weights are following six services: water storage, soil retention, habitat provision, timber production, recreation, and climate change mitigation. We conducted the CE survey along with CV one in 2015, and then estimated weights for each ES. The result showed that the weight for water storage service accounted to 0.201, which means 20.1% of total value of forest ecosystem is attributed to water storage service. Therefore, the weight is multiplied to the unit value and the value of water storage service account to 533 JPY per hectare per household. Using this unit value of water storage service, we estimate the lost value of water storage service due to the construction of solar power plants by multiplying the unit value to area deforested and the number of households in affected area which are estimated in geographical analysis.

3. RESULTS

The result of affected area is shown in Figure 2, and that of valuation is shown in Tables 2 and 3. Table 2 shows the results of geographic analysis in the whole Satetsu-gawa River basin, the total area of the basin accounts to 37952 hectare among which 25239 (66.5%) is dedicated to forest. Most of forest area is owned by private sectors and nationally-owned forest has minor share. The number of forest in the river basin accounts to 7244, as the total number of households in Ichinoseki is 43046, 16.8% of total household in Ichinoseki is in the river basin. In Figure 2, black stripe shows the affected area of all solar power plants. Light green and dark green show broad leaf forest and coniferous forest of the forest registration data, respectively. Overlapping the result with other data, we estimate the forest area and the number of households, in the affected area for each solar power plants. Table 3 shows the results of estimation of deforested area, affected area and the value of lost ES. First, deforested areas vary from 0.9 to 8.2 hectares, mainly depending on the scale of plants. The area deforested tends to be correlated with generation capacity of the plant, the indicator indirectly shows the scale of the plants. The total affected area ranges from 985 to 3672, the higher the location of a solar power plant is, the larger affected area is. Therefore, the plant F has the largest figure followed by the plants C, A and B. When looking at Figure 2, the relation with the location can clearly be seen. The values of lost forest ES: i.e. water storage service range from 0.3 to 3.3 million JPY. As the value considers both deforested area and the number of households in the affected area, the plants located lower in the river basin with less residents performs better.

Table 2. The area and the number of household in Satetsu-gawa River basin.

	Total area (ha)	Total no. of h.hold	Total forest area						
			Government			Private			
			Total	Conifer	Br. leaf	Total	Conifer	Br. leaf	
The whole river basin	37,952	7,244	25,239	559	437	122	24,680	14,761	9,919

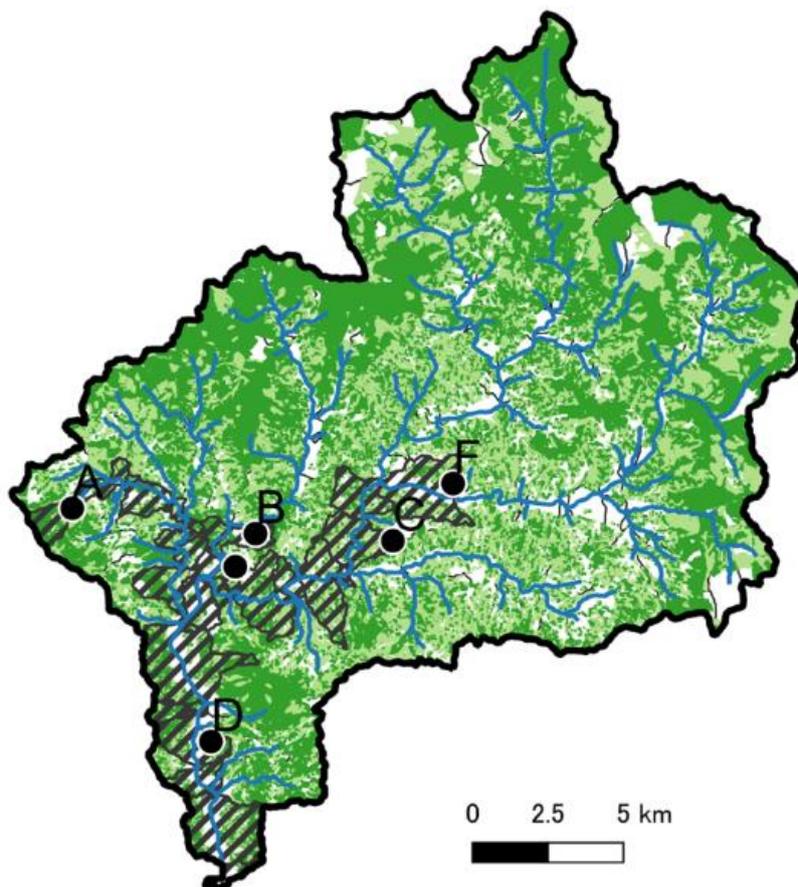


Figure 2. Result of affected area by solar power plants

**Table 3: Area affected and value lost by the construction of solar power plants**

Plant	Deforested area by the construction of solar power plants			Area affected by the construction of solar power plants			Value of water storage service lost by the construction of solar power plants		
	Deforested area (A) (ha)	Share in total forest area (=A/C)	Ratio (=B/A)	Total affected area		Number of h.hold in the affected area (D)	Unit price per ha per h.hold (E) (JPY/ha/h.hold)	Unit price per ha (JPY/ha) (F=D*E)	Total value (Mil. JPY) (=F*A)
				(B) (ha)	Forest area (C) (ha)				
Ind.no	Ind. 1	Ind. 3	Ind. 4	Ind. 2	----	Ind. 5	----	Ind. 6	Ind. 7
A	8.2	0.6%	<b>309</b>	2,528	1,433	767	533	409,038	3.3
B	2.7	0.2%	825	2,202	1,116	938	533	500,232	1.3
C	1.8	0.1%	1,661	3,007	1,593	1,130	533	602,625	1.1
D	1.5	0.3%	640	<b>985</b>	473	<b>328</b>	533	<b>174,921</b>	<b>0.3</b>
E	1.8	0.2%	1,106	1,990	980	824	533	439,436	0.8
F	<b>0.9</b>	<b>0.05%</b>	4,080	3,672	1,881	1,381	533	736,482	0.7

Note: The bold figures are the best results by each indicator among six solar power plants.

#### 4. DISCUSSION

##### 4.1 Indicators to assess the impact of solar power plants

Table 4 shows the seven indicators presented in the valuation. Indicator 1 is deforested area, which the simplest and the most popular indicators. It is obvious that the smaller area of deforestation is preferable, and the indicator has frequently been used by government agencies when approving development permits. Indicator 2 is the area of river basin located downstream of the solar power plant. This represents the area where water storage services decline due to the development of solar power plants and can be the area affected by the development of solar power plants. As this indicator includes the impact on land used for peoples' daily activities and business such as arable, residential, industrial, and commercial areas, it can evaluate the indirect impacts to people through impact to land they use. Of course, the smaller area affected by deforestation is desirable. Indicator 3 is the ratio of deforested area to total forest area in the affected area. Even if small area is deforested, it is not desirable to develop a large part of the forests in the affected area. Therefore, it is desirable that the indicator would be as small as possible. Indicator 4 is the ratio of the development area (Indicator 1) to the affected area (Indicator 2), and even if small are is deforested, it is not preferable if the affected area is large, thus the Indicator 4 should be small. Indicator 5 is the number of households in the affected area, and indicates how many people, in other words, how many households are actually affected by deforestation. The indicator can evaluate the magnitude of the direct impact on the residents, and obviously, the smaller number of affected households is desirable. Indicator 6 is unit price of water storage service per hectare of deforested area. The indicator is calculated by multiplying unit price of forest water storage service and its unit is JPY/ha/household. It can assess the unit value of lost forest water storage service and when based on the indicator, forest with smaller lost unit value should be developed. Finally, Indicator 7, shows the value of water storage services lost by the construction of solar power plants. The indicator is a composite indicator that integrate Indicators 1 and 5, and the indicator measured monetary value is effective when judging multiple different factors in a complex manner and the smaller value of the loss is preferable.

In this study, the above seven indicators were presented Table 4 also indicates the solar power plant selected as the best by each indicator (see also Table 3). The plant D is selected as the best by four indicators: Indicators 2, 5, 6 and 7. The plant D is selected as the best by more than half of all seven indicators. And the indicators mainly relate to the lost value and the number of households in affected area. This implies that the plant D has less influences on residents compared to other plants. The plant F is selected by two indicators: Indicators 1 and 3, and these indicators relates to deforested area, while the plants B, C and E are not nominated by all indicators, which leads to less preferable among others. When looking at the location of the plants, the plants located lower in river basin tend to perform better.

The next issue is, among these indicators, which one should be applied to evaluate the impact of solar power plants and be given the highest priority. It is determined by discussion and consensus building among various stakeholders. Nonetheless, presenting multiple indicators instead of a single indicator can provide more information to stakeholders, facilitating the use of assessments and making the valuation more practical.

**Table 4: Indicators estimated in the valuation**

Indicators	Title	Explanations	The best plant selected by the indicator
Indicator 1	Deforested area	This is the simplest and most popular indicator.	F
Indicator 2	Total affected area	The indicator is defined as area of water basin lower than solar power plants. It can assess impacts including indirect ones on land.	D
Indicator 3	Share of deforested area in total forest in affected area	The indicator is defined as a percentage of deforested area in total forest area in affected area. It can assess how much share in total forest in affected area is deforested.	F
Indicator 4	Affected-deforested area ratio	The indicator is defined as affected area divided by deforested area. The indicator can assess the affected area per unit of deforested area.	A
Indicator 5	Number of households in affected area	The indicator is simply the number of household in the affected area, and can assess how many persons are directly affected by deforestation.	D
Indicator 6	Unit price per hectare of deforested area	This indicator is defined by multiplying unit price of forest water storage service (JPY/ha/h.hold) and the number of household. The indicator can assess the unit value of lost forest water storage service. The forest with smaller lost unit value should be developed.	D
Indicator 7	Lost value of water storage service	The indicator is estimated by multiplying the number of household (Indicator 5) by unit value of water storage service of forest. The indicator can be regarded as a composite indicator integrating Indicators 1 and 5, and can assess the lost value of deforested. The smaller lost value is preferable.	D

**4.2 Practical valuation for closing the information gap**

In this study, we have strictly identified the range of beneficiaries, and estimated the number of them using GIS, and we also conducted an economic evaluation that reflected the number of beneficiaries. As explained in the Section 1, Olander et al. (2017) mentioned one of the factors that give rise to the information gap that local specific factors are not fully captured in the valuation. The range of beneficiary heavily depends on local specific conditions such as geographical, societal and biological factors, and it can be seen as local-specific factors. By considering the beneficiary into the valuation, we believe we can narrow the information gap.

Information gap refers to the absence of the ground in concrete operational decision-making contexts (Levrel et al., 2017). There are mainly three reasons why our economic evaluation which considers the number of beneficiaries can close the information gap. First, by clarifying the beneficiaries of ES, it contributes to the visualization of it, which is also advocated by TEEB and ESP. Most of previous studies have not linked valuations with beneficiaries, and it was unclear who would be affected by the loss of ecosystems and their services. By performing the evaluation that links with the beneficiary, it is possible to identify the person affected by the modification of ES. As a result, the beneficiaries can recognize that they are affected by the alteration of the ecosystem, and can use the valuation in order to make people’s behavior change toward the conservation of the ecosystem. Second, by identifying the beneficiaries, the beneficiary pays principle can be applied in a practical way. As mentioned above, if the people can recognize themselves as those concerned, it will be easier to obtain the understanding when requesting paying the cost for ecosystem conservation. Therefore, the evaluation can be used as a basis for the payment for ES (PES). More broadly, by presenting such grounds to the beneficiaries, it is possible to request paying for the cost with more objective evidences, which also contributes to evidence-based policy making (EBPM). Third, a more rigorous cost-benefit analysis is possible by conducting an economic evaluation that identifies the beneficiaries. Some of the previous studies have been roughly evaluated, for instance, by assuming that the range of beneficiaries is the entire city, which can lead to an overestimation of the benefits. In this evaluation, by conducting a rigorous evaluation that considers the beneficiaries, it is possible to perform a more

realistic cost-benefit analysis, and whether or not the ecosystem modification such as the installation of solar power plants is appropriate considering social costs and benefits for a region and a community. Specifically, our valuation can be used (1) as basis for explanation impact of constructing solar power plants; (2) to make a decision whether the construction is appropriate for the region and community, and to give a permission for constructing the solar power plants. According to Laurans et al. (2013), the purposes for the use of ES valuation can be grouped into three: informative, decisive and technical. Based on this, the former: (1) is categorized in informative purpose, and the latter: (2) are in decisive purposes.

## 5. CONCLUSIONS

This study proposed the valuation that is practically useful for policy decision-makings particularly for local policymakers. Olander et al., (2017) raised the question that local specific factors are not fully captured in valuations. In this study, using cases of deforestation due to construction of solar power plants in Japan, we considered the number of beneficiaries and identified area affected by deforestation as local factors so that the valuation can be practical. The advantages of our valuation are summarized as follows.

First, our valuation can identify area that are affected by the decline of ES as a result of deforestation. Such kind of local specific information is useful for local policy makers because the valuation can be used for explanation to residents who will be influenced by deforestation, and residents can determine whether they accept the deforestation or not. Thus, the valuation with much practical and real information can make residents recognize themselves those who concerned. Second, the valuation can provide multiple indicators for policy makers and residents and can lead to provision of evidences for decision-making in much broader way. The indicators that is applied to decision-making should be determined by discussions and deliberations among various stakeholders. Although our valuation does not provide a methodology to determine the indicators to be applied, we think this is future caveat of this study. Olander et al., (2017) pointed out that one of the factors for the information gap is the failure to develop transparent and unambiguous linkages between ecosystem changes and outcomes. Our valuation can indicate linkage between deforestation and possible influence on residents through geographic analysis, and can contribute to narrow the gap. In addition, Due to recent climate change, we have serious natural disasters more frequently, and from the view point of disaster prevention, more attention is paid for forest ES particularly for regulating services. However, the situation is more pessimistic. In Japan, area of planted forest dominates 40% of total forest area. Under current severe budget and declining timber prices, planted forests are less maintained and in some cases, they are abandoned. This causes lower capacity to supply ES and sometimes people are affected by this as results of disasters like landslides and floods. These are one of the main concerns for local municipalities in Japan. Therefore, in order to implement forest maintenance policies more effectively, policy makers should distinguish existing plantation forest which should be managed and which should be returned to natural. By the analysis in this study, we could identify hotspots of forest ecosystem in terms of supplying the ES, and we believe the results can be practical information for local policymakers.

## ACKNOWLEDGEMENTS

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## RAINFOREST CONSERVATION POLICY ASSESSMENT: THE CASE OF THE ATLANTIC FOREST IN BRAZIL

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### ABSTRACT

The Atlantic Rainforest in Brazil, which used to be one of the greatest tropical forests in the Americas, is now reduced to 28% of its original area as a result of five centuries of strong human occupation. After a long negotiation process, the 2006 Federal Law n<sup>o</sup> 11.428 also known as the Atlantic Forest Protection Law (AFPL), established the formal framework to specifically protect the remaining Atlantic forests, including both primary and secondary forests.

In this article, we assess the effectiveness of AFPL focusing on the state of Sao Paulo, where AFPL has divided the territory into three main parts: the southeast and the northwest regions are protected by the law, whereas the remaining area in the middle is not.

We use a difference-in-differences approach to compare the natural forest cover and the frequency of environmental infraction notices in municipalities from treated and untreated areas. We restrict our analysis to municipalities whose territory is either 100% within the treated area or 100% within the untreated area, removing all municipalities whose territory was split in two parts (treated and untreated). We use a municipality panel data from 2001 to 2019 (treatment starts at year 2006) with natural forest cover as a percentage of municipality's total area from MapBiomass collection 5 data (Brazilian Annual Land Use and Land Cover Mapping Project). The starting date of 2001 was defined through an event study and it is consistent with the Environmental Crimes Law (Law #9605, from 1998), which specified ecological crimes in an effort to promote the legal certainty of previous laws and to make their enforcement credible.

Our results indicate that AFPL had a positive and significant effect on the natural forest cover in treated municipalities. Interestingly, the frequency of environmental infraction notices in treated municipalities is estimated to be lower relative to the untreated ones. The latter result might be a consequence of a legal framework that increased the severity of credible punishment for illegal deforestation.

Using event study, we can see that the effect on the natural forest cover appears after 2013, which is consistent to the fact it may take years for a forest to recover (and for such recovery to appear in satellite data). The coefficients for infraction notices suggest an overall decrease in the treated area relative to the untreated area, but are no longer significant for the most part of the years after 2006.

We are currently extending the analysis to include covariates and robustness checks considering subgroups or alternative treatment starting dates. We are also interested in impact of the law in other Brazilian states.

## **Regular Session: RS18.3- Resilience and Risk Management**

**09:30 - 10:45 Thursday, 27th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/84441830561>**

**Chair Euijune Kim**

## ASSESSING DISASTER RISK BY INTEGRATING NATURAL AND SOCIO-ECONOMIC DIMENSIONS: A DECISION-SUPPORT TOOL

[Marco Modica](#)<sup>1</sup>, [Giovanni Marin](#)<sup>2</sup>, [Susanna Paleari](#)<sup>3</sup>, [Roberto Zoboli](#)<sup>4</sup>

<sup>1</sup>GSSI, Italy. <sup>2</sup>University of Urbino, Italy. <sup>3</sup>IRCrES - CNR, Italy. <sup>4</sup>Catholic University of Milan, Italy

### ABSTRACT

The paper provides a conceptual framework for a multi-dimensional assessment of risk associated to natural disasters. The different components of risk (hazard, exposure, vulnerability and resilience) are seen in a combined natural and socio-economic perspective and are integrated into a Disaster Risk Assessment Tool (DRAT). The tool can be used in supporting disaster management strategies as well as risk mitigation and adaptation strategies at very disaggregated geographical or administrative scales. In this paper, the feature and the applicability of DRAT are demonstrated by mapping multidimensional risk for 7,556 Italian municipalities. DRAT can be particularly useful to identify hot spots that are characterized by high hazard, exposure and vulnerability and by low resilience. In order to identify hotspots, we perform cluster analysis of the municipalities in terms of their risks ranking within DRAT. We also suggest how the tool could be exploited within the processes of disaster risk policy in Italy.

**AN ECONOMIC ASSESSMENT OF RESILIENCE AFTER A LARGE-SCALE  
TSUNAMI IN JAPAN**

**Hiroyuki Shibusawa, Daiichi Matsushima**

Toyohashi University of Technology, Japan

**ABSTRACT**

This study aims to investigate how the production activities in 1886 municipalities of Japan recover when these activities stop due to a tsunami caused by Nankai megathrust earthquakes. As a disaster area, we focus the flooded zones in the hazard map published by Ministry of Land, Infrastructure, Transport and Tourism and prefectures. Furthermore, we assume three damage scenarios and different recovery speeds in each production sector. The dynamic recovery processes are simulated by using an inter-regional input-output model with 1886 municipalities of Japan. We show the recovery processes in the municipalities and analyze the resilience of the regional economy.

## SPATIAL DISTANCING, SPATIAL INTERACTION AND REGIONAL ECONOMIC DAMAGES

[Euijune Kim](#), [Hojune Lee](#), [Min Jiang](#), [Seulki Kim](#), [Dongyeong Jin](#)

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### ABSTRACT

We develop a spatial computable general equilibrium model of South Korea to assess effects of spatial distancing (SD) intervention on regional economies. This paper focuses on calibration of economic losses from the outbreaks in 2020. It examines how each element involved in SD (self-isolation, school closures, public events banned, and complete lockdown) affects the travel behavior of consumers and producers. The overall contribution of SD measures is assessed on national and regional economies in terms of efficiency and welfare. The model measures economic losses from COVID-19, including human health costs in cities and counties based on profit maximization of regional producers on the supply side and utility maximization of regional households on the demand side. We find that if the spatial interaction is regulated such that the travel time (cost) increases by 10%, the national gross domestic product (GDP) drops by between 0.815% and 0.864%. This outcome can be decomposed into -0.729% in agglomeration-loss, -0.080% to -0.130% in social costs associated with medical treatment and premature mortality, and -0.005% in reaction effects. The results of models and simulations shed light on the epidemiological effects of social distancing interventions. This ex-ante evaluation of the effectiveness of social distancing provides guidance for national, urban, and rural policy decisions with respect to changes in regional economic outcomes and spatial distribution of infected and confirmed cases of COVID-19.

## **Regular Session: RS10.7 - Regional development**

**09:30 - 10:45 Thursday, 27th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/82231138454>**

**Chair Hidekatsu Asada**

## MYANMAR'S MANUFACTURING EXPORTS AFTER THE LIFTING OF ECONOMICS SANCTIONS

Hiroyuki Taguchi, Soe Thet Mon

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### ABSTRACT

This paper aims to evaluate the Myanmar's exports of manufacturing products by using a gravity trade model for ASEAN economies. During the previous military-ruled regime before 2011, Myanmar had received the economic sanctions from western countries such as the United States, Canada and the European Union due to the suppression of human rights under this regime. Since March 2011, however, Myanmar has entered into a new regime of market-based economy with open-door policies under the civilian government led by President Thein Sein and the subsequent government headed by State Counsellor Aung San Suu Kyi. In accordance with the regime transformation, the economic sanctions have been lifted by the western countries since 2012. The critical question then arises whether the Myanmar's manufacturing exports have recovered towards the gravity-trade- standard of the other ASEAN countries for the post-sanction period of 2013-2018. It would be a relevant issue and timing to assess the current Myanmar manufacturing exports under the new open-door regime, in the sense that there have been a very limited number of quantitative studies on Myanmar trade under the new regime, and also that five or six years for the post-sanction period are rather enough to be analyzed at a minimum level. The main findings from the gravity trade model estimation are summarized as follows. First, the Myanmar's manufacturing exports for the post-sanction period have been still significantly below the level of the gravity-trade-standard of the other ASEAN countries. Second, the lack in the institutional quality (in terms of government effectiveness) and the high natural resources rents (implying the existence of the Dutch Disease) in Myanmar are identified to be the significant contributors to prevent Myanmar's manufacturing exports from recovering towards the gravity-trade- standard.

## VIETNAM'S CHALLENGE TO BOOSTING LABOUR PRODUCTIVITY

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### ABSTRACT

Vietnam has maintained a remarkable record of economic growth since the 1990s whose average real growth rate over 1990 to 2018 was 6.8%. A growth accounting exercise shows that growth has been largely driven by non-ICT capital investment. Contribution of total factor productivity rebounded to the positive territory in 2010-17 from negative growth in the decade earlier. Contribution of labour input was almost zero in the same period, partly reflecting the labour participation ratio that is high already. The shift-share analysis of labour productivity reveals that the impact of labour reallocation declined toward the period of 2010-17. This implies the slowdown of labour reallocation from low-productivity sectors such as the agricultural sector to higher productivity sectors. The sustained growth of overall labour productivity over the medium to long-term is crucial for escaping the "Middle-income trap". In Vietnam, workers in the agricultural sector still account for a large share of the total number of workers. This implies the potential to materialise productivity gains by facilitating the labour reallocation to the manufacturing and services industries. Human capital development is key to promoting the labour reallocation, making the most of Vietnam's high performance of basic education.

## LOCAL GOVERNMENT EXPENDITURE AND SOCIO-ECONOMIC DEVELOPMENT: A CASE STUDY OF THE PROVINCES IN THE PHILIPPINES

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### ABSTRACT

The analysis of the link between public finance and development is an important topic for policymakers in countries which have experienced decentralization process, particularly on how public funds can be allocated efficiently to induce or accelerate local development. Many countries have pursued decentralization under the assumption that due to proximity and familiarity, local government officials should know what is best for their constituencies. In the case of the Philippines, local governments were given fiscal autonomy alongside with the responsibility of delivering basic social services such as agriculture, health services, social welfare services, infrastructure, and tourism development. This study aims to explore the link between local government spending, specifically, social services expenditure and socio-economic development using the case of the provinces in the Philippines. This study also aims to examine the differences among provinces in terms of socio-economic development and social services expenditure. This paper devises a socio-economic index to analyze the socio-economic condition of the provinces. Socio-economic index is computed using various indicators that falls into four categories: economic, education, health, and infrastructure. This study utilizes OLS regression to estimate the relationship between socio-economic development index and social services expenditure. The result of the study shows that there is a huge disparity among provinces in terms of socio-economic development and social services spending. Provinces located adjacent to the capital have favorable socio-economic conditions and higher spending on social services. While provinces located mostly in Mindanao, particularly Autonomous Region of Muslim Mindanao (ARMM) have both inferior socio-economic state and lower spending on social services. The findings of the study also demonstrate that social services expenditure have positive and significant effect to the devised socio-economic index. To corroborate the findings of study, this study also analyzes the relationship between social services expenditure and human development index (HDI). The link between social service expenditure and HDI also shows similar findings with this study: social services expenditure is positively correlated with HDI. This study also identifies four different types of provinces based on the relationship between socio-economic index and social services expenditure: Type 1 (provinces with high socio-economic index and high social services expenditure); Type 2 (provinces with high socio-economic index but low social services expenditure); Type 3 (provinces with low socio-economic index but high social services expenditure); and Type 4 (provinces with low socio-economic index and low social services expenditure). This study also outlines challenges and policy recommendations for the different categories of provinces.

## **Special Session: SS18.5 - Urban Future in the Global South**

**09:30 - 10:45 Thursday, 27th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89993853386>**

**Chair Abdul Shaban**

## SPACE, FACE, AND NETNOGRAPHY: THE VISIBILITY OF EVERYDAY VIOLENCE IN URBAN SPACES FACED BY THE PAN-NORTHEASTERN COMMUNITY IN BANGALORE

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### ABSTRACT

This research is grounded on understanding the concept of shared space and fragmented identity in Bangalore city. For pan northeastern communities residing here, life is far from ideal. Facing discrimination and forms of everyday violence has become a part of urban space. It hampered with the progress of placemaking, and influenced the community's access to resources (in state, private, and local bodies). As of today there are several online communities representing both singular and commonly shared goals. But does this online space eventually impact the overall safety and future sustainability of the pan northeastern populace towards making a "home" in Bangalore city?

This study adopts a qualitative and ethnographic framework, as a tool to map spaces of safety and uncertainty, through the lens of northeastern migrants. In-depth interviews and netnography are utilised to examine patterns of social interaction and networking among the online northeastern community- especially to cite how the strength of weak ties (Granovetter 1973) can push this community forward.

Significant elements to this analysis are: (1) The engagement of state-led regulatory mechanisms to tackle discrimination with the northeastern community, (2) Local law forums and citizen groups to create accessible networks between state mechanisms and the northeastern community. While there are several state-led mechanisms which are initiated to help reduce discrimination in urban spaces, they are not easily accessible, available, and understood. For example, while several police stations have private online "WhatsApp" groups for northeastern communities, assistance is required at ground level, where migrants face problems in language (conveying), cultural differences, and internalised biases held by state bodies towards the community. This is a dealt by local law forums and northeastern community groups, who intervene to provide agency.

One of the expected outcomes of this paper was to map how people navigate through the city as a geo-political space. The need to find trustworthy connections was important to the pan northeastern community and it was enabled by networking and online social capital. Enabling and engaging with social media networks is definitely a boon for vocalising their needs, however does it have the capacity to introduce a sense of security and allay concerns held by the people?

The need to understand this shared identity stems from abject failure of the state to incorporate tertiary systems into consideration: in terms of shared cultural heritage, artefacts, and a common history. A few subjects this study touches upon deals with shared cultural identity and fragmented ethnic identities. A topic which heavily influences certain northeastern communities is the role of Christian theology it's influencing agendas and goals. Lastly, the gendered nature of discrimination between men and women in urban spaces is also an essential factor to be discussed in future research. By ethnographically mapping urban minority representation this paper attempted to ascertain the patterns of recurring insecurities among pan-northeastern migrants living in Bangalore. Their importance today foreshadows the current political debates around racism, discrimination, and the failures of state mechanisms globally, thereby perpetuating everyday violence as a normative aspect of urban spaces

## URBAN POVERTY AND VULNERABILITY IN GLOBAL SOUTH: ISSUES OF UNDERESTIMATION, CONCENTRATION AND TARGETING

[Anita Rath](#)

Tata Institute of Social Sciences, India

### ABSTRACT

The mainstream conceptualization of poverty and vulnerability has inadequacies in dealing with urban problems, in general, and that of the global south, in particular. The dynamics of urban poverty and vulnerability plays out differently in the Global South which is host to more than three-fourths of the world urban population with ever increasing proportion living in mega-urbanized settings. The inordinate impact of the COVID-19 pandemic on the poor and marginalized urban dwellers and migrants in this region has led to a shift in the locus in the contemporary discourse on poverty and vulnerability towards urban centres, which hitherto had a rural bias in the Global South. The existing literature in this field insinuate at the problem large-scale underestimation of urban poverty, the problem of poverty concentration and rising and persistent inequality. However, there are limited empirical work in this field with a focus on global south.

It is in this backdrop, the current paper focuses on the following objectives: (a) to develop an alternative multidimensional poverty index (MPI), on the basis of a normative analysis of urban poverty with specific refence to the challenges posed by COVID-19 in urban centers in Global South; (b) to test the stability of the alternative index; (c) to review the mainstream approaches for measuring urban poverty and assess the scale of the bias, if any, with reference to the benchmark; (d) to analyse the problem of poverty concentration in the urban areas; (e) to review the poverty targeting practices in the urban centres in Global South. The Alkire-Foster Multidimensional Poverty Index identification and aggregation procedure is adopted in the study as the broad approach. For developing the alternative MPI, recent DHS (The Demographic and Health Survey) dataset for India is considered suitable for this analysis. The focus on India for an in-depth exploration assumes significance due to the following reasons. First, the poverty headcount ratio in urban India as per the official and mainstream sources is around 10 per cent barring exceptions. However, literature in the field indicate problems of underestimation. Second, the unidimensional and multidimensional approaches use the same dimension(s) and indicator(s) for rural and urban areas. Third, the poverty targeting for major central and state government schemes in rural India is now on the basis of Socio-Economic and Caste Census (SECC), 2011 data. However, SECC has not been the basis for indicator-based poverty targeting in urban India so far and disparate practices are being followed in different regions. Finally, the course of growing mega-urbanization in India insinuate at the deepening of these problems and the COVID-19 pandemic has revealed it in gory details. Based on the empirical analysis for India and review and case studies for countries in Global South, the paper reflects on the emerging situation of poverty and vulnerability in the region. It highlights the larger issue of urban and regional planning and best practices in poverty targeting in the region.

## JAIPUR: AN EMERGING ENTREPRENEURIAL METROPOLITAN REGION OF THE GLOBAL SOUTH

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### ABSTRACT

Jaipur metropolitan region, in northern India, is famous for the splendour of its palaces, the beauty of its architecture and the skills of its craftsmen producing semiprecious stones, colourful textiles, carved furniture, painted miniature. From this prestigious past, the city and its region have been able to integrate into globalization with an impressive concentration of prestigious heritage hotels welcoming international tourists, large number of gems, jewels, cloths and handicrafts industries exporting all around the world, not forgetting dynamic computer companies in which successful engineers works in day to day with technopoles in the US and elsewhere.

The region demonstrates significant churning out around learning and human skills and is fast becoming integrated through leisure and knowledge-based economy, technology, and entrepreneurship. Where the historical evolution and inter-generational transfer of knowledge of entrepreneurship adds to the regional advantage, in recent years with globalization and adaptation of digital technologies, there has been constant adaptation to the new trends in production, business, and trade.

The proposed paper aims to analyse the process of learning, adaptation, and innovation in this rising Indian city and in its surrounding, foregrounding the links between a thriving regional culture and a set of strong business communities. Going beyond the debate on the genesis of global productive networks, the research within the framework of learning region (Hirsch et al. 2001) and regional innovation system (Asheim, Smith and Oughton 2011), attempts to explore the case of Jaipur within the framework of entrepreneurial and innovative metropolitan region as an area of established business groups, specific resources, and effective knowledge with global economic networks and processes. Such entrepreneurial metropolitan regions are rising in the global South and have now started to compete at the world level. There are three key questions around which the paper is structured. What are cultural capitals of the region which enhance its advantage in entrepreneurship? This question seems unclear to me. Do you mean cultural factors? What are the nodes around which human interaction get organized for mutual learning and adaptations to the new business environment? How external knowledge (proposition) to the regions are inserted and adapted to make the regional innovation dynamic and entrepreneurship competitive?

The paper as such also implicates not only the human interaction but how also the role of new technologies and the networks of globalised market system.

The data for the paper are drawn from both the government and non-government statistics on enterprises, innovations, businesses, trade and networks, and indepth structured and semi-structured interviews with senior business group officials and entrepreneurs. For the regional history, the paper learns from other relevant literature.

The paper draws methods from previous studies related to the network analysis of business firms (Godesiabois 2015) and frameworks of 'learning region' and 'regional innovation systems'.

## URBANIZATION, PLANNING AND SCOPE OF COLLABORATIVE GOVERNANCE: A CASE STUDY OF DELHI METROPOLITAN REGION

Ujjwal Dadhich

Tata Institute of Social Sciences, India

### ABSTRACT

Global South is now characterized by mega urbanization – a process resulting into rapid expansion of cities and increasing contradictions. One of the major outcome of this mega-urbanization is the shift from government to governance. That is, government cannot be the only single actor in planning and tackling urban challenges. Tackling the city problems now require new collaboration between different stakeholders and implementing agencies. This paper seeks to better understand this scope of collaborative governance and its promises for achieving urban sustainability and resilience in case of Delhi metropolitan region. While Delhi is India's capital region, its urban planning and quality of life is ranked globally at the bottom. Poor planning and complex administrative structure are both a cause of Delhi's compounding problems. Despite this, there have been innovative approaches adopted recently for better urban governance in the capital region. This paper giving an extensive planning history of Delhi, discusses collaborative approaches at six governance aspects – public transport, air pollution, urban greenery, energy supply, housing and climate change. Collaborative measures in each of these fronts exhibit innovation and creativity that has evolved with an active participation and contestation among stakeholders. The paper discusses this evolution and utility of few collaborative approaches in present. However, there are also concerns related to replicability, effectiveness and sustainability of these collaborative approaches. The paper discusses these aspects, presents evidences of success and poses critical questions for a better urban management in global Sout

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# PARALLEL SESSIONS (12)

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## **National Session: SS22 - Regional Disparities in the EU and Hungary in the Age of Digitalization and the Pandemics**



HUNGARIAN REGIONAL  
SCIENCE ASSOCIATION

**11:00 - 12:15 Thursday, 27th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/85253483318>**

**Chair Zoltán Gál**

## DOES FOREIGN INVESTMENT GENERATE REGIONAL ECONOMIC GROWTH IN EMERGING COUNTRIES AND THEIR REGIONS? CASE OF CENTRAL & EASTERN EUROPE AND HUNGARY

**Zoltan Gál<sup>1,2</sup>, András Gyimesi<sup>2</sup>**

<sup>1</sup>Centre for Economic & Regional Studies, Hungary. <sup>2</sup>University of Pécs, Hungary

### ABSTRACT

The effect of foreign direct investment (FDI) on the host economy has attracted much research. Despite the literature is inconclusive it seems to agree that any positive effect of FDI on growth is largest in developed countries. However, in spite of this FDI is considered a panacea for the fundamental problems of economic growth in emerging transition countries including Central and Eastern Europe (CEE) where FDI became main source of investments from the 1990s. Post-socialist transformation is characterized by high dependency on FDI channeled by foreign MNCs into Central and Eastern Europe. In CEE economic restructuring was primarily driven by foreign direct investment (FDI) in the postsocialist period, which in the short term contributed to the increased productivity and competitiveness. The paper examines the effects of FDI on GDP growth and GFCF, and tests the causal relationship between these variables in the Hungarian regions. Based on the econometric analysis, the study argues that it is not FDI that causes GDP growth, but more FDI flowing into the already more developed, higher-growth regions. The inclusion of Gross Fixed Capital Formation (GFCF) into the model also eliminates the significant positive effect of FDI. Government and EU-funds-generated investments play a much greater role in GDP growth than FDI. Our study demonstrates that the attractiveness of target regions for FDI can be explained by their initial higher level of development and geographical proximity to Western European markets. However, this paper also hints that FDI-driven assembly platform economy, in the absence of spillovers and additional factors of endogenous growth, are not sufficient to ensure the the long-term prosperity of regions.

## URBAN STRATEGIC PLANNING FROM THE PERSPECTIVE OF WELL-BEING: EVALUATION OF THE HUNGARIAN PRACTICE

**Zoltán Bajmócy, Judit Gébert, György Málóvics, Boglárka Méreiné Berki, Judit Juhász**

University of Szeged, Hungary

### ABSTRACT

The present paper evaluates Hungarian strategic urban planning from the perspective of well-being. It conceptualises well-being in line with Amartya Sen's capability approach (CA).

An important theoretical and practical consequence of the revival of the strategic approach since the 1990s is the increased complexity of evaluation. This resulted in the quest for concepts and principles (substantive normative criteria), which evaluation could be based on; and revived discussions around the concepts of "common good" or "public interest. We argue that the CA provides a meaningful concept of common good or public interest for evaluation. The open-ended nature of CA allows to embrace the complexity of strategic planning, but it is definite enough to provide a clear normative framework for evaluation.

The CA suggests three main issues for evaluation: (1) how the objectives of the strategies fit to the set of capabilities deemed to be valuable in a community; (2) how can citizens actually make use of the means of well-being in order to further their ends; and (3) to what extent do citizens have the freedom to act as agents during the moulding and the realization of the objectives?

The paper evaluates the Hungarian practice of strategic urban planning. We base our results on 49 semi-structured interviews with various local actors in three second-tier cities. We carried out qualitative content analysis on the word-by-word transcripts of the interviews. We used deductive coding: we restructured the texts into categories derived from the capability approach, both in terms of the freedom for well-being and the freedom for agency.

Our results were rather critical towards the practice of strategic urban planning in Hungary. The CA-based evaluation showed that the actual objectives of strategic urban planning in Hungary are actually just means (and not ends) of well-being, which cannot necessarily be utilized by the actors. The diversity of actors and their values are largely overlooked. The direct concomitant is the loss of a huge set of relevant information for planning. The opportunities for agency are gravely restricted for numerous actors. The main barriers of agency are related to actors' inability to define and shape the spaces of participation.

In terms of theory, we conclude that the CA-based evaluation is able to supplement the dominantly used conformance- or performance-based evaluation approaches. We also found that instead of depicting an unachievable ideal, the CA is able to provide guidance for feasible steps to further well-being.

## SMART COMMUNITIES IN THE COUNTRYSIDE: WHAT COMES AFTER PROOF OF CONCEPT?

Viktória Józsa<sup>1</sup>, Pál Szabó<sup>2</sup>, Ákos Jakobi<sup>2</sup>

<sup>1</sup>Nord Consult Kft., Hungary. <sup>2</sup>Eötvös Loránd University, Department of Regional Studies, Hungary

### ABSTRACT

The objective of our research is to present a new conceptual approach towards the 'Smart City' concept and a pilot application focusing on smart rural communities in a peripheral cross-border environment (Nógrád county, Banská Bystricky & Kosický kraj). The scientific approach is based on the basic concepts of 'smartness' but introduces a new conceptual avenue in connection to small rural communities. Research generally focuses on mid-size and large cities and discover several aspects of smartness that are connected to size, number of inhabitants, functions and large-scale infrastructure as prerequisites.

To the contrary, our research objective was to support the basic hypothesis that smartness can be interpreted to less-developed rural small settlements also. Certainly, a different approach and methodology should be applied.

The main objective of becoming 'smart' is efficiency and technology-related. Our basic concept is that 'smartness' is not the privilege of cities and even rural areas and small settlements can break out from their lock-in situation through activities based on endogenous development, instead of placing and connecting ICT systems and infrastructures or promoting intensive industry settlement. We focus on the development of the local 'soft' elements and aim to generate 'smart citizens' instead of 'smart infrastructures and systems'.

In our previous research, we conducted an empirical research in a peripheral cross-border region in the Hungarian-Slovak border and based on the results, we identified several specific local needs for further development. We proved that smartness is not the privilege of cities, connected infrastructures and ICT are not the only means of the 'smartening' process.

As a follow-up applied research project, our basic concept is that welfare could be also achieved in the countryside with the application of the newest technologies. The main question now, after the proof of concept is: how? For this reason, we developed a new methodology to 'smarten up' small settlements in the countryside, that includes two main directions, such as Smart Village cross-border services and Smart Village know-how transfer. Our main objective is to support the 'smartening' process of rural settlements through the development of direct cross-border services, and thus, to operationalize the 'Smart Village' concept. This is facilitated by the Smart Village Roadmap, the Good Practice Catalogue, the Smart Database and Helpdesk service, the Smart Village Pilot Courses & the Smart Academies, the Mobile ICT Centre trainings, the Local Bloom Movement and the Local Development Hackathon.

As a final step, in order to measure & compare the development of the villages, we plan to elaborate & introduce a new, motivating service in the form of a Smart Village Award, that is based on a Smart Village Indicator System to be programmed together by the Slovak & Hungarian partners.

The objective of the current research is to operationalize the Smart Village concept and develop a conceptual model and an indicator system for Smart Villages. In the current era of planning the next EU programming period between 2021-2027, including the Horizon Europe Programme, the topic and its possible policy implications are outstandingly actual and important.

## IMMUNIZING WORKERS IN THE PANDEMIC? LESSONS FROM SUPPLY CHAINS, TELEWORK AND COMMUTING

Sándor Juhász<sup>1</sup>, Eszter Bokányi<sup>1</sup>, Zoltán Elekes<sup>2,3</sup>, László Czaller<sup>2,4</sup>, Gergő Tóth<sup>5,2</sup>, András Borsos<sup>6,7</sup>, Tünde Szabó<sup>8</sup>, Márton Karsai<sup>7,9</sup>, Balázs Lengyel<sup>2,1</sup>

<sup>1</sup>Budapest Corvinus University, Hungary. <sup>2</sup>ELKH Centre for Economic and Regional Studies, Hungary. <sup>3</sup>Umea University, Sweden. <sup>4</sup>ELTE University, Hungary. <sup>5</sup>University College Dublin, Ireland. <sup>6</sup>Central Bank of Hungary, Hungary. <sup>7</sup>Central European University, Austria. <sup>8</sup>ELKH CSF, Hungary. <sup>9</sup>ELKH Rényi Research Centre, Hungary

### ABSTRACT

Vaccination may be the solution to the epidemic-induced health crisis, but the allocation of vaccines is a complex task in which both economic and social considerations can play a role. A central problem is how the limited number of vaccines can be most effectively used in a country to reduce the risk of infection and mitigate economic uncertainty as well. In this paper, we argue that besides the high risk population, vaccination plans should include workers and rank them according to their infection risk and economic importance. To establish this argument, we explore the empirical relationship between important work-related factors in the local spread of the SARS-COV-2 virus, like telework potential and neighborhood characteristics of workers and their commuting to work, and the structural characteristics of supply-chain networks of Hungarian industries and firms. Our study consists of two related parts. First, we construct industry-region level input-output networks from company reports on value-added tax and demonstrate the significance of telework potential in this network. Next, we explore the residence and commuting patterns of employees in manufacturing companies from mobile cell data, which we compare with the companies' position in the supplier network. Our results suggest early vaccination for workers in urban industries where telework potential is low. These are typically large industries that are central to the input-output network. By immunizing blue-collar workers in densely populated areas, vaccination can not only fight infection risks but can also mitigate production uncertainties of firms that are involved in many and difficult-to-replace value chains.

## National Session: SS53 - Regional Science in Egypt



**11:00 - 12:15 Thursday, 27th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/83942885151>**

**Chair Michael L. Lahr**

## HEAVY METAL AND BACTERIA REMOVAL FROM RIVER NILE, EGYPT BY CARBON NANOTUBE FILTERS THAT ENHANCING THE MARINE CONDITIONS FOR FRESH WATER BIVALVES

**Emad M. Elsehly<sup>1,\*</sup> and Aml Z. Ghonim<sup>2</sup>**

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### ABSTRACT

The contamination of water resources with a wide range of pollutants has become a source of concern in recent decades. Due to their unique properties such as chemical stability, thermal stability, and high surface area, chemically functionalized MWNTs (F-MWNTs) have a lot of potential as a new effective filter. The aim of this study is to see whether F-MWNTs can be used as an efficient filter to improve the aquatic conditions for *Mutela singularis* (*M. singularis*), a freshwater bivalve that is used as a bio-indicator of heavy metal contamination. The histological and biochemical composition of *M. singularis* was studied before and after the use of F-MWNT filters. The bivalves and water samples used in this analysis were obtained in Abu Hummus, Egypt, on the Nile River. At high pH, the metals Co, Cu, Fe, Pb, and Zn had high removal efficiency, while Cd, Cr, and Ni had higher removal efficiency at low pH. Copper was removed 99.8% efficiently by F-MWNTs-based filters at pH=10 for a 5 µg/L concentration. The mechanisms underlying F-MWNT filtration as a feature of pH were discussed. *M. singularis* samples filtered with MWNTs filters had a high standard of structure, as well as a large increase in carbohydrate, lipid, and protein content. The protein increased by 45% due to enhancing the aquatic conditions of *M. singularis*. Our research contributes significantly for water treatment applications, and to the potential feeding fields.

### KEYWORDS

Aquatic conditions enhancement; Bivalves bio-indicators; Carbon nanotube filters; Heavy metal removal; *M. singularis*

## SPATIAL VARIABILITY OF LAND USE TYPES IN RELATION TO SOIL MOISTURE AND CLIMATIC VARIABLES OVER EGYPT

Megahed Hassan

Zagazig University, Egypt

### ABSTRACT

Soil moisture, as a fundamental factor in the hydrological process, it directly influence land use type capabilities in response to rainfall, humidity, temperature and topography characteristics. Many studies have documented land-atmosphere interactions, however, studies that investigate the impact of land-use/land-cover changes in the context of the processes involved in soil moisture-precipitation coupling have been lacking. This would be covered by understanding the spatial variability of land use type and soil moisture induced by different climatic elements.

Spatial modeling in land use types can influenced by slope gradient, followed by soil moisture and elevation and slope position, nonetheless climatic factors can be the reason for changing both soil moisture and Land use types. The coupling metrics exhibit a strong positive soil moisture-precipitation relationship within the water cycle, soil moisture and evapotranspiration (ET) influence each other. Therefore precipitation, humidity and temperature are the main climatic factors to be consider for the land use type and soil moisture changes.

The study provides an insight into policy making of land resource management and can be used in the modeling and integrates field inventory data with the satellite images. Analysis involves four major steps, namely, (i) landuse/cover types, (ii) soil moisture dataset (iii) important climatic factors (iv) change monitoring between land use types and the relationship with other variables.

**GOVERNMENT SPENDING AND REGIONAL POVERTY ALLEVIATION:  
EVIDENCE FROM EGYPT.**

**Dina Elshahawany, Ramy Elazhary**

Faculty of Commerce, Zagazig University, Egypt

**ABSTRACT**

Poverty is one of the fundamental socio-economic problems facing most developing countries. In Egypt 32.5 percent of citizens are living below the poverty line. At the regional level especially in Upper Egypt the problem is more evident. Understanding the relationship between government spending and regional poverty reduction will help policymakers to design and implement programs that reduce regional poverty incidence and income inequality effectively. This study aims to analyze the impact of public spending in various sectors in alleviating regional poverty in Egypt by using panel data from 27 governorates during 2011-2017 period.

## EGYPT'S NATIONAL ROAD PROJECT: ASSESSING THE ECONOMIC IMPACTS OF UPGRADED TRANSPORTATION NETWORK

[Dina Elshahawany](#)<sup>1</sup>, [Eduardo Haddad](#)<sup>2</sup>, [Michael Lahr](#)<sup>3</sup>

<sup>1</sup>Faculty of Commerce, Zagazig University, Egypt. <sup>2</sup>University of Sao Paulo, Brazil. <sup>3</sup>Rutgers, the State University of New Jersey, USA

### ABSTRACT

In 2014, Egypt has started a large infrastructure project (the National Road Project). This project is one of the greatest achievements realized in the history of the Egyptian roads. It aims to connect governorates, enhance accessibility and mobility of goods by expanding the transportation network from 23,500km to around 30,500km with a total cost about US\$9.79 billion. The ministry of transport has recently revealed that 4,500 out of the total 7,000 kilometers of National Roads Project have been implemented so far since the program's inception in 2014; another 1,300 kilometers are under construction, whereas an additional 1,200 kilometers are planned for the near future. The main goal of this research is to explore how the developing road network and increasing accessibility that enhanced by the National Road Project in the last 6 years, has affected the country economic variables at both national and regional levels. For this purpose, we tend to apply an interregional computable general equilibrium (ICGE) model for Egypt that has the ability to estimate the economic impacts of road projects.

## **Regular Session: RS02.5 - Infrastructure, transportation and accessibility**

**11:00 - 12:15 Thursday, 27th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/87555502007>**

**Chair Rosella Nicolini**

## APPROXIMATING THE IMPACT OF THE CONGESTION EFFECT ON USERS' ATTITUDE TOWARD THE PUBLIC BUS TRANSPORT SYSTEM: THE CASE OF BARCELONA

Miquel-Àngel Garcia-López<sup>1,2</sup>, Rosella Nicolini<sup>1</sup>, José Luis Roig Sabaté<sup>1</sup>

<sup>1</sup>UAB, Spain. <sup>2</sup>IEB -UB, Spain

### ABSTRACT

This study proposes to identify the basic features that shape citizens' decision towards the regular use of the bus public transportation. Despite the results of the current literature, income turns out not to be a statistically significant decision factor, whereas education and occupation are. Instead, it turns out that the congestion effect is the key determinants in making the decision to become a frequent bus user. Predictions about the impact of the reduction of congestion on the probability of becoming frequent user of the bus transport system emphasize that bus users with a high level of education and regular commuter in the urban territory are more reactive to the reduction of the congestion effect. These findings open an important discussion about the implementation of effective public policies to support the adoption of the public urban transportation system. Educated persons are very sensitive to the reliability of the public bus service, but to our understanding for other reasons. We previously discussed the potential pollution concerns of this group of people and it is worth noting that the bus fleet in Barcelona is mostly green in terms of source of energy, but the congestion effect may make this service not so reliable as expected. Finally, since income does not have a clear statistical significant impact on the probability to become a bus user, there is an interesting insight to discuss in terms of potential pricing policy for the service. Could a policy tailoring prices to the true trip distance be effective, rather than using a pre-established price criterion based on zoning?

## IS THERE A LIGHT AT THE END OF THE EUROTUNNEL? IF NOT FOR THE INVESTORS THAN FOR THE REGIONS?

Johannes Lohwasser, Axel Schaffer, Andreas Schüler

Bundeswehr University Munich, Germany

### ABSTRACT

Shortly after its opening in 1994, the American Society of Civil Engineers elected the Eurotunnel one of the “Seven Wonders of the Modern World”. The tunnel is 50-kilometer-long and links the region South-East in the United Kingdom with the region Nord-Pas-de Calais in France. It is one of the largest infrastructure projects in Europe financed by private funds only. However, exploding construction costs, which were financed mostly by debt, smaller than expected revenues (due to the delayed opening of the tunnel, fierce competition with ferry operators and overly optimistic passenger and freight numbers) led to substantial financial losses, and brought the operating company to the brink of bankruptcy several times. These losses, often considered transfers to the users, indicate a poor return on investment for the private equity and debt investors.

Against this background, the paper first offers an indepth analysis of the financial development of the operating company since it was founded in 1986. We will quantify the losses covered by private equity and debt investors, analyze the reasons for these losses, and discuss the rationale for investors to agree to several financial restructurings.

Aside from the financial implications for the investors, infrastructure projects of this size always have long-lasting regional impacts. However, many cost-benefit studies of the project reveal only small positive effects and therefore conclude that overall the French and British economy “would have been better off had the tunnel never been constructed” (Anguera 2006, p. 291).

In this context, we seek to analyze regional effects of the tunnel by constructing a counterfactual scenario, enabling us to analytically compare the actual regional development given the construction of the Eurotunnel with the hypothetical development without its construction. In contrast to traditional cost-benefit analysis this procedure allows for a better separation of the effects triggered by the construction of the tunnel from other overarching developments (e.g. EU enlargement).

Following this idea, the paper uses the synthetic control method for assessing the economic impacts of the tunnel on different regions. The method tries to construct a synthetic control group for the treated region(s) by a weighted combination of regions not affected by the Eurotunnel. These regions are chosen to mimic the region(s) affected by the Eurotunnel for a set of predictors of the outcome variable (e.g. per-capita-income). The predictors contain variables that are typically associated with growth potential (e.g. investments, population density or sectoral shares) and refer to regional data from the UK and France covering the years 1975-2015. Preliminary results indicate positive effects of the Eurotunnel on the direct affected regions for the first five years (i.e. 1995-1999). Afterwards, results turn negative.

Finally, for an overall assessment of the Eurotunnel, findings at the financial and regional level are jointly analyzed in a third step, for example in order to try to answer the question, whether regional benefits could have justified public funding of part of the construction costs. As this is work in progress, results are not robust so far, but will be presented at the conference.

## LINKING SUSTAINABLE URBAN MOBILITY AND SEDENTARY LIFESTYLES IN THE DIGITAL AGE

[Aritz Balerdi Blanco](#), [Patxi Ojanguren Asolo](#), [Eguzkiñe Elorduy Cortina](#)

University of the Basque Country UPV/EHU, Spain

### ABSTRACT

Unrelenting population growth and urbanization are hampering efforts to manage urban mobility in an optimal way. Currently, 55% of the world's population lives in cities, rising to 75% in Europe. This figure is expected to continue to rise, asserting the problems arising from urban mobility as detailed in the UN-Habitat report; cities produce more than 60% of the greenhouse gas emissions that affect the health of citizens as a consequence.

This problem in cities poses a challenge in determining the most appropriate actions to achieve urban development with the least possible impact on the environment and citizens' lifestyles.

Based on the objectives of sustainable development, the concept of sustainable urban mobility was born. In view of the impact of the use of "passive" means of transport, it is necessary to implement models that reduce the negative effects of urban development by making certain practices such as walking, cycling, and public transport accessible.

Sedentary lifestyles understood as lifestyles with little physical activity and as one of the key factors in human mortality, have been the subject of much research. According to the World Health Organization, 60% of the world's population does not get the physical activity needed for health benefits, and this is an even greater problem in large, fast-growing cities. This has recently been exacerbated by the impact of covid-19 and the restrictions put in place to address it.

In the new digital era, using information and communication technologies (ICT), tools are emerging that can monitor physical activity and provide feedback to the user. Although several studies have shown that the characteristics of the urban area have an influence on the amount of physical activity that is carried out and can favor or discourage it, the relationship between the promotion of sustainable urban mobility and the rate of sedentary lifestyles has not yet been studied in detail.

Therefore, this proposal aims to analyze whether there is an inversely proportional relationship between the implementation of sustainable urban mobility policies and the rate of sedentary lifestyles. To this end, certain indicators will be shown on the basis of certain technological monitoring tools and the linkage of certain indicators proposed in documents from European institutions will be studied.

## SPATIAL JUSTICE (INEQUALITY AND INEQUITY) IN THE PROVISION OF PRIMARY SCHOOLS – THE CASE OF PORTUGAL

João Lourenço Marques, Jan Wolf, Fillipe Feitosa

University of Aveiro, Portugal

### ABSTRACT

Spatial equity can be understood as the central principle of spatial planning which is, ultimately, concerned with guaranteeing that the attribution of property rights and the distribution of public funding counters spatial inequality (Kunzmann, 1998). But the way we judge spatial inequality is not self-evident and, necessarily, implies some overarching principle of justice. Probably the most frequently cited author when discussing matters of justice is John Rawls. Rawls' principles of justice, being broadly defined and including aspects such as power and self-esteem, besides economic resources, is also focused on the actual conditions of exercising different types of freedom (Rawls, 1971, 1981). Thus, even if assuming that inequality will always exist at some level, it is the responsibility of democratic institutions to redistribute resources and promote social justice in order to provide the maximum degree of freedom to different social groups and, in particular, to the least well-off (Resosudarmo, Kuncoro, & Hewings, 2019). In other words, spatial planning and public policy must assume the responsibility to ensure social justice principles in their actions, trying to find the right balance between: i) maximizing effectiveness and efficiency; and ii) minimizing inequalities (uneven distribution of opportunities and resources) and inequities (differences arising from poor governance).

The aim of this paper is to study and analyse territorial inequalities in the access to education. More specifically, it presents: i) an exploratory approach to assess spatial justice for different types of territories at different spatial scales, analysed by the relationship between the location of primary schools and the spatial distribution of different socioeconomic groups; and ii) a spatial econometric model to explain spatial equity, measured by an aggregated and single indicator of accessibility, regressed against a set of socioeconomic and territorial indicators. This study is developed in the context of Portugal, using the statistical subsections of the BGRI as the smallest spatial units. Three types of data are used: school locations, provided by the Portugal Directorate-General for Science and Education Statistics; a street network, available from OpenStreetMaps; and socioeconomic data, available from the National Statistical Institute. A database with approximately 240,000 subsection allows to assess how close different socioeconomic groups are to schools. This data can then be aggregated at different scales (e.g. parishes or municipalities), for which it is possible to calculate different measures, such as the minimum, maximum or average distances or the ratio of school by inhabitants.

The conclusions allow to identify two main dimensions of accessibility: i) distances to primary school and ii) coverage level of schools. A significant negative and non-linear relationship between the socioeconomic conditions of people and the level of accessibility, which is independent of the type of territories (clustered by the different kind of accessibility). For the number of schools by inhabitant, no relation was found with the IQ. This means that the inequalities in the provision of primary schools is restricted to distance and does not necessarily hold a relation to the per capita investment in territories.

## **Regular Session: RS15.3 - Theoretical and empirical urban economics**

**11:00 - 12:15 Thursday, 27th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/81262412877>**

**Chair Katarzyna Kopczewska**

## NATURAL SPATIAL PATTERN–WHEN MUTUAL SOCIO-GEO DISTANCES BETWEEN CITIES FOLLOW BENFORD'S LAW

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### ABSTRACT

According to Benford's law, the first one or more digits of numbers in any natural dataset appear with defined frequencies. For the first time, we use Benford distribution for spatial analysis to the geo-location of cities. The long-term history of urban locations is usually explained by social and economic factors. However, the spatial pattern of the geo-location of cities and their populations is unknown. We claim that the geo-location of cities and inhabitants around the world followed the evolutionary process, which results in natural spatial distribution. Our study proves that mutual 3D socio-geo distances between cities and populations in the majority of countries conform to Benford's law, and thus the urban geo-locations have natural distribution. In a search for factors driving Benford's conformity, we discover that a mixture of three pure point-patterns: clustered, ordered, and random in proportions 15:3:2 makes the 2D spatial distribution Benford-like. We also find that the 1D distance between population modeled with the composition of gamma distributions follows Benford. In the simulation, we prove that for complex 3D Benford-like pattern, the conformity in 1D or 2D distributions is sufficient, although the spatial factor is more important. For spatial statistics, this study develops new spatial distribution to simulate natural locations and shows that n-dimensional space can be reduced to a one-dimensional variable of distances. For urban studies, it shows that evolutionary settlement patterns resulted in the natural location of cities, and historical distortions in urbanization, even if persistent till now, are being evolutionary corrected.

## EQUAL OPPORTUNITIES TO ACCESS THE UNIVERSITY IN CHILE? AN APPLICATION WITH A SPATIAL HECKMAN PROBIT MODEL

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### ABSTRACT

The aim of this study is to contribute to the debate of the accessibility of higher education in Chile, focusing on both socio-economic and geo-spatial dimensions of access to university education. The central question we address in this paper is the following: Does geography (physical distance, neighborhood effects) play a significant role in determining accessibility of higher education in Chile? We use Heckman-type (Heckprobit) models to adjust for selection in the process of completing the trajectory towards higher education – that is, pre-selection, application for university place, and, ultimately, admission (or refusal) of participation in higher education.

The results shows that the geo-spatial have a significant effect on the postulation and accessibility of the student on Chilean universities.

**RELATED VARIETY: A META-ANALYSIS**

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**ABSTRACT**

The concept of related variety allowed a more precise understanding of Jacobs effects, allowing the analysis of positive externalities from unrelated and related sectors. It took off with Frenken, van Oort & Verburg (2005) but was quickly followed by dozens of other papers. This literature finds many contradictory effects, depending on the place and time analyzed, the setup of the related variety variables, and other study characteristics. We employ meta-analysis to trace these contradictions back to the sources of variation.

## **Regular Session: RS06.3 - Methods in Regional Science and Urban Economics**

**11:00 - 12:15 Thursday, 27th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/84441830561>**

**Chair Patrick Lehnert**

## NEW EMERGING POPULATION AND SETTLEMENT PATTERNS: THE CASE OF SLOVAKIA

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### ABSTRACT

The paper's main objective concerns population and settlement changes in the spatial-temporal dimension in the 1996 – 2019 time span. As a main methods of the research concentration quantities and local indicators of spatial autocorrelation were used. Achieved results point to the emerging outer city migration circle and inner – rural migration circle in most Slovakia regions on district LAU 1 level. Some of these clustering patterns also became statistically significant. Furthermore, the results show an apparent difference in population redistribution in municipalities between the Bratislava region and the rest of Slovakia; and significant imbalances between municipalities classified by size. Lower and medium-size municipalities (1,000 to 10,000 citizens) become decisive stabilization elements in settlement network formation. However, the current prevailing settlement form is unsustainable, especially in the Eastern part of Slovakia. Conclusively, in current terms, Slovakia is missing decisive territorial-urban policy. The urgency of the large scale communal reform in Slovakia is inevitable.

### KEYWORDS

Municipalities, population redistribution, urban-rural dynamics, urban-territorial policy

### 1. INTRODUCTION

#### 1.1 The general context of the settlement system formation

The world continues to urbanize. The long-term prospects continue to predict that the world will further urbanize over the next decade, from 56.2 percent today to 60.4 percent by 2030. Every region is expected to become more urbanized in the next ten years, although highly urbanized areas are expected to slow their rate of urban growth; UN-Habitat (2020). The increase in urban population has not been evenly spread throughout the world. By far, Asia has the highest number of people living in urban areas, followed by Europe, Africa, and Latin America; UN-Habitat (2016).

There are considerable differences in regional demographic patterns across the European Union (EU) from overcrowded, dynamic metropolises that may have relatively youthful populations to more remote, rural regions with declining population numbers and poor access to a range of services; Eurostat (2017). The share of the urban population in the EU continues to rise. Although almost three-quarters (72.5%) of EU-28 inhabitants lived in cities, towns and suburbs in 2014, there are considerable differences in the size and spatial distribution of urban developments between EU Member States. Overall, the increase in populations and the limited space available for urban developments has resulted in the divide between urban and rural areas becoming increasingly blurred. In many cities, people have tended to move out of inner cities to suburban and peri-urban areas on the outskirts of existing metropolitan regions; Eurostat (2016).

The EU's rural areas are diverse in nature, characterized by their specific natural environments and endowments. Just over one quarter (28%) of the EU-28 population lived in a rural area in 2015, with a somewhat higher share living in towns and suburbs (31.6%), while the biggest share of the EU-28 population lived in cities (40.4%). During the five years from 2010 to 2015, there was a gradual increase in the number of people living in rural areas across the EU-28, their relative share of the total number of inhabitants rising by 1.7 percentage points; the increase in the share of the population living in towns and suburbs was even greater (rising by 4.7%), while the share of people living in cities declined at a relatively rapid pace; these patterns possibly reflect Europeans leaving inner-city areas in search of more (affordable) space, in suburbia, towns, or the countryside; Eurostat (2017).

Urbanization developed independently in different regions, more or less in the wake of the agricultural transition's local completion. Explanations of these first transitions to city-based economies have emphasized several factors. The local concentration of population, stressed by Boserup (1981) or the emergence of cities as a function of trade, interpreted by Jacobs (1969) is one of the possible explanations; Knox, Agnew and McCarthy (2008). Zhao, Guo, Li and Smith (2017), as another factor, introduce the city's political power, which drives the government to allocate more resources toward the prime city, attracting migrants, resulting in a multiplier effect on income and population growth.

Stutz and Warf (2012) associate the Industrial Revolution with the cities' growth. In this period, the transformation of agriculture freed millions from rural toil lives and allowed for large, dense urban settlements. Almost everywhere, industrialization and urbanization have been virtually simultaneous.

It isn't very likely if there is some theoretical consensus about causative factors that resulted in urban forms of living. However, a more realistic interpretation is generated if the concept of an 'urban revolution' is replaced by the idea of an urban transformation involving a host of factors operating over a long period. As „ Redman (1978: 229) explained: urbanization was not a linear arrangement in which one factor caused a change in a second factor, which then caused a

change in a third and so on. Instead, the rise of civilization should be conceptualized as a series of interacting incremental processes that were triggered by favorable ecological and cultural conditions and that continued to develop through mutually reinforcing interactions “; Pacione (2009).

Cities could persist – as they have for thousands of years – only if their advantages offset the disadvantages. In economic terms, the advantages are labeled increasing returns to scale or economies of scale, just two sides of the same coin. Related to cities, we might speak about agglomeration economies. O’ Flaherty (2005) explains that an agglomeration economy exists when production is cheaper because more activity is going nearby. Agglomeration economies that arise from having many people located together, no matter what industry they work in, are called urbanization economies.

Furthermore, urbanization economies are the primary reason why cities are productive. Economic gains – higher output per worker, higher wages, higher profits, higher incomes – that come with firms and people’s geographic concentration. The reasons why agglomeration raises productivity – and thus incomes have been the subject of intensive research performed by Glaeser (2000), Henderson (2003), Duranton and Puga (2002). In all nations for which such data are available, cities, especially larger ones, generate a disproportionate share of wealth; Polese (2009).

Different types of agglomeration economies became focus of study, taken by Lichtenberg (1960), and Vernon (1960) and Chinitz (1961). The traditional analytical framework of agglomeration phenomena undertaken by authors had emerged as a fusion of Marshall’s (1890) insights and Hoover (1948). Marshall (1890) focused on the role of local knowledge spillovers, and the existence of non-traded local inputs and a local specialist labour pool, while Hoover (1948), Ohlin (1933) and Isard (1956) allocated the sources of agglomeration advantages into internal economies of scale and external economies of scale in the form on localization and urbanization economies, McCann and van Ort IN Capello and Nijkamp (2009).

Geltner, Miller, Clayton and Eichholtz (2014) speak rather about cities, which serve a functioning economy and geographic region. This suggests two points:

- Centralizing city causation (centripetal) forces are counterbalanced by opposing decentralizing (centrifugal) forces
- The relative strength of the centralizing and decentralizing forces differs for different functions and activities

The centralizing forces cause cities to form in the first place and to tend to agglomerate into fewer and larger cities over time. The decentralizing forces tend to limit city size growth and tend to make more small cities dispersed throughout the territory.

These empirical observations and economic intuition have been developed into a body of geographic theory known broadly as Central place theory, including extension known as the theory of urban hierarchy. Perhaps the most famous names associated with CPT development are the German geographers Walter Christaller (1933) and August Lösch (1944). In its nutshell, this theory explains the arrangement of the spatial distribution of sites known as service centers; Čadil (2010) and Ivanička (1983). Despite many simplifications, the main tribute of CPT is its ambition for explaining of geographical organization of society as a whole, including the definition of various features of the system of cities; Blažek & Uhlíř (2011).

The urban expansion process is the key driver of urban transformation. Urban expansion takes place in substantially different forms. In any given city, new expansion can take place with the same densities (person per square kilometer) as those prevailing in existing built-up areas, with increased densities, or with reduced densities. It can occur through the redevelopment of built-up areas at higher densities, through infill of the remaining open spaces in already built-up areas, or new ‘greenfield’ development in areas previously in non-urban use; Angel, Sheppard, Civco et al. (2005). However, the new greenfield development can either be contiguous with existing built-up areas or ‘leapfrog’ away from them and incursing to the rural areas located in the city’s hinterland. This phenomenon, commonly known as urban sprawl or peri-urbanization, may become the dominant 21<sup>st</sup> century challenge for regional and city planning and design. Increasing economic welfare and living standards, together with smaller household sizes but increasing household numbers, are important drivers behind this development; Nilsson et al. (2014).

So far, we haven’t mentioned the rural areas and related rural-urban interactions yet. There is broad consensus about no exact definition of the term ‘rural’, either conceptually or empirically; Wiggins and Proctor (2001), Hoggart et al. (1995) and Halcafree (1993). Wiggins and Proctor (2001); Ashley and Maxwell (2001) put forward three features that mark rural areas. The first and most evident is the relative abundance of land (and other natural resources). The second is that significant distances lie between rural settlements and cities. Moving goods between rural areas and either other parts of the countryside or the cities are costly. The third fact is the poverty of so many of the inhabitants. Average incomes are lower in rural areas than in towns and cities.

The number of authors highlights relatively abundant rural-urban relations and their role in developing the region (Satterthwaite and Tacoli, 2003; Tacoli, 1998; Akkoyunlu 2015; Berdegué et al., 2015 and Von Braun, 2014). When exploring rural-urban linkages, Satterthwaite and Tacoli, (2003) suggest that small and intermediate urban centers where most rural people and rural enterprises interact. There are a number of activities that such centers play in supporting social and economic development within rural areas – providing rural populations with access to schools, and health care centers, being a location for agricultural extension services, irrigation offices, and agro-industries linked to local products. Tacoli (1998) and Tacoli (2003); and Akkoyunlu (2015) point on rural-urban linkages, which include the flows of backward and forward linkages between agriculture, manufacturing and service sector. Also, many households in both urban and rural areas rely on the combination of agricultural and non-agricultural income sources for their livelihoods. Bellet and Llop (2000) in Berdegué et al. (2015) identify four services that urban centers offer to their rural surroundings:

- Specialized goods and services
- Greater social, economic and cultural interaction
- Links to infrastructure networks that connect local communities with regional, national and international communities
- Public and government administration services through which local demands and needs can be channeled

Von Braun (2014) conceptually distinguishes two dimensions: flow and linkage facilitators when speaking about urban and rural relations. The first includes infrastructures and government and other public and private actors; the second contains flows of people, goods, money, knowledge, information, and waste. Water, biomass products, and nutrients are relevant from biophysical perspectives, land and soil utilization.

Finally, we might speak about the processes which are driving rural-urban dynamics. Primary, we can speak about the time dimension and migration. 'Rural' vs. 'urban' is more than a simple dichotomy. There is a strong interdependence that produces a continuum from dense urban places to remote rural places. Before the Industrial Revolution, high transport costs and the relatively low productivity of farmers limited population densities and urbanization. In the nineteenth century, labor-saving technologies in agriculture and scale economies in manufacturing fueled large-scale rural-to-urban migration and the emergence of many large and medium-sized industrial cities. In the twentieth century, distinctions between rural and urban began to blur. After World War II the pattern changed dramatically: Urbanization slowed and population and production decentralized, leading to urban 'sprawl' and exurban development; Irwin et al. (2016).

## 2. SETTLEMENT OVERVIEW OF SLOVAKIA

According to the data provided by Joint Research Centre EU, urban centers in Slovakia in 2015 comprised approximately 14.98% of the total population, followed by urban clusters with 36.92% share, and the rest belonged to rural areas. Moreover, urban centers comprised only 9.81% in terms of built-up area, followed by urban clusters with 32.32% share and rest belonged to rural areas JRC (2020). According to a new common methodology for delineating cities, urban and rural areas (EU, FAO, ILO, OECD, UN-Habitat, WB, 2020); it suggests that the Slovak population predominantly settles rural areas and intermediate-density areas. Even taking the built-up area into account, there is another shift towards the rural area. The settlement system of Slovakia is politically and geographically tied with the polycentric settlement system of the EU. Urban development, including settlement development on the EU level, is coordinated through the ESPON program. The settlements are a major topic of interest in strategic goals and priorities in the strategy of Europe 2020; ESPON Atlas (2013).

The Slovak settlement system structure is defined in the Urban Development Conception of Slovakia and Slovak Spatial Development Perspective.

According to these two documents, settlement system is formed by a (i) network of settlement core areas, (ii) development axes, (iii) settlement centers, and other (iv) regional and local networks of small urban and rural settlements (the Urban Development Conception of Slovakia, 2001).

The system's foundations represent settlement centers developed on a five-tier hierarchy. Settlement centers fill the role of tertiary and even quaternary service centers. In their respective hinterland, settlement core areas are being formed, which are belts of the settlement groups. The Slovak Republic's development axes are created within a hub-belt settlement system, the core of settlement centers, and a transportation-communication system connecting individual centers.

The settlement centers with their respective core areas became focal nodes for commuting to work and services from their subordinated towns and countryside, short-term and long-term frequency, and even exchanging the labor between these centers. Moreover, these areas support labor mobility and migration on an interregional and even national basis (Slovak Spatial Development Perspective, 2012).

However, it does also exist other definitions of Slovak settlement structure. The most important classification in the so-called Functional urban areas concept (FUA) based on spatial interactions between the city and its hinterlands; Bezak, (2000). The system comprised fifty-one functional urban areas (the so-called system FMR 91-A) identified on interurban short-term migration from population census realized in 1991; Bezák (2008). In 2009 social typology of Slovak settlements was developed. The typology comprised nine classes based on sixteen identified variables. It showed a diversity of settlements based on its inhabitants' characteristics like predominant job occupations, social stratification, and settlements' functional structure; Gajdos and Moravanska (2009). One of the newest documents outlining settlement development strategy is The Conception of Urban Development of Slovakia. The crucial topics of the conceptions are (i) affordable housing, (ii) sustainable transportation, (iii) healthy environment, and (iv) cultural diversity of urban settlements; The Conception of Urban Development of Slovakia until 2030 (2018).

### 2.1 Urban-rural processes in Slovakia

Klobucnik and Slavik (2013) distinguish four main phases in the settlement development of Slovakia. They considered the second phase through the 13<sup>th</sup> and 14<sup>th</sup> centuries as the most important in terms of settlement system establishment in Slovakia. Mostly flatlands and basins were settled. In the third phase, foothill and mountain areas became occupied, and in the fourth phase, in the 18<sup>th</sup> and 19<sup>th</sup> century the settlement structure had stabilized. With a low industrialization rate and urbanization, Slovakia's country was predominantly rural until 1918. The communism period became an important phase of the development of the regional structure of Slovakia. This period's main feature was strong, balanced

industrialization and the collectivization of agriculture; Korec (2003). This period's urbanization process was managed according to the central settlement system's principles. Based on this principle, small and medium-size towns (20 to 50 thd.) of inhabitants were intentionally formed; Andrasko, Ira (2010); Fal'tan (2010), Ministry of Transportation (2001). Slavík et al. (2011) speak about the period of quantitative urbanization. The number of inhabitants living in the cities increased from 857 thd. to almost 2.9 mil. to 1989. Thus, the growth index reached the value of 351%. The degree of urbanization increased from 24.9% in 1950 up to 56.7% in 1989.

Danielova (2014) divides these processes into three groups: elementary transformation processes – which affect the only single structure (morphological, functional, demographical). Typical processes are intensification, revitalization, functional fragmentation, deindustrialization, or reindustrialization. Secondly, we might speak about partial transformation processes, which typically affect two or more structures like residential districts' humanization, commercialization or gentrification. Finally, complex transformation processes simultaneously affect morphological, functional, and demographical structures. Here belongs suburbanization or re-urbanization.

Fal'tan and Pašiak (2004) evaluate the major developing trends of the Slovakia settlement system during the transformation period: (i) the development leads to the deepening of divisions between the rural and urban environments. We might speak about social-economic differences contributing to regional gap growth, shaping core and peripheral regions; (ii) there are ongoing trends of suburbanization and decentralization. The growth or decrease of the cities or rural areas has significant, selective character. (iii) there is an ongoing depopulation and aging process of rural areas, especially tiny ones. These areas lack attractiveness, which is related to the shortage of job opportunities and low population density.

The rural settlement structure in Slovakia is now well differentiated. Up to 41.4% of municipalities in 2011 haven't had at least 500 inhabitants, and 69.6% of municipalities had less than 1000 inhabitants. In 2011 only 10% of municipalities had more than 2000 inhabitants. Concerning the spatial distribution of bigger municipalities, we may speak about the high concentration in Western Slovakia, predominantly located in the Bratislava region, followed by the Trnava region and Nitra region. In the middle part of Slovakia, the number of big municipalities is severely diminished, just 8.3% share, and the lowest share is in Eastern Slovakia, only just 5,6% Bleha et al. (2014), Drinka and Majo (2016). Fal'tan (2010) highlights the two-way development of urban-rural relations in the current period. Suburban pressure and its local demonstration mostly reveal on the municipalities located in suburban corridors (just copying carrier transport corridors) and in the hinterland of bigger cities. It is also a case of small municipalities' if they have good access to higher urban units. These municipalities record positive demographic increases. In a relatively worse situation, rural areas are located in lagging regions, with poor infrastructure, a weak labor market, and bad transport access. These marginalized factors initiate the mechanism of one-side spatial mobility outwardly from the region, which further worsens the situation.

The rural decline is an inevitable process associated with the agricultural transformation to the urban-industrial economy and, further on, to the knowledge economy. However, the rural decline is not pre-destined. It is by the interactions between rural areas and the external environment that rural communities either grow, decline or even vanish. In this process, rural communities of different geographic conditions, natural resource endowments and social relationships, and people's values, attitudes, and institutions will make different responses, which finally lead to different evolution patterns and outcomes; Li, Westlund, and Liu (2019). Several authors Allison and Hobs (2004); Gleeson (2008); call for better rural policies leading to revitalization, rural renewal, or rebirth. Birkmann (2016) points on the over congestion of resource environmental bearing-capacity of cities, especially small and medium-sized, due to the emigration outflow from the rural areas in developing countries.

### 3. MATERIAL AND METHODS

The paper's main objective is to search Slovak population and settlement dynamics in 1996 – 2019 on regional level NUTS 2 and local (district) level LAU 1. Firstly, we focus on imbalances in the spatial distribution of population among the settlements and regions. For this purpose, we used the concentration quantities for measuring the concentration ratio of Slovak sites, varying by size in each region on the NUTS 2 level. All used data come from the national statistical office of Slovakia. Formally, we observe  $m$  regions ( $i = 1, 2, \dots, m$ ), with  $n_i$  municipality (settlement) frequencies  $i = 1, 2, \dots, m$  units. Within each region there are  $c_k$  categories of municipalities by size  $k = 1, 2, \dots, s$  units. In total we have  $\sum_{i=1}^m n_i$  units. We distinguish ten sites categories by size in interval scale from 0 – 199 as smallest to > 100,000 as the biggest. The intervals are not equal.

The concentration measures might be expressed as the coefficient of concentration (also Gini coefficient) or the concentration ratio. In the regional analysis, both concentration statistics evaluate the distribution of some statistical phenomena in the area. In this relation, we might speak about the diversification (unequal) or equal distribution, Minařík, Borůvková and Vystrčil (2013); and Chajdiak (2009). The concentration coefficient may be written as

$$K = 1 - \sum_{i=1}^m p_i(X_{i-1} + X_i) \tag{1.0}$$

And the concentration ratio as

$$P = \frac{\sum_{i=1}^{m-1} (F_i - X_i)}{\sum_{i=1}^{m-1} F_i} \tag{1.1}$$

Where

$p_i$  is relative value frequency in  $i$ - class

$F_i$  is cummulative relative value frequency up to  $i$ - class

$X_i$ - cummulative relative frequency of variable  $X$

Both statistics have helped us reveal the degree of population concentration within the municipalities in regions; however, we do not know which particular municipality category dominates within the regions yet. For solving this issue, we introduce HHI-score (Herfindahl-Hirschman Index) modified for our purposes for measuring the degree of concentration of municipalities in particular size category in regions. Formally we can write:

$$HHI - score = (\%S_1)^2 + (\%S_2)^2 + \dots + (\%S_n)^2 \tag{1.2}$$

Where  $S_i$  is relative share of municipalities in particular region

Finally, we have evaluated rural-urban dynamics as population switch between the urban settlements and rural areas on local level LAU 1. Nowadays, there are 140 municipalities on the list, with city status. Moreover, *Act no. 50/1976 Coll. on territorial planning and building order (Building act)*, set the mandatory conditions when the settlement can achieve the city's status – exceeding the population over the 5 000 permanent residents in the municipality cadaster. For the study, we picked up all municipalities designed as cities according to the Ministry of Interior and all municipalities exceeding 5 000 inhabitants in 2019.

It is necessary to note that urbanization changes within each district's settlement structure include the population's migration changes and natural changes. Whereas the natural changes of the population could have a more or less even pattern of distribution over the entire country (Slovakia), migration changes could behave unevenly in various regions. The research sample consists all administrative units of Slovakia on LAU 1 (district) level, thus  $N = 79$ . The growth in the rural-urban ratio  $g_{urr}$ , between period  $t$  and period  $t + 1$  can be expressed as

$$g_{urr} = \ln \left( \frac{URR_{t+1}}{URR_t} \right) = \ln \left( \frac{\frac{PU_{tj+1}}{PR_{tj+1}}}{\frac{PU_{tj}}{PR_{tj}}} \right) \tag{1.3}$$

which simplifies to

$$g_{urr} = \ln \left( \frac{PU_{tj+1}}{PU_{tj}} \right) - \ln \left( \frac{PR_{tj+1}}{PR_{tj}} \right) = g_{pu} - g_{pr} \tag{1.4}$$

The growth in the urban-rural ratio over time is simply the difference in the urban and rural populations' growth rates, respectively Bloom et al. (2007). However, it is reasonable to suspect that the magnitude of urban-rural differences is not necessarily uniform over the regions but rather varies from one part to another. To capture this phenomenon's spatial variability, we must rely on another set of measures that can indicate possible spatial autocorrelation at the local scale. These types of measures are referred to as *local measures*. There several statistics for measuring the spatial autocorrelation (Moran's I, Geary's C and general G-statistics), but for our purpose, we use Local Indicators of Spatial Association (LISA), which commonly refers to the local version of Moran's I, Geary's C; Anselin, (1995) in Wong and Lee (2005). To indicate the level of spatial autocorrelation at the local scale, a spatial autocorrelation value must be derived for each areal unit. The local Moran statistics for areal unit is defined as

$$I_i = z_i \sum_j w_{ij} z_j \tag{1.5}$$

Where  $z_i$  and  $z_j$  are deviations from the mean for the corresponding  $x$  values, or

$$z_i = \frac{x_i - \bar{x}}{\delta} \tag{1.6}$$

Where  $\delta$  is the standard deviation of the variable  $x$ . Therefore,  $z_i$  is basically z-score of  $x_i$ . Similar to the interpretation of Moran's I, a high value of the local Moran statistics means a clustering of similar values and low value of local Moran statistics indicates a clustering of dissimilar values. High or low local Moran statistic for each district may occur by chance. These values must be compared with their expected values and interpreted with their standardized scores. According to Anselin (1995) in Wong and Lee (2005), the expected value under randomization hypothesis is

$$E[I_i] = \frac{-w_i}{n-1} \tag{1.7}$$

And

$$Var [I_i] = w_{i.}^{(2)} \frac{\left( \frac{n - m_4}{m_2^2} \right)}{(n-1)} + 2w_{i(kh)} \frac{\left( \frac{2m_4 - n}{m_2^2} \right)}{(n-1)(n-2)} - \frac{w_{i.}^{(2)}}{(n-1)^2} \tag{1.8}$$

Where

$$w_{i.}^{(2)} = \left( \sum_j w_{ij} \right)^2; w_{i.}^{(2)} = \sum_j w_{ij}^2, i \neq j; m_2 = \frac{\sum_i z_i^2}{n}; m_4 = \frac{\sum_i z_i^4}{n}$$

And the term

$$2w_{i(kh)} = \sum_{k \neq i} \sum_{h \neq i} w_{ik} w_{ih} \tag{1.9}$$

The z-scores for each unit is obtained by

$$z[I_i] = \frac{I_i - E[I_i]}{\sqrt{Var[I_i]}} \tag{2.0}$$

#### 4. RESULTS AND DISCUSSION

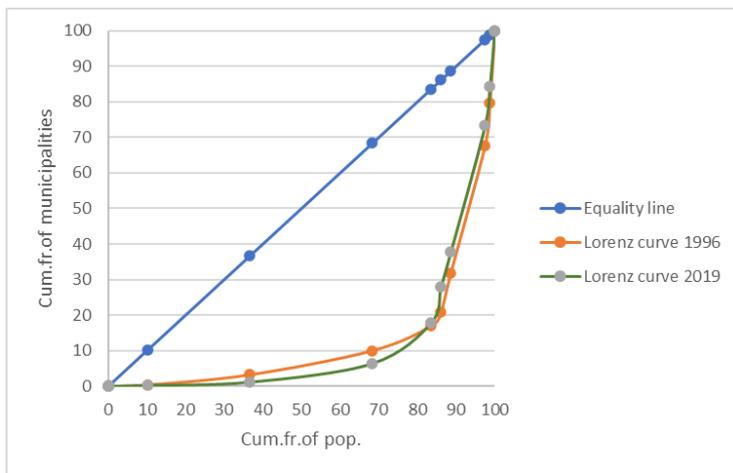


Figure 1: Concentration of population in Region of Bratislava, own calculations

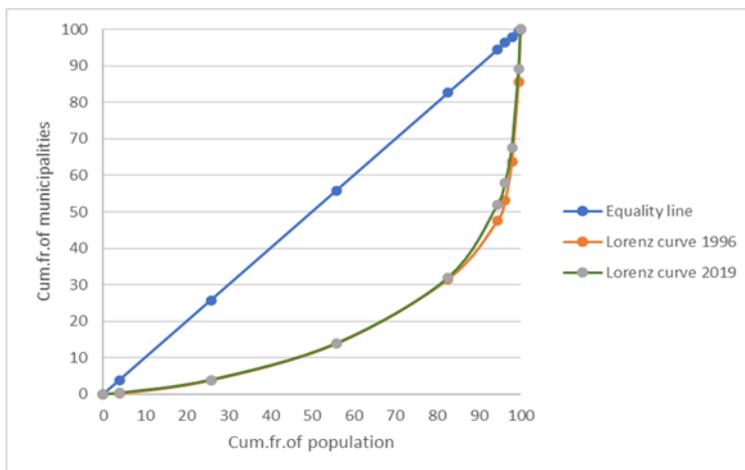


Figure 2: Concentration of population in West Slovakia area, own calculations

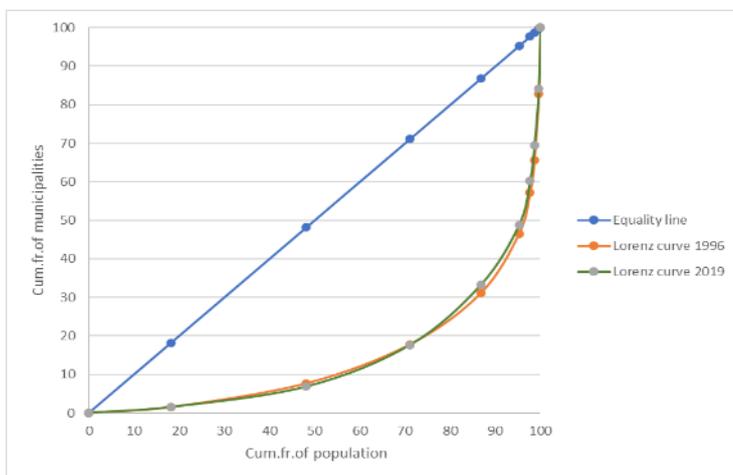


Figure 3: Concentration of population in Central Slovakia, own calculations

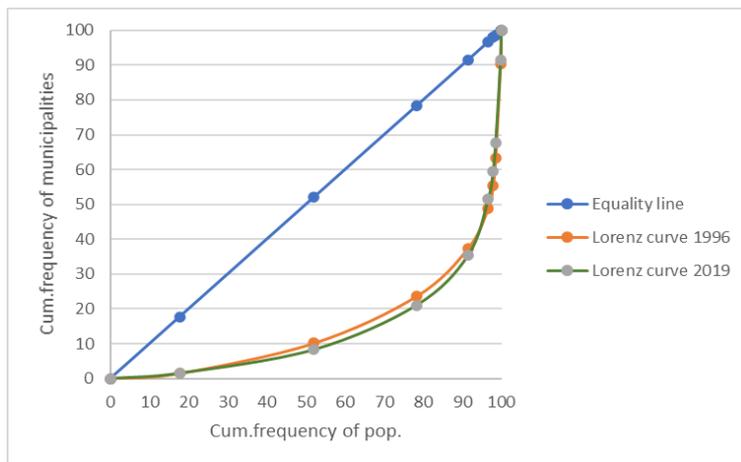


Figure 4: Concentration of population in East Slovakia, own calculations

Figures (1.,2.,3, and 4.) on layout 1 show the degree of concentration on NUTS 2 level in Slovakia. The horizontal axis captures the cumulative frequency of population, and the vertical axis captures cumulative frequencies of municipalities (settlements).

All regions on the NUTS 2 level show a fairly increased concentration level, graphically depicted by the Lorenz curve. We might also observe slight variations in the degree of the concentration between the period 1996 and 2019. So, it might be concluded that population patterns have not changed very much.

Table 1: The concentration measures in Slovak region on NUTS 2 level in 2019

Region/ NUTS 2	Coefficient of concentration (K)	Concentration ratio (P)
Bratislava region of Slovakia	0.519	0.689
West Slovakia	0.426	0.626
Central Slovakia	0.454	0.697
East Slovakia	0.459	0.694

Source: Own calculations.

Table 1 shows concentration measures calculated on Slovak NUTS 2 level in 2019. Taking it more detail, we might observe differences between the Bratislava region and the rest of Slovakia. Bratislava region has shown an increased coefficient of concentration, which results from imbalances between the population shares, which live in relatively small municipalities in the Bratislava region. Interestingly, in 2019, municipalities with up to 5,000 citizens capture just 17.8% of the population's share in the Bratislava region. Other Slovak regions on the NUTS 2 level show somewhat lower concentration levels. On average, they exceed 50% of the population share, currently living in municipalities with up to 5,000 citizens. In the term of the concentration ratio, West Slovakia and Bratislava region have shown lower figures, because of fairly representation of the medium and bigger sized municipalities (1,000 to 5,000 citizens) with 45% share on average, which can capture a significant portion of citizens up to 30% on average. Conversely, the Central and East Slovakia regions have shown up slightly higher concentration ratios, which results from a relatively high share of municipalities with up to 5,000 citizens (95% on average for both regions) on a total number of municipalities. In the Bratislava region, the relative share of municipalities with up to 5,000 citizens represents 75%.

So far, results point to relative significant imbalances between the population concentration observed in the Bratislava region; and the concentration of small municipalities in Central and East of Slovakia. However, it is still unclear what category of municipality dominates in each region based on its population share.

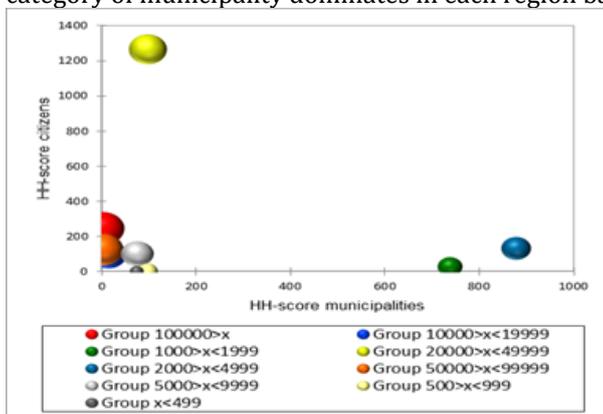


Figure 5: HH-score municipalities vs. citizens in Bratislava region

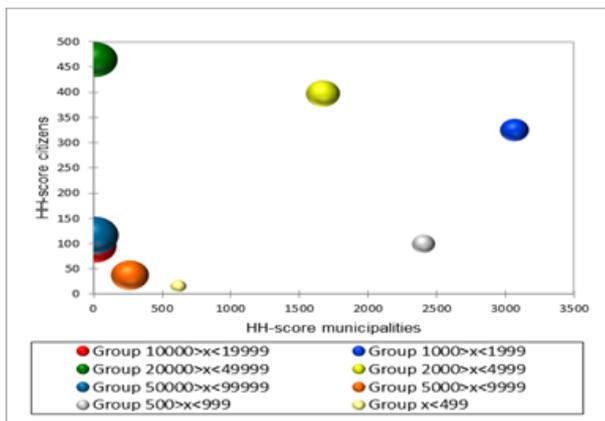


Figure 6: HH-score municipalities vs. citizens in West Slovakia

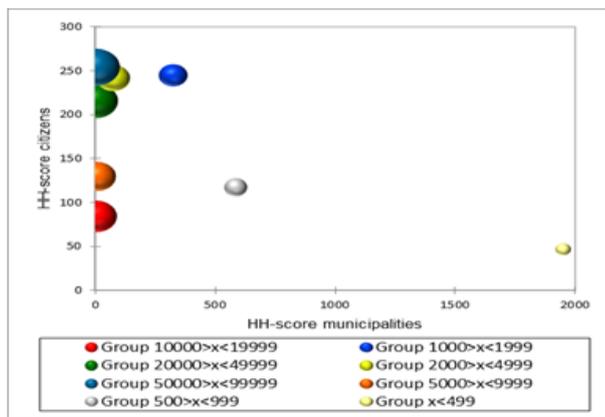


Figure 7: HH-score municipalities vs. citizens in Central Slovakia

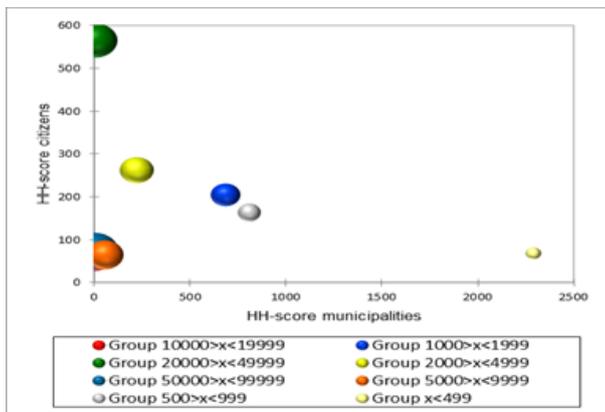


Figure 8: HH-score municipalities vs. citizens in East Slovakia

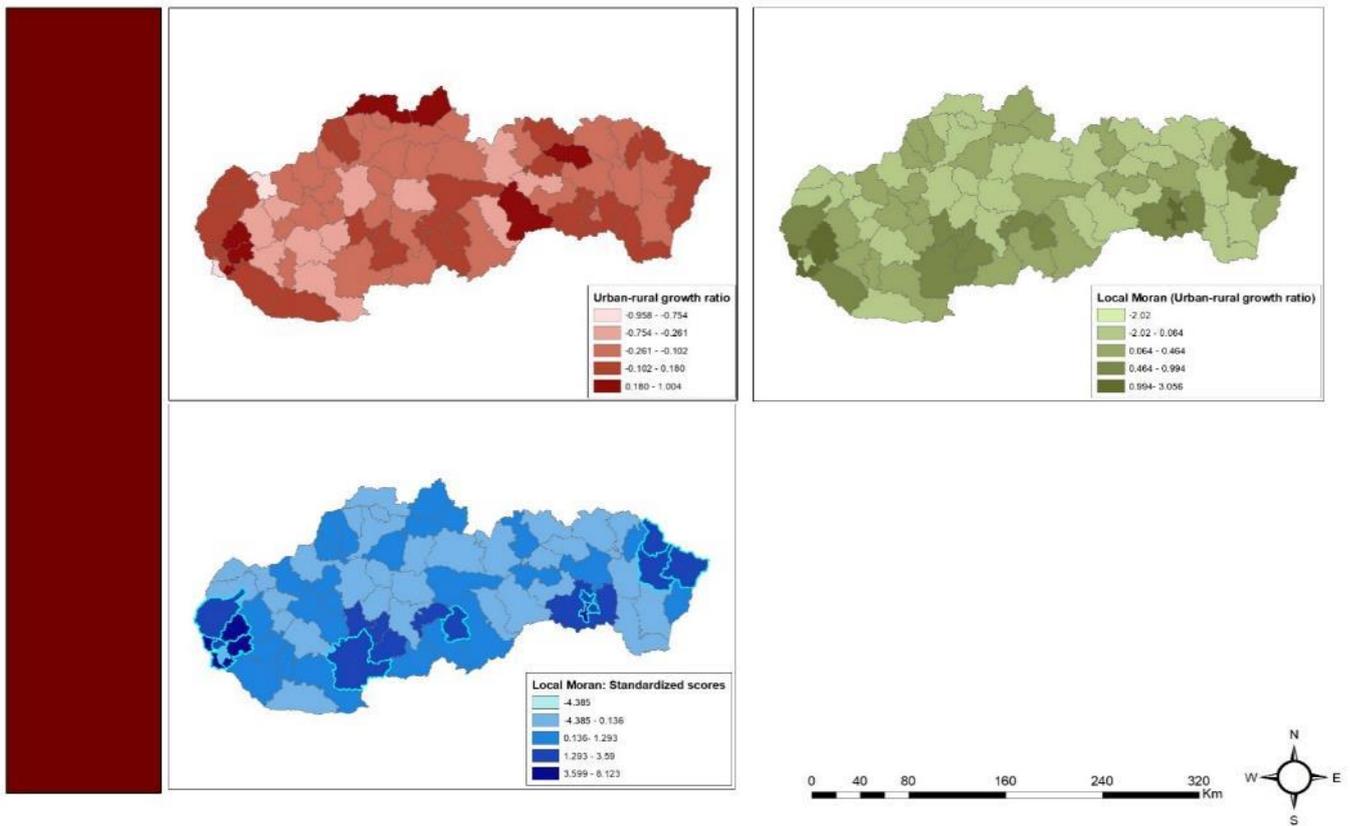
Figures (5,6,7, and 8.) on layout 2 show scatterplots of calculated HH-scores of municipalities vs. citizens by size on NUTS 2 level in 2019. For the scatterplot diagram, we have used nine (in the case of Bratislava ten) size groups of municipalities. In each region, the distribution of size categories shows an uneven pattern. HH-score varies between 0 and 10,000. In general, values close to 0 show more proportional shares in represented sample units, whereas higher values indicate disproportional shares in the sample.

Bratislava region and West Slovakia show some similar features. Bigger size groups of municipalities (>10,000 citizens) have shown only small HH-score weight in the settlement system, and they are located in the lower-left corner of the scatterplot diagram. However, lower and medium-sized groups (1,000 to 10,000 citizens) have caught significant weight in both displayed variables and become a stabilizing element of the settlement system.

Central and East Slovakia have shown patterns with uneven HH-score weights distributed between the municipalities and citizens. Big-sized municipality groups (>20,000 citizens) located leftward have shown high citizen HH-score but only scant municipality HH-score. Conversely, tiny municipalities (<1,000 citizens) have caught the highest municipality HH-score and considerably lower citizen HH-score. Exception represents only lower and medium-sized municipalities (1,000 to 5,000 citizens), which have caught comparable proportions of the HH-score in both variables.

Finally, we switch our attention to evaluating spatial patterns by observing urban-rural growth rates on the LAU 1 level in 1996 – 2019. For measuring the dynamics, growth of the rural-urban ratio as a difference of the growth rates between the urban areas (municipalities >5,000 citizens) and rural areas (municipalities <5,000 citizens) has been used. The

statistics show a long-term pattern of spatial population distribution between the urban areas and the countryside. For evaluating broader spatial relations, local Moran's spatial autocorrelation statistics have been used.



**Figure 9: Spatial changes in population redistribution between the Urban and Rural areas on LAU 1 in Slovakia, 1996 – 2019 time span**

The upper leftward figure shows the urban-rural growth ratio, according to equation 1.4, on LAU 1 level, calculated over the 1996 – 2019 time span. Subsequently, local Moran statistics about spatial autocorrelation were computed (upper right figure). The lower leftward figure shows computed standardized - score for each district on a significance level. The maps were arranged into the classes based on the *Natural breaks (Jenks optimization)* method realized in the ArcMap application. We might observe relatively distinct spatial patterns. In the western part of Slovakia, the ratio mostly has shown negative values, which does mean that cities (>5,000 citizens) lose population and rural areas gain population. So it is in line with current ongoing suburbanization trends observed also elsewhere. However, it is not the case in the Bratislava region, which despite witnessing one of the most vital suburbanization trends in the 90-years, most of the districts showed urban population gain. It might be explained that the population primarily prefers bigger municipalities (over 5,000 citizens), or either as a result of intensive suburbanization over the years, previously smaller municipalities (<5,000 citizens) have gained enough population and switched to city category, or simply urban areas have outpaced the rural ones in the rate of immigration.

Central Slovakia has shown mixed results, mostly prevailing ruralization patterns, except few areas located in the south and north. The same picture provides East Slovakia, where interestingly, several peripheral and border areas have shown urbanization patterns. Their spatial remoteness, poor transport infrastructure, or lack of services make those people generally prefer moving into cities.

Local Moran statistics have shown mixed patterns across all regions of Slovakia. It shows a higher level of similarity between the neighboring district in the Bratislava region, which also became statistically significant. Similar clustering values also show the Central-south, South-east, and North-east districts of Slovakia. Finally, a few cluster pockets reveal in the North of Slovakia; however, they did not become statistically significant. Conversely, the Central and Eastern part of Slovakia mostly shows clustering of negative values, indicating dissimilar values; however, any of them (except Bratislava II district in the far West) did not become statistically significant.

## 5. CONCLUSION

The paper's main objective has been to search for population and settlement changes in the spatial-temporal dimension in the 1996 – 2019 time span. In terms of the settlement changes, the population concentration measures in municipalities on the NUTS 2 level were observed. The results have shown relatively great imbalances between the population shares currently living in cities (more than 5,000 residents) and other municipalities (below 5,000 residents) located mostly in the countryside. There are also significant differences in shares of small municipalities (below 1,000 residents) represented in regions. Central and East of Slovakia have the lion's share of these municipalities; however, in

the West, there is much more balanced between the small (below 1,000 residents); and medium-sized or bigger municipalities (1,000 to 5,000 residents). Slovak settlement disintegration; Šprocha et al. (2015), Drinka and Majo (2016), Hrdina et al. (2019), Bucher (2011), Černenko, Harvan and Kubala (2017), Ištók and Lovacká (2005) as a major development barrier was also highlighted in a number of studies; Gajdoš (2009), Ira et al. (2010).

In terms of measuring of HH-score of the municipalities vs. citizens, on the municipality level, in respect to size, results also point to significant regional disparities. Central and East of Slovakia show an uneven distribution of HH-score weights between small municipalities (<1,000 citizens) and its citizens. However, in the Bratislava region and West of Slovakia, lower and medium-sized municipalities (1,000 to 10,000 citizens) show more balanced distribution HH-score weights, thus becoming a stabilization element of the settlement system creation. Nowadays, living in small communes and in the hinterland of big and medium-sized cities is becoming more attractive; Mladek and Čupelová (2010).

Finally, results point to selective population redistribution between the urban areas and the countryside; Fal'tan and Pašiak (2004). Significant population immigration to urban areas was observed mostly in the border and peripheral regions or economically disadvantaged regions, located mostly on the country's South and East. Poor infrastructure and lack of services might be the reason for this pattern; Fal'tan (2010). Michniak (2014) stresses the multi-dimensional nature of problems of the most marginalized regions. These regions are specific for diffusion or accumulation of several adverse characters and phenomena. They could be related to the physical-geographical constraints, historical legacy, demographical and social-economical aspects.

Districts located in the 'inner' part of the country mostly show rural immigration patterns. Broader spatial relationships in the case of several districts could not be ruled out. Several clusters of districts located in the Bratislava region and South and East of Slovakia show statistically significant similarity in local Moran standardized scores.

We might conclude that Slovakia, in general, is missing a more decisive territorial-urban policy. Over the years, more adverse settlement shaping patterns have developed, which do not contribute to the overall sustainability of living in Slovak settlements. Slovakia has too many very small municipalities located mainly in the East, lacking the infrastructure and services, and conversely congested Bratislava metropolis with its urban hinterland. More proactive policy measures toward municipality merging and using alternative transport moods are being demanded. Long-term urgency of this issue also stressed Sloboda (2005), Nižňanský (2005) and Nižňanský (2009); and Brix (2019).

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## PROXYING ECONOMIC ACTIVITY WITH DAYTIME SATELLITE IMAGERY: FILLING DATA GAPS ACROSS TIME AND SPACE

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### ABSTRACT

Satellite data has gained increasing popularity among economists. The most commonly used type of satellite data is night lights data, which constitutes a valuable proxy for economic activity (i.e., GDP) at the national and subnational levels. However, evidence-based policy analyses may require measures of economic activity beyond the spatial and temporal scope of night lights data. When government policies affect economic activity in small regional units (e.g., urban districts), investigations of such policies need regional measures of economic activity. Moreover, studies on the economic consequences of historical events demand measures of economic activity with a long time series (e.g., analyzing economic activity in the former German Democratic Republic). Night lights or other data might not yield the necessary regional and temporal scope in these contexts.

We develop a novel approach to proxying regional economic activity. We use daytime satellite imagery and apply machine-learning techniques to identify six different surface groups, that is, types of land cover such as built-up land or cropland. We demonstrate (a) how we compute these surface groups and (b) that the regional combination of these surface groups is a valid proxy for economic activity. The surface groups allow the measurement of regional economic activity both over a longer time series and at a more detailed regional level than other existing measures. While we demonstrate our approach for the example of one country (Germany), we have produced them also for other European countries and are currently producing them for the U.S. In principle, our procedure is generalizable to any region in the world, for which various types of economic policy analyses might require data on economic activity.

We obtain the surface groups from Landsat satellite data, which has three advantages over night lights data. First, Landsat data has a substantially higher resolution (30 meters) than night lights data (one kilometer), thus making possible analyses at more detailed regional levels. Second, the Landsat data we use starts in 1984 (whereas night lights data starts in 1992), therefore allowing for analyses over a longer time series. Third, Landsat data enables researchers to identify different types of surfaces, thereby providing a more nuanced measure of economic activity.

We compute the surface groups by applying a machine-learning algorithm in Google Earth Engine, thereby closely following the remote-sensing literature. To assess the value of the surface groups for economic research, we test their validity as a proxy for economic activity for Germany, using reliable and regionally detailed administrative data on GDP (available since the 2000s). Furthermore, data on household income (RWI-GEO-GRID) make possible an analysis at the level of very small grid cells (sized one square kilometer).

Our analyses show that the surface groups constitute a valid proxy for economic activity. At small regional levels, they predict economic activity even more accurately than night lights. Furthermore, the prediction error tends to be less spatially and temporally biased. The surface groups thus constitute a valuable measure for economic research, particularly for assessing policy changes affecting small regional units and for analyzing historical contexts.

## IMPROVING VACCINATION RATE THROUGH COMMUNITY AWARENESS<sup>160</sup>

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Fiscal Policy Agency, Ministry of Finance, Indonesia

### ABSTRACT

The novel coronavirus 2019 (Covid 19) outbreak has devastated public health in general and a significant economic threat worldwide, including in Indonesia. The existence of vaccines has become the possible source of the decline in Covid 19 additional cases per day in various countries. Indonesia has started the vaccination program on January 13, 2021, which costs are estimated to be around Rp. 73 Trillion or equal to 500 million US dollars. However, there's a widespread concern that the vaccination program may not rapidly implement. On average, there are only 66 thousand people vaccinated per day in Indonesia. Those numbers are small compared to other countries such as the United States, which can vaccinate up to 1 million people per day. This paper investigates whether the vaccination acceleration plan can improve Indonesia's vaccination implementation by employing machine learning tools. Using the dataset from SUSENAS 2018-2019 and the Ministry of Finance, we estimate the proportion of health workers, the elderly, and the community aged 18-59 years who have morbidity symptoms and receive outpatient and inpatient health services proxy to health access. This study comes up with five simulations to estimate the result of vaccination programs under five different scenarios. In the first simulation, people go to government health facilities to get vaccinated. In the second simulation, we add to the first simulation with the assumption that the vaccines are given for free. In the third simulation, we add to the second simulation by expanding health facilities such as private hospitals, clinics, doctor and midwife practitioners. Since Indonesia also has a community access problem to health facilities, we add free transportation in the fourth simulation. Finally, in the fifth simulation, we try to integrate community awareness into the vaccination program. Community awareness is when one head of the household persuades and escorts at least one person to the vaccination facility. In the first and second simulations, we obtain the vaccination rate, which is around 66 thousand people per day, similar to what occurs nowadays. At this rate, there will be only 27 million people in Indonesia get vaccinated in March 2022, far below 181 million people as targeted by the government. The vaccination rate reaches 175 thousand people/day under the third simulation and 177 thousand people/day under the fourth simulation. However, under the fifth simulation, the vaccination rate can reach a staggering 1 million people/day. These results show that besides the availability of health facilities, health practitioners, and transportation assistance, community awareness plays a prominent role.

### KEYWORDS

Covid19, Vaccination rate, Community awareness

<sup>160</sup> This paper is a personal opinion and does not reflect the policies of the institution in which the authors work

## **Regular Session: RS09.4 - Regional and urban policy**

**11:00 - 12:15 Thursday, 27th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/82231138454>**

**Chair Patricia Ikouta Mazza**

## THE ROLE OF SHARED WORKSPACES AS AN ANCHOR OF COMMUNITY RESILIENCE FOR LOW-INCOME URBAN POPULATIONS

[Dalit Harel](#), [Sigal Kaplan](#)

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### ABSTRACT

In the last decade shared workspaces are widely spread world-wide with thousands of public and private sectors shared work-spaces. This study investigates the role of shared workspaces as an anchor of community resilience for low-income urban populations. To date, studies explored the role of shared workspaces from the employee and regional innovation perspective, while the effect on the community empowerment remains unraveled.

This study focuses on a new municipality owned multi-functional shared workspace serving the variety of uses and is geared towards empowering the residents and promoting low-income young adults. Besides providing a workspace, the following activities are initiated by the management staff (all residents) in order to answer community needs: ii) lectures and community events, iii) university exam preparation courses, women empowerment, entrepreneurship events and networking opportunities; iv) a hub for learning support.

Interviews were conducted with the management staff (ten employees) and with a sample of thirty 18-21 years-old attending the workspace. We identified processes leading to behavioral change among the young adults attending the workspace. We looked at the change processes via the lens of the Trans-Theoretical model positing five stages of behavioral change: observation, preparation, change action, maintenance and assimilation, including successes and backsliding. Additionally, via the existence-relatedness-growth model we identified the layers of human need that this venue meets.

The changes undergone by attendees who spend time and engage in activities at the facility foster personal and community resilience in Jaffa. According to the management staff, 60% of the young adults assisted by the facility enroll to universities, compared to 20% enrollment rate in the surrounding neighborhood. The venue creates anchors for young people and is a major springboard in areas of crucial importance: education and employment. The facility activities are aimed at all the five stages of behavioral change. Need awareness is promoted through school visits and collaboration, through word-of-mouth by creating a neighborhood "buzz", and through community activities and lectures by community and industrial leaders. Preparation is facilitated by courses and information. Action change is supported with personal help in scholarship submissions, networking and internship programs. Maintenance and long term assimilation is supported by the staff involvement over time. The workspace contributes to the young adults in three main areas. Firstly, the facility alleviates functional barriers by providing university preparation courses, language and academic writing courses, and information about university, enrollment, scholarships, student aid programs. Obstacles are addressed by the helpful, attentive, and closely-involved staff, who create a sense of personal connection. Secondly, the facility promotes social inclusion by providing a meeting-place and giving its users a homelike, familial atmosphere and sense of belonging. Thirdly, the facility plays a substantial role in strengthening the confidence and self-image of young Jaffa residents by offering them an experience of success helping them leave their comfort zone. All of these things help the venue's young clients achieve success in self-management.

## ON SMART INSTITUTIONS: TOWARDS NEW TERRITORIAL ACTORS TO SUPPORT ECOLOGICAL TRANSITION AND REGIONAL DIVERSIFICATION<sup>161</sup>

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### ABSTRACT

The paper addresses the need for a change in the institutional framework of smart regions to address three challenges: (i) sustainability (SDG), (ii) innovation-diversification (RIS3), and (iii) the ability to properly allocate structural funds (Green Deal and Next Generation EU). These three challenges are assessed taking into account the complexity of managing smart regions, considering the presence of first and second-generation territorial commons, that lead to innovate the configuration of new institutional forms. In this context, the paper analyzes the role of territorial actors and their impact on the territorial systems. Some guiding criteria are outlined to support the configuration of smart institutions as the basis to enable the emergence and consolidation of smart regions.

### KEYWORDS

Smart Institutions, Territorial Actors, Smart Regions, Institutional Innovation, Sustainable Development

### 1. INTRODUCTION

During the last decade, significant efforts have been done to strengthen the configuration of Smart Regions where the main challenge was to support innovation-diversification and, at the same time take advantage of the different assets and capabilities already available in the territories and regions. However, problems to implement RIS3 have been observed, especially in the process of screening, selecting, prioritizing sector, and allocate the ERDF, where the idea of Smart Specialization is confronted with the difficulties that political operators face by managing innovation funds D'Adda et.al. (2021), remembering the problem of "picking winners".

Part of the problem is the complexity behind the idea of RIS3, and in our opinion, the lack of appropriate institutional settings to implement it. In contrast, the origin of the Smart Specialization policy, back to the work of the "Knowledge for Growth" Expert Group (see Forey et. al. 2009a), specified that Smart Specialization is an "entrepreneurial process of discovery"<sup>162</sup> and is far from being a top-down industrial policy or any form of "grand plan", where territorial actors, especially enterprises, are those that *discover future areas of specialization-diversification*. However, it has been the case for its implementation?

Capello and Kroll (2016) already observed the challenges regarding RIS3 in translating theory to practice, pointing out mismatches between functional and political-administrative regions, lack of inclination to admit bottom-up participation, lack of capabilities to engage regional entrepreneurial discovery; hence calling for *new governance* and linking projects with a broader approach considering the "*territorial capital*" (Camagni, 2009) avoiding narrow industrial policy perspectives and introducing more territorial complexities within RIS3, considering different actors and different typologies of assets and ownership.

Balland et. al. (2019) also remarked on the limits of Smart Specialization policies, especially regarding the lack of analytical tools and frameworks capable of orient policymakers in the selection-investment processes, where the authors propose to consider the analytical framework of *relatedness and knowledge complexity* as a valid instrument to foresee areas of feasible innovation and diversification of regions:

"We need to think more deeply about how to tackle the inherent tension within smart specialization policy between prioritizing and selecting activities based on regional potentials (as in the proposed framework), on the one hand, and reliance on the entrepreneurial discovery process in which this selection process is completely decentralized, bottom-up and process-led [...] One potential way to solve this tension is, first, to identify diversification opportunities in each region based on their scores on relatedness and complexity, after which, within that range of opportunities, the entrepreneurial

<sup>161</sup> The paper can not be cited without the permission of the authors

<sup>162</sup> Additionally, the experts of "Knowledge for Growth" not only conceived that SS was a bottom-up process, and spontaneous dynamic that would require governmental support on this matters, but also considered the need to *use one simple tool*: the General Purpose Technologies (GPTs) that can be diffused among regions promoting chatching-up dynamics base on waves of digitalization, Industry 4.0 , new business models, etc.

discovery process will unfold, in which a range of local actors will decide which activities to target...” Balland et al. (2019:1264).

Certainly, we can mention several limits and challenges that RIS3 where deeper analysis has been carried out by Hassink and Gong (2019) that deserved a reach and detailed response from Foray (2019), acknowledged that the word “specialization” was regrettably misleading. highlighting that “ the main function of the concept is to introduce a bottom-up component in a process that also has a top-down component” Foray (2019a: 2074), what he called a combination of planning logic and entrepreneurial discovery logic. However, revising the policy after ten years he proposed a “more obvious process that regions will find easier to implement [...], the three steps needed for the design and implementation” Foray (2019: 2068): (i) identify priorities for the region, (ii) translate these priorities in transformational roadmaps, and (iii) implementing with an action plan.

So what we observe is that the Smart Regions approach, if embedded in RIS3, is strongly shaped by a policy-mechanical tool containing several planning-implementing aspects to manage financial resources to support regional development in the EU, that is expected to work, taking into consideration business bottom-up dynamics, where, is excepted that in some stage policymakers will prioritize, select and support (see OECD, 2013). However, we ask if this intervention approach can make a region smart?; nevertheless, before deepen our analysis, we consider it important to understand what Smart Region is.

For practical purposes, and although our intent in this contribution is not to explore a proper definition of Smart Regions, we need to specify what we understand by a Smart Region as a basis to deepen our analysis on “Smart Institutions”. For this aim, we will synthesize this concept taking the main elements that characterized them as referred by the EC Smart Specialization Platform<sup>163</sup>, in part due to the lack of studies on this concept. Based on this review, we can define Smart Regions as those capable to take specific *actions* and mobilize *resources* to provide support to *bottom-up entrepreneurial dynamics* based on unique *territorial knowledge and innovation* capabilities, allowing the discovery and development of new sustainable regional growth paths, a process that takes place through a *polyarchy governance system*, avoiding top-down and governmental-driven industrial policy approaches.

In our understanding, Smart Regions are intrinsically characterized by collective actions that shape the regional development assuring its sustainability through innovation and new forms to preserve and expand its territorial capital. However, is for this type of region the main role of local and regional governments to screen, select, prioritize, and mobilized the main resources?

According to Rodriguez-Pose et. al. (2014) in the RIS3 approach are different territorial actors (firms, higher education institutes, public research centers, members of civil society, and other local actors) as those suited to discover the promising activities for regional innovation, where these different set of actors should be part of the formulation strategy, emphasizing that the role of the government institutions in more on the quality of the government system (efficient, transparent, inclusive) with effective control and incentives; so providing good conditions for the operation for the territorial actors that implement the innovation and transformation processes. On the other hand, Cortinovis et.al. (2016) highlight that the role of the regional government to foster diversification matters when “bridging social capital”, it means when government supports the emergence of a specific type of social capital that “bridge”, peoples and communities, enabling open networks of cooperation.

All these aspects indicate that the actions of regional authorities, to shape Smart Region, will be more related to exert a role for enhancing the institutional quality of the territorial. Such quality is achieved, with the presence of inclusive institutions, that encourage the participation of the great majorities in the economy using their talent and skills (see Acemoglu and Robinson, 2012:144). All these aspects pointed out that the configuration of Smart Regions depends on the role and participation of the regional stakeholders, configured by different territorial actors and under a polyarchic territorial institutional system.

Rodrik et. al. (2004), Acemoglu and Robinson (2008-2012) exposed how institutions precede development over trade and geography among deep fundamentals of growth, however, the latter two influence institution through its effects on integration patterns (distance, environmental condition, and linked diseases, ruggedness, natural resources, etc) and behavior of the actors. Nowadays, we are not facing malaria and colonization, however, our regions are facing a significant impact due to Covid-19, and climate change is putting under pressure on our eco-system; where urban development and land regulations have a key role regarding carbon dioxide emission, (see Glaeser and Kahn, 2010). Now, the EU has launched the largest financial package to deal with these exogenous variables, Covid-19 and Climate Change, where Next Generation EU and Green Deal will allocate in the following years an unprecedented quantity of economic resources. In this context, the question is, how these supra-national policies will shape the Smart Regions strategies? will this massive fund impact the institutional setting? Are the regions ready to allocate efficiently such resources?

## 2. SMART REGIONS: CHALLENGES FOR SUSTAINABLE DEVELOPMENT AND REGIONAL DIVERSIFICATION IN TIMES OF MASSIVE STRUCTURAL FUNDS

Smart Regions, as we defined above, face several challenges and opportunities in times where the EU is approaching to apply a significant amount of resources to change the energy matrix, achieve CO2 neutrality, support information technologies as GPT for a massive transformation of business models. In this historical momentum, we have identified five main challenges for Smart Regions as exposed below:

- (i) *Centralism in times of crisis and recovery*

163 See <https://s3platform.jrc.ec.europa.eu/home>

In times of crisis is known that subnational authorities are shadowed by the power of central authorities (Douglas, 2019), leading a process of centralization cascade (Raudla et. al. 2015). So we ask if the massive presence of EU funds for recovery and CO2 neutrality may lead toward more centralization and less participation of local actors in shaping sustainability? Previous experience of crisis management and fiscal stimulus have shown the possibility to observe that such kind of patterns. The challenge is relevant because if such a phenomenon takes place, regions and localities may lose bottom-up dynamics generating an effect on policymakers and local authorities to monopolize the use of the resources increasing the presence of bounding rationality in decision-making processes (see Nelson, 2012).

(ii) *Resource allocation model*

We acknowledge that *traditional government allocation models* in a time of crisis (pandemic and environmental) may face the main challenge different challenges: (a) *efficiency, fairness, and speediness* in resource allocation, (b) *precision*: allocate in the right territorial actors and projects, and (c) *effectiveness*: support the bottom-up entrepreneurship and innovation processes.

The first issue (efficiency, fairness and, speediness) is linked to the institutional quality in terms of administration quality, transparency, and processes; the second issue (precision) is a more complex task, and the decision-making in this context of potential increasing centralism and political pressure for resource allocation would face significant challenges to should screen, select and decide how, when and who will receive financial resources, where such concentration of power and resources may lead to institutional problems and even increasing corruption or collusion, with the possibility of leaving behind territorial actors that has not the political space and capabilities to access to benefits. The third issue (effectiveness in supporting bottom-up entrepreneurship) is even more challenging in a scheme where top-down priorities are leading the ecologic transformation and recovery. Consequently, is rational to expect that in a context of crisis and recovery the complex process of supporting discovery dynamics and bottom-up entrepreneurship, would become a marginal activity, finishing in standards project calls, classical schemes of incentives for SMEs among others that may not have the capacity to respond to the urgent challenge of fostering sustainable development, deeper economic diversification and increasing knowledge intensity in the local economies.

(iii) *From linear value chains to circular ones*

Another relevant challenge in regions that look for ecological transition are changes in the value chain configuration and management. For decades companies and local entities have been managing linear value chains; focusing on the required infrastructure to support input and output process under a linear value chain perspective. In this way, institutions were arranged to support the provision of energy, transport infrastructure, water facilities, as well as water management, and waste management. Nonetheless, the increasing pressure of waste disposals and raising environmental concerns increases the need to work with semi-circular value chain processes, with a massive introduction of recycling centers based basically on management materials that were easy to recovers. Even so, the ecological transition is demanding a circular economy defined as “a regenerative system in which resource input and waste, emission, and energy leakage are minimized by slowing, closing, and narrowing material and energy loops. This can be achieved through long-lasting design, maintenance, repair, reuse, remanufacturing, refurbishing, and recycling” (Geissdoerfer et. al. 2017:759). In this perspective, the traditional recycling system and waste and water management solutions, that currently, most territories have, may be insufficient to respond to the challenge of a broader circularity, even more, if the idea to create regions of a circular economy is targeted, the strategy would demand to rethink the institutional set-up to manage circular value-added systems.

(iv) *SDG as core goals among territorial system*

The SGD goals of the Agenda 2030 set clear and broader goals; showing that sustainability not only considers planetary boundaries but also social once as Raworth (2017) conceptualized. These goals to be implemented, necessarily go through the implementation of 17 SDG at the territorial level, showing that, is at this level where the problem can effectively tackle. Bramanti and Brugnoli (2019) proposed a synoptic framework of how structural transformations that include the green economy, digitalization, demography are interlinked with different models of territorial development systems, which are synthesized in three types (see Table 1), where in one pole are those with a high level of industrialization, in the other pole areas with high environmental value and the middle the urban systems.

**Table 1. Synoptic framework: structural transformations, territorial models and sustainable development in 17 SDG<sup>164</sup>**

Model of territorial development	Area with widespread industrialization	Urban systems	Areas of high environmental value
<b>Structural Transformation</b>			
<i>green economy - decarbonization</i>	4-5-7-8-9-10-11-12-13-16-17	5-7-8-9-10-11-12-13-16-17	2-5-6-7-8-10-12-13-14-15-16-17
<i>digitalization</i> Smart city / smart land	4-5-7-8-9-10-11-16-17	1-2-3-5-6-7-8-9-10-11-13-16-17	2-5-6-7-8-9-10-11-16-17
<i>demography - active aging / immigration</i>	3-4-5-8-9-10-12-16-17	1-2-3-5-8-10-12-16-17	2-3-5-8-10-12-16-17
<i>SDGs with high relevance for territorial development model</i>	3-4-5-7-8-9-10-11-12-13-16-17	1-2-3-5-6-7-8-9-10-11-12-13-16-17	2-3-5-6-7-8-9-10-11-12-13-14-15-16-17

Source: Bramanti and Brugnoli (2019)

As the authors specified that SDG Goals SDGs 5, 8, 10, 16, 17 recur in all quadrants, indicating the unquestionable contribution that the territorial systems have, in particular bottom-up SMEs dynamics, can offer for the achievement of these goals.

Additionally, the achievement of ecological transition based on decarbonization, push up digitalization as GPT, and innovation to shape Smart Regions requiring the support of the overall territorial system, which is moved by its actors where large corporations play also a key role. Consequently, our main concerns and questions rely on the current *regional government and governance systems* have enough “smartness” to identify such level of complexity, where is required to capture micro-signals, foreseen potential opportunities, and can raise and allocate massive resources with *efficiency, fairness, speediness, precision, and effectiveness*; set of concepts that are closer to “smart actors” prone to entrepreneurial and innovation dynamic. Consequently, we believe that it is important to identify territorial systems and models that better can tackle SDG goals using the appropriate tools and policy frameworks relying on *smarter institutional settings* which in our opinion require to foster the emergence of smarter territorial actors.

**3. SMART REGIONS AND THE ROLE OF TERRITORIAL ACTORS AND ACTIONS**

Forey (2019b) argues that in the last thirty years the policies of innovation “have been characterized by a moderate degree of interventions and neutral logics of resource allocation [...] of innovation policies are insufficient in supporting more radical transformation, such as the modernization of an old industry or the acceleration of innovation to solve certain grand societal problems.” Forey (2019b:1379-1380), suggesting that to increase the level of transformation, it is required to shift the level of intervention advocating for non-neutral policy intervention. Consequently, following this approach, is rational to think that in a Green Deal scenario, would be expected to move in the direction of radical innovation and transformation with strong non-neutral intervention, privileging the role of public authorities. However, the main problem of “transformational approaches” is how interventions take place?

Critical questions are in non-neutral intervention who is expected to (a) identity, (b) priorities, (c) allocated resources,(d) innovate, and (e) transforms?. Hence, in our opinion, the debate is not only about grades of intervention (moderate or radical) and orientation (neutral or non-neutral), but especially regards “*who acts*” the process. In the SIR3 approach, issues (a) and (b) are mainly led by policymakers and public authorities, with less of more degree of protagonism; issue (c) is also usually managed by central authorities and regional governments but also is supported in several cases by a financial mechanism where local bank systems matter; issue (d) is usually a cooperative process between the private sector and knowledge institutions (public, private or mixed) and the transformation (e), usually not discussed, is under the role of industries. So “a, b and c”, are the main areas of discussion in term o innovation and growth policy in the SIR3 approach, however, is not the case if we consider other perspectives.

For instance, transformational and planning shaped approaches are usually far away from remarkable schools of thought that have significantly impacted the understanding of innovation and sustainability (key vectors for Smart Regions), as is the case of the Austrian School and the Bloomington School, both schools that converge in different aspects as Aligica et. al. (2017) analyze, concluding that innovation - the whole processes from “a” to “e”- is linked to collective actions, where disruptive innovation take place through “non-linear and polycentric process whose participants include a wide

164 1: No Poverty, 2: Zero Hunger, 3: Good Health and Well-being, 4: Quality Education, 5: Gender Equality, 6: Clean Water and Sanitation, 7: Affordable and Clean Energy, 8: Decent Work and Economic Growth, 9: Industry, Innovation and Infrastructure, 10: Reduced Inequality, 11: Sustainable Cities and Communities, 12: Responsible Consumption and Production, 13: Climate Action, 14: Life Below Water, 15: Life on Land, 16: Peace and Justice Strong Institutions, 17: Partnerships to achieve the Goal

variety of actors (including researchers, university administrators, entrepreneurs, venture capitalists, corporations, and public officials)” Aligica et.al. (2017:12).

This polycentric approach allowed to reduced the problem of bounded-narrow rationality and reduced the problem of selection, prioritization, and resource allocation. A varied set of collaborative territorial actors are more fitted to manage the risk and evolutions of the whole territorial system.

For example, in the experience of Silicon Valley widely studied (see Engel, 2015; Kenney, 2000, Adams, 2003-2005; Bugos, 2001), the smartness of the place was configured by a network of specific territorial actors with precise action. It is also the case of the innovative milieus; however, part of the limitation to understand these smart places is that this experience has been mostly studied by urban economists and less by historians, where the role of the actors and their actions has not been fully captured and studied. From a historical perspective, we can learn more about historical facts, actions of people, families, groups, associations, universities, etc; to better understand dynamics without leaving behind a fundamental part of the “telling story” of smart places; where concrete (smart) people, or group of them, or specific institutions are the explanatory variables of outstanding experience.

Brugnoli and Garrone (2018) identified the case of the “Systemic Actor”, understood as a territorial actor that is capable to mobilize in a certain way the territorial capital of a place, capable to interact with Multi-Actors, Multi-Sector, and in Multi-Scale (3M) perspective; identifying that these kinds of actors can be entrepreneurs, or a group of them, or universities, local governments, or foundations, among others; so the sector o activity to which they belong, may vary, however, their traits are similar although different experience analyzed.

In this perspective, we consider that possibly much attention has been given to the “neutral” and “non-neutral” policy approach or the strategic and analytical frameworks that policymakers should take into consideration to “better select” sectors and activities. Instead, we suggest providing more attention to the study of “actors-actions” and adopt policies and practices according to the territorial actor setting. We argue that also several other potential categories or actors can be identified, characterized by a set of specific actions, and impact the evolution of territories.

To better explain this aspect, we have considered the experience of a well-known smart place, the Silicon Valley, analyzing, briefly the group of people that were behind this outstanding experience (see Table 2), where be trace, briefly the role of Leland Stanford.

**Table 2. Traits of a Systemic Actor in the experience of Silicon Valley**

<i>(i) Engagement and empathy with the community and the territory:</i>	Leland Stanford, founder of Stanford University, before ist endeavor, and even before be nominated Senator of the Union, became the Governor of California; a sign of its interest and commitment with the place, building a broad view of the region.
<i>(ii) Capacity to mobilize and raise large economic resources:</i>	Standford was a railroad magnate, and entrepreneur, capable to understand the economic environment. He can mobilize its 8.180 acres (stock farm) in Palo Alto to configure the campus of Standford University (territorial anchor institution).
<i>(iii) Inclusive mindset and behavior:</i>	On of the co-founder of the university, D. Starr Jordan shared with the Stanford family and collaborators the idea to build an institution "nonsectarian, co-educational, affordable, to produce cultural and useful graduates, to teach traditional liberal arts and technology and engineering" (Standford Univestity). As matter of fact the US West Coast, was already a place with strong migration dynamics and the university bridge different cultures and backgrounds and create a vibrant community.
<i>(iv) Market-driven and practical approach</i>	Frederick Terman, a historical professor, was focused to teach their students not only to invent and create, but also tocommercialized, linking the invention with market dynamics, to better read needs and providing useful innovations.
<i>(v) Vision and purpose:</i>	Since its foundation, the university clearly states its purpose “to promote the public welfare by exercising an influence on behalf of humanity and civilization” (Standford Univestity). This statement goes beyond short-term and pecuniary approaches, rather was focus on transcendental goals for the community with a global purpose.
<i>(vi) System mobilizers</i>	The systemic actor has a particular capacity to shape territorial institutions and to mobilize collection actions and support territorial capital creations. Its core capacity is to protect, expand and co-create different types of "commons".

Source: Own elaboration based on Nicholas, and Lee (2014).

They built was a strong community in the territory, with the will to transform the place, adding a strong quote of collective actions. After this dynamic was very well established, attracted the attention of Federal Government funds, with directionality in some specific areas, allocating, producing more radical innovation, and reinforcing the human capital, and innovation capacity of the place, adding significant knowledge spillovers in the area.

We understand that similar processes were also carried out in milieux (see GREMI contribution 1991 and 2004) experience and industrial districts (Becattini, 1979); however, as mentioned, a historical review of the actors among Smart Regions would significantly contribute to understanding the role and specific actions of the place.

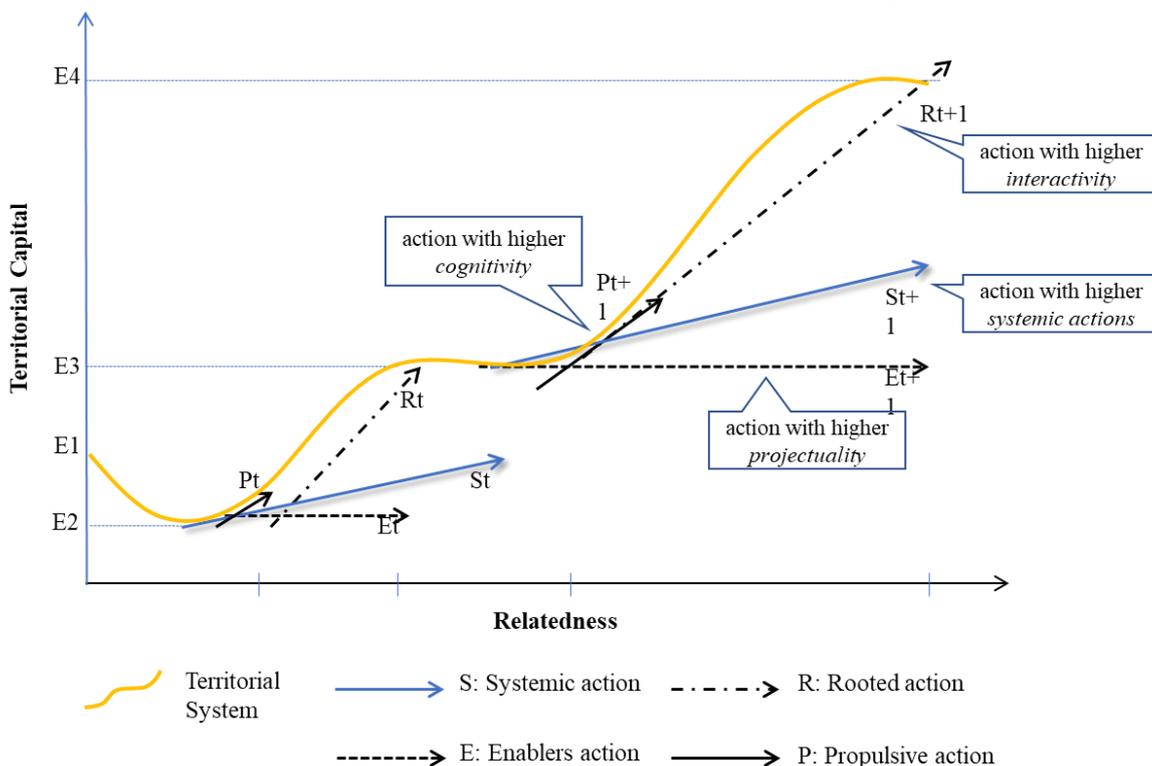
What we wish to emphasize is that the transformation towards Smart Region cannot be built without the presence of certain types of actors-action, given their capacity to generate changes in the territorial system structure and to mobilize the institutional system. Following the case of Silicon Valley, that due to the scope of this contribution we will not fully expose, we wish to extract also the presence of other specific typology of actors-actions, where we found the following profiles:

- *propulsive*, characterized by its R&D capabilities, able to ignite new development trajectories; configured by researchers institution, think tanks, R&D enterprises, etc.
- *enabler*, characterized by its capacity to mobilize capital (financial and human), hence configured by financial institutions and educational ones.
- *rooted*, characterized by actions and actors that are deeply engaged with the territorial dynamic, these are citizens, manufacturers, investors and usually are not under a free-rider scope and its activities are deeply rooted in the place.
- *systemic*, as mentioned, it can mobilize the whole territorial system and attract different actors. Systemic are from different nature (public, private, mix) and scope (profit, not-for-profit, or fourth sector).

It is important to mention that Territorial Actors are not separate from governmental institutions (from different levels), rather in several experiences systemic actors may coincided also with local government in certain characteristics and capabilities, but due to the heterogeneity or regions, this can vary on nature and scope.

Such preliminary typology of territorial actors-action shapes new institutional settings and fosters collective actions mobilizing and transforming the territory in growth or backward performance. Hence, what we are highlighting is that RIS3 policies and the problem of industries and resource targeting should take into consideration the actors perspective and do not rely only on one typology of actor – usually public one – as those that lead resource allocation, selection, and investment activities to look for a Smart Region configuration.

On the other hand, we think that is also important to model in some way the dynamics of the territorial action that shaped innovation-diversification and increase (when positive) the territorial capital of the place. In this analysis, we found that *Boschma (relatedness)* provides key elements for understanding the *flow* dimension and *Camagni (territorial capital)* provides also key elements for understanding the *stock* dimension, to the complex dynamics behind the territorial transformation. Consequently, we consider that RIS3 and the Smart Regions policies require to rethink their approach giving more attention to the actors-action point of view. Fig. 1 provides an intuitive model of the function of the territorial system, where relatedness interplay with the territorial capital supported by specific actor-actions.



Source: Own elaboration

**Fig 1. Territorial System and growth trajectories based on action-actors**

**4. ON SMART INSTITUTIONS: THE CHALLENGE OF INSTITUTIONAL SETTINGS FOR SMART REGIONS**

The main two challenges that we observe when Smart Regions are approached, are: how sustainability-transition and innovation-diversification can be shaped. Main issues rely on the *nature of the problem* which is deeply rooted in the problem of the *commons*. The territorial system, cities, and regions deeply rely on the quality of the commons and its institution for collection actions (see Foster, 2018). This aspect has been deeply by Rajan (2019) who emphasized the need to support local actors to provide balance to the territorial system, as an essential pillar to achieve sustainability. Moreover, Giraud (2013) remarks also the nature of the problem, considering novel forms of commons that demand the reconfiguration of local and global actors to achieve ecological transitions.

Here we approach essentially two types of commons, one of first-generation, part of the territorial Common-Pool Resources (CPR), from natural resource base, and one of the second-generation, the commons of knowledge (Hess and Ostrom, 2007).

Hess (2008) defines CPR as “resources shared by a group where the resource is vulnerable to enclosure, overuse, and social dilemmas. Unlike a public good, it requires management and protection to sustain it” Hess (2008:37), presenting a large number of second-generation commons, among these are traditional commons and global commons (agriculture, forest, land tenure, water and irrigation, wildlife, biodiversity, pollution, waste, etc) as well as knowledge commons (universities, civic education, internet infrastructure, access, libraries, open sciences, genetic commons, peer production as open-source software, etc). The complexity of the commons relies on the innovation-collaboration capacity to design and agree on institutions for collective actions. In this perspective; Ostrom (1990) approach the commons under three fundamental institutional models for its management:

- Leviathan as the “only” way: argue that the tragedy of the commons cannot be resolved by cooperation, hence to avoid the tragedy it is required a powerful central government to protect and rule the resource system.
- Privatization as the “only” way: argue that to avoid the tragedy it is required to end the common-property system and work only under private property rights.
- An alternative solution: Ostrom argues that due to the particular nature of the commons, and applying the game theory framework, is demonstrated that collaborative private-public solutions in different forms can maximize the benefits for the community, proposing an institutional system that promotes the development and balance exploitations of the commons, control monopolistic and purely extractive behaviors and proposing a polyarchy system where “institutional deals” are required. Such alternatives are varied and work on self-governance structures.

Such analysis is particularly in the case of natural resources is well known their different application in special institutions; however the common of knowledge reserve more detail. For Hess and Ostrom (2007) knowledge commons, which can also be referred to as information, commons are not pure “open access” information, rather a complex set of information and actors which parts are open and other managed under exclusive networks and are not free, protecting essential property rights and at the same time providing an open basis for knowledge capitalization. This is extremely important in the context of the negative ‘market stealing’ effect from non-interactive knowledge search as explored by (Roper et al 2016).

Additionally, knowledge commons are particularly important in the configuration of regional and territorial technological externalities where knowledge spillovers boost innovation (see Breschi and Lissoni, 2001). Such resources are essential to managing strategic knowledge of a place and, usually are not the proper institutional settings that protect and administrate such dynamics. In these conditions “knowledge leaks” take place, and actors, with not rooted in the place grasp knowledge to be copied and replicated in other regions, that later may directly compete with the territories that create them, threatening the competitiveness of regions.

However, what is also significant is knowledge commons where R&D externalities take place, are prone to create their institutional settings, a dynamic that may help to re-shape Smart Regions institutional settings. Weder and Grubel (1993), following Coase principles, found that R&D externalities will induce the creation of self-organized private institutions able to internalize these externalities, where a vibrant institutional setting may be established.

However, some may suggest that under EU innovation fund interventions, would be better to keep control and lead innovation processes. However, authors have explored the impact of regional governments on innovation, and the results are not encouraging. Cortinovis (2016) and Boshma (2017) found that the role of regional governments on diversification is only remarkable when these “bridging social capital”, so when support institutional relatedness, mobility, and interaction between territorial actors. These are indications that support polyarchy regional systems with varied institutions may significantly help to support innovation particularly under a bottom-up approach; where different institutions may be specialized in specific functions, as well as in practices for resource allocation, and to reach new market opportunities. This regional innovation system would prevail on pushing up selection, specialization, and prioritization, a process and may lead to significant errors and strong inefficiencies, and loss of resources.

On the other hand, Boshma and Gianelle (2013) argue that to face the tension regarding prioritizing, and selection of activities is feasible to identify opportunities based on scores of relatedness and complexity, so local actors based on this information may decide. We argue that this is a valid but very sophisticated strategy framework difficult to assess and promote at the territorial and regional level because few institutions are capable to understand and work on these parameters; therefore local leaders may relying on regional advisors to translate these interpretations and applications the risk to do not verify its feasibility with local actors. However, if these instruments are work by *propulsive actors* as

research centers, local think tanks, etc., and may cooperate with *systemic actors*, this kind of policy and a sophisticated instrument may find a feasible way to be implemented.

Additionally, a regional specialization on actors' functions, rather than in sector, may provide more efficiency to the territorial system. For instance, local financial institutions are essential for the adequate allocation of resources, having in good knowledge of clients and capacity to innovate with financial instruments. Such kind of *specialized institutions* exert an *enabling* action in the territorial system and are essential to be engaged in the strategic process of resource allocation, rather than rely mainly on public leaders that may divert resources due to political pressures as explored by Dellmuth and Stoffel (2012) regarding European fund allocation.

Moreover, from an accurate analysis of the Bloomington School, we can derive that "Green Deal" and "Next Generation EU" funds are configured as a precise type of commons, a fact that has a significant impact on the model in this regional institutions are configured. Such fund are a specific (second-generation) type of common, because of:

- Is a common-pool resource based on the large accumulation of collective action of EU members and financial institutions (tax collection, collaterals, assets, production).
- Impact the overall territorial system and his contributions are intended to provide a resilient and protective measure of essential commons or the regions.
- Resources are limited and face high pressure and competition among EU actors and may put the resources under significant stress, requiring special protection and administration procedures.
- The resource can be expanded and even replicated again, due to the particular circular nature, allocation, interest, returning of loans ore return through future taxes increasing the CPR system.

So, what we consider is that regions and Smart Regions, require special settings or institutions to be able to manage such complexity of commons, rather we can observe an increasing centralization and a "leviathan way" unable to foster bottom-up dynamics, and shape Smart Regions.

Our analysis leads us to rethink the institutional setting of regions, to be able to achieve the Smart approach, with a structure able to support resource and knowledge sustainability fitting its particular nature. For this aim, we suggest considering that the following policy criteria to rethink institutions of Smart Regions:

(i) *Identify regional territorial actors*

Heterogeneity is intrinsic to regions as well as their institutional quality. And although EU regional administration may have similarities and the allocation of EU funds follow guidelines and rules for all the EU, the effectiveness of the allocation and quality of the efforts to pursue sustainability-transition and innovation-diversification will rely on the territorial actors-action. Consequently, it is important to identify, regional actor's capacities, specialization, and roles within the territorial system and support a new institutional arrangement.

(ii) *Apply the "golden rule": strong governance systems to manage commons including funds*

Polyarchy is essential to boost innovation and shape Smart Regions. This kind of regional approach implies a change of paradigm, particularly in terms of resource allocation. Smart Regions are not fitted to depend on top-down decision-making regarding funds and other resources. Smart Regions should be able to innovate on new institutional settings to manage public resources.

(iii) *Support institutional specialization and diversification, rather than targeting economic specialization-diversification*

Smart Regions should provide and support specialization on actors' functions increasing its capabilities.

(iv) *Support institutional innovation:*

Relatedness dynamics are not only essential for the evolution of business and more complex products; however, such kind of system also requires more complex and innovative institutions, where different types of actors (private, public, third, and fourth sectors) should configure new institutional settings to respond in a better way to territorial needs. Fear to lose control lead to path-dependence and lock-in dynamics. As an example, several policymakers see Singapore as a leader in the radical innovation process; however, little attention has been given to its complex institutional setting that has been created to manage different investment processes, governance structures, *fund allocation systems* to accelerate investment in new technology and knowledge capture. Singapore's "smart city" transformation cannot be understood without an accurate understanding of its complexity and varied institutional setting with mixed forms of institutions, showing how Ostrom's "alternative way" can release unique territorial dynamics to shape sustainability and diversification through institution innovation processes.

(v) *Support the emergence of strong territorial actors:*

Smart Regions require to reshape their institutional structure and be able to be supported by strong territorial actors that may exert *systemic, propulsive, enablers, and rooted actions*. This support is expressed in creating the proper legal framework for delegate, empower and support new roles and resource mobilization capabilities.

(vi) *Identify, expand and protect territorial commons:* Smart Regions should be able to identify traditional and new commons as having the smartness to support institutional agreements to support and protect them.

Finally, Table 3 synthesizes a process of change in the institutional setting of regions to support the emergence of smart dynamics.

**Table 3. Old and New Institutional Paradigms in Smart Regions**

Old Paradigm	New Paradigm
Prioritization led by government	Prioritization led by territorial actors
Target Sectorial specialization - diversification	Target Institutional specialization-diversification
Government-driven resource allocation	Actor-driven resource allocation
Self-government control	Self-governance control
Innovation Agenda led by government and experts	Innovation Agenda led by territorial actors
Golden rule: government decision making	Golden rule: governance decision making
Institutional silos	Hibrid institutional structures
Fiscal packages and stimulus as public resources	Fiscal packages and stimulus as commons
Stakeholder participation	Stakeholder empowerment

Source: Own elaboration

**5. CONCLUSIONS**

The Smart Specialization Strategy approach that shapes Smart Regions presents significant limits, particularly in its institutional setting approach that may reduce the capacity of regions to achieve the expected development results. Major limits of RIS3 are in process of screening, selecting, prioritizing, usually led by public authorities that decide on discovery-driven processes that are not inherent to their social functions. Smart Regions work on pivotal resources that take the form of “commons” (first and second-generation), where natural and knowledge common-pool resources are by nature complex and demand a more complex institutional setting to shape collective actions to preserve and transform essential territorial commons.

In the current context, Smart Regions dynamics expect to be reinforced through new massive structural funds as Green Deal and Next Generation EU. However, such resources may increase top-down dynamics and centralization, reducing the capacity of regions to achieve the goals that Smart Regions pursue and its SDG. Nonetheless, EU public funds, analyzed under the Bloomington School framework, shown that are configured as a new generation of commons, consequently demand the emergence of a new institutional regional system for resource allocation; rather new forms of “tragedy of new and traditional commons” would take place. In this perspective, we observed that the Bloomington School and the Austrian School, present similarities showing that sustainability and innovation fitted with a strong polycentric institutional setting; a paradigm that is coherent with the Smart Region approach.

We also observed that the development paths of the territorial system require considering Boshma actors-knowledge relatedness (flow dimension), and Camangi territorial capital (stock dimension), elements that support the mobilization and transformation of the territorial system through a specific actors-actions framework. Based on our work and using case studies analysis as Silicon Valley, among others, we have identified four different types of territorial actors: systemic actors, propulsive, enablers, and rooted. We recognize that such typologies require further analysis. Finally, we consider that to better understand the development of the smart regions from the actor point of view, it would be required to encourage its analysis using the historical method that can provide a wider understanding of the actors and its action in specific historical spaces.

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## DIGITAL REGIONS: A DIFFERENT EUROPEAN REGIONAL SPACE STRUCTURE

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### ABSTRACT

The Europe 2030 Agenda for Sustainable Development gives emphasis to people and to sustainable way of life. Sustainable development was identified as important aspect for European Strategy 2020, which is based on three pillars of growth: 1. *Smart growth*, focus on fostering education and innovation, 2. *Sustainable growth*, focus on low carbon emissions, tackling climate change and protecting the environment, 3. *Inclusive growth*, focus on establishing new jobs and reducing poverty.

In the last decade, there has been given a strong emphasis on Smart growth, which was mainly achieved through the transition of cities to the digital era and introducing the concept of Smart City. However according to our knowledge, the concept of Smart Region is slightly examined by literature.

Regions in contrast to a city, are associations of more areas or cities with different growth rates, with different spatial development and physical - technological infrastructure and with different needs of citizens. Moreover, the digitalization of our societies force regions to face new challenges such as e-economy, e-government, etc, issues that have already be examined in the context of Smart City”.

The goal of this study is to contribute to the literature and to the public discussion of smartness in our life, by introducing the concept of Digital Region.

The idea of Digital Region is the result of the rapid development of Information & Communication Technology (ICT) and their applications. Internet of Things, Artificial Intelligence, Cybersecurity, Big Data are some of applications that transform the both economy and society. The concept of region is redefined by this new digital environment. At the same time, the pandemic of the COVID-19 has highlighted the urgent need, to take actions in terms of digitalization at regional level. The introduction of the concept of Digital Region as a mental region that will consist of regions with common characteristics and common problems to face and which knows no borders but focuses only on creating the appropriate strategies to deal with a common emergency is the subject of this paper.

### KEYWORDS

Digital Regions; Smart Growth; Urban Planning; ICT's, Sustainable Development, COVID-19.

## **Special Session: SS18.6 - Urban Future in the Global South**

**11:00 - 12:15 Thursday, 27th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89993853386>**

**Chair Abdul Shaban**

## INFORMAL ENTREPRENEURISM IN THE GLOBAL SOUTH CITIES: CASE STUDY OF STREET VENDORS IN MUMBAI

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### ABSTRACT

The concept of urbanization and economic growth are mostly discussed together in the literature. Entrepreneurship is an important component for economic growth because it creates new business/job opportunities and fosters economic growth through increased productivity. Compared to the cities of the North, Global south cities like Mumbai in India, Dhaka in Bangladesh represent modern urban spaces with distinctive remnants of a traditional structure. The presence of informal workspaces like street vendors, daily wage or contractual laborers represent this duality; they are often considered the residuals of a traditional backward economy and society. The recent literature has started to give importance to entrepreneurship which does not have the ideal characteristics. This includes entrepreneurship in the informal sector. Street vending can be also considered as a form of 'street entrepreneurship', whereby vendors start-up a business venture/manage or own a business. This study, on street vendors, in three popular market places of Mumbai shows an interesting mix of vendors: some who are working on a subsistence basis and others who have turned their business into a profitable enterprise, willingly choose to work in an informal set-up and can be termed as commercial vendors.

What stands out is compared to the Global North, cities in India still do not recognize street vending as a legal occupation. Recently, the Street Vendors Act, 2014 was an attempt to legalize this occupation. However, it has added to the chaos and not resolved the question of effective rights, rents, and orderly and sustainable development of the city. In spite of the Street Vendors Act, 2014, the discrepancies and discrimination still continue. The social networks and relations of the vendors, thus, form an important part of their entrepreneurship and livelihood. Their daily negotiations with customers, local leaders and each other, influences their business environment. However, it is a fact that common spaces, especially the streets and pavements, in the city in the want to effective government policies are turning into tragedy of commons. They are facing increased occupation by the marginalised sections due to compulsive subsistence and survival questions. The lack of effective context-based urban planning to provide the spaces for hawkers, which form substantial share of population in the city, results into this tragedy of commons. The better-off vendors enjoy the free riding behind the poor and marginal vendors. The lack of effective rent even from the better off vendors results in lack of maintenance of the pavements which adds to the disorderliness of common spaces and walkways. The paper, thus, also engages with the question of this tragedy both through the policy analysis and vending politics through collective organization of vendors. The three street markets chosen, Colaba Causeway, Bandra Hill Road and Chembur station market, are popular destinations each with its distinctive feature. Chembur market caters more to the local population with essential household items while Colaba and Bandra are popular tourist hubs. The individual street vendors in Mumbai are the unit of analysis in the present study. Vendors who are static and have a particular spot from where they vend regularly were interviewed. Developing cases based on qualitative interviews and in-depth discussions with vendors, the paper attempts to show not all vendors are subsistent in nature, and how the nature and culture of entrepreneurship varies among the vendors which in turn gives rise to inequalities and a heterogeneity in the business environment of the vendors. In-depth interviews with government official, local leaders and NGOs were also conducted. These interviews and discussions have been essential since the study is exploratory in nature. Hence, while the interview schedule gives a more objective idea regarding the street vendors, the political economy of the vending business can be better analysed with the discussions where they shared their daily lived experiences.

### KEYWORDS

Informal Workers, Urban space, Urbanization, Entrepreneurism, Tragedy of commons

## SUSTAINING THE CREATIVITY AND INNOVATION: *CHIKANKARI* INDUSTRY OF LUCKNOW

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### ABSTRACT

In urban studies literature, the Global South towns have not found their due place with respect to the agency and creativity. They have been often considered as dormant, traditional, subordinate and less modern and innovative than the towns in the Global North. Robinson (2006) demonstrates that all the towns need to be understood in their context and also read through the lens of alternative modernity. From this latter perspective, many of the Global South towns can be considered possessing their own modernity and creativity. Lucknow is one such town which has been historically famous for its creative arts and in contemporary times hosts one of the leading creative embroidery sector, called Chikankari. Inspired by the Turkish embroidery, the Mughal empress *Noor Jahan* introduced Chikankari craft in India during late fifteen century AD, which flourished in Awadh region with local block printing techniques. During colonial rule Lucknow was a major centre for agriculture and art and craft industries like jewellery and embroidery clothes. Now, Lucknow and Chikankari is synonymous with national and global recognition by complementing each other as a brand. The creativity among the workers is produced from human interaction process. The first interaction is learning within the family and neighbourhood from elderly, that is inter-generation process of knowledge transfer. The second major source is external, that is, interaction with the contract providers, designers, buyers, and visit to the local hats and exhibitions. However, now-a-days the internet has become major source of receiving the design, videos how to produce the design, etc. A large share of Chikankari workers are women from Muslim community, and due to patriarchy and *Purdah (veil)* system they are immobile, which creates their dependency on external contractors. However, use of mobile phone and digital technologies are easing their interaction even from the four walls of the house.

This proposed paper will attempt to examine, (a) how for generations the creativity among the workers has been maintained in the city through the inter-generational transfer of knowledge, (b) what are the ways the external knowledge are constantly brought in to shape the products to maintain the relevance of the products to the market, and (c) what are the ways the workers benefits from this industry and whether the digital technologies (for communication, design, imitations, etc) and emerging globalization of the products have helped them to improve their wages and prospect of the industry.

As there are no public sources of data, we will try to estimate the total output by contacting Chikan producers' organization in the city. Further, we will take up case studies to 3 households to depict the process of how creativity is intergenerationally transferred, how the interaction to external agencies adds to the changes and sustenance of the craft and market relevance. The individual and community interactions in space will be depicted by drawings and descriptions. The paper also draws the data and method of investigation from the previous studies. Given the unorganised nature of the sector and lack of detailed data, the case studies method, structured and semi structured methods of interviews with workers, community leaders, entrepreneurs, executive, government officials is considered most appropriate. These methods will be used for the collection of the needed data. The samples of the cases, one each, will be from the family working for a reputed international company, that working for a national company and the family that it not connected with any of them but with local NGOs and market. The paper uses the framework of knowledge transfer developed by Argote and Ingram (2000).

The study may through light on how human interaction is essential for the creativity and sustaining the creative products in a globalised market system. It may also throw light on the causes of chronic deprivation among the workers of the Chikan industry, which if not resolved may undermine the creative city nomenclature of Lucknow.

There are hardly any studies which depict the knowledge transfer and method and sources of innovations in the Chikan industry in the city and this study will as such is original and adds to the knowledge about this sector.

The study will help us to understand the churning out taking place within the industry and impact of technology and globalised market system on the industry. This will also help us to understand the kind of policies needed to sustain the industry.

### KEYWORDS

Creative towns, creativity creation and transfer, human interaction, craft, development.

## DEMOCRATIC PARTICIPATION IN NEGOTIATING URBAN PUBLIC SPACE IN INDIA: COEXISTENCE OF COLLECTIVISM AND INDIVIDUALISM AMONG STREET VENDORS

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### ABSTRACT

This article explores how street vendors negotiate with different classes of people to sustain in urban space. Vendors' rights to use and appropriate public space have long been proven to be crucial to the emergence of intensive street life and productive urbanity in many cities of the global south (Bromley, 2000; Saha, 2017; Kamalipour and Peimani, 2019). Collectivism and individualism are discussed to understand workers' bargaining process within industrial relations framework (Olson 1965; Tilly 1978; Martinez Lucio and Stewart 1997; Kelly 1998; Beck and Beck-Gernsheim 2002; McGovern 2003; McBride and Martínez Lucio 2011; Taylor and Moore 2014). This study shows how street vendors as informal workers are practicing these interests as methods of negotiation to survive on the streets of urban India. Drawing case studies from New Delhi (North), Mumbai (West), Kolkata (East) and Guwahati (Northeast) during 2007-2021, the study examines the processes and natures of various forms of collective actions that vendors practice on the public space while vendors as a socio-economic group are discussed from researches conducted by the author during 2010-2019 using mixed methods research (MMR).

Vendors co-opt quasi-relationship with various stakeholders — civic authorities, service providers, fellow workers and customers— where class difference exists. Contrasting interests of individualism and collectivism are co-existed through self-devising strategies, participation, mobilization and organization. Unlike other cities in the nations of the Global South, labour market institutions (the Street Vendors Act 2014) legitimises re-construction of binaries—organised/unorganised, legal/illegal and licit/illicit— and power relations, thereby re-defining urban governance structure for street vendors in India. Male vendors are more engaged with large-scale operations, while females are engaged with small-scale operations selling perishable goods (Bromley, 1978; Agadjanian, 2002). As Saha (2017) argues, women's uses of public space are linked to the problems of vulnerability, intimidation, and insecurity posed by authorities, their male counterparts, passers-by, and customers.

A vendor exercises two kinds of bargaining – economic and social – across gender and class. Individualism and rationality are practised during economic bargaining for interest rates and bribes mainly among male vendors who sell products which has higher value. Collectivism are exercised by female vendors and those vendors selling lower valued products. Social bargaining is performed during collectivism to build social relations with different actors such as customers, other vendors and moneylenders. Thus, vendors exercise economic, political and social bargaining to form collective solidarity in acquiring controls over resources, accessing public spaces, and forming unions/other membership-based organisations to build relations and negotiate with various stakeholders, viz., vendors, shopkeepers and state. Vendors' collective interests are subdued in the class-based organisational structure. It can be protected through democratic process at the local level, thereby making collective and inclusive city.

## BLUE-ING CHILDREN'S SPACE: THE PROMISE OF BLUE URBANISM TO MAKING CHILD-FRIENDLY CITIES IN THE SOUTHEAST ASIA

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### ABSTRACT

This paper proposes a framework for child-friendly coastal cities at risk (CCaR) in Southeast Asia (SEA) toward an inclusive blue urban agenda in the Global South. Southeast Asian coastal cities encompass two-fold projections: (1) the impact of climate change and (2) increase in children population. The low-lying Southeast Asian coastal cities are disproportionately vulnerable to environmental hazards such as floods, storm surges, and coastal erosion. Simultaneously, SEA cities expect a surge of young population by 2050. Focusing on children in SEA cities offers an understanding of the topographical and demographical uniqueness of Global South urban settings. Such context suggests South-South dialogue among Southeast Asian (SEA) coastal cities as they share vulnerable futures arising from coastal city risks. In line with the UN's Sustainable Development Goals (SDGs) and New Urban Agenda (NUA), this study examines five Southeast Asian "Global Future Cities" identified by Global Future Cities Programme (GFCP) under the UK Foreign and Commonwealth's Prosperity Fund (UK FCO): Surabaya (Indonesia), Iskandar (Malaysia), Melaka (Malaysia), Cebu (Philippines) and Ho Chi Minh (Viet Nam). Through a secondary data analysis, this study reviews City Context Reports from these five SEA cities and identifies opportunities and challenges to urban child-friendliness based on the UNICEF-recognised Child Friendly City. Drawing lessons from a comparative analysis, this paper discusses urban issues in coastal cities that impact children, as well as underlying barriers and enablers for a child-friendly blue urbanism observed across the five cities of interest. Three main observations transpire from such examinations. *First*, diversity of materials (manuals/maps) on child-friendly disaster guidelines is lacking, which calls for producing materials based on children's diverse backgrounds (differences in language, religion, gender, disability and/or ethnicity). *Second*, despite the existing efforts to educate children on resilience against coastal-related disasters, there is a need to draw attention to raising awareness and communicate climate change risks to marginalised children (urban poor and street children). *Third*, child participation in urban planning is limited, implying the need to include children as key informants to contribute toward climate change adaptation measures. With the wisdom from such observations, this work proposes a Child-friendly Blue Urban Framework customised for the SEA context and child-friendly city framework. This work hopes to encourage South-South dialogues among SEA coastal cities toward integrated coastal zone management that are both resilient and child-friendly.

### KEYWORDS

Blue urbanism, child-friendly cities, coastal cities, Southeast Asia

### 1. INTRODUCTION

Many of the world's largest cities are located along the coast (Creel, 2003; Barragán and de Andrés, 2015). Coastal cities in Southeast Asia (SEA) are of particular interest because they face a double burden—climate vulnerability and crowding urban space. Most Southeast Asian coastal cities are low-lying coastal zones, which are disproportionately vulnerable to urban disasters and environmental hotspots compared to other water-based cities (Keogh and Törnqvist, 2019). Several recent extreme meteorological events in SEA have caused catastrophic human and economic losses in coastal areas, with adverse consequences including increased flooding, salinization, erosion, and wetland and biodiversity loss (Kelman, 2019; Kulp and Strauss, 2019). At the same time, the growing population of young people in Southeast Asia has gained traction in international policy-making to promote livability and sustainability in coastal cities (Asian Development Bank, 2016). Southeast Asian cities are predicted to increase in population by 520 million in 2050, with children comprising a significant portion of the population (Asian Development Bank, 2011). As such, the surge of urbanisation in SEA cities calls for attention as it amplifies risks to children. The young population of coastal cities face climate-related consequences and vulnerabilities arising from exposure to climate hazards, such as floods, storm surges, and coastal erosion coupled by a persistent spread of human settlements in high-risk urban areas (Neumann et al., 2015). In disaster-prone areas, children depend on other people for special care and supplies at times of crises and developmental, physical and psychological support in post-disaster contexts (Save the Children, 2015). The double burden of increasing population density and disaster risks put the children in SEA cities into a vulnerable position as urban dwellers. As such, coastal cities fall on a duty to accommodate the unique needs of children as most vulnerable citizens during disasters and in the long run, children will inherit such coastal urban spaces. Yet, while the ocean serves as an integral part of the urban experience of children in coastal cities, discussions on children's connection with blue spaces receive far less attention. This work aims to examine children's place in urban planning from selected Southeast Asian coastal cities and propose a framework for coastal cities toward a more child-oriented agenda, within their overall coastal city ideals. In doing so,

attention is given to the position of children as urban citizens, highlighting children's rights to the city. Through secondary content analysis complemented by relevant literature, this work provides a meta-analysis of the conditions by which children are included (or marginalised) in coastal cities of Southeast Asia. By drawing lessons from a comparative analysis, this article discusses urban trends in coastal cities issues that impact children, as well as underlying barriers and enablers for a child-friendly blue urbanism observed across the coastal cities in Southeast Asia. Finally, some pointers are provided that can serve as a basis for developing a child-friendly blue urban agenda.

## 2. LITERATURE REVIEW AND KEY CONCEPTS

### 2.1 Blue Urbanism in Southeast Asia

The notion of *blue urbanism* views the ocean as a non-human actor, which is "a common good that should be a shared aspiration of society" (Fletcher and Potts, 2007: 513). Non-human entities such as bodies of water, land and air enmesh with urban life through natural events such as disasters, crises and emergencies (Franklin, 2017). Blue urbanism places emphasis on both the environmental and social significance of the ocean in the process of urbanisation. It primarily fills the gap of urban frameworks that mainly foreground inland spaces and barely represent the nature of coastal cities. For instance, urban policymakers have typically employed the Brown and Green Agenda; the former represents pro-poor agenda for social justice issues in post-industrial areas, and the latter promotes sustainability in urban forest ecosystems (Du Plessis, 2015). Despite these achievements, the importance of oceans and marine environments in urbanity remain largely underrepresented. While there has been an effort to advance The Blue Urban Agenda to recognise the constant interplay between land and sea (Mycoo and Donovan, 2017), such literature mainly focuses on the Caribbean and Small Island Developing States (SIDS) in the Pacific while the Southeast Asian region remains at the margins.

Yet, the principles of blue urbanism resonate well with the history and development of Southeast Asian coastal cities. The ocean is part of a collective, environmental, transnational and transgenerational process of urbanisation in Southeast Asia, along with their distinct patterns of history and emergence of urban centers (Lieberman, 2003). For instance, maritime trading is a common trait of urban development in Southeast Asia (Suarez, 1999), which created urban centers or dominant metropolises (Kusno, 2000). Moreover, urbanity in SEA coastal cities share a built-in vulnerability arising from their exposure to physical hazards combined with a persistent spread of human settlements in flood-prone urban areas at risk. Disasters in developing countries, many of which are in Southeast Asia, will put more than 325 million people below the poverty threshold in large coastal cities by 2030 (Gitay et al., 2013). Thus, blue urbanism in Southeast Asia highlights that while urbanisation is a driver of economic growth, this also induces rapid concentrations of population in risk-prone areas and affects the natural wet/lowlands and drainage network. Such urban processes increase the vulnerability of children induced by urban coastal flooding (Zang et al., 2011; Wright et al., 2019). Further unregulated urbanisation leads to degradation and destruction of wetlands surrounding coastal urban agglomerations due to higher demand for land and subsequent territory grabbing (Seto et al., 2012), which in the past decades has already disrupted coastal ecosystem functions and programs for the urban and surrounding populations, in particular flood regulation (Hardoy et al., 2001; Costanza et al., 2008).

### 2.2 Blue Spaces for Children

When scaled to the lives of children, a key challenge is to build blue spaces that encourage children's involvement and participation towards blue urbanism. However, most literature on children's relationship with urbanisation and policies on urban safety for children mainly focus on land-based agenda. For instance, in the UN New Urban Agenda (2016), while there are child-specific action plans (e.g. Decade of Action for Road Safety), these plans do not cover the threats to children in coastal cities. Aside from disaster preparation, Southeast Asian coastal cities need stronger targeted search and rescue operations as response to modern-day piracy, from small scale sea-robber attacks to organised pirate gang hijackings (Mccauley, 2014). Moreover, although with the best intentions, most Child-friendly Cities initiatives (CFC) (UNICEF, 2004) mainly focus on streets and concrete in conducting placemaking activities for children. For example, non-government efforts (e.g. NACTO, 2019) developed a child-focused street guide to set a new global standard for urban streets designs focused on pedestrians, cyclists and transit riders. While these are all important developments in CFCs, coastal cities remain underrepresented. To be sure, there have been previous efforts in the scholarship on children's geographies to analyze the child-friendliness of cities in terms of policies, planning and design (e.g. Riggio 2002; Innocenti Research Center and Childwatch International, 2011; Carvalho and Koteng, 2014; Chan et al., 2016) The key areas that these instruments assess include criteria such as walkability and children's independent mobility in cities. The ability to compare different locations using CFC guidelines makes child-focused urban studies more commensurate in analysis due to its replicability and associated contextual descriptions about urban layout and form. However, there are limitations in terms of using the CFC guidelines since they are mostly inspired by Anglo-European settings. Using such standards may not be applicable to the complexity of the coastal cities across Southeast Asia. Children in Southeast Asia are more likely to suffer from economic, social and environmental disadvantages because the provision of basic needs such as water, housing, health and sanitation remain key challenges for urban policy-making. Whilst among the primary concerns of blue urbanism is intergenerational sharing of the ocean (Earle, 2010; Beatley, 2014), the literature that connects child-friendly cities and blue urbanism has received little attention, leaving discussions disjointed, along with weak connections between studies on child-friendly cities and coastal areas. What transpires from the urban approaches for children is that while the literature is rich in the interaction of children and the city environment, blue spaces remain at the periphery of discussions.

To address the literature gap, this paper draws together the principles of blue urbanism and child-friendly cities to map out the relationship between children and coastal cities. The relevance of creating a blue urban agenda inclusive of children is grounded in the two-fold anticipation of the effects of climate change and increase in children's population in urban areas. As such, to have child-friendly coastal urbanisation means to be future-oriented and far-sighted in terms of climate risks and sustainability. The connection between child-friendly cities and blue urbanism is critical because it addresses specific concerns on resilience of children in disaster-prone cities. Coastal communities are relevant because disasters disrupt the sense of routine and normalcy among children (Peek, 2008: 20), which emphasises the underlying child-ocean relationship constituted in the community. Although the issues raised about children's vulnerability can be considered universal issues of inequality, justice and fair distribution of resources, these concerns have unique implications for children in coastal environments such as the uncertainty of having permanent homes since coastal cities are sinking in Southeast Asia. In considering such issues, this work thus brings a child-focused geographical lens to coastal cities in order to reveal implicit tensions, and seeks to provide understanding and direction for further academic inquiry and key areas for research.

### 3. METHODOLOGY

For the purposes of this study, discussions mainly focus on Coastal Cities at Risk (CCaR), which refers to "contiguous area[s] along the coast that is less than 10 meters above sea level" (McGranahan et al. 2007: 17). This paper adopts a comparative approach to map out the shared contexts among selected Southeast Asian coastal cities and to flesh out cross-national contexts within which urban policy and planning practice take place. A comparative analysis is instructive to avoid repeating mistakes, missing out on lessons learned elsewhere in the region or inappropriately implementing foreign programs to local contexts (See Cropper, 1982; Masser, 1986). Each Southeast Asian country may assume similarities with existing urban frameworks abroad, as a matter of convenience or pragmatism, which overlooks the importance of regional distinctiveness. As such, this method provides some guidelines for research endeavors with respect to understanding where SEA cities resemble each other in relation to children's lives on the coasts, and where they are different. In view of blue urbanism and child-friendly cities framework, this paper examines the child-friendliness of Southeast Asian coastal cities through report analysis.

An important part of this comparative research work is the use of crosscutting and integrative themes that can show similarities (and differences) across Southeast Asian cities. The sample cities for this study is based on the identified "Global Future Cities" by the Global Future Cities Programme (GFCP) under the UK Foreign and Commonwealth's Prosperity Fund (UK FCO). In line with the United Nations Sustainable Development Goals (SDG) and New Urban Agenda (NUA), GFCP is an initiative that offers assistance to cities with high potential but face "considerable challenges such as rapid urbanisation, climate change and high and persistent inequality". Based on GFCP's assessment, five Southeast Asian cities were selected for this study because they have low-elevation coasts, increasing urban population and particularly interesting local contexts: Surabaya (Indonesia), Iskandar (Malaysia), Melaka/Malacca (Malaysia), Cebu (Philippines) and Ho Chi Minh (Viet Nam). Each city has published a City Context Report that reflects their own geographical vulnerabilities and policy approach that are instructive for understanding SEA cities. To provide the necessary comparative context, the reports from these five Global Future Cities were assessed by identifying which of their urban coastal practices are aligned with the principles of child-friendly cities based on UNICEF-recognised Child Friendly City vision and Framework for Action (2018). In this context, this paper analyses cross-national variations in city-level intervention plans and target impacts in terms of their potential implications on the young population:

- **Non-discrimination:** Every child and young person is valued, respected and treated fairly within their communities and by local authorities;
- **Participation:** Every child and young person has their voice, needs and priorities heard and taken into account in public laws (if applicable), policies, budgets, programmes and decisions that affect them;
- **Access:** Every child and young person has access to quality essential social services; a safe, secure and clean environment; and opportunities to enjoy family life, play and leisure

To increase the policy relevance of this research, it also takes relevant literature as a guide to the context of the five selected coastal cities to explore other potentially neglected discussions crucial to SEA coastal cities. The use of secondary sources is important for a substantive and context-based analysis and for fleshing out alternative perspectives in understanding urbanity at a regional level. There is no easy line to be drawn between opportunities and challenges in SEA coastal cities to be child-friendly. Nevertheless, this work contributes to discussions on Global South urbanism in terms of showing the shared aspects of SEA coastal cities and where they diverge in terms of urban contexts planning attached to the existing institutions, procedures and political actions.

### 4. RESULTS

#### 4.1 Common Urban Contexts

Although there are many country-specific challenges in each Southeast Asian coastal city, there are two shared issues that transpired from the reviewed documents: demographic and topographic. Urbanisation in Southeast Asian coastal cities brings about various water-related vulnerabilities that directly or indirectly affect children. The common challenges among the selected coastal cities in this study include urban congestion near the coasts, leading to negative externalities such as flooding, water pollution, soil subsidence and urban runoffs.

Surabaya, Melaka and Ho Chi Minh are challenged by the interruption of socio-economic activities and damage to infrastructures due to flooding from the sea-level rise, especially in slums areas. This threat is amplified by a growing population and increasing human activities that cause such cities to sink faster than through only a geological process. Moreover, since coastal cities are unable to support the increasing urban population, the growth of slums persists in many flood-prone areas. Children are mainly affected in terms of their vulnerability to urban flooding (Vanos, 2015; Mavhura et al., 2017; Quintão et al., 2017). For instance, being the second biggest city in Indonesia, Surabaya hosts a dense population, whose activities lead to soil degradation (Imaduddinaa and Subagyo, 2013) that potentially jeopardises the environment where children live at present and in the long term (Rahmat et al., 2016). Meanwhile, there is a trend of a growing population accommodated in Ho Chi Minh’s highly flood-vulnerable areas as per its local government’s development strategy to attract more property investments into new districts (Duy et al., 2018). This results in an extension of water-protected areas in Ho Chi Minh, which increases the urban runoff (Vachaud et al., 2018). Speaking of attracting people, Melaka has reinforced its waterfront tourism industry as part of its image as a world heritage site (Erham and Hamzah, 2014). This tourism industry has attracted infrastructure development in flood-prone areas such as souvenirs and food shops near the fort (Syakir et al., 2017). Such an increase in population density in flood-prone zones makes children vulnerable because of human activities in an increasing urbanisation that results in soil subsidence. In cases of disaster, the social and psychological costs for children are high too, including being unable to play with friends, loss and damages in toys and personal possessions, and anxiety about uncertainties of the situation (Mort et al., 2016).

Cebu and Iskandar confront serious negative externalities of ocean pollution, together with an increased cost of traffic congestion, social and spatial segregation and environmental risks. Cebu’s exposure to hydrometeorological hazards such as flooding on top of challenges concerning “enormous amount of garbage that obstructs the flow of natural and [hu]man-made waterways” (ALMEC Corporation Oriental Consultants Global Co., 2015: 12). Such a condition exposes children, especially those living in slums, to “inadequate drainage infrastructure, sporadic and fragmented solid waste collection and the siloed approach to urban planning in producing and exacerbating flood risk” (Ramalho, 2019: 30). Meanwhile, Iskandar’s ecological challenges extend to Singapore’s borders. While Iskandar addresses pollution issues through government control over development and building plans and through facilitation of waste collection and water treatment, the city’s rapid industrialisation continues to pose a threat not only to its own urban space but also to Singapore’s coastal and marine environments (Cook and Hangzo, 2014). In the contexts of Cebu and Iskandar, children in informal settling conditions are particularly affected due to the hydro-hazards in the surface waters brought by the polluted ocean. Children living near the coasts are exposed to waterborne toxins and contaminants, hazardous sea waste, fecal infection and untreated stormwater which compromise their immune system (Soller et al. 2014; Jennings et al. 2018). This can be exacerbated by the urban poor settlements in the rapidly urbanising SEA cities, in which children live in crowded neighborhoods with sparse conditions (Dodman and Brown 2013; Purwar et al. 2020), which can easily transmit pathogen-laden water from septic tanks down to open channels and into street drains (Johannessen et al. 2014; Rothenheber and Jones 2018).

**4.2 Beyond Water: Urbanisation Challenges in SEA Coastal Cities**

Aside from water-related concerns, there is a clear variation among the urbanisation challenges faced by SEA coastal cities, which can distress children. Table 1 shows that different urbanisation issues exacerbate the already vulnerable conditions of SEA cities. For instance, Melaka and Ho Chi Minh share mobility and housing issues that affect young people in their daily lives. Cebu and Iskandar are faced with issues in land-use and distribution. Meanwhile, Surabaya has unique challenges, such as earthquakes and threats of volcanic eruption and typhoons altogether.

**Table 1: Urban context of SEA coastal cities**

Cities	Challenges	Intervention Plan	Target Impact
Surabaya	<ul style="list-style-type: none"> <li>• Earthquake Risk</li> <li>• Moderate seismicity level</li> </ul>	<ul style="list-style-type: none"> <li>• Setting-up a standard of urban transformation guidelines in neighborhoods</li> <li>• Earthquake Preparedness Strategy</li> </ul>	<ul style="list-style-type: none"> <li>• Preparedness strategy for the poorest communities as they are most exposed to risks</li> </ul>
Iskandar	<ul style="list-style-type: none"> <li>• Rapid economic and population growth compromise sustainable urbanisation</li> <li>• Heavy real estate investments cause drastic levels of urban sprawl</li> </ul>	<ul style="list-style-type: none"> <li>• Smart integrated mobility management system</li> <li>• Enabling data utilisation and data management for evidence-based urban and transport planning</li> </ul>	<ul style="list-style-type: none"> <li>• Strengthened capacities of civil servants and increased citizens’ inclusion in planning and decision making processes</li> </ul>
Melaka	<ul style="list-style-type: none"> <li>• Exposure to environmental pollution induced by transport inefficiency</li> <li>• High levels of traffic congestion &amp; burgeoning tourism industry</li> </ul>	<ul style="list-style-type: none"> <li>• Green Transport Corridor Implementation Plan for sustainable travel</li> <li>• Heritage Area Integrated Mobility Plan to alleviate the heritage area from the many urban stresses</li> </ul>	<ul style="list-style-type: none"> <li>• Better coordination and cooperation between government and its offices</li> <li>• Sustainable and resilient mobility options in favour of using public &amp; non-motorised transport</li> </ul>
Cebu	<ul style="list-style-type: none"> <li>• Monocentric urban system concentrated in the center since neighboring cities’ topographies do</li> </ul>	<ul style="list-style-type: none"> <li>• Cebu Data Hub to support the development of a data centre that enables data use across city</li> </ul>	<ul style="list-style-type: none"> <li>• Sustainable urbanisation including land-use planning,</li> </ul>

Cities	Challenges	Intervention Plan	Target Impact
	match the center’s urban development	departments and enhances evidence-based planning	transport planning and planning for climate change issues
Ho Chi Minh	<ul style="list-style-type: none"> <li>• Insufficient mobility: heavy reliance on motorbikes for transport and unaffordable fares</li> <li>• Current database of drains and canals is not updated</li> </ul>	<ul style="list-style-type: none"> <li>• Smart ticketing system to optimise public transport</li> <li>• Comprehensive GIS database for developing flooding models such as catchment, city and neighbourhood scale.</li> </ul>	<ul style="list-style-type: none"> <li>• Increased capacity, improved strategies and tools, especially for public transport and drainage system management</li> </ul>

The quandaries faced by Southeast Asian coastal cities are also beyond climate-related concerns. On top of topographical vulnerability, the process of urbanisation itself complicates coastal cities in terms of congestion, mobility matters, issues on access to services and infrastructures and urban exclusions. When contextualised in children’s lives, such issues are entangled with children’s capacity to own their rights to the city due to the lack of safety, clean environment, fair access to urban amenities and efficient mobility. The problems in Surabaya, Iskandar, Melaka, Cebu and Ho Chi Minh are indicative that children are affected by issues of fairness in design or implementation of an inclusive urban planning concerning the distribution of spaces in coastal cities. This is especially relevant to children who reside in urban informal settlements in coastal cities, with crowded and deteriorated settings in which they live, play, and in some circumstances, work.

### 4.3 Urban Child-friendliness Comparison: Lessons and Challenges

The selected Southeast Asian coastal cities in this study have a mix of achievements and challenges in terms of an urbanism that is sensitive to children’s backgrounds and participation in urban design. Table 2 shows that some aspects of the Urban Transformation Plans in the five SEA cities recognise cross-cutting issues of children and youth with climate change, gender equality, human rights, and sustainable and inclusive economic growth. However, these cities also miss out on identifying specific needs of children and young people. The examination of the selected SEA cities unpacks the logic which fosters children’s relationship with their coastal city in terms of: 1) non-discrimination; 2) participation; and 3) access.

**Table 2: Alignment with child-friendly cities principles**

Cities	Non-discrimination	Participation	Access
Surabaya	Identification of child-oriented potential project partners (e.g. Save the Children)	Pilot projects and the community engagement with special attention to young people	Mainstreaming of environmental safeguards young people, gender equality, and Human Rights
Iskandar	Including young population in most integrated plans, frameworks and approaches to promote a more sustainable, resilient, and socially inclusive city	capacity building with data-related expertise to benefit young people citizen participation in developing municipal plans and decision making processes	Mobility designed “with special attention to the needs of those in vulnerable situations, women, children, persons with disabilities and older persons”
Melaka	Acknowledgement of public transportation issues among vulnerable citizens including children, the elderly, women, and low-income groups	Participatory planning to understand the different needs of diverse consumer groups including children and youth	Accessible and attractive non-motorised transport for all social groups, with attention to young people
Cebu	Interventions guided by mainstreaming of young people along with environmental safeguards, gender equality and human rights	Data hub with new protocols & data-gathering processes with disaggregated data to monitor improvements in equality of participation and access to opportunities for young people and women	Increased data availability for young people’s security
Ho Chi Minh	Transportation fares are assessed to ensure that the future ticketing system are inclusive of young people	Inclusion of young people in citizen participation toward developing municipal plans and decision making processes	Improvement of the public transport system for safer mobility, increasing young people’s accessibility to schools

*First*, the five SEA cities in this work have indicated non-discriminatory intervention plans for children but only Surabaya identified child-oriented organizations as partners. However, these cities do not show sensitivity to the heterogeneity and diversity of their young residents. For instance, children might have mobility needs that prevent them from engaging in resilience efforts. This potentially neglects marginalised children, excluding them from participation in the overall sustainable development efforts of the city. It is then crucial that urban policies produce frameworks that are sensitive to children’s diverse backgrounds in terms of religion, gender, disability and/or ethnicity.

*Second*, participation is stipulated in the intervention plans that include young people. Yet, there is a need to communicate marine and coastal science to children for an enhanced participatory planning in building resilience to the impacts of climate change and improving young people’s adaptive capacity through their own urban designs for climate change

adaptation measures. As aligned with the principles of child-friendly cities, participatory research with children is an explicit recognition of children’s special capacity to judge their experiences and express their own needs and of their peers. Aitken (2001: 8) notes that “children see things in environments that we may have forgotten to see, let alone understand”, making them capable of voicing out their views on urban disaster risk reduction (Dodman and Brown, 2013: 3).

Third, there are existing efforts to educate children to build resilience as preparations for disasters and for greater accessibility to urban facilities and spaces. However, there is a need to further strengthen raising awareness and communicate coastal-related climate change risks. While young people are included in the target population to benefit from intervention plans, no specific child-oriented guidelines were provided. For instance, the cities of Iskandar, Melaka, and Ho Chi Minh aim to improve transportation inclusive of vulnerable populations including children but there was stipulated plan for increasing the awareness of children about mobility issues.

However, due caution is to be applied in reading these urban contexts. The “Global Future Cities” reports do not take into account the distinction between the heterogeneity of potential impacts of interventions. For example, the reports did not take into consideration that mega-urbanisation plan and market-oriented development projects have fostered further gentrification by forwarding disaster and flood management plans that justify the displacement of slum dwellers in areas classified as “danger zones” (Ramalho, 2019). Property-led development of high-end residential real estate commodities creates a wider gap between classes (Chuangchai, 2019). Moreover, a given economic agenda can compromise the lives of children from boat-dwelling sea nomads, commonly known as Badjao in Southeast Asia. Urban industry presents territorialist policies that are intrusive of the Badjao culture of being “collectors of marine produce, guardians of sea lanes and knowledgeable pilots” (Andaya, 2019: 26). Children are especially affected as the economic agenda stigmatizes sea nomad children as “primitive, wild and uncivilised” (Hoogervorst, 2012: 250). Since these children are stateless, they are called “obstinate to the point of stupidity, dirty to the point of contagion and backward to the point of invalidity” in Southeast Asia (Hope, 2001: 140). This, nevertheless, highlights the relevance of further examining the diversity in SEA coastal cities with a focus on the lives of children who are socially marginalised and entirely lacking in resources and amenities in the metropolitan coastal zones.

5. DISCUSSION

5.1 Child-friendly Urban Agenda for Southeast Asian Coastal Cities

Despite their challenges, Southeast Asian coastal cities are not without potential for blue urbanism, such as being blessed with coastal resources and access to other rich natural amenities, making it easier for such cities to maximise these resources for children’s benefits. These cities also have substantial urban cores, with potential to prosper if sufficient urban size or density is sustained to provide spaces for various child-oriented urban features from educational public spaces to evacuation centers with children’s play spaces. Moreover, various non-government initiatives place emphasis on children’s participation in urban initiatives such as raising children’s environmental awareness through “children ecolife project” in Iskandar (Low Carbon Asia Center, 2013) or Surabaya’s “Child Friendly Village” with children and youth leading change in their communities (World Vision International, 2016). As such, this work proposes a **Child-friendly Blue Urban Agenda** for Southeast Asia, containing a child-focused adaptation plan for coastal urbanisation in SEA. Figure 1 shows a framework that integrates child-friendly city principles with the Ocean Cities Regional Policy Guide that is already being implemented in the Small Island Developing States (SIDS).

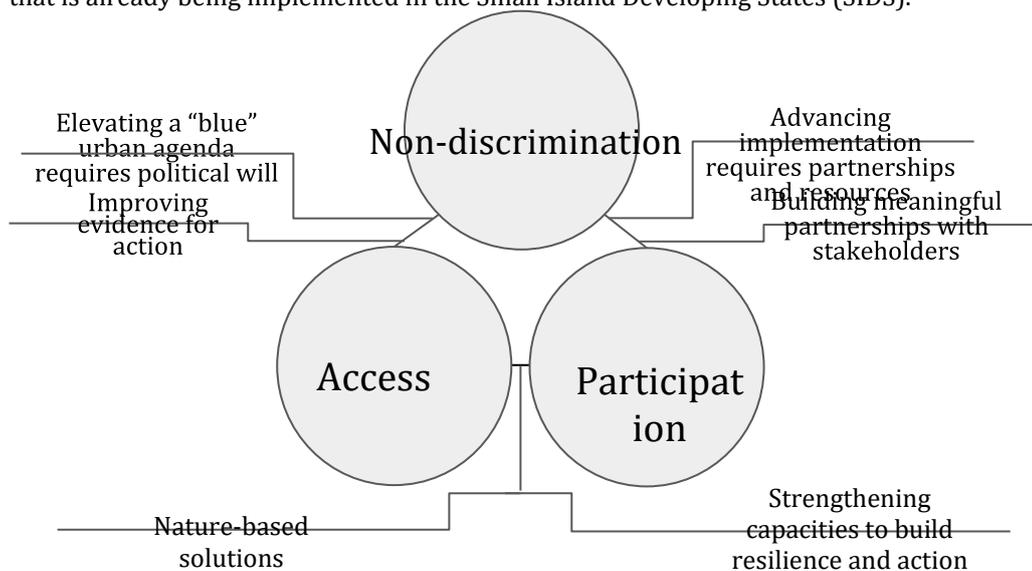


Figure 1. Child-friendly Blue Urbanism Framework

Child-friendly Blue Urbanism views children as solutions rather than problems in coastal cities. It is an invitation to put into dialogue the three main principles of child-friendly cities (in circles)—non-discrimination, access and

participation—and the principles of Ocean Cities Regional Policy (in branches), which are actions that bridge the overlapping aspects of two child-friendly cities principles. For instance, nature-based solutions (lower-left side) address the overlapping concerns of access and participation because of the wide accessibility of nature-based solutions, which also encourage the participation of more urban residents, including children. This results in an integrated urban approach for child-friendly and ocean-friendly urban development that is adapted to and sustainable in island systems, supporting regional and global frameworks for the overall aim toward sustainable development. Meanwhile, partnership with stakeholders (upper-right side) promotes a resilience strategy that is non-discriminatory and participatory at the same time, by taking children seriously as stakeholders, thus veering away from being a “city of elites” (Florida, 2017). This enables an urban policy that responds to the needs and demands of children for respect and dignity. All these point to a version of urbanity that views children as solutions rather than problems in coastal cities. It also opens the opportunity to craft an urbanity that is just & committed to children’s rights.

## 5.2 South-South Urban Dialogue

An urban agenda that places strong emphasis on children’s well-being in coastal cities is an opening for South-South urban dialogue among Southeast Asian coastal cities. The question that confronts Southeast Asian coastal cities, as well as all other archipelagic states, is how to balance ocean-related and urban development interests in a manner that protects the environmental capital for future generations and simultaneously facilitates development opportunities for children. In order to fulfill both environmental and human development principles, coastal cities in Southeast Asia need more coherent policy dialogue to address the increasing population of young people on urban coasts. The SEA cities presented in this study are at the frontier of both potential and vulnerabilities that could leverage a nuanced and unique strategy for a sustained and inclusive growth for urban residents. Moving forward, Southeast Asian cities are expecting new environmental challenges from the double burden of climate change and increasing children’s population in urban areas. A South-South dialogue among SEA cities is thus a promising agenda to foster exchanges of knowledge and experiences about (1) links between the role of children in the restoration of marine ecosystems; (2) the economic viability of child-friendly coastal and waterfront cultural heritage; and (3) the influence of age-related inequalities on the success of disaster response and overall coastal urbanity management. Ultimately, involving, training and nurturing the young members of coastal cities will further strengthen such South–South dialogue.

## 5.3 Key Areas for South-South Dialogue on Coastal Urban Policy and Research

In order for Southeast Asian coastal cities to make a real contribution to the future of Global South, it is important for urban planning and design to consider the issues unique to children for policy action and further studies:

*First*, it is crucial that policy research provides child-oriented frameworks that reinforce marine science communication with children, which emphasizes the role of children in the restoration of marine ecosystems. It is important for coastal cities to emphasise the value of coastal resilience through initiating science-based educational programs for children. For example, child-focused blue schools (Pittman et al., 2019) or ocean-related educational programs can enrich the child-ocean relationship (Mackintosh, 2017; Puchol-Salort et al., 2021). Children are to be provided with a child-friendly system for enjoying the seascapes. Urban planning also needs to secure infrastructure systems that reinforce children to learn more about the marine ecosystems such as provision of child-appropriate materials for fishing. Equally important is the promotion of disaster response appropriate for children such as nature-based solutions, which offer alternatives over very technically demanding solutions that may not always fare well in coastal environments. This extends to disaster response strategies that work with, rather than against, coastlines’ physical properties (Olsen et al., 2005; Lambert and Oberhaensli, 2014).

*Second*, children need to be integrated in cultural and heritage-building endeavors of coastal cities. This entails actively seeking children’s views on building and preserving the culture of their waterfronts and seascapes. An important aspect of this is a continuous performance assessment of the Southeast Asian “Global Future Cities” from the stakeholders’ perspective, with special attention to children’s participation. For instance, child-oriented participatory appraisals in coastal cities would be valuable to how they perceive the heritage of coastal cities and examine the suitability of street signs, public maps, and disaster resilience instructions/materials toward this goal. With their ecological competence growing up, together with their unique spatial experience (Chawla and Helft, 2002; Karsten, 2005; Freeman et al., 2015), children are able urban citizens to participate in collaborative coastal community-led planning activities to demonstrate the importance of their unique cities.

*Finally*, future research is encouraged to focus on how children’s backgrounds and the inequalities they carry shape children’s urban needs. City policies, finance and programmes need to come together with proactive responses to disparities in children’s lives in order to ensure inclusivity of the city and to address “recognition gaps” or the deprivations felt about one’s own worth (Lamont, 2018). Data on the intersectional deprivations of children related to their diverse backgrounds in terms of gender, ethnicity, and/or disability among others should assist local city authorities, urban planners, development agencies, and various stakeholders altogether to put weight to the needs of underprivileged and vulnerable children not only in terms of protection against risks but also children’s overall empowerment.

## 6. CONCLUSION

Imagining the future of urbanity in the Global South is incomplete without taking into consideration marginalised populations in vulnerable areas such as children residing in coastal cities. As presented in this study, using a child-

oriented approach in the context of Southeast Asian coastal cities is instructive to understanding urbanism in the Global South and the struggles it seeks to lend weight to. The identified challenges and potentials in each SEA city shape an urban fabric characterised by the urban sprawl combined with their geographic vulnerabilities of coastal cities. This work has shown how the current dynamics between the premises of child-friendly cities and blue urbanism encompass and direct the make-up of children's relationship to the ocean. The child-friendliness of coastal cities in this study is uneven. Despite the existence of good practices, there are recurrent challenges and limitations in respect of child-friendly sites standards that undermine their effectiveness in practice. This paper has also presented a framework for understanding children's place in coastal cities, weaving together some of the most pressing issues surrounding child urban vulnerability identified in the literature. Salient issues such as flooding and ocean pollution in SEA coastal cities are yet to be addressed through policy and research. Overall, however, Southeast Asian coastal cities have a potential to accommodate the visions of child-friendly cities at different levels.

The challenges of urbanisation in Southeast Asian coastal cities are massive but so are the opportunities. As a way forward, this work encourages the need for dialogue among SEA coastal cities to learn from each other. Standalone efforts to address climate-related risks for children living in coastal cities are less optimal than integrated coastal zone management that are both future-oriented and child-friendly. The insights generated in this work suggest that the issues at stake for children can undermine the current potential of the emerging child-friendly blue urbanism agendas in improving outcomes for children in coastal cities. Applying the wisdom gleaned from examining Surabaya, Iskandar, Melaka Cebu and Ho Chi Minh, this work hopes that a child-friendly blue urbanism agenda not only provides valuable insights for further research endeavors but also will help inform local governments and international networks in Southeast Asia as well as urban citizens at large towards improving children's conditions unique in coastal cities. Analysis in this work hopes to propel coastal urbanity in order to be "exposed for investigation and scholarship as it is made and remade, or via contestations" (Pierce et al., 2011: 61). Otherwise, the urban future in the Global South will remain uneven and only favorable to those whose present conditions are secure.

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# PARALLEL SESSIONS (13)

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## National Session: SS60 - Greek Regional Science



**13:15 - 14:30 Thursday, 27th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/85253483318>**

**Chair Yannis Psycharis**

**CREATING AND STRENGTHENING COMPARATIVE ADVANTAGE: THE  
REGION OF THESSALY – UNIVERSITY OF THESSALY COOPERATION  
NEXUS**

**Maria Adamakou, Dimitris Kallioras, Spyros Niavis, George Petrakos**

University of Thessaly, Greece

**ABSTRACT**

The literature on the role of universities on regional performance is broad and diverse, and some notable theoretical approaches have been developed over the years. The “entrepreneurial” university model attributes to universities the role of commercializing scientific knowledge. The “regional innovation system” university model perceives universities as carriers of innovation. The “mode 2” university model suggests that universities must be engaged in collaborative research with other organizations towards producing connecting-to-the-environment knowledge. The “engaged” university model understands that adaptation of university functions to regional needs. Looking at the other side of the theoretical spectrum, the literature on the role of regions on academic performance is scarce and no body of literature has been formed. Apparently, scientific knowledge, up to now, seems to perceive the linkage between regional performance and academic performance as a one-way – and not as a self-sustained - process.

The paper perceives the Region of Thessaly – University of Thessaly cooperation nexus as a means for creating and strengthening comparative advantage. Under this perspective, the paper scrutinizes the interplay between regional performance and academic performance. To this end, the paper conducts a pilot questionnaire survey on the basis of structured (on the 1-5 Likert scale) questions that cover both the topics already accentuated in the literature and some equally important topics that need to be analyzed. The survey is addressed to the actors that are (or need to be) engaged in the Region of Thessaly – University of Thessaly cooperation nexus. The findings of the paper provide valuable insight to both theory and policy-making.

**TRACING THE CHANGING PATTERN OF LOCATION AND  
AGGLOMERATION OF MANUFACTURING ENTERPRISES IN GREECE: AN  
APPLICATION OF POINT PATTERN ANALYSIS**

**Yannis Psycharis, Anastasios Karaganis, Leonidas Doukissas**

Panteion University, Regional Development Institute, Greece

**ABSTRACT**

The aim of this paper is to estimate the trends of location and agglomeration of manufacturing activity in Greece during the period 2002-2018. The location of manufacturing enterprises and the composition of manufacturing activity in the Greek regions has undergone important transformations during the last two decades. The introduction of euro in 2002 and the economic crisis in 2008 have signified important turning points that have affected/changed the evolution of manufacturing activity across time and over space. The analysis is based on a novel dataset that includes the point geolocations of manufacturing firms in Greece that have been classified into NACE-2 codes. The estimation of spatial agglomeration of industrial activity is measured by the spatial agglomeration index (SPAG) which is a recently introduced distance based technique which provides an exact and unbiased analysis of the spatial structure of the distribution of economic activity (Kopczeska et al, 2019). Results indicate the changing regional pattern of agglomeration of manufacturing enterprises and they are relevant to the location theory and the regional policy literature.

**ECONOMIC CRISIS AND RESILIENCE AT LOCAL LEVEL IN GREECE**

**Panagiotis Artelaris<sup>1</sup>, Dimitris Kallioras<sup>2</sup>, Anastassis Katsinis<sup>3</sup>**

<sup>1</sup>Harokopio University of Athens, Greece. <sup>2</sup>University of Thessaly, Greece. <sup>3</sup>Joint Research Centre (JRC), Italy

**ABSTRACT**

A new strand of literature, known as regional resilience, has gained prominence in spatial economics in the recent years. Regional resilience has attracted academic attention in the current unfavourable economic environment mainly because of the generalised sense of uncertainty and insecurity, necessitating the search for formulas for adaptation and survival. The main aim of this study is twofold: firstly, to evaluate and map the impact of the 2008 economic crisis at the municipal level, comparing the income distribution pre and post crisis; secondly, to examine the main determinants of economic resilience among the Greek municipalities. As a result, a range of economic and other variables are included in a spatial econometric model built investigating several important hypotheses. The data used in this study were obtained from a relatively new database, including annual taxable household income at the micro-region level (zip codes). The results clearly point at very heterogeneous resilience for the Greek municipal level yielding critical policy implications.

## EXPLORING POLARIZATION AND SOCIAL SEGREGATION TRENDS IN GREEK METROPOLITAN AREAS: THE CASE OF ATHENS

Yannis Psycharis, Anastasia Panori, Panayotis Pantazis

Panteion University, Regional Development Institute, Greece

### ABSTRACT

Studies on polarization and social segregation are widespread in international literature, given that multi-developmental changes that are taking place within urban areas, influencing the evolution of income inequalities. This paper analyses the polarization and segregation trends in Athens during the period 2004-2015. The analysis is based on a novel database that utilises individual household data from the EU-SILC and declared income postcode data from national official sources. The paper applies spatial segregation indices in order to explore the evolution of segregation and polarization trends before and during the economic and fiscal crisis. Mapping declared income in the broader metropolitan area of Athens shows distinct patterns of high and low income concentrations. Our analysis shows a division between centre and periphery with local differentiations between north-south, particularly in the eastern part of Attica. More specifically, higher declared incomes are concentrated in the north-eastern part of the metropolitan agglomeration, in the centre of the Municipality of Athens, in the southern part and in an enclave that includes Psychiko and some zones of the Municipality of Filothei. Lower incomes cluster in the western part of the Municipality of Athens, a number of zones in the Municipality of Agios Ioannis Rendis and Tavros as well as parts of the north-western zone comprising. There is limited “mobility” of the spatial analysis units in the income hierarchy. Areas at the upper end of the distribution have a very high probability to stay there or move upward, while low-medium areas are likely to “move” either higher or lower. Economic crisis has intensified the segregation trends. Results are relevant to public policy and inclusive growth and development.

**Special Session: SS38.2 - Resilience and  
peripheral areas: development patterns and  
policies in the borderlines**

**13:15 - 14:30 Thursday, 27th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/83942885151>**

**Chair Gabriela Carmen Pascariu**

## DISCONTENT IN THE “PERIPHERIES”: AN INVESTIGATION OF THE RISE OF POPULISM IN ITALY

Giulia Urso, Alessandra Faggian, Alessandro Palma

Gran Sasso Science Institute, Italy

### ABSTRACT

The concept of periphery is not an absolute one. It goes beyond the mere interpretation in terms of geographical distance from a centre and of location on the fringes of a country or a region. It incorporates a “relational” character that is implicitly characterised by connotations of power and/or inequality. Therefore, peripheries can be actively created as an outcome of shifts in economic and political decision-making at various scales.

This study explores them from what we deemed to be a powerful lens nowadays, i.e. the growth of populism, and the discontent, as the perception of being too far away in relation to sources of power, it expresses. The recent populist wave has in fact brought to the fore the issue of peripheries as areas “left behind”, striking back in the ballot boxes.

In our paper, in order to investigate the role of different dimensions of peripherality and their changing geographies on populist voting patterns, we analyse the growth of discontent between the two last Italian general elections (in 2013 and 2018). To this aim, we first consider a spatial dimension of peripherality, i.e. the geography of access to services of general interest. Second, we explore some factors which might be associated with a condition of peripherality, meant as marginality. We find that geographical peripherality is a key factor in explaining the growth of recent Italian discontent with more remote municipalities driving populist voting. However, sources of resentment, very different in nature, are also present in another periphery, within cores, i.e. urban belts, where some conditions of social or material vulnerability, likely to be related to a condition of feeling “peripheral”, are strong predictors of the growth of populist parties.

## THE RELEVANCE OF EUROPEAN FUNDING IN BUILDING REGIONAL ECONOMIC RESILIENCE

Liviu-George Maha, Elena-Daniela Viorica, Diana-Elena Abalasei, Lucia Ciubotaru

Alexandru Ioan Cuza University of Iasi, Romania

### ABSTRACT

An important objective of the European funds is to enhance economic development and to increase competitiveness of the European markets so that the regional economic disparities between the Member States are likely to lessen. These economic disparities are more visible for the borderline regions, as they are more likely to suffer from less administrative, economical or technological progress. The objective of this paper is, firstly, to estimate the effects the European Funds granted from the European Union have on the regional economic resilience, and secondly, to evaluate if the regional disparities between the borderline regions and non-borderline regions are likely to reduce under the influence of these funds. Considering the time period 2007-2020, which covers the budgetary cycle 2007-2014 that was hit by an economic crisis, whose effects are still visible today, a panel regression model will be estimated in order to assess to which extent the European funds contributed as a support-factor in building regional economic resilience of the European Union (EU). A visualization tool to spatially analyze the regional disparities will be further employed to assess the dynamics of the borderline regions in terms of economic development generated by EU funding. The results will add additional information to a body of research with inconclusive results, which did not manage to decisively state that this EU project effectively ensures a long term and sustainable economic development.

## CAN CITIES FROM PERIPHERAL REGIONS BECOME BOTH RESILIENT AND SUSTAINABLE?

**Alexandru Banica<sup>1,2</sup>, Karima Kourtit<sup>3</sup>, Peter Nijkamp<sup>3</sup> Corodescu-Rosca<sup>1</sup>**

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### ABSTRACT

In a world in which more and more turbulences occur and risks are more present than ever, resulting in increasingly numerous natural and human-made disasters, cities and metropolitan areas find themselves in a difficult spot. The risks become higher if one refers to cities that are located in less developed or peripheral regions. They should make serious adjustments to simultaneously achieve a good resilience capacity (i.e. ability to resist and restore after destructive/damaging events), while also reducing vulnerabilities and ensuring present well-being for the population and long-term sustainability (i.e. maintain the main functions and resources to a degree that satisfies not only the present but also the future needs of society). Our approach intends to test, in an international context, whether disasters can become a "blessing in disguise" by looking at some extreme events that occurred in metropolitan areas and changed the approach of urban planners and institutions in peripheral regions. Within a selection of most damaging natural and technological disasters that occurred in some of the most remote or less developed regions in the world, we first correlate data on the losses with resilience indicators (preparedness capacity, coping capacity, and response capacity, Resilient city index), quality of life (Human Development Index) and sustainability (sustainable development index and environmental footprint of cities) – before and after the disaster. The statistical analysis using, classical methods but also machine learning techniques results in a typology that reflects the relation between disaster occurrence and the overall outcomes. Furthermore, taking into account one case study for each category, we try to look at the conflicts between the goals of the comprehensive sustainable development approaches and the more pragmatic purposes of resilience approaches. Examples of planning issues are taken into account and analyzed from a comparative perspective by using qualitative methods. An institutional and administrative approach taking into account the strategies and the overall approach on planning metropolitan areas leads us to insightful conclusions on good and bad practices that could conciliate short term purposes of resilience with long-term sustainable development goals in vulnerable urban areas from peripheral regions.

**BUILDING RESILIENCE BEYOND THE EU'S EASTERN BORDERS. EU ACTORNESS AND SOCIETAL PERCEPTIONS IN UKRAINE AND REPUBLIC OF MOLDOVA**

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**ABSTRACT**

The resilience approach as EU's newfound paradigm places societies and communities at the heart of its interactions with external partners, and especially with its immediate neighbours. As such, in order to enhance its resilience and that of its neighbours, the EU has turned its attention from state to society, from a general top-down to a bottom-up approach. The success of this to a certain extent depends on the local trust in the EU's performance as a transformative actor. The present paper inquires how the EU actorness is perceived by citizens beyond its eastern borders, mainly in the border regions of Ukraine and Republic of Moldova and explores the implications for building a more resilient society in the Eastern neighbourhood. We argue that in spite of the EU's attempts to enhance its actorness in the region, to bring about reforms and promote European values, the positive citizens' perceptions and the overall awareness of the EU's impact are still modest, thus limiting EU's capacity to act towards building a 'stronger and more resilient society'.

## **Regular Session: RS03.3 - Knowledge and innovation**

**13:15 - 14:30 Thursday, 27th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/87555502007>**

**Chair Sandro Montresor**

## SKETCHES VERSUS THE NEW TECHNOLOGY'S INNOVATION IN THE CREATIVE PROCESS

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### ABSTRACT

The conceptual processes of most designers are based on the development of ideas through its expression in sketches. There is a deep relationship between sketches and creativity. As the designer has to conceive and develop solutions for specific problems which may be of different nature, sketches may present themselves as an operative support for creative reflection, problem solving and critical analyses within the several phases of the design process. Sketches arise from the human imagination and result from a constant iteration that culminates in creative approaches. Despite the innovation that new technologies introduced, sketches are universally used as a tool for thinking, planning, and exploring concepts. It is applied by a wide range of people including scientists, mathematicians, engineers, economists, publicists and teachers to help explain, provide instruction, or to register the evolution of ideas. One of the main questions we want to discuss and to find answers is if the nowadays wide use of new technologies doesn't invalidate the important role played by sketches, within several professional areas, as a stimulating instrument when sketching the first ideas and as a critical verification of the solution hypotheses.

### KEYWORDS

Creative Process, Design, New Technologies, Sketches

### 1. INTRODUCTION

This paper stems from a current post-doc research project motivated for the need to produce more knowledge about the Drawing relevance in the conceptual process in Architecture and in Design.

The essential question of determining whether sketches will be the key of the design process, constitutes the starting point for this postdoctoral research project on the use of freehand drawing in design practice.

Through the study of several statements from various authors we intend to investigate not only the permanence of sketching important role since mid-last century to present, but also its possible use in the future. From this theoretical approach we also intend to verify the sketching relevance, despite the paradigm changes that emerge from time changes. We also want to discuss if sketching may serve as mind stimulus during the creative process phase and to verify its permanence and importance in different areas, although the use and the progress of the new technologies.

### 2. SKETCH DEFINITION

The word Sketch, deriving from the Italian *Schizzo*, has its origin from the Latin *Schedium*, which derives from the Greek *Skhedios*, both meaning 'done extempore': done without preparation, improvised. "Moreira da Silva (2010)"

According to the Oxford English Dictionary the word Sketch means: "a rough or unfinished version of any creative work", which directly implies creativity.

In the Cambridge English Dictionary: "a simple, quickly-made drawing that does not have many details", relate to its scarce rigor or definition.

So the word Sketch describes a quickly-made freehand drawing and its intention is to give a general overview or the guidelines of something, in relation to the intended final shape or figure, a rough drawing representing the chief features of an object or idea and often made as a project preliminary study.

Sketches are synthetic drawings, executed freehand, where we represent ideas that have not yet been fully defined. Sketches emerge from the need to fix those first ideas that occur in the project act and that are manifested through the first signs, coming from the thought, traced on a sheet of paper. A sketch can be like the 'thought of the hand', the hand as an extension of each thought fixed at the moment by the gesture that registers it. "Moreira da Silva (2017)"

### 3. SKETCHES IN THE CREATIVE PROCESS

A two-way link is established between the sketches and the mind, between thought and the action of representing it, and at the same time the character of the creative process is evidenced by allowing its self-exploration and self-evaluation. This last characteristic is important since it allows or encourages the method of qualitative approximation as it constitutes a vehicle for new modifications that optimize the original idea and open ways for obtaining new ideas.

The images are not created by the sketches, they only allow them to emerge from the ideas, creating the right environment for them to be recognizable and providing a means for their expression and for their realization.

Sketches arise from the human imagination and result from a constant iteration that culminates in the creative solution, the transposition and dissection of the mind's image generates abstract or concrete drawn forms. Reflection and experimentation through sketching, approximates the reality of things, recreating them. From sketches are born more sketches, from sketches are born things, in a cognitive iteration. Crucial reinterpretations for the advancement of the design process, especially when sketches are perceived and reconfigured for new interpretations. We can see that there are several types of sketches, according to its purposes: 'the thinking sketch', 'the talking sketch', 'the storing sketch'. "Van der Lugt (2001); Tversky (2009); Goldschmidt (2014)"

A sketch assumes a peculiar and determinant character in the conceptual/creative process, giving thought the possibility of transfiguring itself through graphics that reveal the ideas that give rise to it. It allows the anticipatory structure and the envisaged solution to be recognized.

Sketching, not only makes the author's idea become visible, which until then was purely mental, but also makes possible, through graphic signs, quick and decisive ones, which help him/her to better clarify the design subject, its transformation into a project.

Sketches allow concepts and ideas to come out. If they were impossible to be formalized through words, once fixed on a sketch, become analyzable, recognizable, evaluable, modifiable, that is, became capable of being explained verbally. The main objective of this type of drawing is to fix the idea, the design global image 'in thought', which the author gradually matures. The sketch works as a bridge between the abstract world of the imaginary and the concrete material explanation through graphic synthesis.

The act of sketching enables that reasoning and thoughts we have developed can be gradually translated and decoded throughout the drawn lines. Somehow we debate ourselves with our own ideas in this quickly-drawn lines. We scratch, we draw, we overwrite features, we configure, we represent, we visualize, giving physical form to our thoughts. There is a direct link between the thinking and the hand that performs the sketch. The hand as an extension of the brain, of the reasoning. "Moreira da Silva (2017)"

Embryonic ideas are quickly thrown onto the sheet of paper for primary analysis, before they disappear, relieving limited memory resources, leaving room for reflection and detailed observation of ideas, validating or discarding them, generating a constant flow of more ideas. "Barreira da Costa (2019)"

The moment when sketches are carried out is characterized by a propitiatory capacity for reflection, which allows and encourages the elaboration of new ideas.

We can conclude that it is important to recognize a creative system within the act of sketching that is part of the author's self-investigation process about his work.

#### **4. SKETCHES TRANSDISCIPLINARITY AND THE NEW TECHNOLOGIES**

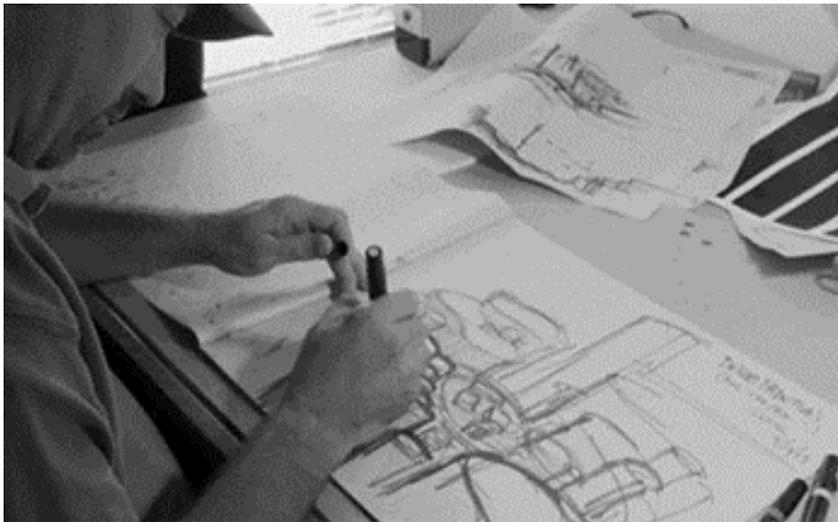
Sketching has been traditionally used over the centuries, so it is often seen as an outdated method for design, as tradition can be thought as a strong and unalterable link to the past. In this sense sketching is often considered outdated, but nowadays its use has evolved and expanded, being widely used by various areas of knowledge and professional practice, surpassing the previous and restricted use only by areas linked to the project such as architecture, engineering and design.

Many creative professions use sketching as a tool in their design process, from UX designers to movie directors, great ideas start with simple sketches. One thing many share in common is the simplicity and usefulness of sketching.

Hayden Mills presents a few professionals, not only designers, which use sketching to help them brainstorm new ideas and better communicate with one another:

a) For civil engineer Peter Carrato, hand sketching is a means to clarify his thoughts. Ideas can be tested, relationships explored, and details developed. Without sketching, Carrato considers that a structural engineer may be at a loss to perform critical structural engineering thinking;

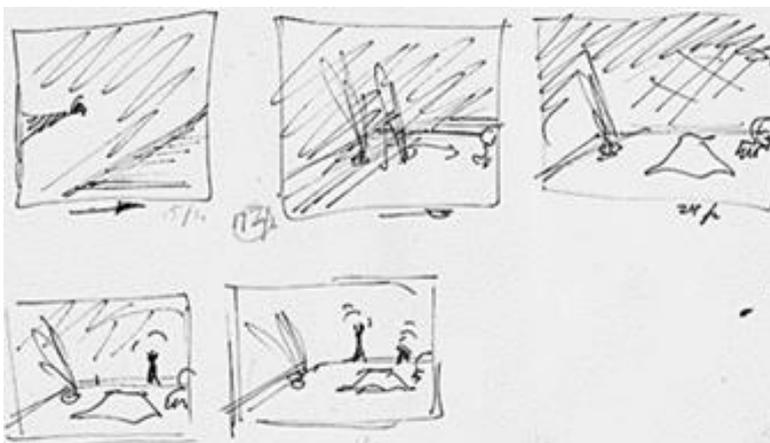
b) Designers at Disney Pixar Films say that Pixar's artists use traditional media to draw the initial design of the creation of characters or a new world for a movie. At Pixar, despite being a high technology company, an artist typically does hundreds, sometimes thousands, of sketches before they are satisfied with the design of their new character or a new movie environment. They also say that sketching out a storyboard is a way to write a story using pictures instead of words and that achieves the goal in a better and more practical way;



**Figure 1: Pixar artist drawing a new world for a movie**

(<https://medium.com/@haydmills/11-creative-professions-that-use-sketching-as-a-tool-in-their-design-process-and-why>)

- c) Industrial designer Adam Fairless, states that a sketch conveys the designer's ideas without being overly worked. Freehand drawings permit to get several good ideas down quickly and relay multiple thoughts and ideas at a glance;
- d) Nike footwear designer Tinker Hatfield, says he adopted sketching as a primary tool for moving through the early phases of a project. For him one sketch leads to another and he feels like having a conversation with himself;
- e) UX designer Jared Spool, says that words are powerful, but sometimes they do not clearly describe what we are imagining, but a sketched diagram usually does this and even more quickly;
- f) Mike, woodworker and carpenter, says that his sketchbook is where everything begins, where he works out designs and proportions, asks questions and solves problems;
- g) For graphic designer Aaron Draplin, sketching is meant to be fast, fun, and free, his hand is much freer than it would be with using Illustrator;
- h) Movie director Tim Burton, says that sketching helps him to hone in on his thought process, which tends to be all over the place; sometimes a doodle will remain, drawing it over and over until finding his own meaning.



**Figure 2: Movie director Tim Burton's storyboard sketches**

(<https://medium.com/@haydmills/11-creative-professions-that-use-sketching-as-a-tool-in-their-design-process-and-why>)

From these examples, presented by Hayden Mills, we can conclude that the use of 'traditional hand sketching' can be transdisciplinary and used in many new professional areas, even those more connected to new technologies, opening useful and innovative paths to the 'old drawing by hand'. "Mills (2017)"

The fact of using new technologies does not invalidate the vital role played by freehand drawing, both at the initial stage of recording the first ideas and during their subsequent development and in the critical analysis of the different hypotheses. "Moreira da Silva, (2017)"

To John Roome it is, in fact, the possibility of cross-fertilization between traditional and digital platforms that is interesting, beneficial and innovative. "Roome (2011)"

People have been sketching for a long time, but, with the advent of digital drawing tools, Hayden Mills tries to answer why some people still prefer to sketch with a pen, or a pencil on a paper. He concludes that, in the first place, sketching gives a place to start: many creative professionals begin with a pen and paper. The process of thinking through sketching

helps them getting their creativity flowing. Besides, it helps everyone to document the process. Early design process ideas come and go, sketching forces to shift the ideas into paper, helping to document those ideas in real-time as they arise in few seconds. Documenting the different iterations makes it easier to visualize, allows to see what was explored and, more importantly, what was not explored yet. “Mills (2017)”

Embryonic ideas are quickly thrown onto the sheet of paper for primary analysis, before they disappear, relieving limited memory resources, leaving room for reflection and detailed observation of ideas, validating or discarding them, generating a constant flow of more ideas “Barreira da Costa (2019)”

In summary, sketching is a very simple tool used by many professionals. A sketch helps to communicate visually what is in our head, a method to help moving from one idea to the next while keeping everyone on the team on the same page, it also can help professionals advance and inspire future innovations.

For Joshua Brewer, senior designer at Twitter and UX designer, the real value of sketching is that it allows you to explore and refine ideas in a quick, iterative and visual manner. Rapid ideation flow and interact, layout and hierarchy can be quickly established, rearranged or discarded, all of this without ever touching a computer. “Mills (2017)”

We all drew with crayons when we were children. Sketching is a universal language that helps us understand one another, explaining what words sometimes can't. Sketching breeds clarity. The only way to for others to clearly see what is in our mind is by showing them visually. Coming to a meeting with sketches, communicates to the rest of team that the idea is not finished. This promotes conversation and collaboration. It helps getting others involved in the design process.

In so many different professions, even not related to design like biologists or marketers, salesmen or teachers, no one can't share information and interact with any other way so easily than with sketches. People can draw on top of sketches and add information or new ideas or solutions to them. It can be a great way to garner feedback from others. With sketching, nobody have to learn any fancy design tools. It is enough to put a pen to paper or marker to whiteboard and let the ideas flow. It allows everyone in a team to work together regardless of title or position. This can be considered as an innovative approach to the traditional use of sketching.

Nowadays, with new agile technologies, it is fundamental to enhance the design process and make it leaner. And it is even more important that this process leads to a successful product.

Sketching can be a fundamental step in any design process. It pushes designers to step away from their desks and work with different tools. Furthermore, this can become a team's exercise where non-designers (developers, product owners, project managers, etc.) can contribute with their ideas and input from an early stage. “Carqueija (2016)” Once on paper, the ideas are ready to be tested with other teams, stakeholders or even potential users to feed into initial designs and help iterate.

Lean User Experience has been a much used design methodology in the last few years. Lean is about developing fast, through iterations, with multidisciplinary teams working together throughout the entire project. “Dourado (2014)” The focus of Lean UX is creating value for the customer while reducing waste, avoiding anything that deviates the focus from the design and the product being built. According to Andreia Carqueija it is imperative that the multidisciplinary team becomes more agile but they also need to be allowed to easily testing ideas. Even with a limited timeframe, the designer should be able to quickly put together some designs for early testing. And this is where sketching can be applied. “Carqueija (2016)”

So we can conclude that sketching can be useful in multidisciplinary team design even when applying recent innovative methods like Lean User Experience methodology.

According to José Silva et al. although drawing is being sometimes considered as an expressive tool far from the digital universe, it allows a holistic perception of information, connecting associations in a timeline map, presenting the various options along the project development. In addition to its representation possibilities, sketching gives access to a deeper learning, through the interactions and evolutions of a certain problem challenge. “Silva et al. (2017)”

Drawing holds, in itself, the making visible quality of the whole mental process underlying the conceiving stage, from the first sketches of a vague idea to the object to create final solution. Sketch's transcendent importance lies on the capacity it gives the designer to materialize abstract conceptualizations and to create the ideational basis for design creations. “Moreira da Silva (2017)”

Mike Rohde states that the real goal of sketching is about generating ideas, solving problems, and communicating ideas more effectively with others, particularly in an age dominated by digital media. For Rohde, sketches can work like a visual thinking tool as a primary language for capturing thoughts, exploring ideas, and then sharing those ideas. He gives an example where he used sketches for redesigning a Mac application. He says that sketches allowed him to visually capture and share his design ideas, making possible that he was able to show to the developer a variety of options for UI controls and structure before moving to the visual mockup and prototyping stage, saving time and efforts. “Rohde (2011)”



**Figure 3: Pencil sketches with notes began Rohde’s process of redesigning the user interface of a Mac application.**

(<http://alistapart.com/article/sketching-the-visual-thinking-power-tool>)

Sketching survival facing nowadays artificial intelligence growing importance is one of this research issues, as it can proves the innovative sketching ability to adapt to new paradigms. As we have already testify, even in the professions basically linked to artificial intelligence technologies, sketches continue to be successfully used during their creative process stages.

Frank Gehry is one of the contemporary architects who most uses new artificial intelligence technologies to achieve his final work, however, he always uses sketches to fully develop his creative ideas.

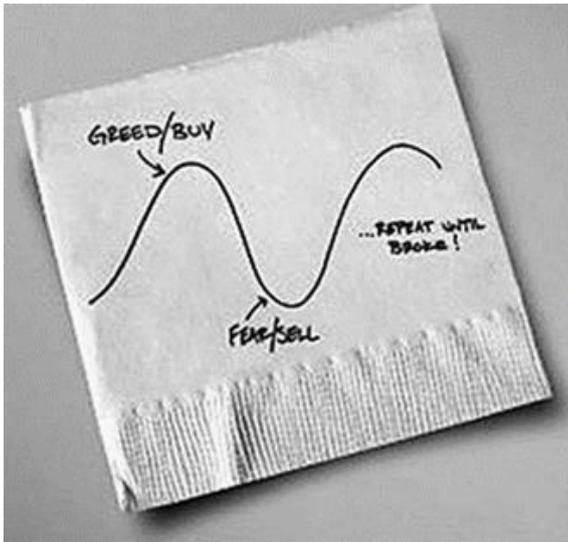
Bill Buxton, principal researcher at Microsoft, describes the process as a quick way to generate and share many ideas in such a way that this ideas can generate even more ideas. “Buxton (2007)”

The new information technologies offer new ways, allowing to save time and facilitating many of the daily practice tasks, even becoming indispensable in many work phases. However, they do not replace sketching, which continues to assume a ‘chameleon’ shape during the various historical periods, in a constant time adaptation, and, especially by incorporating a critical dimension in the creative process. “Moreira da Silva (2017)”

According to Peter Hamilton, the value of sketching is associated with the knowledge that hand-drawing is the essence of creativity and its measure would lie in the individual ability to continuously express and create, using self-exploration and creative thinking through the process of drawing, linking together interesting ideas and technical know-how, enhanced by assistance and interaction with new technologies. “Hamilton (2009)”

Pedro Domingos in his recent book, *The Master Algorithm*, talks about the extraordinary advances of Artificial Intelligence and its promising future, but as he mentioned throughout this book, Artificial Intelligence is developing in the direction of Automatic Learning, but not yet capable of creating something new which is the very essence of Creativity. Domingos is a fellow of the Association for the Advancement of Artificial Intelligence and Professor at the Washington University, being an expert in this subject. “Domingos (2017)”

Automatic Learning based on Artificial Intelligence can enlarge our data and integrate multiple learning components, and so, can be very useful for generating creativity through knowledge, but still, creativity is something more beyond knowing, it is a special ability that, for now, is an intrinsic part of the human being. Creativity is something that big data does not explain, but, however, machine learning can help us to build more accurate fundamentals and research findings for our creative works. “Moreira da Silva (2018)”



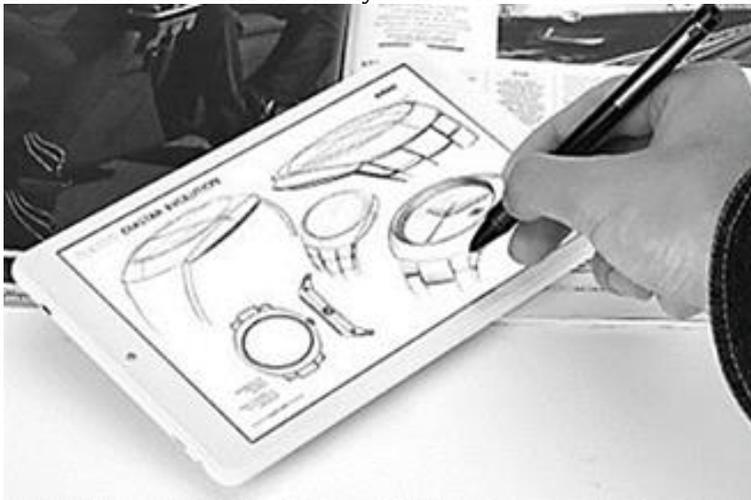
**Figure 4: Napkin sketches about financial investment strategies by Carl Richards, financial planner and finance advisor**

(<https://www.businessinsider.com/carl-richards-napkin-sketches>)

Countless great ideas, in many professional areas, have recently started out as napkin sketches. Facebook’s data center electrical system sketches by Jay Park where made on a paper napkin. The first ideas of the recent Louvre Abu Dhabi started with a simple sketch on a restaurant paper napkin, says the author, the French architect Jean Nouvel. “Moreira da Silva (2018)”

One of the advantages of sketching is that we can sketch everywhere, anytime with any medium in many different supports. We don’t need special conditions for sketching so we can sketch everywhere and we can do it using pencils, pens, markers or chalk, on any kind of paper, on sketchbooks, whiteboards, chalkboards and even new surfaces like tablets.

Mike Rohde says that he found the iPad an interesting tool for sketching, especially with the advancement of software like Sketchbook Pro. He usually uses a Griffin Stylus for iPad for sketching, sometimes he also uses his own fingers which he considers to work reasonably well for loose sketch work too. “Rhode (2011)”



**Figure 5: Using tablet tool for sketching**

(<https://www.google.com/search?=design+sketches+ipad&tbm=isch&source>)

Thanks to the new technologies we can easily use a tablet as support for our drawings. However, when sketching, in many different supports even the innovative ones, the hand is still working as an extension of our human brain.

The act of sketching allows that the reasoning and thoughts we have developed can be gradually translated and decoded throughout the drawn lines. Somehow we debate ourselves with our own ideas in this quickly drawn lines. We scratch, we draw, we overwrite features, we configure, we represent, we visualize, giving physical form to our thinking. There is a direct link between the thinking and the hand that performs the sketch. The hand as an extension of the brain, of the reasoning. “Moreira da Silva (2017)”

Sketching capacity to perform a link between the brain and the hand, since the first human drawings in remote times, is one of the reasons why sketching can perform actually a transdisciplinary and innovative role in many creative professions linked to project or communication besides the design area.

## 5. CONCLUSIONS

We can conclude that, in spite of the paradigm shift required by changing times, freehand drawing remains inseparable from many professional practices, assuming an essential operating support for developing creativity.

Although technological development has created several tools and new techniques for graphic representation, we can deduce about the importance of sketches permanence in many creative processes. Freehand drawing is used to facilitate the development of ideas and show them more quickly and efficiently, and is an essential tool for many professionals, regardless if the work is in informational, graphic, product, fashion or another design areas, engineering, architecture, marketing, advertising, cinematography, teaching and many others. Sketching seems to be present in almost all disciplines that identify with creativity and communication.

In creative teams, sketches represent a valuable tool, validating brainstorming, materializing concepts, externalizing the various ideas that float in different work groups. Sketching breeds collaboration and is a tool accessible to the whole team, like a common language that can bring clarity to ideas.

Sketching is fast and easy, it gives freedom to explore ideas as quickly as they arise, it helps problem solving faster. We can conclude that sketching's characteristics can be described as a fast and effective means of communication, universal in its reading and universal as a thinking tool used by a wide variety of people.

Sketches capacity to perform a useful link between the brain and the hand is one of the reasons why sketching can perform actually a transdisciplinary and innovative role in many professions linked to project or communication besides the design area.

No doubt new information technologies offer new ways, even becoming indispensable in many work phases. However, they do not replace sketches, which continue to assume a 'chameleon' shape during the various historical periods, in a constant time adaptation, and, especially by incorporating a critical dimension in creative processes.

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## “WITH NO SIBLINGS, BUT WITH HOME”: SINGLE PATENT-CLASS INVENTIONS (SPIS) AND REGIONAL TECHNOLOGICAL DIVERSIFICATION IN EUROPE

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### ABSTRACT

This paper aims to investigate the extent to which the incidence of single patent-class inventions (SPIs) on the regions’ knowledge base can affect their technological diversification. Drawing on the literature on technological relatedness, we argue that SPIs contribute to make regional knowledge bases more “siloeed” and reduce the opportunities of knowledge recombination on which technological diversification depends. We also maintain that SPIs contribute to attenuate the role of relatedness in regional technological diversification, as siloeed knowledge bases entail less dense local knowledge networks, with lower cognitive constraints for the entry of new technologies. Our empirical application, undertaken with respect to EU-28 NUTS2 regions over the 2008-2015 period, introduces different measures of regional SPIs and show that, as expected, they both negatively correlate with the regional propensity to technologically diversify and negatively moderate the effect of relatedness on the same capacity. Important implications are drawn with respect to the implementation of regional specialization strategies of research and innovation.

## PRODUCTION EFFICIENCY OF ADVANCED TECHNOLOGY-GENERATING INDUSTRIES IN THE EU: STOCHASTIC FRONTIER ANALYSIS OF INDUSTRY-LEVEL PANEL DATA

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### ABSTRACT

This research aims to analyze how the R&D spending contributed to the production efficiency of advanced technology-generating industries in the European Union. We applied the stochastic frontier analysis model for industry-level panel data from 1995 to 2017, based on a Cobb-Douglas production function. Results revealed that R&D spending had a statistically significant impact on the production efficiency for the whole sample. However, there was no statistically significant impact of this contribution to efficiency growth in most advanced technology generating industries in the EU. Physical capital (gross fixed capital formation) remained the key input for higher production efficiency. Therefore, advanced technology uptaking processes played an important role in the production efficiency growth in industries analyzed.

The comparison of levels of production efficiency in different EU countries revealed that some small countries and catching up economies like Lithuania and Estonia had comparatively high-efficiency scores of using available resources for an output generation. Therefore, this research contributed to the debate on previous findings that production efficiency is not necessarily lower in catching up economies. Higher investments in such countries' advanced technology-generating industries suppose to increase value-added considerably.

## **Special Session: SS17.1 - Data science, machine learning and big data for regional Sciences**

**13:15 - 14:30 Thursday, 27th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/81262412877>**

**Chair Jean-Claude Thill**

## PREDICTIVE MODELLING OF GULLY EROSION IN ARID ENVIRONMENT: CASE OF THE RURAL COMMUNE OF EL FAID LOCATED IN THE SOUTH-MOROCCO

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Ecole Nationale Forestière d'Ingénieurs, Morocco

### ABSTRACT

Land degradation is major threat to food security and to the sustainable provision of ecosystems goods and services. In arid environment characterized by reduced vegetation cover, erosion process is the main threat to soil capital leading to its degradation. Gullies are one of the main expressions of soil erosion in such environment. Soil and water conservation interventions must then be implemented in order to curb soil erosion. However, there is need to precisely verify gullies location and distribution within remote and inaccessible lands. This study aims to develop model predicting the occurrence of gully in order to propose correction interventions that reduces erosion and flooding risks. The study concerned arid lands located in the rural commune of El Faïd located in south of Morocco which is an arid region. Gullies within the watershed have been identified using Google Earth and GIS. Eight hundred ninety-four (894) gullies have been mapped verified through field visits. Maps of predisposing factors have been digitized and include physical factors and anthropic factors (including Lithofacies, Land use, Slope, Slope Length, Aspect, Curvature, Topographic wetness Index, stream power index). The gullies database has been randomly split into two sets, training dataset (715) and testing dataset (179). Several predictive models have been trained including information values and machine learning based approaches (Artificial Neural Network and Random Forest) using R language. The model's quality was assessed using the area under the curve to choose the model with a best predictive capacity. Further, our results stressed out the main predisposing factors to gullies prediction. The fitted model has been used to predict, for all the watershed, even in inaccessible lands, the gullying susceptibility. Such maps are very important for managers in order to contribute to land degradation neutrality and to prevent flood events on the flat lands. Key words: Water erosion, gully, vulnerability, prediction models, Machine learning, El Faïd.

## MACHINE LEARNING FOR FOREST STAND DELINEATION USING YEARLY LANDSAT TIME SERIES

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### ABSTRACT

Forests as natural capital provide goods and services contributing to human wellbeing. As their contributions to sustainable development goals are widely recognized, it has been globally agreed that forests need to be sustainably managed. Forest management rely on accurate information concerning forest resources, their dynamics and the social and market needs. Such information needs to be accurate and periodically updated. Forest stand maps remain a major tool for characterizing forest resources and for prescribing interventions to be undertaken within each stand and at the required timestamp. Nowadays, within Moroccan forestry context, forest stand maps are mainly produced using conventional approaches based on aerial photo-interpretation, and then ground truth verification using field mission. This process is time and resources consumptive. Within our study, we focus on the use of satellite imagery time series in addition to machine learning techniques in order to update forest stands map. The study focused on Cedar Forests located in the Middle Atlas region which has been recognized as national heritage. The used data consist on "Landsat" images time series, circular random plots randomly chosen from national forest inventory database, in addition to limited number of inventory plots measured within small scale forest management studies and at various timeframe. Data have been organized and preprocessed, then supervised classification of forest stands have been performed using either truth plots and the corresponding imagery or the whole imagery database while focusing on the sites on which the most important stands types changes have been undergone. Classification algorithms where based on various commonly used machine learning algorithms, whose effectiveness has been proven in several research studies. Supervised images classification, using different algorithms, gave satisfactory results with a high variability. Furthermore, temporal segmentation of the archive appears to be a feasible and seems promising.

## MODELING FOREST TYPE TRANSITION OF MIDDLE ATLAS-MOROCCO ASSOCIATED TO HUMAN ACTIVITIES

**[Anass Legdou](#)<sup>1</sup>, [Aouatif Amine](#)<sup>1</sup>, [Said Lahssini](#)<sup>2</sup>, [Hassan Chafik](#)<sup>3</sup>, [Mohamed Berrada](#)<sup>3</sup>**

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### ABSTRACT

Due to climate change scenarios projections, predicting higher probability of extreme/adverse climatic events, to the context of socio-economical changes of the population and the production systems, forest resources are ongoing/experiencing steady degradation process threatening the future of forest as natural capital. The higher anthropogenic pressure in addition to ecological fragilities leads to deep transformation of forest cover and then to the land use systems in mountainous area; such transformation is scale dependent. In order to sustainably manage forest resources, there is a need to understand the mechanisms underlying changes in forest cover either at the occurrence of the process or at the intensity of its manifestation. Then, the objective of our work is to develop models explaining the impact of various biotic and abiotic factors on cedar ecosystems and to predict the future state of such forest. The study was carried out on Ain Leuh Cedar Forest (Sidi M'Guild) located on the middle Atlas-Morocco. This forest is part of the UNESCO heritage Man and Biosphere Cedar Reserve. The used data consist on time series of "Landsat" satellite images covering a 14 years period from 1990 to 2004, maps of 19 bioclimatic factors, digital elevation model and socio-economic criteria including human settlement location, demographic data and human development criteria. The approach consisted on classification of the images then calculating transition probability using Markov chain for respective forest cover types and then modeling, the transition probabilities as function of the various bioclimatic, physical and socio-economic factors. On the other hand, ground truth data at different time laps was provided by forest management studies, national forest inventory and field visits. The most common transitions concern mainly species cover, species transformation remain very rare. In this work, factors that contribute to explain the transition between Cedar cover state and the other spaces in the same space of Ain Leuh Cedar Forest are six important parameters in which social parameters affect those transitions. The predicted forest cover map provide guidance to forest scientists, managers and decision-makers on the prospects for preserving and rehabilitating this natural capital.

## CLOUD COMPUTING SOLUTION FOR MONITORING PROTECTED AREA IN MOROCCO

**Said Lahssini<sup>1</sup>, Said Moukrim<sup>2</sup>, Hicham Alaoui<sup>3</sup>, Hicham Hajji<sup>4</sup>, Loubna El Mansouri<sup>5</sup>**

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### ABSTRACT

Morocco is qualified as a major contributor to the Mediterranean Basin biodiversity hotspots. Network of protected area has been established to protect its natural capital and to promote local population development. In spite of the protection efforts made by government, there is a need for an evidence-based approach to measure the conservation effectiveness, not only in management, governance and equity, but also in terms of ecosystem functioning and its ability to sustain the provision of ecosystems services. With the lack of data related to natural resources monitoring, the wide availability of open access earth observation data, acquired primarily by free access satellite such as Landsat, MODIS and Sentinel has triggered new development perspectives. Moreover, and in addition to this crowd sourced satellite data, the parallel cloud-based computational platforms such as Google Earth Engine (GEE) that becomes increasingly accessible, allowed to overcome data lack issues and to scale analysis across space and time. This work tries to assess the effectiveness of protection strategies on a Moroccan protected area case and aims to develop an automated solution for monitoring rehabilitation dynamics or degradation trends within a protected area located in arid region through harnessing the use of satellite data products with parallel cloud spatial big data processing. The study area concerned the Argane Biosphere Reserve which is recognized by Unesco MAB as natural Heritage since 1997. Data-driven modelling (DDM) based approach allowing the combination of Big Data, artificial intelligence algorithms were adopted. Ecosystem restoration trends was assessed through spectral indices analysis and continuous cover change detection based on temporal segmentation of satellite time series. The process was implemented using GEE API for java script. As results, a graphical user interface and an application prototype was released. It is exploitable using standard web browser and is accessible even to people without any background regarding programming languages or remote sensing skills. Such graphical user interface facilitates the process of analyzing temporal trajectories (time series) of different spectral indices derived from satellite images (Landsat or Sentinel) at the required spatial analysis scale. Further, the analysis of forest cover trends, using temporal segmentation, has been promising. It permitted to identify the occurrence and the intensity of abrupt forest cover changes underlying forest harvesting or land use changes through its rehabilitation.

## **Regular Session: RS21.3 - Agriculture, fisheries and food security**

**13:15 - 14:30 Thursday, 27th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/84441830561>**

**Chair Nugraheni Kusumaningsih**

## PHYSIOLOGY OF MERLUCCIUS MERLUCCIUS IN THE NORTH ATLANTIC OF MOROCCO

**Chaimae El Bouzidi<sup>1</sup>, Mounir Hassani Zerrouk<sup>2</sup>, Said Benchoucha<sup>3</sup>, Mohammed Bakkali<sup>1</sup>**

<sup>1</sup>Faculté des Sciences et Techniques de Tanger, Morocco. <sup>2</sup>Multidisciplinary faculty of Larache, Morocco. <sup>3</sup>Centre régional de l'INRH, Tanger, Morocco

### ABSTRACT

The common hake (*Merluccius merluccius*) is a unique specie. With various positive aspects such as a high Business value in term of monetary growth as well as representing a considerable part of the Moroccan fisheries. Even though bibliography about the specie is rich, yet few disparities persist. In particular on some of its biological, and ecological aspects. This lack of data has retrograding repercussion upon the quality and accuracy of the stock evaluation and falconry management. This study is targeting a more effective and rigorous bio specification that will assist us surveying and evaluating the local common hake stock as well as the administration of fisheries all along the north Atlantic Moroccan coasts. In this project, we chose the *Merluccius merluccius* hake, because it is the most important of the high-value demersal fish species exploited in Morocco from the point of view of landings; The maximum production of hake in Morocco according to the ONP (National Fisheries Office) was around 7000 tonnes in 2005 then dropped to 1538 tonnes in 2013. The *Merluccius merluccius* suffer from the lack of development plans which ensure a rational exploitation. This study then will contribute to improve the management of the common hake in the Moroccan fisheries, through a complete study of the biological aspects based on three axes: reproduction, growth, and diet of the *Merluccius merluccius*. The study of growth to determine body size as a function of age, this is why all stock assessment methods rely on age composition data, which form the basis of calculations growth rates and growth in the production of stocks (INRH 2013) Reproduction It is for the protection of the stock of hake which is constituted of 85% of juveniles at the level of the zone and the reconstitution of the areas of concentration of the common hake (INRH etat des stocks et des pêcheries au Maroc [Rapport]. - 2013). Sexual maturity and laying are always linked to a change in diet (Parz et al, 1993). Thus, the increase in energy requirements related to sexual maturity may be the critical factor explaining the change in eating habits of hake. Also, we will study the indicators of exploitation in order to show the economic value of this species and to show the current state of the stock of common hake in the North Atlantic of Morocco. This full review on all different biological facets of *Merluccis merluccius* (reproduction. growth conditions, nutritional restriction) could help to reduce the pressure of fishing on the common hake and to ensure sustainable production for the future generation.

## CAN PHONE USAGE IMPROVE TECHNICAL EFFICIENCY OF RICE FARMING? EVIDENCE FROM INDONESIA

[Nugraheni Kusumaningsih](#)

Fiscal Policy Agency, Indonesia

### ABSTRACT

Several studies have found that mobile phones are a promising tool to improve the livelihoods of smallholder farmers in developing countries, however whether the phone usage in rice farming can really improve the technical efficiency is mostly uninvestigated. There has been an increasing number on phone usage in rice farming in Indonesia for the past decade. In Indonesia, rice is the most important commodity because it is the staple food for around 270 million people. The agricultural sector still contributes greatly to job creation, about 30 percent of workers in Indonesia are in the agricultural sector. There has been a great concern within the country on the importance of food security and even going toward food self-sufficiency. Various challenges faced in rice farming, such as productivity that needs to be continuously increased, the lack of agricultural production factors, climate change, and the potential for supply disruption due to the Covid-19 pandemic, make this study necessary. This study aims to investigate whether the phone usage improve technical efficiency of rice farming as well as to determine the level of technical efficiency. The main data used in the study is household survey data from the 2014 Indonesian Family Life Survey (IFLS) managed by RAND (2015). The sampling carried out at IFLS used the stratified random sampling method by using the province and the regency / city category as the strata. Samples were randomly selected based on these strata. From these secondary data sources, we obtain 2120 rice household data. This study uses a production function which includes rice farming and capital as input. Stochastic frontier analysis with the Cobb Douglas production function which has been widely used to measure technical efficiency in various sectors including agriculture, especially rice farming is employed. Analysis using the stochastic frontier production function shows the technical efficiency of rice production in Indonesia is 0.6, where the area of rice and the use of new superior seeds has a significant effect on the output produced by rice farmers. In fact, labour does not have a significant effect on the estimated output because the number of workers in the agricultural sector is too large when compared to the availability of existing rice land. The estimation results of the stochastic frontier production function also show that there are inefficiencies in rice production in Indonesia. The inefficiency model shows that phone usage, farmers' education and irrigation improve technical efficiency. Phone usage in rice farming allows farmers to get information and coordinate better with other farmers. In addition, the use of cell phones, especially those connected to the internet, can provide opportunities for farmers to access more knowledge in rice production, thereby helping to use optimal inputs.

### KEYWORDS

Phone; technical efficiency; stochastic frontier production function; rice farming; Indonesia

## **Regular Session: RS11.2 - Rural development**

**13:15 - 14:30 Thursday, 27th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/82231138454>**

**Chair Anna Mikhaylova**

**FAIR TRADE AND RURAL DEVELOPMENT: ASSESSMENT OF PREFERENCES AND POTENTIAL PARTICIPATION OF SMALL PRODUCERS IN NORTHERN MOROCCO**

**Eddahmouny Hicham, Elbroumi Soufiane**

FSJES FES, Morocco

**ABSTRACT**

Since mid-1980, there has been a growing international awareness that « trade not aid » is one of the most effective tools to reduce poverty in developing countries. It is in this global context that the Fairtrade movement began more than 50 years ago. It starts from a simple observation: rather than providing financial assistance to poor small farmers, it is better to offer them the means and techniques to develop themselves. Indeed, numerous studies have examined the impact of fair trade on the well-being of small producers participating in programs and the willingness of consumers to pay for Fairtrade and other labelled products. However, few studies have examined farmers' preferences for participation in the movement. Our research is part of this framework and proposes the use of an experiment of choice, to examine the preferences of small farmers of olive trees in northern Morocco for Fairtrade standards. The results indicate that small producers prefer long-term contracts, individual and cash payments.

**RETROSPECTIVE ANALYSIS OF RURAL DEVELOPMENT IN MOROCCO****Nora Hammouda<sup>1</sup>, Hicham Alaoui<sup>2</sup>**<sup>1</sup>Departement of agriculture, Morocco. <sup>2</sup>Climatic and forest risk management center, Morocco**ABSTRACT**

In Morocco, rural areas are experiencing a revival of interest, in particular with ambitious public policies in terms of rural and agricultural development and natural resource management. In view of its importance, rural areas seem to be the driving force behind all efforts and political concern because of their demographic, social and economic importance. Several sectoral programs have been launched to reduce the gaps in rural areas in terms of infrastructure and access to basic services, such as the National Rural Roads Programme (PNRR and PNRR2), the National Education and Training Charter, the National Plan for the Promotion of Health in Rural Areas, the Programme for the Collective Supply of Drinking Water to Rural Populations (PAGER) and the Comprehensive Rural Electrification Programme (PERG), the National Rural Roads Programme (PNRR and PNRR2), the Green Morocco Plan (PMV). As a result of these interventions, considerable achievements have been made in the area of basic infrastructure. They have made it possible to achieve an accessibility rate of 78% in 2014, a rate of access to drinking water in rural areas of 94% in 2014 and an electrification rate that will rise from 18% in 1995 to 98.6% in 2014. Thus, the school enrolment rate for rural girls in the 12-14 age group was 61.5% in 2014 instead of 39.9% in 2007. Life expectancy at birth increased from 67.4 years in 2004 to 71.7 years in 2010. This paper presents a retrospective analysis of different facets of rural development in Morocco and raises questions about the effectiveness and efficiency of public policy governance, particularly the related axes, the convergence and coherence of plans and programs with the national strategic vision of rural development.

## PLACE-BASED AND PARTICIPATIVE APPROACHES: REFLECTIONS FOR POLICY DESIGNS IN RURAL DEVELOPMENT

**Kim Pollermann, Lynn-Livia Fynn**

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### ABSTRACT

Across the European Union the so-called “Community-Led Local Development” (CLLD) is a well-established policy design. It all started with LEADER in rural areas 25 years ago and now counts 2,600 Local Action Groups (LAGs). LEADER is a place-based and participatory approach where a Local Action Group (LAG) composed of stakeholders from local government, civil society and economy steers the implementation of its local development strategy. LAGs each have a budget at their disposal (approx. 3 million euro) to support project implementation within a funding period (time for implementation is around five years). A set of LEADER principles describes the characteristics of LEADER: territorial approach, bottom-up, public-private partnerships, integrated and multi-sectoral approach, innovation, cooperation with other regions and networking. The aim of this contribution is to discuss different options for the policy design of the LEADER implementation regarding different steering options of this place-based and participatory approach. To examine the performance of LEADER, we utilise results from the 2014-2020 funding period, especially structural data of 115 LAGs in Germany. Main material was collected by means of three surveys using written questionnaires (mainly executed as online surveys: LAG member survey n=1999, LAG management survey n=114, survey of beneficiaries: n=1079). The results are related to single variables of the LEADER implementation and their impact on LEADER performance. Due to complex relations of different aspects, we mainly elaborate findings on simplified output indicators. Regarding a suitable policy design, the results offer several insights: one being that a higher staff capacity in LAG managements in the different LEADER regions fosters a higher share of innovative projects. This supports a policy recommendation to predefine minimum targets for staff capacity as a prior condition for funding the LAGs as this shows to be an important factor for fostering innovation and participation of local actors. In the context of place delimitation, results show that a suitable region design/delimitation is not dependent on the population size of the various LEADER regions.

### KEYWORDS

Community-Led Local Development (CLLD), LEADER, participation, place-based

### 1. INTRODUCTION

#### 1.1 Place-based and participative approaches in rural development

The EU is characterised by enduring regional inequalities, partly as a product of successive enlargements, in which lower income countries acceded to membership, but also because of enduring structural problems in some regions in Western Europe (Tomaney 2010). Regarding rural development, there are different challenges in European regions. To deliver assistance for rural areas, different policies from the European Union as well as from national states try to support declining regions in particular. Sharing of power and participatory decision-making could facilitate more flexible, inclusive and effective solutions and planning (Castro-Arce & Vanclay 2020). Thereby, long-term strategies are required for adaptations to the present and future challenges. Thus, the commitment of the local actors is a crucial strategic success factor for planning processes (Pollermann 2014).

In recent decades, rural development policy made a substantial shift from a sectoral top-down approach to a territorial and integrated approach, which aims to include a variety of sectors relevant for rural development and a variety of government levels and stakeholders (Moseley 2003).

Such territorial or ‘Place-based’ development policies are partially a response to perceived failures of earlier regional policies, and focus instead on tackling underutilised economic potential and reducing social exclusion, through supply of integrated goods and services tailored to local contexts and triggering innovation, which is critical to economic growth (Tomaney 2010).

The participation of local stakeholders is another crucial element of such policies. Different experiences show that revitalisation succeeds when bottom-up initiatives of local stakeholders work in combination with assistance and support by government (Li et al. 2016, 511f). Thus the roles and co-working of different groups are important to develop a suitable design of structures for participation. In addition, the support and animation activities of some kind of local management (with its own staff) could foster suitable and effective participation.

Across the European Union, the so-called “Community-Led Local Development” (CLLD) is a well-established policy design. It all started with LEADER in rural areas 25 years ago and now counts 2,600 Local Action Groups (LAGs). The word LEADER is an acronym derived from the French language: “Liaisons Entre Actions de Développement de l’Economie Rurale” = Links between actions for the development of the rural economy.

## 1.2 Implementation in LEADER

To describe the characteristics of LEADER, there is a set of LEADER principles: territorial approach, bottom-up, public-private partnership, integrated and multi-sectoral approach, innovation, cooperation with other regions and networking (Thuesen & Nielsen 2014; Pollermann et al. 2020). A key element is a so-called Local Action Group (LAG) composed of stakeholders from local government, civil society and economy, formed to steer the implementation of a local development strategy. This contains a description of the regional demographic, economic and natural situation, an analysis of strengths and weaknesses, opportunities and threats as well as selected development objectives for the various LEADER regions<sup>165</sup> and different parameters regarding the organisation of the LAG, the selection of projects and the administration of funds, amongst others. The LAGs dispose their own budgets (approx. 3 million euro in examined regions) to support project implementation. Time for implementation is around five years.

The LEADER instrument requires tailoring to a specific area, so the delimitation of the LEADER region is a crucial explanatory variable. In Germany, LEADER regions are often designed beyond the traditional administrative borders and their size usually varies from 30,000 to 150,000 inhabitants.

Another crucial aspect of the LEADER approach is the establishment of an LAG management, which promotes participation of different stakeholders: usually one to three staff members per LAG work on coordination, consulting services and public relations.

A main result of LEADER is the implementation of projects (related to tourism, village development, basic services, mobility, education, culture, climate protection), whereby an innovative character of the project is not a precondition for funding the individual projects although it is an essential aim of LEADER to create innovative projects in the sense of new approaches to local development in the LEADER region (Dax et al. 2016, Navarro et al. 2018).

## 1.3 Research Questions

The research topic of this contribution is to discuss the influence of different variables of LEADER implementation on the performance of this place-based and participatory approach.

Thereby we will focus on two aspects:

- **Delimitation of the LEADER region:** What are differences in suitability for rural development related to the size of the region (= number of inhabitants)? Here, we use the opinions of LAG members as an indicator.
- **Staff capacity of the LAG management:** What are the effects of staff capacity (number of full-time equivalents/ hours per week capacity) on the outcome of the funded projects? In examining the implications of staff capacity, we use the share of innovative projects in different regions as an indicator.

Both aspects are important for the future policy design for LEADER since programme authorities may set guidelines and requirements with the aim of generating positive outcomes of local development in rural areas.

## 2. METHODS AND MATERIAL

To examine the performance of LEADER, we utilise results from the 2014-2020 funding period, especially structural data of 115 LAGs in four German federal states ("Bundesländer"). These constitute 24 LEADER regions in Hesse, 41 in Lower-Saxony, 28 in North Rhine-Westphalia, and 22 in Schleswig-Holstein. Main material was collected by three surveys using written questionnaires (mainly executed as online surveys):

- LAG member survey: members of the LAGs' decision-making bodies in all examined federal states in 2017/2018 (requested persons N=3308, answering persons n=1999, response rate: 60 %). Usually, a six point Likert scale was used to classify personal estimations of the LAG members.
- LAG management survey: one manager per LAG was surveyed in 2018 (N=115, n=114, response rate 99 %) with a mixture of general questions about the situation in the region, open questions to grasp more detailed assessments about specific problems, again using Likert scales and open questions.
- Survey of beneficiaries: questions regarding LEADER projects (for the implementation of local development strategies, sub-measure 19.2), (N=1267, n=1079, response rate: 85 %), the respondents were asked for estimations about project development, funding procedures and the results of their project, again using Likert scales and open questions.

To judge the performance of LEADER, several output indicators are compiled (in connection with the LEADER principles and the related expected benefits).

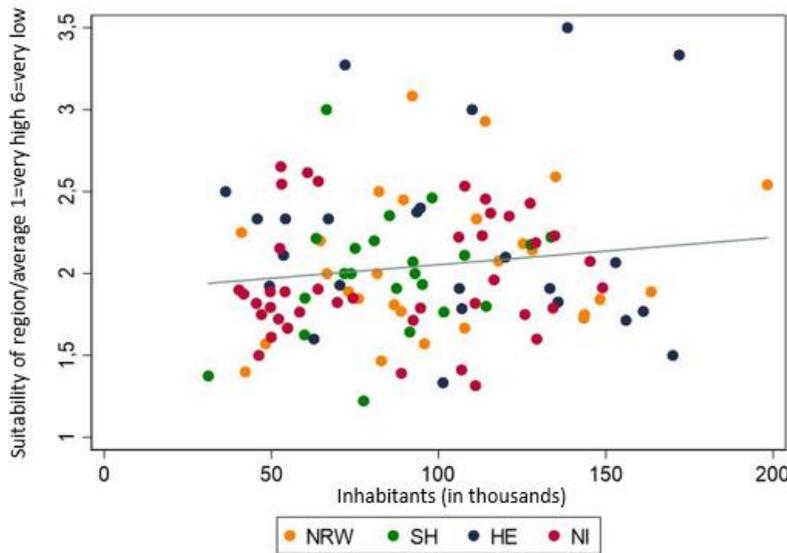
## 3. RESULTS

This paper contains only preliminary results; more detailed deliverables will follow in the session. The results are related to single variables of the LEADER implementation and their impact on LEADER performance.

### 3.1 Place delimitation

Regarding place delimitation, results show that a suitable region design is not dependent on the population size of the various LEADER regions when it comes to promoting regional development. The satisfaction of the LAG members surveyed is generally quite high with no significant differences based on population size, although a minor tendency of rating smaller regions more positively could be detected (see figure 1).

<sup>165</sup> Sometimes referred to only as „region(s)“ in this paper.



**Figure 1: Size of region & opinions on size suitability (own illustration, n=115 regions)**

NRW= North Rhine-Westphalia, SH = Schleswig-Holstein, HE = Hesse, NI = Lower Saxony

**3.2 The role of LAG managements in promoting participation for innovative projects**

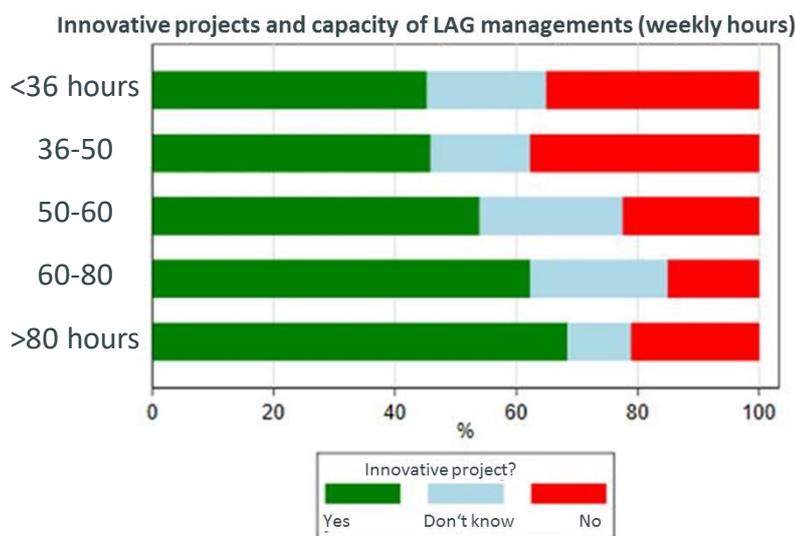
Analyses of the structural and organisational data on the various LEADER regions show that working hours of LAG management teams in the four states vary on average between 40 and 60 hours per week. In some regions, weekly working hours fall below 36 or exceed 80 hours.

Regarding the incidence and kind of innovative projects the results are as follows: 56 % of the beneficiaries classified their own project as being innovative based on a definition of innovation provided in the questionnaire („ideas or approaches/strategies for action, that are new to your region“).

The nature of the innovation is also specified: 61 % of the respondents mentioned new products or services, 16 % new technological processes, 39 % the exploration of new markets/ customer groups and 42 % mentioned new forms of cooperation or organisation. A few examples of innovative ideas given by the respondents were the use of iPads in schools, organization of a poetry slam to engage the youth and an adventure trail for bike tourism.

In addition to that, in 33 % of the innovative projects the beneficiaries reported that interested persons contacted them to make enquiries about their projects.

Looking at the influence of personal capacity of LAG managements (number of weekly hours) there is a positive correlation between capacity and share of innovative projects (see figure 2). Thus preliminary results indicate that the existence of a well-equipped LAG management team contributes to innovative approaches in project development.



**Figure 2: Staff capacity & share of innovative projects (own illustration, n=115 regions)**

**4. CONCLUSION**

The establishment of a LAG management is a prerequisite for all regions funded through LEADER. However, a lack of predefined targets often results in understaffing. One of the insights our results offer is that a higher staff capacity of LAG

managements fosters a higher share of innovative projects. This supports a policy recommendation to predefine minimum targets for staff capacity as a prior condition for funding the LAGs. A suitable minimum could be 60 hours which brings with it the extra benefit of a minimum of two persons, thus enabling continuous functioning/availability of the LAG management and smooth transitions in the event of staff changes if this concerns only one of the LAG managers. As mentioned before, the LEADER instrument requires tailoring to a specific area. Our results, however, indicate that place delimitation based on the regions' population is not the main requirement in this case. The recommendation is therefore, to give the LAGs a wide range of freedom in this decision. Suitable delimitation is more dependent on local specificities such as administrative or natural boundaries, or certain requirements in connection with the objectives of the local development strategies rather than the mere number of inhabitants.

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## DIGITAL TRANSFORMATION OF RURAL SOCIETIES: THE CASE OF KALININGRAD REGION

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### ABSTRACT

Digitalization of rural territories is often proposed to be the effective development strategy that could overcome the peripherality – lack of public infrastructure and services, unemployment, economic backlog, and depopulation. Digital technologies are seen to foster social innovations in the countryside, as well as promote self-employment and freelance via the Internet. However, rural societies are highly heterogeneous. Different groups of the population live in the countryside – those employed in large agricultural production and farms, people involved in personal subsidiary plots, as well as the rural population working in the city and living in the countryside with an urban lifestyle. The aim of the study is to identify the differences in readiness for information and communication technologies across the different types of municipalities and population groups. The research design is based on the comparative assessment of rural areas of the Kaliningrad region by the Internet coverage, user density, the availability of various online services and e-government. The research sample includes rural settlements near the city and remote ones featuring different socio-economic structures, which are compared by infrastructure development and readiness of the population to implement digital routines. Results suggest that top-down initiatives will not be adopted by the local society if a population does not perceive the benefits of digitalization. A place-specific approach should be applied when drafting the digital transformation programs considering the established lifestyle, the needs of different types of residents, as well as the readiness of local societies for digitalization.

### KEYWORDS

Information society, digital divide, digital service, internet coverage, digital sensibility, receptiveness to digitalization, digital routines

### 1. INTRODUCTION

Rural areas are experiencing depopulation worldwide, which is due to urban-rural inequality in the quality of life, including the state of public infrastructure, utilities, and services. Daily commute to more populated areas for the purpose of work, leisure, or personal needs, such as shopping, banking, professional consultations, etc. is inconvenient or impossible in many peripheral rural areas. Therefore, rural communities have to pay a 'rural penalty' (i.e. an extra amount of money) for using same or even inferior quality services because of greater distances from the service providers, low market capacity, and weak competition (Hindman, 2000; Onitsuka et al., 2018). Moreover, the sparsely populated rural locations, especially those distant from urban centers or key transport communications are looping in a vicious circle, where low returns on investment repel companies from opening a subsidiary or providing a full-flagged integration of rural areas into their current business processes (Malecki, 2003; Pěluča, 2019). One of the most prominent research topics with respect to territorial cohesion is, therefore, the issue of 'rural-urban digital divide' (Whitacre & Mills, 2007).

Nowadays rural areas can be labelled as 'digital periphery' both in terms of poor information and communication technologies (ICT) infrastructure and the actual internet usage statistics (Pěluča, 2019). Salemink et al. (2015, p. 360) note that "rural communities are most in need of improved digital connectivity to compensate for their remoteness, but they are least connected and included". Digitalization of rural territories is seen as an effective strategy to combat depopulation and its major reasons – lack of public infrastructure and services, unemployment, economic backlog, and social isolation (Komorowski & Stanny, 2020; Pěluča, 2019).

The internet and digitalization facilitate the transition of rural societies to non-agricultural sectors supporting diversification and economic resilience, providing a better integration with their surrounding regions and the world. Smart rural economic development and 'de-agrarianisation' are expected to bring the modern lifestyle to the countryside, along with an increased occupational plurality (along with declining share of labor in farming), improved spatial and social mobility, and intensified rural-urban interpenetration (Berdegué et al., 2014; Fahmi & Sari, 2020; Onitsuka et al., 2018). However, the effects from digital technologies in transformation of rural societies depends on numerous factors (digital inequality dimensions), such as usage purpose and the perception of benefits, the availability of ICT infrastructure and the quality of internet, the required digital skills, etc. (Barzilai-Nahon, 2006; DiMaggio & Hargittai, 2004; Onitsuka et al., 2018; Selwyn, 2004).

Bürgin and Mayer (2020) suggest that, on the one hand, penetration of digital technologies offers new economic opportunities to rural areas, but, on the other hand, puts pressure on local communities of becoming digital. Their study on mountainous countryside of Switzerland stresses on the difficulties of digital transformation. A study of Fahmi and

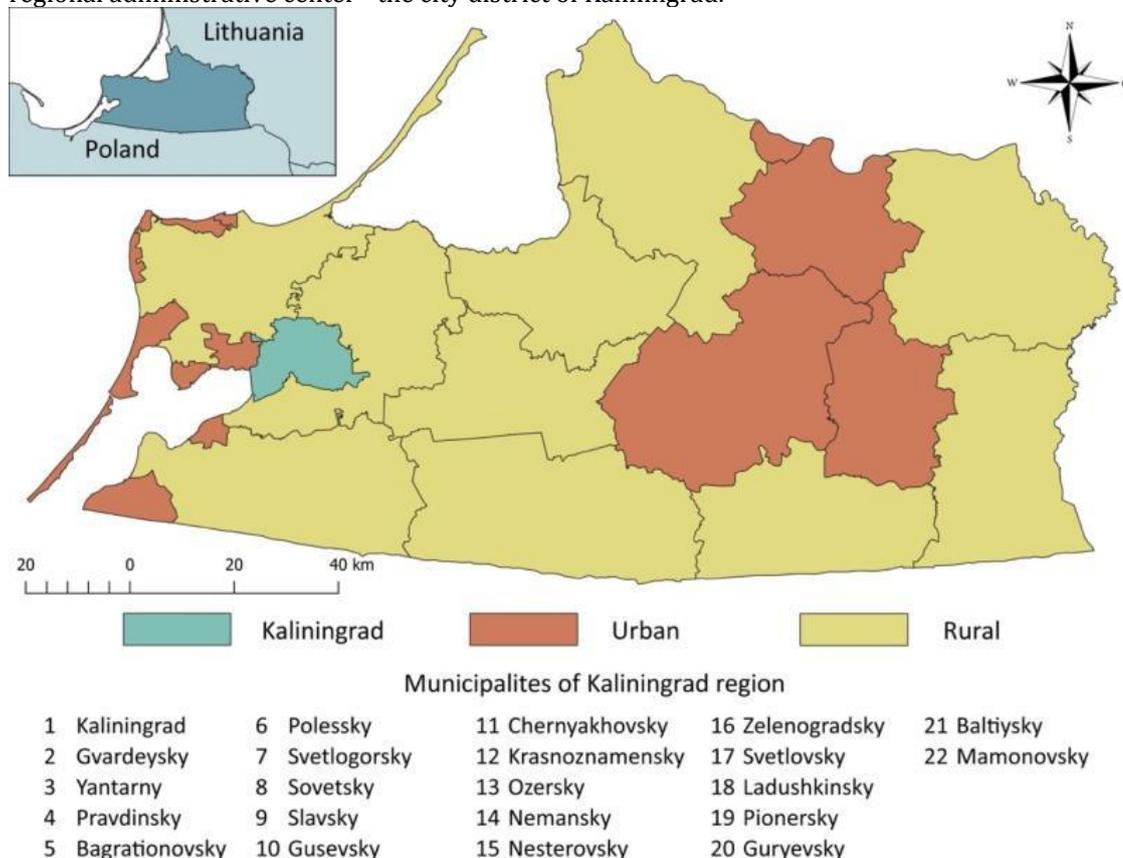
Sari (2020) further indicates that not all rural residents are taking the full advantage of digitalization – only those with the required skills. As mentioned by Meyn (2020), digitalization offers immense potential for rural societies, but it can only be realized given the appropriate skillset and the mindset required for using digital technologies. Studies suggest that the adoption of ICT and the issue of ‘digital connectivity’ are to be further analyzed for developing place-sensitive digitalization projects and policies (Komorowski & Stanny, 2020; Mikhaylov et al., 2019; Pěluča, 2019; Sept, 2020).

This study focuses on the problem of digital divide between municipalities within the region, with an emphasis on studying the effects of digital transformation in rural areas. Its purpose is to identify the differences between different types of municipalities in the willingness of the population to implement digital routines. We expect that in municipalities where the majority of the population lives in rural areas, the overall receptiveness to digitalization will be lower than in municipalities where the majority of the population lives in an urban lifestyle. However, we also believe that in some cases, agricultural municipalities can demonstrate higher rates of digitalization if this allows them to solve problems significant for the population in their everyday activities being difficult to solve without ICT.

The object for studying the problem of digital divide in the urban-rural inter-municipal space is the Kaliningrad region of Russia. This exclave region is a good example to explore for a number of reasons. Firstly, the region has an almost equal number of municipalities, which can be classified as “predominantly urban” with a share of urban population over 50% and “predominantly rural” with a share of rural population over 50%. This will allow avoiding data skewness in one direction or another when studying the phenomenon of digitalization in both urban and rural areas. Secondly, in the last few years, the Kaliningrad region has been actively pursuing a policy to reduce the digital divide between urban and rural areas, including via the development of ICT infrastructure in rural areas and the organization of free Wi-Fi hotspots. Thus, it is possible to assess the progress of the digital transformation of rural societies in relation to urban areas, highlighting the remaining problem areas. Thirdly, the issue of active digitalization of the village for the Kaliningrad region is of interest, since the region continues to have a trend towards a reduction in employment in agriculture and it is necessary to look for alternative ways to ensure employment and the quality of life in rural areas.

**2. RESEARCH METHODOLOGY**

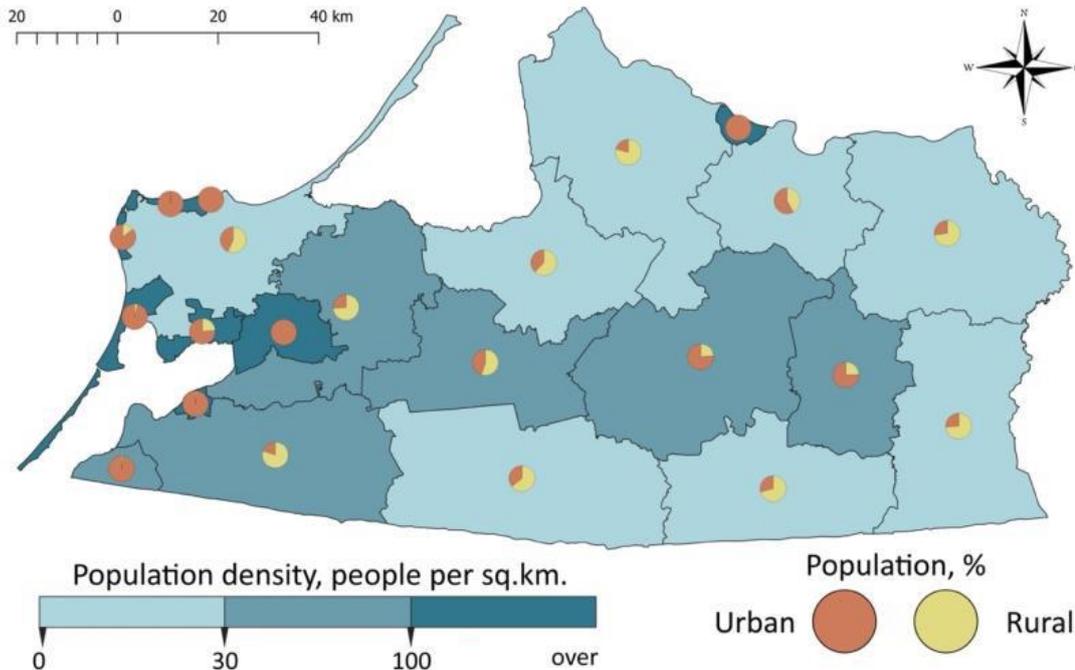
The geography of the study covers 22 municipalities of the Kaliningrad region of Russia (Fig. 1). All of them are divided into 3 groups: the first group “urban municipalities”, which unites 11 municipalities of the region, whose share of the urban population is more than 50% - these are Pionersky, Sovietsky, Svetlogorsky, Ladushkinsky, Mamonovsky, Baltiysky, Yantarny, Chernyakhovsky, Svetlovsky, Gusevsky, Nemansky ; the second group of “rural municipalities” unites 10 municipalities of the region, in which the share of the rural population is more than 50% - Gvardeysky, Zelenogradsky, Polessky, Pravdinsky, Ozersky, Krasnoznamensky, Nesterovsky, Guryevsky, Slavsky, Bagrationovsky as well as the regional administrative center - the city district of Kaliningrad.



**Figure 1: Municipalities of the Kaliningrad region of Russia**

Source: developed by authors.

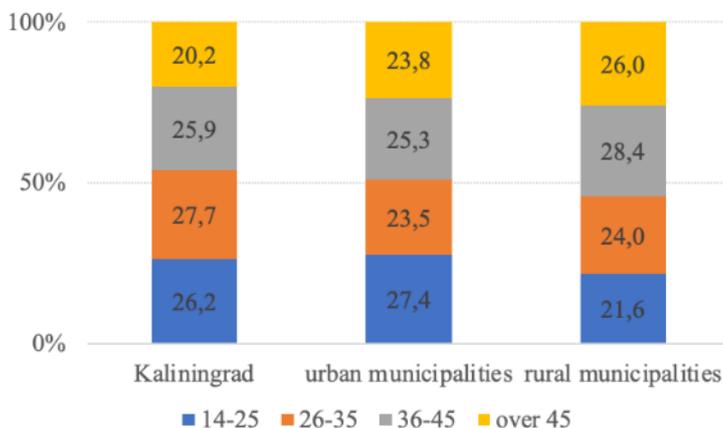
In total, 1.01 million people live in the Kaliningrad region as of January 1, 2021. Of these, the urban population is 792.1 thousand people, and the rural population is 226.6 thousand people. About half of the region’s population is concentrated in the administrative center – Kaliningrad, in which the highest population density is 2,179 people per sq.km (Fig. 2). In total, 82.6% of the region’s residents live within the boundaries of the Kaliningrad agglomeration, including 85.9% of the urban population and 70.9% of the rural population. The regional center is the main attractor of the population in the Kaliningrad region, forming a strong imbalance in the territorial development of the region. Also, a higher population density is characteristic of coastal municipalities, border municipalities with large checkpoints on the border with Poland and Lithuania, municipalities along the main transport route E28 (road of the European route network) – Fig. 2. On the contrary, most of the rural-dominated municipalities occupy a peripheral position in the eastern part of the region. Therefore, the problem of digitalization is really significant for them.



**Figure 2: Population density of municipalities of the Kaliningrad region, 2020**

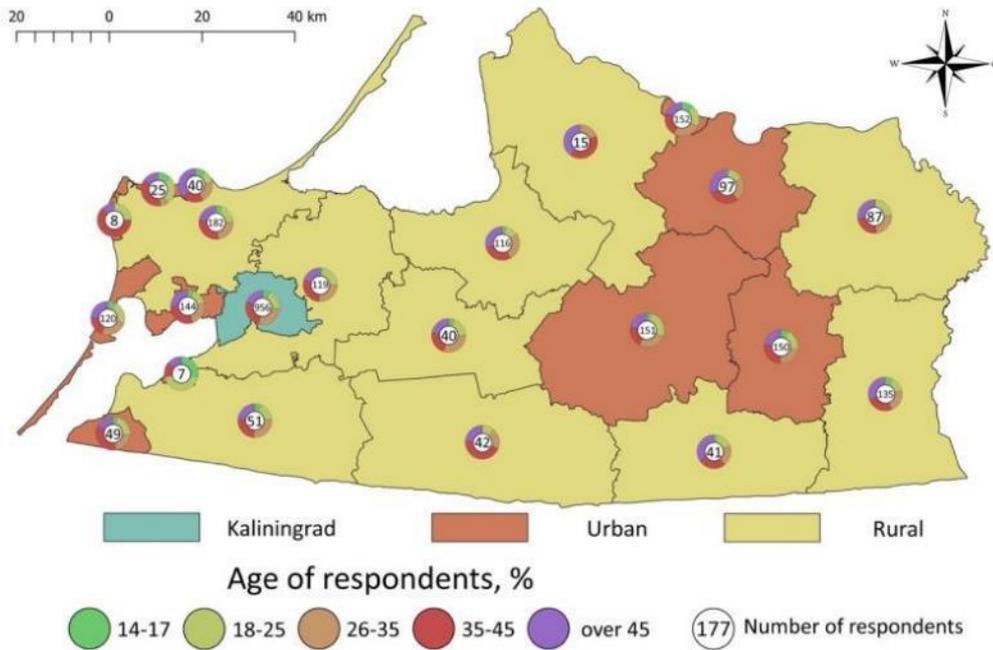
Source: authors’ elaboration based on Kaliningradstat data.

The main data for assessing the digital susceptibility of the population of the Kaliningrad region were the results of a sociological survey in the format of an electronic questionnaire. A survey of citizens on the use of information and telecommunication technologies (ICT) was conducted in late 2020 – early 2021 by the Ministry of Digital Technologies and Communications of the Kaliningrad region on the portal [https://cct.gov39.ru/press-center/opros/?SOURCE\\_LINK=CCT](https://cct.gov39.ru/press-center/opros/?SOURCE_LINK=CCT). In total, 2,727 respondents completed the questionnaire, while ensuring diversity and balance by age groups (14-25 years old, 26-35 years old, 36-45 years old, over 45 years old) and geography of residence in the context of all municipalities (Fig. 3, 4). Sociological data were analyzed in an impersonal and aggregated form in the context of three groups: Kaliningrad, urban municipalities, rural municipalities. This was done in order to identify differences in digitalization depending on the urban or rural lifestyle of the population.



**Figure 3: Distribution of respondents who completed the questionnaire on the use of ICT, by age groups, %**

Source: authors’ elaboration based on data from the Ministry of digital technology and communication of the Kaliningrad region.



**Figure 4: Geography of respondents who completed the questionnaire on the use of ICT**

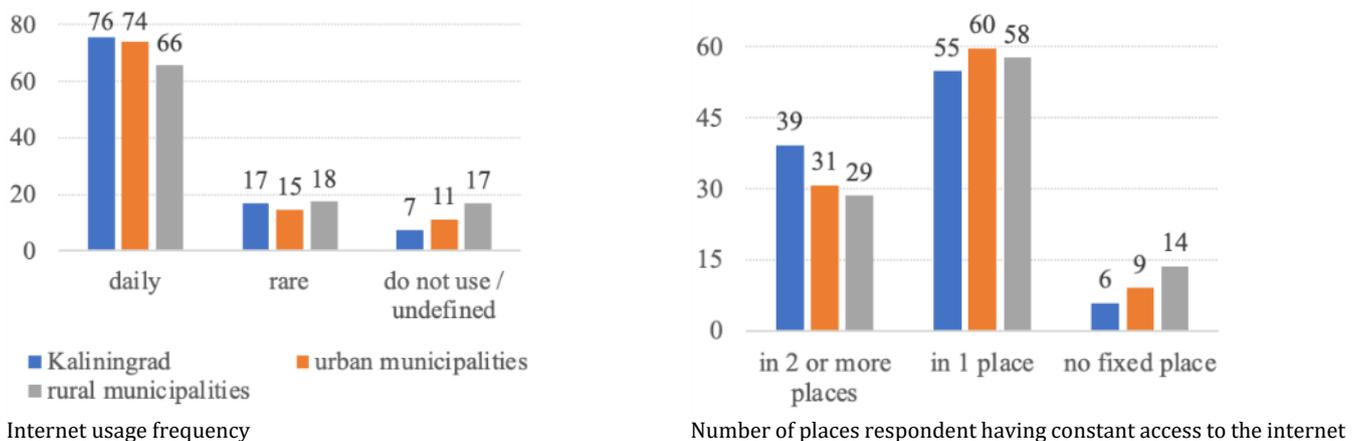
Source: authors' elaboration based on data from the Ministry of digital technology and communication of the Kaliningrad region.

The questionnaire consisted of 8 mandatory closed-ended questions with multiple answers: “How often do you use ICT?”; “I get access to ICT and services <choose a place>”; “I prefer to use <select devices> for working with ICT”; “Indicate what services you use”; “Assess your level of ICT proficiency”; “Using ICT during this year, your activity is <choose the nature of change>”; “Have you studied information technology?”; “Give an assessment of the benefits of using ICT”. Since this questionnaire was filled out online, the results of the questionnaire do not reveal the gap between those who use and who do not use ICT. When analyzing the data of this survey, we focused on assessing the territorial heterogeneity of the introduction of digital routines by the population of the region.

Data on the population's receptiveness to digital technologies were supplemented by an analysis of the infrastructural component of the digitalization process, primarily the density of Internet coverage and the location of free Wi-Fi hotspots in the rural area. The Internet coverage map is the total result of overlapping coverage by 3G and 4G networks of the main Internet providers in the region (MTS, Beeline, Tele-2, Megafon) as of 2020. Data on the location of free Wi-Fi hotspots in 127 rural settlements presented by Rostelecom within the framework of the federal project “Eliminating the Digital Divide”.

### 3. RESEARCH RESULTS

Most of the respondents who filled out the questionnaire use the Internet on a daily basis, while more than half have permanent access to it only in one place (usually at home or at work) – Fig. 5. Analysis by groups of urban and rural municipalities showed that there are differences between them both in terms of frequency of use and permanent access to the Internet.

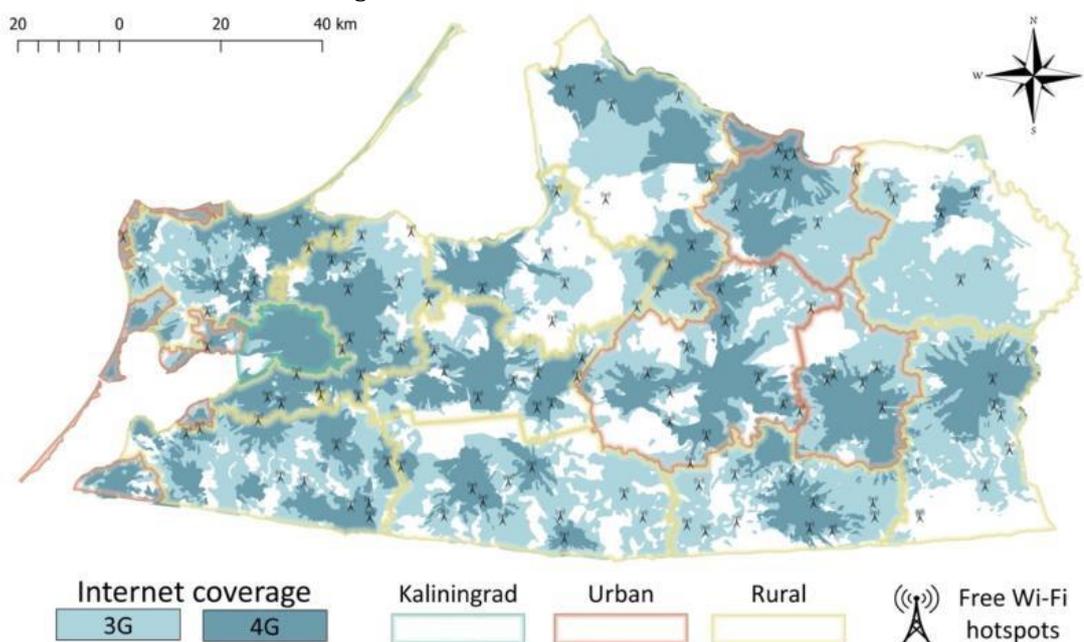


**Figure 5: Penetration of the Internet in the municipalities of the Kaliningrad region**

Source: authors' elaboration based on data from the Ministry of digital technology and communication of the Kaliningrad region.

The most active users of ICT are residents of Kaliningrad, which, among other things, is explained by the better availability of digital technologies. 39% of respondents are residents of Kaliningrad, have constant access to the Internet in 2 or more places. Also, among the surveyed Kaliningraders, the lowest proportion of those who do not have constant access to the Internet is 6%. For a group of urban municipalities, as well as for Kaliningrad, a high rate of ICT use is characteristic (74% daily), but constant access to the Internet is provided mainly from one place, while 9% have no permanent access at all. Rural municipalities show the most modest indicators of population involvement in the use of ICT. About 17% of respondents indicated that they do not use the Internet or could not remember the frequency of its use, which is 1.5 times more than in urban municipalities, and 2.4 times more than in Kaliningrad. Also, rural municipalities are characterized by a lower availability of the Internet. In total, 29% of respondents have Internet access from 2 or more places, and 14% have no permanent place for Internet access at all.

Figure 6 shows the total Internet coverage by 3G and 4G standards across the territory of the Kaliningrad region. The territory of Kaliningrad is covered by 89.2% mainly by 4G standard. The average coverage density of the territory of urban municipalities is slightly lower – 87.2%. At the same time, this group includes both small municipalities, 100% of whose territory is covered by Internet communications (Pionersky, Sovietsky), and larger ones (such as Chernyakhovsky, Gusevsky, Nemansky), where the coverage level is lower (minimum – 72.2%) and in a number of localities of municipalities, only 3G network is presented. For rural municipalities, the average level of Internet coverage is the lowest at 69.8%. The 4G standard is usually presented around the administrative centers of municipalities, and for the Guryevsk urban district – around Kaliningrad.



**Figure 6: Density of Internet coverage of the Kaliningrad region, 2020**

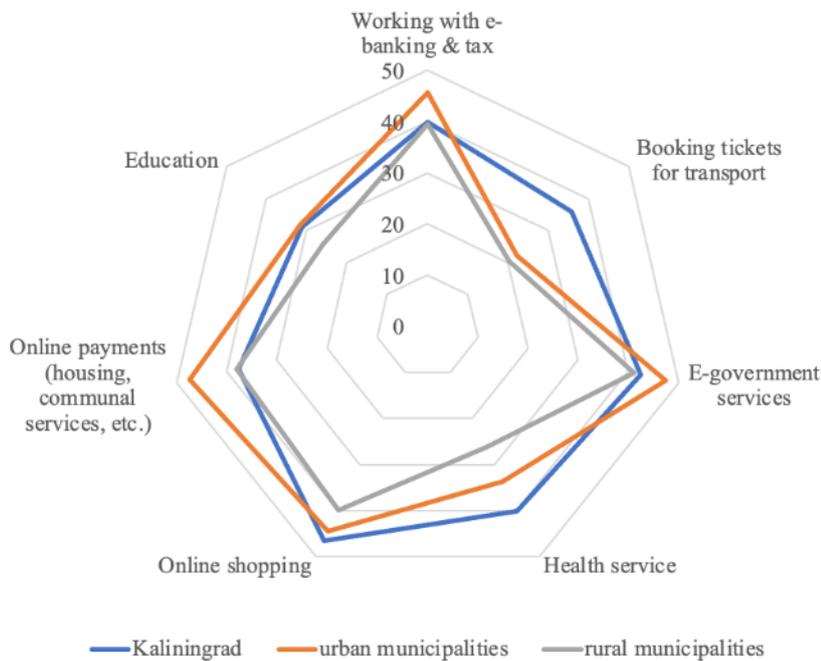
Source: developed by authors.

Part of the problem with access to the Internet in villages is being solved by installing free public WIFI access hotspots. In 2020, they are installed in 127 rural settlements with a population of 250 to 500 people and are usually used by residents to perform digital routines such as paying bills, communicating with relatives or sending letters. Also, residents note the emergence of such a phenomenon as “online walk” in the center of the village near the wi-fi access point (<https://vesti-kaliningrad.ru/v-kaliningradskoj-oblasti-organizovany-besplatnye-tochki-kollektivnogo-dostupa-v-internet>).

In general, the distribution of digital services by the level of their use by the population of Kaliningrad, urban and rural municipalities is shown in Fig. 7. The most popular are E-government services and Online shopping, followed by Working with e-banking & tax and Online payments (housing, communal services, etc.). There are noticeable differences between the types of municipalities in terms of the availability of various online services for the population and the willingness of the latter to use them. So, booking tickets for various types of transport, incl. taxi services are more widely used by Kaliningraders, while among the rest of the region’s residents, these services are much less in demand, least of all by residents of rural areas.

A similar trend is typical for Health service, Online shopping, Education. In many ways, the lower penetration of these services is due to their worse infrastructural accessibility for residents of rural municipalities in comparison with the group of urban municipalities and Kaliningrad (for example, taxi services are less developed, less provision of online shops with delivery desks, difficulties in using services for school education due to the instability of the Internet, etc.). The situation is somewhat better with digital services related to government services, electronic banking and payment

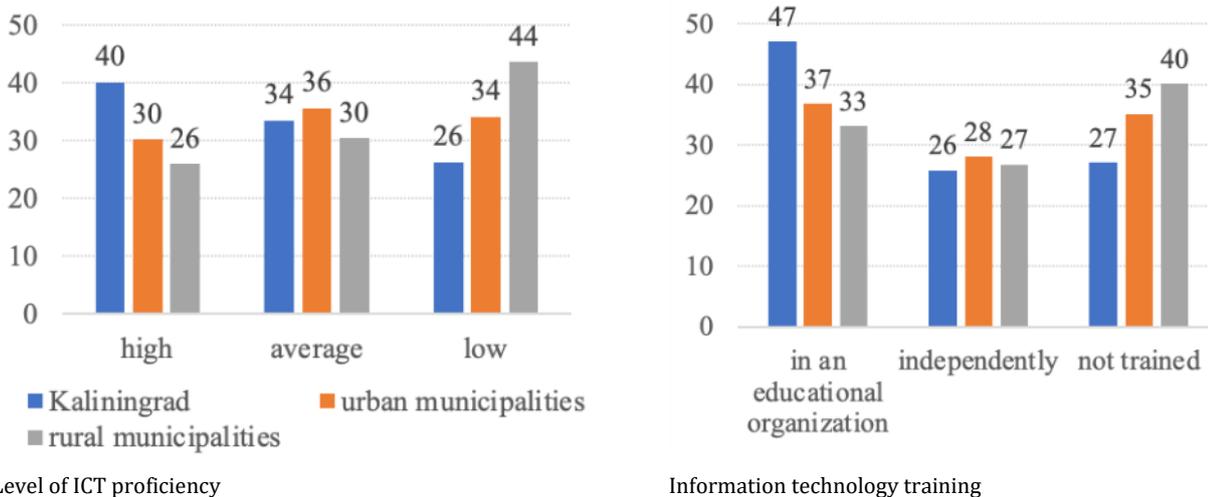
of utility bills – Fig. 7. The indicators for these digital services for rural municipalities are at the level of Kaliningrad, and the group of urban municipalities with the highest figures.



**Figure 7: Distribution of digital services used by respondents – residents of the Kaliningrad region**

Source: authors' elaboration based on data from the Ministry of digital technology and communication of the Kaliningrad region.

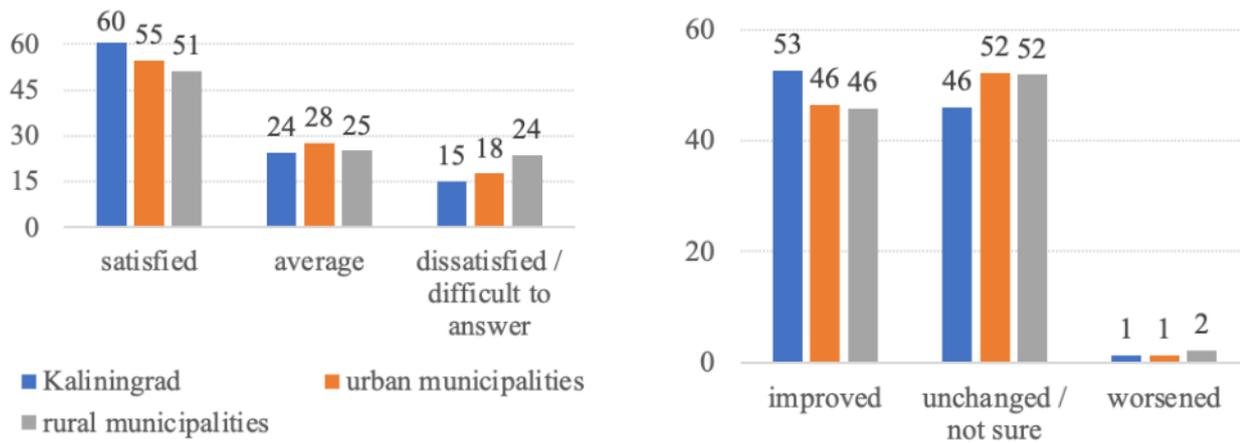
The receptiveness of the population to the introduction of digital routines is significantly influenced not only by the infrastructural factor, but also by the development of digital culture and skills in using digital technologies. Figure 8 demonstrates the difference between the types of municipalities in terms of participation of the population in the educational process in the field of ICT. While no significant differences were found between Kaliningrad, urban, and rural municipalities in terms of self-education, the residents of Kaliningrad have more opportunities in the field of vocational training and additional education. As a result, there is a significant gap between rural municipalities and Kaliningrad by 1.4 times in terms of the share of respondents who received ICT skills in an educational institution or in courses. In this regard, there is a significant lag of the population of rural municipalities in terms of ICT proficiency. If among the respondents – residents of Kaliningrad, 40% rated their ICT skills as high (professional and confident user), in rural municipalities only 26%, which is 1.5 times less.



**Figure 8: Digital skills of respondents – residents of the Kaliningrad region**

Source: authors' elaboration based on data from the Ministry of digital technology and communication of the Kaliningrad region.

The survey results also made it possible to assess the self-perception of the population on the impact of digitalization on their daily life – Fig. 9. More than half of the respondents of all types of municipalities positively assessed the benefits of using ICT and over 40% noted improvements in their activities in the last year from digitalization. However, among the surveyed residents of rural municipalities, the share of those who are dissatisfied with digitalization and have negative experience from using ICT is higher than that of urban municipalities and Kaliningrad.



Assessing the benefits of using ICT

With the use of ICTs during this year, your activities <...>?

**Figure 9: Assessment of ICT implementation on the life of the population of the Kaliningrad region**

Source: authors' elaboration based on data from the Ministry of digital technology and communication of the Kaliningrad region.

**4. CONCLUSION**

Assessing the susceptibility to digitalization of the population of various types of municipalities: the regional center, municipalities with a predominance of the urban population and the rural population, a significant digital divide between them was identified using the example of the Kaliningrad region. Differences have been identified both in infrastructure and technological provision, and in digital culture. Rural municipalities, despite the implemented state measures, still have a lower Internet penetration among the population. This is reflected both in the density of the Internet coverage and in the number of stable places with Internet access. The installation of free Wi-Fi hotspots has undoubtedly had a positive impact on the situation with Internet access in a number of villages. Residents have expanded opportunities to carry out such digital routines as communicating with relatives through instant messengers, paying bills or using a public service website, but the short range of the free Internet does not allow for longer actions, primarily remote work via the Internet. Therefore, this initiative has not yet brought a significant impact on the digital transformation of the rural environment.

Also, the rural population lags far behind in terms of the development of their educational skills in the use of digital technologies. This also does not allow us to draw a conclusion about the possibility of broad development of alternative digital employment in rural areas based on the existing potential. This is negatively impacted by the lower availability of specialized vocational training, courses and special education. As a result, the rural population turned out to be less prepared for the implementation of various digital services and has a higher proportion of those who perceive them negatively, including services implemented as response to the coronavirus pandemic, when digitalization has become more pervasive. It can be predicted that in conditions of high digital illiteracy aggravated by infrastructural insecurity, accelerated rigid digitalization in rural areas without duplication of traditional process options will lead to rejection and discontent rather than widespread adoption and receptiveness of ICT. A full-fledged digital transformation of a village is impossible without providing its residents with opportunities for Internet access, equal to those of townspeople, and implementing a broad program to improve digital literacy.

**ACKNOWLEDGMENT**

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## **Special Session: SS40.1 - The productivity gap and the re-launch of productivity in Europe**

**13:15 - 14:30 Thursday, 27th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89993853386>**

**Chair Silvia Cerisola**

**AGGREGATE PRODUCTIVITY GROWTH FROM FIRM LEVEL DATA: THE CASE OF VIETNAM AND SOME METHODOLOGICAL ISSUES**

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**ABSTRACT**

In this paper we use Vietnamese firm level data to provide a decomposition of the economy wide GDP per worker growth. The main components of the decomposition are: regional migration (labour movement across regions); TFP growth; Capital Deepening. In order to provide a figure for these components we propose to use production frontier methods to assess the performance of firms in each industry and in each region. After building the nonparametric production frontier we use it to quantify the magnitude of each component and aggregate it into economy wide effects. We discuss the methodological issues associated with the use of firm level data and their aggregation into the economy wide components and provide some empirical evidence on the magnitude of these components in the Vietnamese economy. The underlying challenges in terms of estimating productivity growth are common to many other available datasets, including European firm level data.

## A BALANCED POLICY APPROACH TO REGIONAL GROWTH: PRODUCTIVITY AND RESILIENCE

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OECD Spatial Productivity Lab, Italy

### ABSTRACT

In the quest for efficiency, the considerations of resilience, which may or may not go hand in hand with productivity, are often disregarded until a shock hits. Large-scale shocks, such as the Great Recession and the ongoing COVID-19 pandemic, bring resilience forcefully to the forefront of policy agenda.

To understand how productivity and resilience are linked, it is useful to take a closer look at the concept of resilience. In the engineering literature, three dimensions define resilience of a system.<sup>[1]</sup> These dimensions are robustness, resourcefulness and redundancy. Bruneau and co-authors (Bruneau et al., 2003<sup>[1]</sup>) give the following definitions. Robustness is the ability to withstand a shock without the loss of a function; resourcefulness is the ability to deploy resources in order to resist a disruption or to recover from a shock and redundancy denotes the presence of elements that can be deployed instead of the affected ones in order to support uninterrupted functioning of a system.

Most generally, policies to promote productivity (growth) increase robustness and resourcefulness, thus buttressing resilience at the firm, industry or regional levels. The quest for productivity comes in obvious conflict with resilience in the redundancy element. Any redundancy is inefficient by definition. Firms and industries often strive to remove such redundancy by relying more on lean processes, just-in-time delivery and other practices. Narrowing the networks of suppliers to the “best” ones can also reduce redundancy and the associated costs of maintaining contacts with more partners. The downside is that a more concentrated supply networks can leave firms and regions vulnerable to shock affecting the suppliers (e.g. as a result of a natural disaster in the area of concentration or for other reasons).

Finally, the link between productivity and resilience also emerges from the system itself. Becoming a part of a system offers many opportunities to increase productivity, mostly through learning but also access to a wider range of suppliers and customers. In terms of resilience, the effect is not straightforward. On the one hand, embeddedness in a system can hedge against localised shocks where inputs can be procured from outside if local supplies are disrupted. At the same time, being a nod in a system makes an agent (a firm, an industry or a region) potentially susceptible to shocks in other nodes. The final effect depends on the configuration of the system and the nature of a shock.

This paper reviews productivity and resilience policies against different types of shocks and demonstrates where such policies go hand in hand, where they are independent and where they counteract each other. A discussion on how to better combine considerations of productivity and resilience in regional policy design is also offered.

<sup>[1]</sup> The full list normally includes four elements, adding rapidity to robustness, resourcefulness and redundancy (Bruneau et al., 2003<sup>[1]</sup>), although it is often reduced to the three most appropriate elements in specific applications (Fekete, 2019<sup>[2]</sup>).

## THE CHANGING ROLE OF LONG-RUN DRIVERS OF LABOR PRODUCTIVITY

[Yoki Okawa](#)<sup>1</sup>, [Alistair Dieppe](#)<sup>2</sup>, [Atsushi Kawamoto](#)<sup>3</sup>, [Cedric Okou](#)<sup>1</sup>, [Jonathan Temple](#)<sup>4</sup>

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### ABSTRACT

This research explores the drivers of global long-term productivity growth and how their roles have varied over time, through extensive literature review, examination of the development of drivers, and empirical analysis using the Bayesian Model Averaging.

The following findings emerge. First, historically, labor productivity growth has been driven by innovation, better education, and investment in physical capital. Innovation and private sector investment require a growth-friendly environment, with supportive institutions and policies, including policies that promote macroeconomic stability and the rule of law. Productivity growth also seems to benefit from expertise in producing relatively complex and sophisticated exports, which is associated with international technology diffusion.

Second, the effects of different drivers on productivity growth have changed over time. Innovation and experience with economic complexity, related to participation in global value chains and cross-border technology transfer, seem to have increased in importance. So have demographic factors, notably changes in population age structures. In contrast, the importance of urbanization, related to the sectoral shift from agriculture to manufacturing and services, has weakened. Third, many productivity drivers in EMDEs fall short of advanced-economy conditions, despite remarkable improvements over the last 60 years in key human capital indicators such as the provision of primary education and infant mortality rates. This research documents these gaps in a systematic way. For some productivity drivers, including ones that are essential to innovative economies—tertiary education, financial development, and patents per capita—the gaps have widened. Improvements in other drivers, such as institutions and economic complexity, have stalled. In addition, many drivers of productivity growth have faltered, including those which had previously supported strong productivity growth. Working-age population growth has slowed, along with growth in average educational attainment. As the expansion of global value chains has lost momentum, so has the movement toward more diverse and complex forms of production.

Fourth, the COVID-19 pandemic has made the near-term outlook for productivity growth even more challenging. Weaker investment and trade, erosion of human capital, slower labor reallocation, heavier public and private debt burdens, and widening inequality could push down on productivity growth. Yet, the pandemic may also create productivity-enhancing opportunities such as lasting organizational and technological changes for business and education, diversifying global value chains, and changing social norms.

Fifth, the recent slowdown in productivity growth has multiple sources and, hence, action on a range of fronts will be needed. Governments seeking to raise productivity growth can increase public investment and stimulate private investment; improve human capital; foster firm productivity, partly through on-the-job training and upgraded management capabilities; increase the exposure of firms to international trade and foreign investment; enable the reallocation of resources toward more productive sectors; and, seek to diversify production. The benefits of many productivity-friendly policies could be enhanced by improving the macroeconomic and institutional environment.

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## PLENARY SESSION IV

14:45 - 15:45 Thursday, 27th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/86122976972>

### Keynote Speech



*New Spatial Data, New Spatial Knowledge?*

**Prof. Isabelle Thomas**

Université catholique de Louvain, Belgium

**Chair Sumana Bandyopadhyay**, University of Calcutta, India

**Discussant Dusan Paredes**, Universidad Catolica del Norte, Chile

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# PARALLEL SESSIONS (14)

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## National Session: SS54 - Regional Science in Paraguay



16:00 - 17:15 Thursday, 27th May, 2021

Room FIPE

<https://us02web.zoom.us/j/85253483318>

Chair Eduardo A. Haddad

## SYSTEMIC IMPACTS OF CLIMATE CHANGE IN PARAGUAY FROM BUSINESS AGRICULTURE

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### ABSTRACT

The climate conditions may affect crops productivity and, as a consequence, as well as regional agriculture earnings. In this paper, we use a CGE model for Paraguay, which incorporates detailed information about the value chain of the agriculture sector in the country. According to the 2014 information input-output matrix, we calibrate climate shocks associated with the agriculture business in Paraguay. We model the climate shocks as a technical change in the agriculture-producing sector. Moreover, we calculated uncertainty systemics effects on crops productivity due to the climate change. Given the specific economic environment for the model and the proposed simulation; it is possible to observe the Paraguayan real GDP reduction around 2.55%. In terms of household consumption reductions, representing 4.15% of (2014) current per capita annual consumption.

### KEYWORDS

Climate change; Agricultural; Paraguay; Computable general equilibrium

### JEL Classification

C68; Q13; Q54

### 1. INTRODUCTION

Effects of climate on agriculture and rural areas have been extensively studied, such as in Mendelsohn and Massetti (2017), Carter et al. (2018) and Nordhaus (2019). Agriculture is one of the most vulnerable economic sectors regarding climate change as it is directly affected by fluctuations, such as the temperature and rainfall. In general, the direct effects of climate change on agriculture are mainly related to lower crop yields, causing productivity loss. However, according to Stern (2006) the real economic impacts due to climate shocks are still uncertain. According to Nordhaus (2019) the damages are likely to be most heavily concentrated in natural systems as well as in low-income and tropical regions such as Latin America. In this context, Paraguay is not an exception, once the agricultural sector represents its economy and has regional disparities, so it is likely to have greater damage.

Therefore, there are not many studies that explored the systemic climate change impacts on the agriculture sector within a region. According to Haddad et al., (2014), given productivity shocks that a region may face, backward and forward linkages which will affect, to different extents, the local demand by the various economic agents sectoral and spatial sectoral linkages will also play an important role in the adjustment processes. The extent of the impact will depend on the degree of linkages with other regions. In an integrated interregional system, there is a need to address these issues in a general equilibrium framework. This regional view is essential to convey valuable insights to policy makers considering approaches to production value chains.

Thus, what are the economic costs of climate change? Which regions are chiefly affected and to what magnitude? How could the uncertainties of climate change affect the results in a qualitative way? Within this context, the aim of this study is to analyze climate change systemic impacts in Paraguay from business agriculture. We use a methodological framework in which physical and economic models are integrated for assessing the higher-order economic impacts of projected climate changes in Paraguay between 2010-2100 by the Economic Commission for Latin America and the Caribbean (2014).

The interregional computable general equilibrium (ICGE) models can take into account the associated productivity changes and generate the systemic impact of projected climate variables by considering the linkages of the agriculture sector with other sectors of the economy and the locational impacts that emerge to other regions. Thus, assessing the economic contribution of a part of a country or region economic sector requires some consideration of the likely paths

of interactions that are a consequence of the effects of climate on crop yields, consequently, on the economy (Haddad et al., 2014).

Accordingly, the process adopted here is to use estimates from ECLAC (2014) between climate variables and agriculture productivity, and then to feed the results into an inter-regional CGE model to capture the system-wide impacts of the projected climate Paraguayan scenario. In addition, we used the methodology proposed by Haddad and Garber (2012) in order to compare the uncertainties rising from the techniques employed, enabling the analysis of robustness and the consistency of the results throughout the Paraguay regions.

## 2. CLIMATE CHANGE AND ECONOMICS IMPACTS

The exercise of assessing the climate change impacts appears to be complex, since it contains an uncertainties set about the degree of future global warming and its effects on the whole economy, as well as how far the future technological capacity will evolve to counteract the negative effects. Nevertheless, it is possible to analyze these effects, having as reference the territorial space and the current data related to the present variables.

Recent studies presents developing economies tend to be more affected by climate shocks. According Wade and Jennings (2016) the countries of North America and Western Europe are less vulnerable to global warming. However, the countries vulnerable are distributed between the African and Asian continents. For example, Roson and van der Mensbrugge (2012) evaluated the impacts regional distribution due to climate change. The results presented that the impacts of climate change are substantial, especially for developing countries and, in the long term, it is necessary to take adaptation and mitigation measures to guarantee sustainable economic growth.

However, the countries vulnerable are distributed between the African and Asian continents. Nevertheless, even with the asymmetric on the spatial distribution of the effects of climate change, it is estimated that in the long run, the climate change effect on economic growth will be widespread and negative, taking into account the financial, political and economic integration of the world's economies. In this sense, global warming will mainly influence economic growth through the damage it will cause to infrastructure, productivity losses, migration and security threats (Wade and JENNINGS, 2016).

The global externalities due to climate change reaffirms that private markets do not allocate resources efficiently and that often the climate change economics involve a lot of uncertainty and risk. Thus, modeling it is a challenge, at the same time that it is an ally for the process of understanding the direction that human actions are taking the planet (Nordhaus, 2019). According to Guesnerie and Stern (2012), economists can evaluate the cost-benefit of decisions. In this sense, the study of climate change is part of its scope analysis because it involves understanding that actions taken will have long-term consequences, amid an uncertainty environment in which everyone can influence in some way.

In this context, Van Passel, Massetti and Mendelsohn (2017) estimated the climate change effect for European agriculture using a Ricardian model. The results report that the increase in temperature would increase the agricultural land prices in northern Europe and reduce prices in southern Europe. Increased rainfall would benefit all countries except Scandinavians. The sensitivity measure agricultural sector varies depending if the farm irrigates the plantations or not, in this second case it is more vulnerable to weather. According to Mendelsohn and Wang (2017), the intensive agriculture returns greater benefits due to the fertile soil and adequate climate, in the other words, applying intensive agriculture in non-fertile soils and with unfavorable climate, can bring losses. Therefore, if climate change reduces the productivity of agricultural activity, this will result in less revenue and farmers can reduce inputs demand. In view of the low supply, prices may rise and producers may increase inputs demand again.

The climate change effects can be intensified when other factors, such as public health, are affected. According Rasul (2021), climate change affects agriculture by changing the temperature, level of rainfall, floods and droughts. The South Asia already lives with the climate change negative effects on agriculture, these effects, together with others, for example a pandemic (COVID-19), reinforce the importance of the environment, climate and public health for the countries economies, especially for developing countries.

### 2.1. Business agriculture sector in Paraguay

Paraguay is a country located in the center of South America, and has Argentina, Bolivia and Brazil as bordering countries. It has a territorial extension of 406,752 square kilometers and an approximate population of 7,300,000 inhabitants by the end of 2020 (DGEEC, 2021). The country is divided into 17 States and the District Capital (Asunción). In turn, the Paraguay River separates the country into two main geographical regions: The Eastern Region or "Paraneña" and the Western Region or "Chaqueña" (REDIEX, 2021).

Considering the 2019 GDP, the 5 main sectors, with their corresponding shares are: Manufacturing (18.6%), Commerce (10.6%), Agricultural Production (9.8%), Government Services (9.6%) and Electricity and Water (8.2%). Therefore, with regard to exports (2019) equivalent to 7,962 million USD: Manufactures of Agricultural Origin corresponds to 33%, Primary Products (31%), Electric Energy (24%) and Manufactures of Industrial origin (12%). According to data from the REDIEX (2021), Paraguay is the first world producer of Stevia (Stevia rebaudiana Bertoni), the first net exporter of clean energy worldwide, the fourth world exporter of soy (Glycine max), the fifth world exporter of soybean oil, sixth world exporter of corn (Zea mays) and seventh world exporter of beef.

According to Borda and Caballero (2020) the Paraguay during the last 70 years faced three considerable economic cycles. The first growth cycle (1961-1983), of the accelerated type with expansion of the agricultural frontier and the construction of the Itaipú Hydroelectric Dam. The second cycle (1984-2002), slow, due to external shocks and financial crisis. The third economic cycle (2003-2018), a return to growth was observed, due to the good production of raw

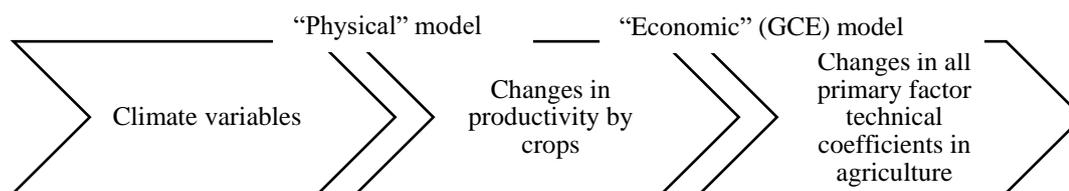
materials, mainly related to agribusiness, and the macroeconomic stability reached by the country. Agribusiness, in recent years, has become one of the engines of economic growth in Paraguay. According to data from the Central Bank of Paraguay - CBP (2021), the production of commodities and bovines for meat, both as raw material and its derivatives, largely drove this growth.

Some consequences evidenced in Paraguay due to climate change presentation that in the period 1961-1990, the country registered 1.5 ° C above the average temperature of the period, therefore, an even greater difference with respect to the pre-industrial period 1850-1900. With reference to rainfall, an average annual increase of 3 millimeters was evidenced in the last 70 years and in the last decade 2010-2019 it was observed that rainfall exceeded the average of 1961-1990 by 11%. As for droughts, it is increasing and heat waves are three times more intense than in the last 40 years (Grassi, 2020). Therefore, we can see the importance of business agriculture sector for the Paraguayan economy and how much climate change can affect its performance. Therefore, understanding this process and estimating the possible costs becomes important for policy makers, since they can devise strategies to mitigate the possible consequences.

**3. THE MODEL**

We use the B-MARIA model that is an inter-regional CGE model in order to evaluate the wider and regionalize economic impacts of climate change on the business agriculture sector in Paraguay. The model structure represents a variant of the well-documented B-MARIA model (Haddad, 1999), calibrated for the Paraguayan economy. The B-MARIA model – and its variants – have been applied to many countries (Haddad et al. 2014). Following the Australian tradition, it qualifies as a Johansen-type model in that the solutions are obtained by solving linear equations system model. The result presentations the percentage change in the set of endogenous variables, after the policy is carried out, compared to their values in the absence of such policy, in a given environment. Johansen’s systemic solutions for such models are standard in the literature. Further detailed analysis can be found in Dixon and Parmenter (1996) and Haddad (1999).

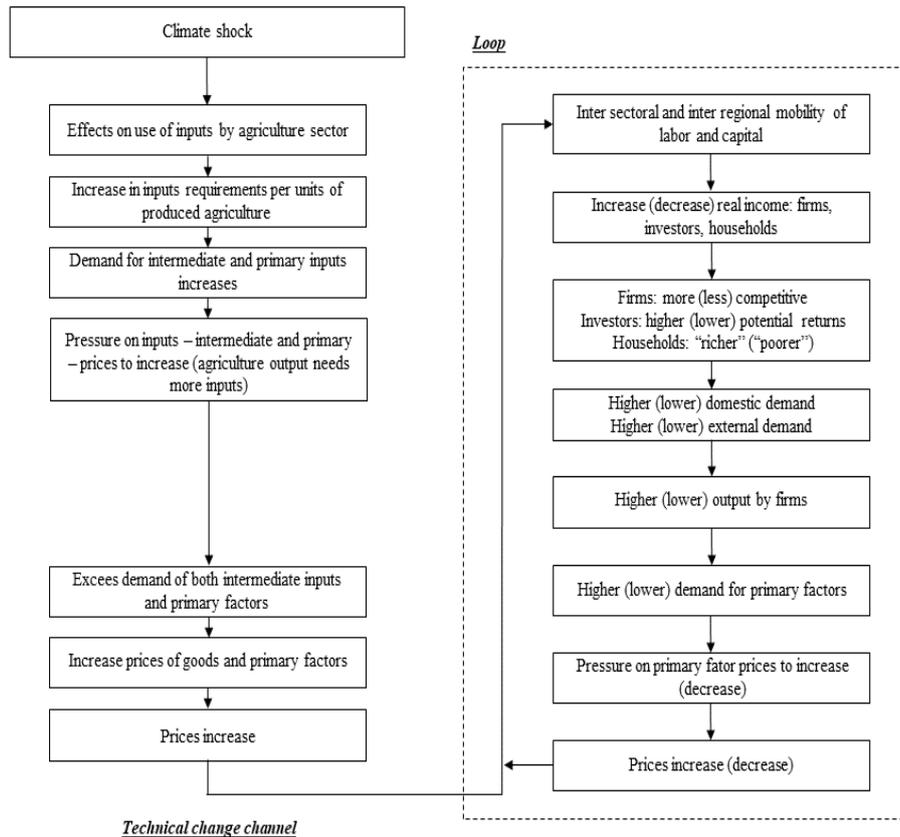
The B-MARIA version Paraguayan model makes it possible to capture the effects of the entire economy and of all regions through an intricate plot of input-output relations for 18 regions and 33 sectors (Appendices A1 and A2). We calibrate climate shocks by defining a main transmission channel physical variable into economic inputs for CGE models (Figure1). As we do not econometrically estimate the direct links between the climate scenario and economic variables, we build narratives based on specialized literature to quantify the exogenous scenarios stylized to feed the CGE model.



**Figure 1: Transition channel physical variable into economic inputs for CGE models**

The quantity channel is the transmission channel deriving from a decrease in the agricultural productivity sector. We used the information carried out by the Government of Paraguay study together with The Economic Commission for Latin America and the Caribbean (ECLAC) (ECLAC, 2014), which estimated the agriculture business mean variation yield resulting from climate changes for the 2010-2100, as the increase in average temperature and the modification of precipitation patterns in the Paraguayan regions reduce the area and the quantity harvested. According to data from ECLAC (2014), the soybean production is expected to decrease by a mean point of -14.2%, wheat production should decrease by an average of -17.2% and maize should increase by 7.3%. It can be seen that soybean and wheat crops are most affected by climate change, on the other hand, maize benefits from these changes. Therefore, it is expected that the regions producing the soy and wheat be the most affected in relation to the regions producing maize. We model this channel climate shocks as a technical change in the agricultural production sector by region, decreasing the productivity of these crops in the agricultural sector.

According to the model analytical structure, the reduction in overall productivity is also associated with an increase in the inputs and primary factors requirements per unit of output in the business agriculture sector (technical change channel). This creates an upward pressure on input prices, wages and capital rentals, which are passed on in the form of higher prices.



**Figure 2: Causal relations underlying the simulation results**

Figure 2 summarizes the transmission mechanisms associated with first-order and second-order effects in the adjustment process underlying the model's aggregate results in the context of the major channels through which the shocks operate. Second-order prices changes go in both directions – decrease and increase. The net effect is determined by the relative strength of the countervailing forces.

Lastly, the total economic impacts of climate change analysis, as well as accumulating all the aforementioned uncertainties, involve a plethora of hypotheses about the Paraguayan economic regional and sectoral productive structure, in addition to the assumptions coming from the EGC models analytical and functional structure.

The confluence of all these uncertainties breed a well-documented “snowball” effect in the science of the economic impacts of climate change (Stern et al. 2006). In order to try to deal with this effect, we will use the methodology that deals with this process in an explicit way based on the framework proposed by Garber and Haddad (2012). To implement this method, we explore the potential links of a physical model with the functional structure of the EGC model.

For such case, the idea is to conduct simulations that reproduce the behavior of a given set of endogenous variables from B-MARIA. Thus, it is enough to replicate the desired information within the exogenous set variables in the model, and similar shocks in order to achieve the best effects combination for its endogenous variables. In other words, we will use the real GDP variables and the regions consumption and place them as a “target” for the replica EGC model. Thus, the objective is to calibrate the exogenous productivity shocks on B-MARIA structure that will endogenously generate the aforementioned target results.

Therefore, given the intrinsic uncertainty in the magnitude of agricultural productivity shocks in the regions, the method can be applied in order to integrate the results with the structure of the B-MARIA model and, thus, deal with the uncertainty explicitly in the construction the productivity shocks for agricultural crops in the regions. Thus, for this study, 10,000 productivity shock simulations were carried out in order to assess the impacts on the state GDP and on household consumption. Each simulation was constructed from a randomly draw for the state productivity shock from a Gaussian distribution with mean and variance equal to the shock calculated based on ECLAC (2014) (Appendices A3).

#### 4. RESULTS AND DISCUSSION

To measure the wider impacts of the prevailing climatic conditions that will affect agriculture business in Paraguay in 2014, we run the model under a long-term macro-adjustment closure. The adopted closure is chosen from the standard B-MARIA's long term closure (Haddad, 1999). In the long-term closure, capital and labor have intersectoral and interregional mobility, it is possible to assess the different impact if the policy takes over a permanent character. The main differences in relation to the short-run are in the labor market configuration and the capital accumulation process. In the first case, aggregate employment is determined by population growth, labor force participation and natural

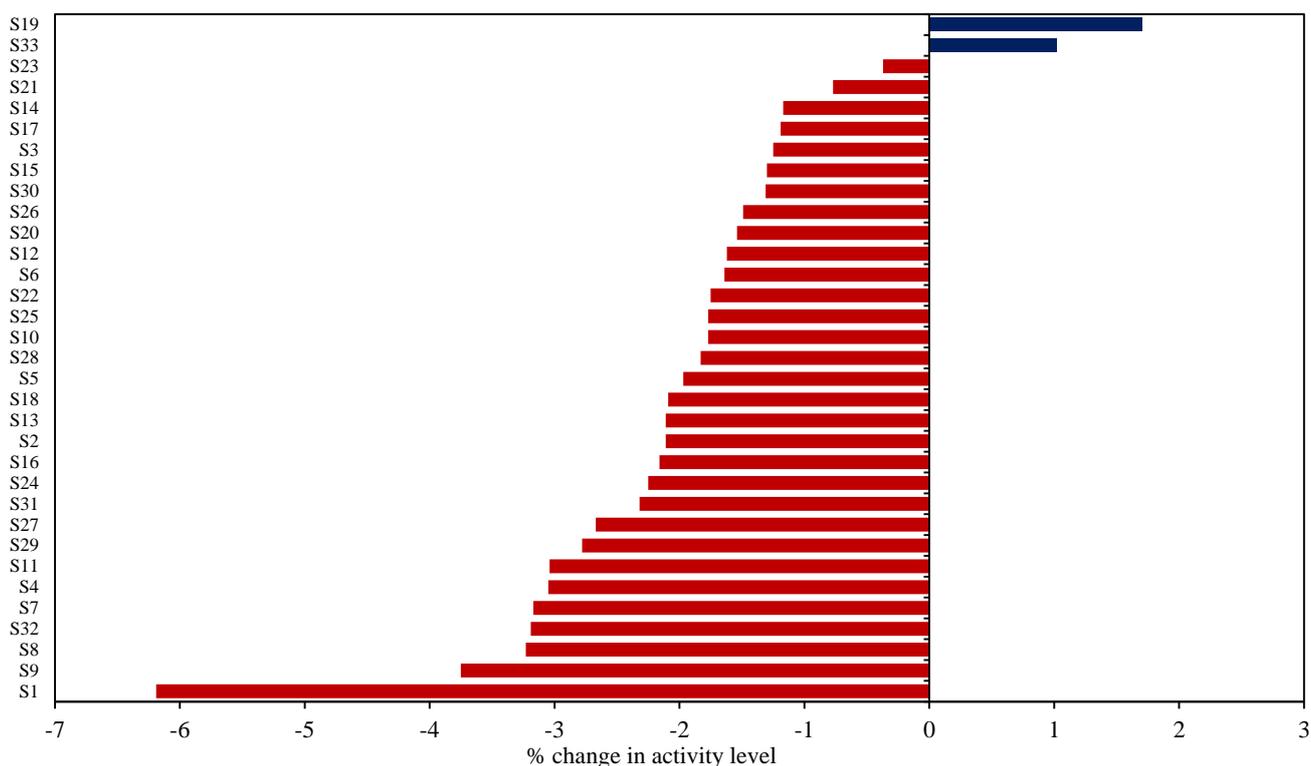
unemployment rates. The spatial and sectoral workforce distributions are fully determined endogenously. The labor is attracted to the most competitive sectors and the favored geographical areas. Likewise, the capital is oriented towards the most attractive sectors. This movement keeps the return rates on capital at their initial levels. It should be noted that the base year of the B-MARIA model for Paraguay is 2014, so that the effects are conditioned to the economic structure for that period.

Table 2 presentation of the total impacts on economic aggregates arising from agricultural productivity shocks due to climate change. The combined effects of lower output agriculture would lead to a reduction of Paraguayan real GDP by -2.55%. Overall, a decrease in real investment (negative impact on GDP of -2.20%), followed by exports and imports (negative impact on GDP of -1.29% and 2.88%, respectively). Followed by a reduction in household consumption (-2.2%), reduction in national employment (-0.01%) and decrease in nominal wages (-5.36%) made the main contributions to the aggregate GDP result.

**Table 2: The impacts on Paraguayan GDP**

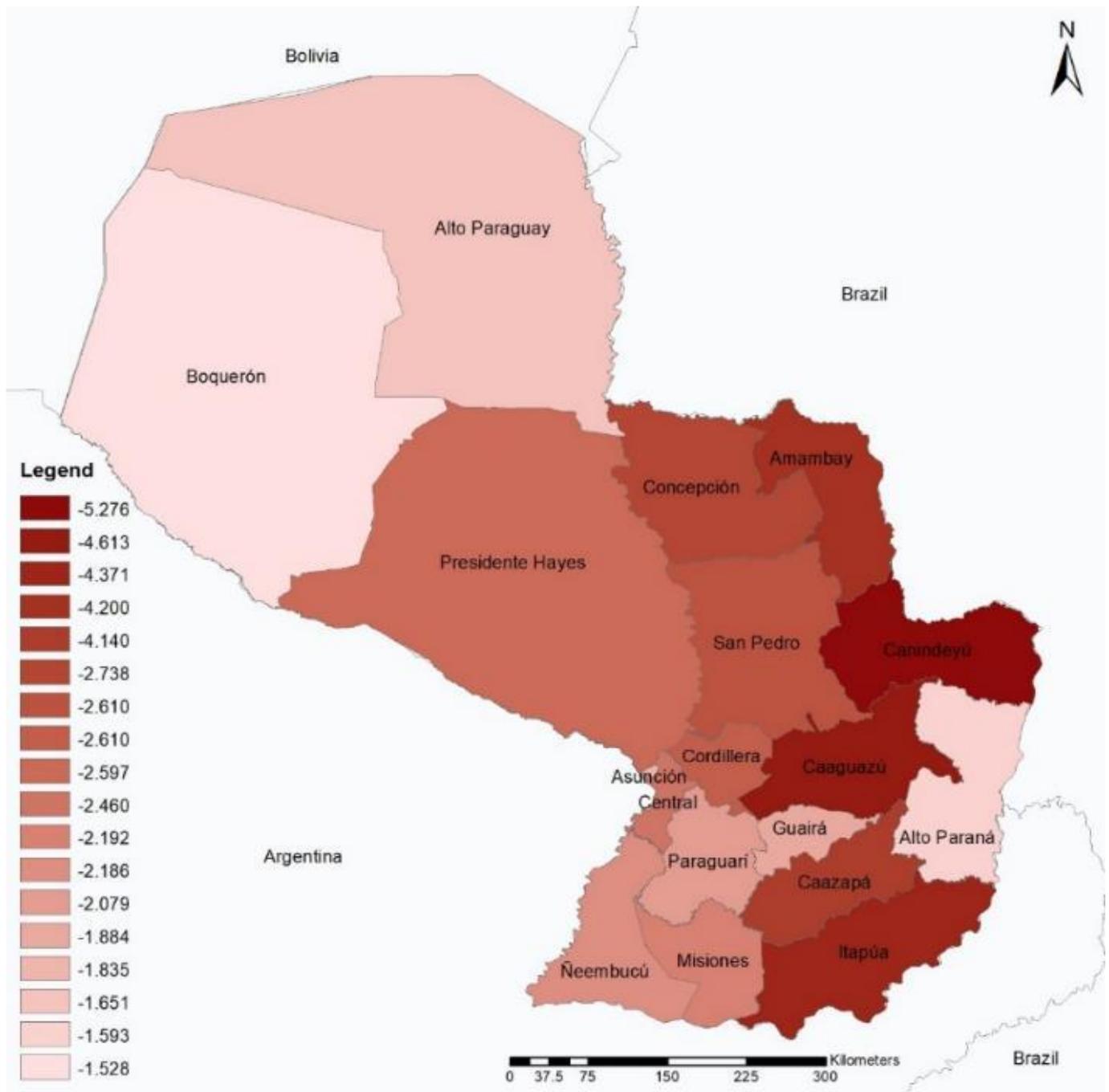
	<i>Total</i>
Nominal GDP from expenditure side	-3.75
Real GDP from expenditure side	-2.55
Aggregate real investment expenditure	-2.20
Export volume	-1.29
Import volume	-2.88
Real household consumption	-4.15
National Employment	-0.01
Nominal wages to workers	-5.36

In addition to the sector directly affected (agricultural business), the sectors (indirectly) most affected by climate change that affects crops yielding, which are those related to the agricultural business value chain, according to Figure 3. The mean change on the activity level in the sectors has been -1.94%. However, the government services sector (S33) and basic metals (S19) have been positively affected.



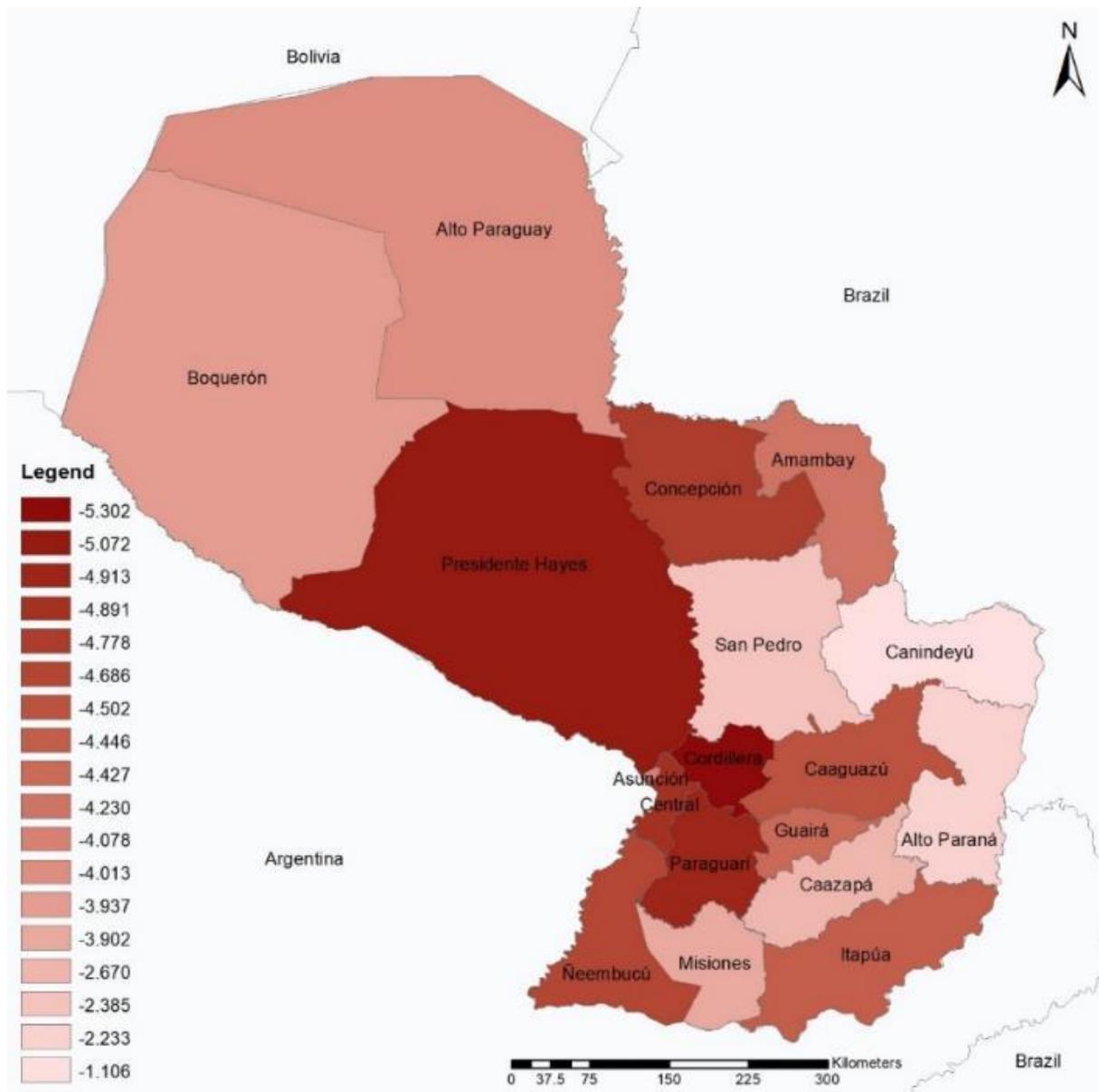
**Figure 3: Impact on activity level, by sector**

According Taconet, Méjean and Guivarch (2020) the climate damages will be shared unevenly among regions, because physical impacts may differ, and because the vulnerability to climate change vary widely across regions. Figure 4 presents the regional productivity changes impacts in agricultural business crops due to climate change on real GRP / GDP (% deviations from 2014 baseline). In terms of regional GDP, the states of Canindeyú (-5.27%), Caaguazú (-4.16%) and Itapúa (-4.37%) were the ones that obtained the highest results in the regional GDP. However, the regions of Boquerón (-1.52%), Alto Paraná (-1.59%) and Alto Paraguay (-1.65%) were the ones that obtained the lowest decrease in the regional GDP. In general, the most affected states are located in the eastern region of Paraguay, therefore, the least affected are located in the western region.



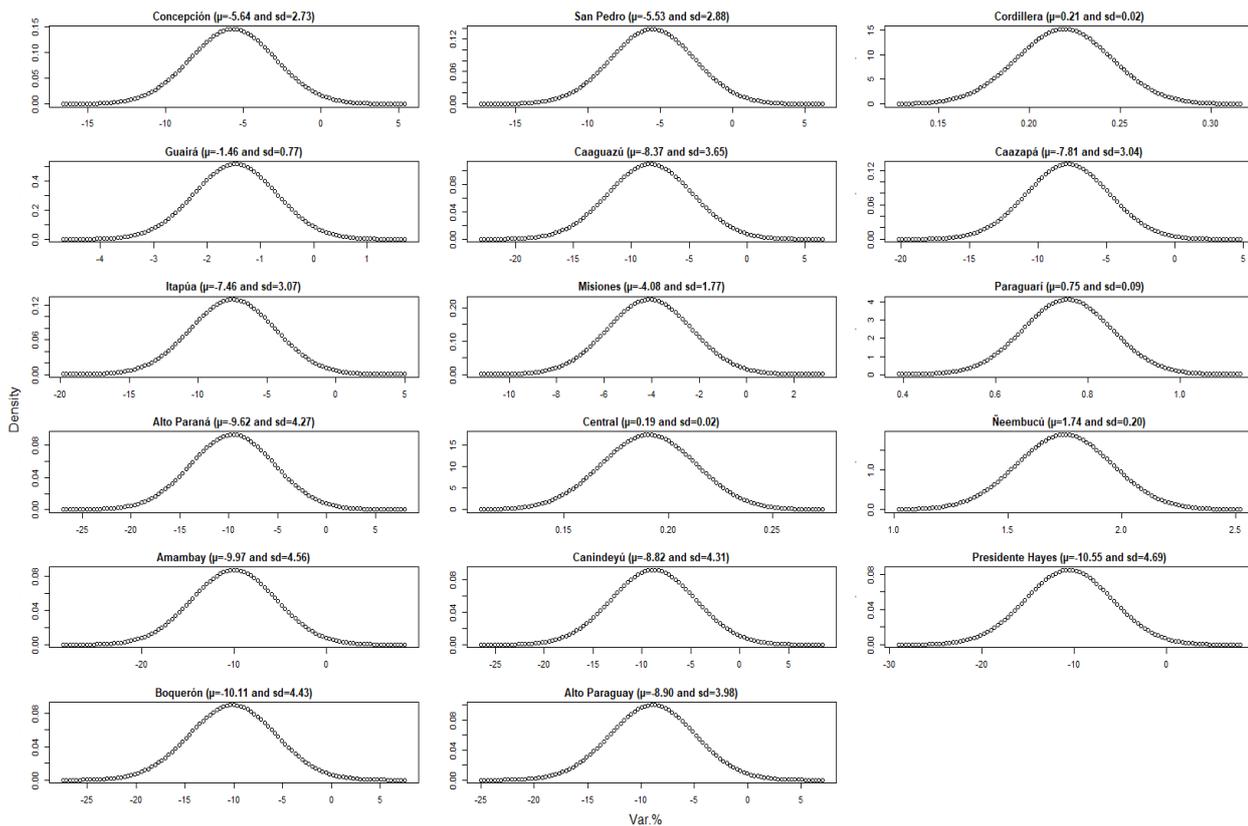
**Figure 4. Regional impacts of productivity changes in business agriculture crops due to climate change on real GRP/GDP (% deviations from 2014 baseline)**

The climate shocks have negatively effect on economy and, in particular, on agricultural productivity, affecting consumption and increasing economic inequality between households and individuals (Amare et al., 2021). Figure 5 presents the regional changes impacts in productivity in commercial agricultural crops due to climate changes in real consumption per capita (% of deviations from the 2014 baseline). The states of Cordillera (-5.30%), Presidente Hayes (-5.07%) and Paraguari (-4.91%) were the ones that obtained the highest levels of real consumption per capita. The regions Canindeyú (-1.10%), Alto Paraná (-2.23%) and San Pedro (-2.34%) were the ones that had the smallest decrease in real consumption per capita. In general, the most affected states are located in the western region of Paraguay and, consequently, the least affected are located eastern region.



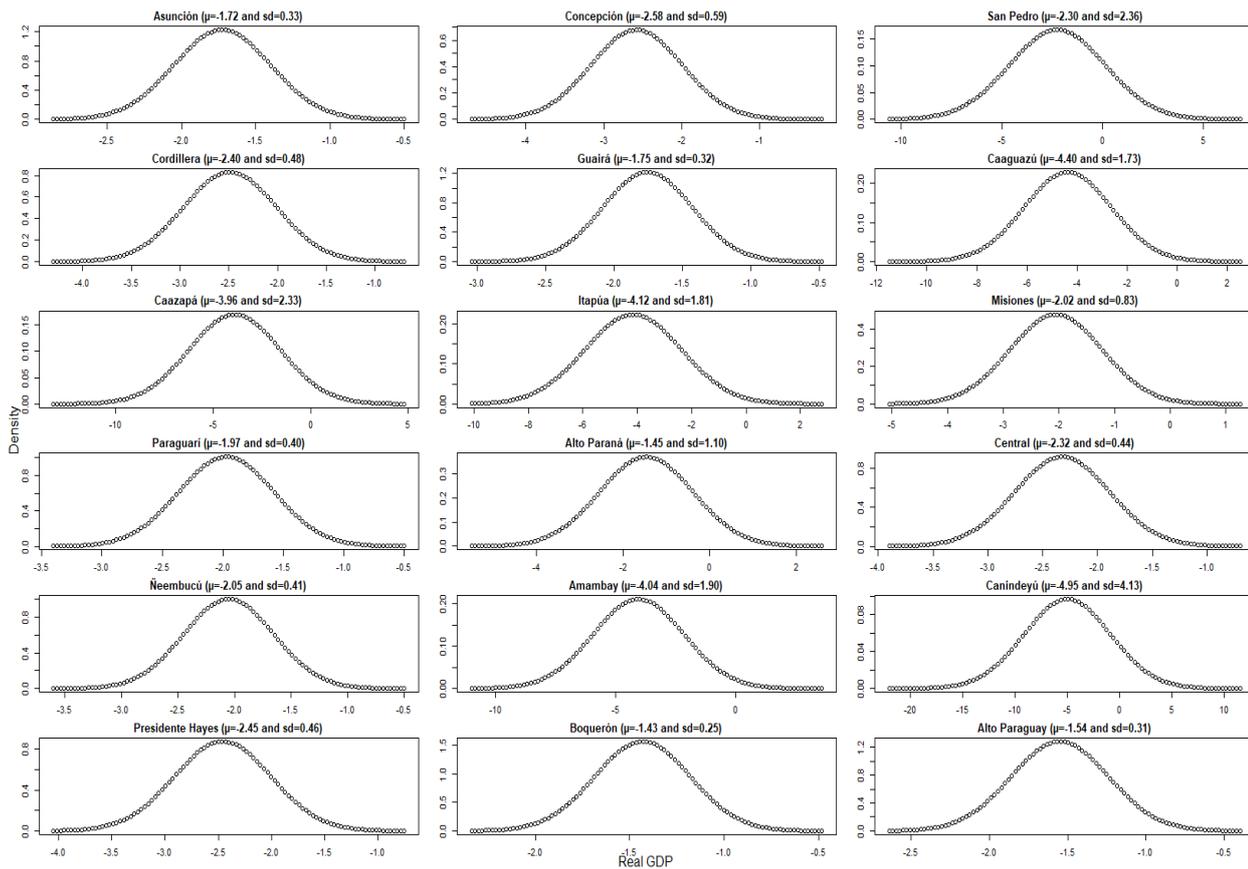
**Figure 5: Regional impacts of productivity changes in business agriculture crops due to climate change on real per capita consumption (% deviations from 2014 baseline)**

There are considerable regional disparities in the possible impact of climate change on crop productivity in Paraguay. The Figure 6 presents the distribution of the simulations for each Paraguayan state with the aim of mitigating a series of uncertainties about the possible impacts of climate change on agricultural production and, hence, on the economy as described by Stern et al. (2006). The analysis makes it possible to compare the magnitude and the difference in agricultural productivity shocks for each state. There is a great heterogeneity in the variation of agricultural business production between the states of Alto Paraná, Canindeyú, Presidente Hayes, Boquerón and Alto Paraguay. These states are located in the eastern region (bordering Brazil) and in the western region (bordering Argentina and Bolivia). In all regions, uncertainties with respect to the magnitude of the expected changes result in uncertainties of the impacts agricultural, such as in study Taconet, Méjean and Guivarch (2019).



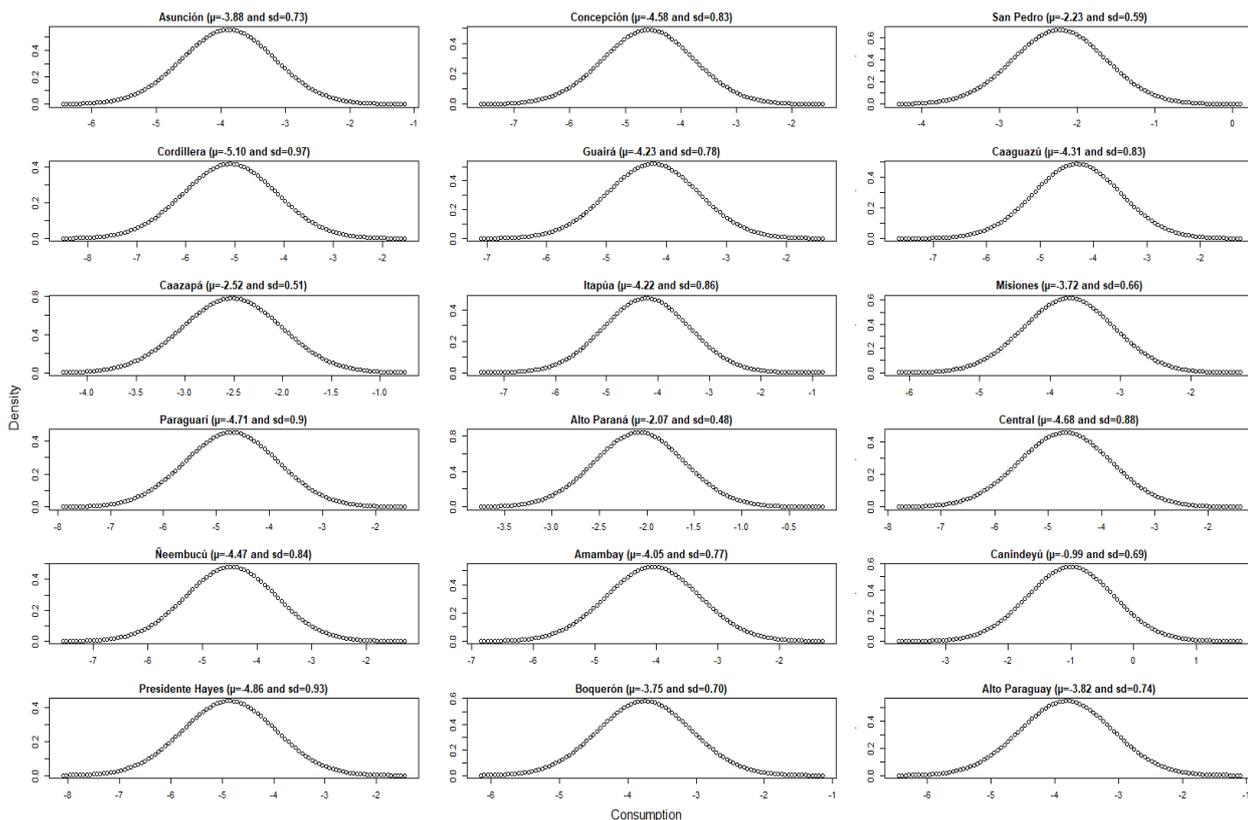
**Figure 6: Simulated Distribution productivity shocks**

Figure 7 presents the effects on the GDP real regions corresponding to each simulation the regional productivity impacts changes in agriculture business due to climate change compared with 2014 baseline. The distribution of effects must be interpreted as the possible response the regions production may have to uncertain agricultural productivity shocks. The possible responses to GDP rising from climate change in 10 regions are negative magnitudes, and the remaining ones can be positive. The states with the highest variances are Canindeyú, Caazapá, San Pedro and Caaguazú.



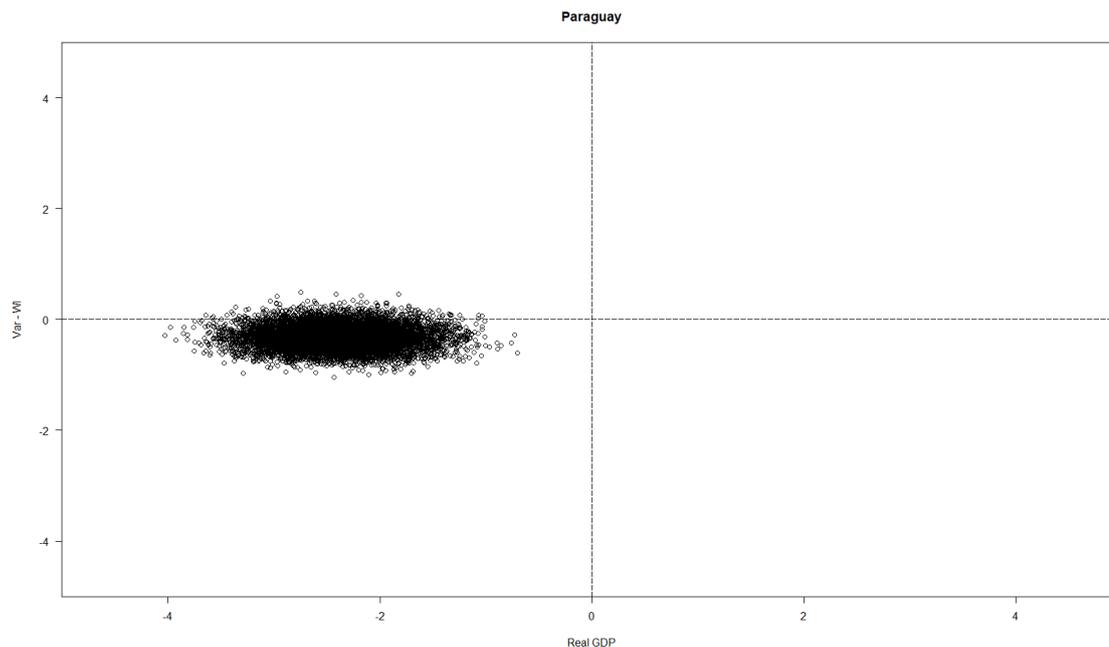
**Figure 7: Distribution of simulated impacts for regional GDP (% deviations from 2014 baseline)**

Figure 8 presents the effects on real per capita consumption for the regions corresponding to each simulation the regional impacts of productivity changes in agriculture business due to climate change compared with 2014 baseline. The distribution of effects must be interpreted as the possible response the consumption of the regions may have to uncertain agricultural productivity shocks. In most regions the results on consumption can be negative. The states of Cordillera, Paraguarí, Central and Presidente Hayes may experience a decrease in consumption up to -8% compared to the baseline.



**Figure 8: Distribution of simulated impacts for regional consumption (% deviations from 2014 baseline)**

Climate change increases the unpredictability and inequality between regions regarding future economic outcomes, effects that may alter the valuation of climate damages beyond their expected cost (Hsing et al. 2017). The results understanding may be reached through the inequality index on each simulation. Thus, how important are the regional results on inequality, associated with climate change in Paraguay? To answer these questions, we calculated the Williamson index for each model simulation results (regional GDP and population). Figure 9 presents the results of the Williamson index and the real regional GDP in baseline percentage. The distribution of effects must be interpreted as the possible response inequality between the regions; it may have uncertain agricultural productivity shocks. Most of the simulated results are concentrated in the negative quadrant where there is a reduction in real regional GDP and an inequality index. However, there are results that presentation an increase in regional inequality. According to Hsiang (2017) climate change, in addition to increasing the unpredictability of its real impacts, it can increase the regional disagreement that it causes since there is a transfer of production factors from the most affected regions to the least affected ones.



**Figure 9: Dispersion between the Williamson index and the regional real GDP (% deviations from 2014 baseline)**

The analysis of the images presents some possible dimensions to be verified, such as the relationship between the variables at national and regional level and the dispersion of the simulated impacts. In summary, the imagens analysis presentation the possible conjectures are due to of climate change from different simulated scenarios and economic integration framework across regions.

**6. CONCLUDING REMARKS**

In this study we have computed estimates regions economic impacts, if climate change conditions (2010-2100) that prevailed in Paraguay in 2014. We have used an inter-regional CGE model calibrated for the Paraguayan economy using data for 2014. The general equilibrium approach adopted in this paper allowed a broader understanding of potential responses of agriculture business in Paraguay to a climate change scenario taking into account its whole value chain and, consequently, its uncertainties.

The results revealed the relevance of economic integration framework across regions and its heterogeneities to understand the systemic effects due to climate change. Revisiting the main results of the paper, if changes in productivity of agriculture business crops associated with climate change in Paraguay by 2100 prevailed today (2014), current GDP would be 2.55% lower, i.e. the annual cost in terms of GDP would reach close to USD 1 billion. In terms of welfare, the average Paraguayan citizen would have lost around PYG 719 thousand (USD 155) yearly, in terms of the projected reductions in household consumption, representing 4.15% of current (2014) per capita annual consumption.

The results are not without limitations. In our simulation-based approach, results depend heavily on the analytical, functional and numerical structures of the model. The other limitations refer to the model pre-selection and how climate change conditions may have affected other crops and regions sectors. Additional research is needed to help provide further evidence to evaluate these issues more completely. Our study of the economic impacts from climate change on crop yields in Paraguay, despite its limitations, shows that there are potential high costs and associated risks in more vulnerable country regions.

## ACKNOWLEDGEMENTS

We are grateful for the comments and suggestions received from many colleagues at The University of Sao Paulo Regional and Urban Economics Lab (NEREUS) - in particular, we wish to thank Inácio F. de Araújo. Évilly C. D. Bezzera acknowledges financial support from CAPES. Gustavo H. L. de Castro acknowledges financial support from FIPE. Plínio E. R. Alvarez acknowledges financial support from University Nacional of Asunción.

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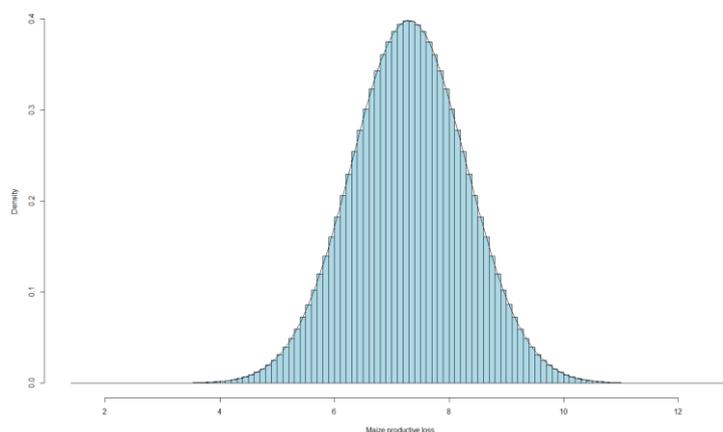
## APPENDICES

<i>ID</i>	<i>Sector</i>	<i>Sectors</i>
1	S1	Agriculture and related service activities
2	S2	Animal production, hunting and related service activities
3	S3	Forestry
4	S4	Fishing
5	S5	Mining and quarrying
6	S6	Processing and preserving of meat
7	S7	Manufacture of vegetable and animal oils and fats
8	S8	Manufacture of dairy products
9	S9	Manufacture of grain mill products, starches and starch products
10	S10	Manufacture of sugar
11	S11	Manufacture of other food products
12	S12	Manufacture of beverages and tobacco
13	S13	Manufacture of textiles and wearing apparel
14	S14	Manufacture of leather and footwear
15	S15	Manufacture of wood
16	S16	Manufacture of paper and paper products
17	S17	Manufacture of chemicals
18	S18	Manufacture of non-metallic mineral products
19	S19	Manufacture of basic iron and steel
20	S20	Manufacture of fabricated metal products
21	S21	Manufacture of machinery and equipment
22	S22	Other manufacturing
23	S23	Electricity and water collection, treatment and supply
24	S24	Construction
25	S25	Wholesale and retail trade
26	S26	Transport
27	S27	Telecommunications
28	S28	Financial service activities
29	S29	Real estate activities
30	S30	Administrative and support service activities
31	S31	Accommodation and food and beverage service activities
32	S32	Other service activities
33	S33	Public administration and defense

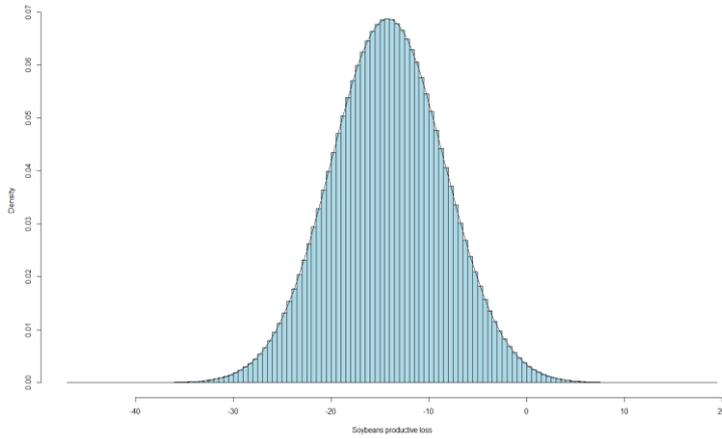
### A1: List of sectors

<i>ID</i>	<i>Region</i>	<i>Department</i>	<i>ID</i>	<i>Region</i>	<i>Department</i>
1	R1	Asunción	10	R10	Paraguarí
2	R2	Concepción	11	R11	Alto Paraná
3	R3	San Pedro	12	R12	Central
4	R4	Cordillera	13	R13	Ñeembucú
5	R5	Guairá	14	R14	Amambay
6	R6	Caaguazú	15	R15	Canindeyú
7	R7	Caazapá	16	R16	Presidente Hayes
8	R8	Itapúa	17	R17	Boquerón
9	R9	Misiones	18	R18	Alto Paraguay

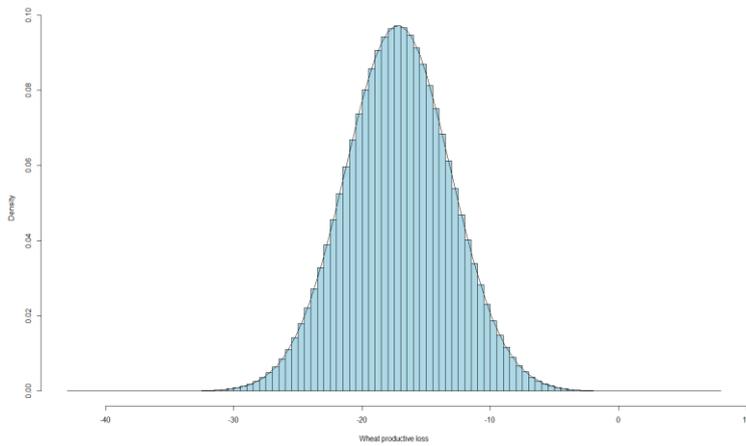
### A2: List of regions



Maize productive loss



Soybeans productive loss



Wheat productive loss

**A3: Gaussian distribution**

## DIVERSIFICATION IN THE DESTINATIONS OF PARAGUAYAN EXPORTS: WHAT CAN THE TRADE COMPLEMENTARITY (TC) INDEX EXPLAIN ABOUT IT?

**Plinio Esteban Ramirez Alvarez, Victor Ramón Enciso Cano**

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### ABSTRACT

The theory of international trade states that a free trade agreement enlarges the market for the subscribing parties and allows economies of scale. With an agreement, the trade between the parties grows as it happened with Paraguay's trade during the first years of the Southern Common Market (MERCOSUR in Spanish). Despite this, since the beginning of the millennium, it can be observed that regional market share in Paraguay's export is declining almost linearly. What is happening with Paraguayan exports? Is it diversifying, because the regional market is no longer attractive? Are Paraguayan exports a competition for the production of its commercial partners, which forces Paraguay to search for new markets? Perhaps, the Paraguayan exporters with the internationalization, due to the MERCOSUR, have improved the country trading as well as international negotiation capacity, resulting in the accession to new markets. Of these questions, and others, that may arise, this research focuses on the reduction of the regional market as a result of a lesser coincidence between the export supply of Paraguay and the import demand of MERCOSUR. Specifically, it aimed to: (i) calculate trade complementarity (TC) index between Paraguayan exports and MERCOSUR imports, using Brazil as a proxy for the regional market; (ii) identify which products are subject to change in their complementarity; (iii) identify those products that did not show any changes in their complementarity. It concluded that the participation of the regional (Brazilian) market has been reduced in the number of products, but there has been a strong increase in value, presenting a concentration of exports of products in which there is complementarity between the Paraguayan supply and Brazilian demand.

### KEYWORDS

MERCOSUR, Paraguay, Trade complementarity index.

## PRODUCTIVE STRUCTURE AND AGRICULTURAL SECTOR OF THE PARAGUAY: AN INPUT-OUTPUT APPROACH

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### ABSTRACT

Researches report that Paraguay's agriculture sector has shown a high-performance last years, which put the sector in a key-sector status, in terms of economic growth. Actually, the agricultural and livestock sector is in evidenced, mainly in exports to the others countries; although it generates low incomes and jobs directly from the activity, it generates a high multiplier effect of these variables in the input supplier sectors to its production. The main goal of this paper is identifying the role of agricultural and livestock in Paraguay economy with an economy growth theories basis, which in a large viewpoint, consider the agriculture sector being essential to the growth of other productive sectors. For this purpose, it was used, the interregional input-output system for Paraguay, for the year 2014. The analyzed empiric data confirm the importance of agriculture sectors as a supplier of raw material to the other sectors, and as a buyer of manufactured products.

### KEYWORDS

Paraguay, Agriculture, Productive structure, Regional economics, Input-Output Model.

## ANALYSIS OF THE CONVERGENCE OF THE PRODUCTIVITY OF SOYBEAN (GLYCINE MAX L.) IN THE EASTERN REGION OF PARAGUAY. PERIOD 2007 - 2018

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### ABSTRACT

It is extremely important for the country's economy to analyze the behavior of soybean cultivation, because it is the main agricultural export product of the country and the one that generates the greatest amount of income, that is why this research had as its objective the main objective is to evaluate the convergence of soybean productivity in the producing departments of the eastern region during the period 2007-2018, to test the hypothesis of the existence of absolute convergence. For this, an exploratory data analysis was carried out, which were measured by the spatial econometric model where the initial level of crop productivity was associated with the increase in this same productivity over a certain time. The dependent and independent variables were used as study parameters, which were the growth rate of soybean production and the natural logarithm of soybean productivity, respectively. The parameters studied were significant at the 1% confidence level, this indicates that the dependent variable (y) is influenced by shocks from all departments, with the closest departments being the most influenced. Likewise, the spatial dependence through the residuals was detected, indicating the existence of non-modeled factors that may be influencing this process.

### KEYWORDS

Soy; Convergence; Productivity; Agricultural; Paraguay

## National Session: SS58.2 - Argentinean social and economic challenges

# **SAER**

SOCIEDAD ARGENTINA DE  
ECONOMÍA REGIONAL

**16:00 - 17:15 Thursday, 27th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/83942885151>**

**Chair Pedro Luis Elosegui**

## HOW TO MEASURE THE TERRITORIAL ECONOMIC IMPACT OF THE COVID-19 PANDEMIC IN CONTEXTS WITH SCARCE REGIONAL DATA? A METHODOLOGICAL PROPOSAL AND APPLICATION FOR ARGENTINA (APRIL-SEPTEMBER 2020)

Andrés Niembro<sup>1</sup>, Carla Daniela Calá<sup>2</sup>

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### ABSTRACT

The trade-off between epidemiological prevention and economic activity is one of the most pressing issues that governments and societies are facing. Recent studies highlight that, unlike other crises such as that of 2008-2009, the impact of the pandemic has been regional rather than national. This is why the literature raises the need to adopt a regional perspective in the analysis of the economic impact of the COVID-19 pandemic.

However, the study of the regional economic impact often faces several limitations, in many cases due to the limited availability of updated information at the subnational level. The abundance of real-time epidemiological statistics for multiple geographical scales contrasts with the scarcity of economic statistics, which in developing countries are often non-existent or very outdated. Moreover, available estimates of the economic impact of COVID-19 are usually presented at an aggregate level, that is, by country or by sector.

In this paper, we wonder how we can measure the territorial economic impact of the COVID-19 pandemic in contexts with scarce or outdated regional data. To this end, we propose the calculation of an index that, with minimal adjustments or adaptations to each context, could be used to measure the regional economic impact of the pandemic and isolation measures, based on data or statistics that are usually available in most countries. Our index of territorial economic impact by COVID-19 (ITEI-COVID) takes into account: a) the sectoral production structure of the different regions, based on pre-pandemic data, b) the operational level of each sector, based on secondary post-pandemic information at the national level, c) the mobility of workers in each region, based on the easily accessible data from Google Mobility Reports, and d) the possibility of remote work across different activities or sectors, based on recent studies that have been carried out in many countries.

As an application, we show the results of the ITEI-COVID for the 24 provinces and the main 85 Labor Market Areas (LMAs) of Argentina, throughout the six months -or two quarters- of greatest economic contraction, from April to September 2020. In line with recent literature, the ITEI-COVID reveals large disparities between the 24 provinces and the main 85 LMAs of the country, as well as the heterogeneity within some provinces, which revalues the use of smaller geographical units. The results also showed that, although the economic impact of the pandemic has been decreasing over the months for the country as a whole, there is considerable stability in the relative position of the most and least affected regions. Besides, the economic impact in many regions has been dissociated from the health impact or the relative number of cases.

Finally, the comparison with sporadic official indicators of the regional economic impact of the pandemic emphasizes the validity of the proposed index, which also has a higher geographical and temporal coverage. Although we propose a relatively simple and descriptive exercise, the calculation of an index of territorial economic impact can be a relevant input for the design, implementation, and monitoring of targeted and place-based policies, which seek to mitigate the harmful economic impacts of the pandemic and isolation measures.

## GREEN EXPORTS IN ARGENTINA: TRAJECTORIES AND OPPORTUNITIES FOR DIVERSIFICATION AT THE REGIONAL LEVEL

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GSSI, Italy

### ABSTRACT

This project aims to analyze the trajectory and opportunities for export diversification in green products for the Argentinean provinces between 2003-2019. The development of products with environmental benefits (green products) is considered one step towards a sustainable transition, an issue of utmost relevance to any economy.

In particular, developing countries present conditions that could promote and limit a sustainable transition in these economies (Hansen et al., 2018; Köhler et al., 2019). On the one hand, Argentina has a wide range of resources that could be considered an opportunity to foster green development strategies. On the other hand, it faces structural problems that constrain regional development. In this context, ECLAC argues that it is possible to strengthen the productive capacity towards a green and more inclusive economy (ECLAC, 2019). Even though, a radical transformation could be perceived as not urgent or not possible in Latin America, we need to study niche options that can help avoid a lock-in process (Marin & Benavente, 2011). In this line, this research focuses on a group of products with environmental benefits, considered preferable in the world, with a growing demand that may represent an opportunity in terms of green development.

In order to distinguish these products, we follow the list provided by Mealy and Teytelboym (2020) that identify 543 traded green products (HS 6 digits). We analyze export data at provincial level (HS 6 digits) for Argentina between 2003-2019.

The empirical strategy draws on economic complexity and proximity concepts (Hidalgo et al., 2007; Hidalgo and Hausmann, 2009). We calculate indices that capture the present capacities of green production and identify potential diversification opportunities. The study presents an overview of the green economy in the Argentinean regions and concrete indications on future diversification opportunities. These results can be useful as a basis for regional policies that foster the green economy.

Preliminary results show that the green economy has a heterogeneous spatial distribution across the country. This pattern has also remained stable over time. In this line, the ranking is led by central provinces (Buenos Aires, Ciudad Autónoma de Buenos Aires, Santa Fe y Córdoba). Diversification opportunities are also seen to be greater for the above-mentioned regions, as well as for Neuquén, Chubut, Santa Cruz, and Mendoza.

## ARGENTINA'S INTEGRATION INTO GLOBAL VALUE CHAINS: A SECTORAL AND PRODUCT ANALYSIS, AND AN ATTEMPT AT REGIONALIZATION

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### ABSTRACT

The aim is to identify sectors and products with potential for participation in value chains on a regional scale (South America) and in dynamic global markets. The type of integrations is that of importing goods as inputs and exporting them with a certain level of additional processing. In other words, an input is purchased from the region or the rest of the world and exported to the region or the rest of the world for final consumption or to continue the productive transformation process.

The identification of sectors with potential for participation in regional and global value chains was carried out using the information provided in the South American Input-Output Matrix (MIPS). Three types of indicators were constructed, each of which captures different ways of viewing the phenomenon under study: domestic intersectoral linkages, vertical integration with the international economy, and the degree of proximity to final demand. The selected sectors have high import contents, are generally far from the final demand, and have an important regional integration. Within the selected sectors, 90 products were identified. The main destination markets for these products depend on the type of good, although there is a clear presence of Brazil and other South American markets (although to a lesser extent) in all the selected sectors. For each of the selected products, the main inputs were analyzed using information from the temporary admission import regime, which allows linking inputs with products at an appropriate level of disaggregation. In general, the linkages refer to inputs that originate in countries outside the South American region, on which there is a high level of industrial transformation and which are then exported to countries in the region.

To complement the analysis, tariff and non-tariff barriers were considered to detect concrete possibilities and barriers to achieve productive linkages, especially in the case of trade with countries with which there are no trade agreements. For inputs where opportunities for regionalization were identified, Argentina already has a preferential tariff rate equal to zero for most of these products with its regional partners. In the case of inputs with low regional supply, most products have preferential rates equal to zero for partners in the region, but for extra-regional suppliers, there are no preferential agreements and the rate applied corresponds to that of Most Favored Nation.

With reference to the analysis from a regional perspective, using a provincial input-output model, we evaluated the regional impacts of an increase in exports in the eight selected sectors with the potential to join global value chains. These impacts differ according to the destination country considered (given the characteristics of the exported goods and existing trade links). The results show that for almost all the selected sectors, the region that benefits the most is the Pampean region, mostly through an increase in exports. In the second place, it appears CABA, which, in contrast to the Pampean region, benefits indirectly through an increase of sales to other regions inside Argentina.

## **Regular Session: RS22 - Nexus: water, agriculture and energy**

**16:00 - 17:15 Thursday, 27th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/87555502007>**

**Chair Ana Serrano**

## A GAME-THEORETIC MODEL OF WATER THEFT DURING A DROUGHT

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### ABSTRACT

We study water use by two geographically proximate farmers in a particular region during a drought. The two farmers each have an endowment of time that can be used either to produce water or to steal water. The price of water is exogenously given. The goal of the two farmers is to maximize their wealth from water production and water theft. In this setting, we perform three tasks. First, we determine the Nash equilibrium of the game-theoretic interaction between the two farmers. Second, we study how this equilibrium depends on the ease with which water can be stolen. Finally, we show how the preceding equilibrium is impacted when there is no water theft and then we determine the maximum amount that a farmer would be willing to pay to prevent theft.

### KEYWORDS

Drought, Nash Equilibrium, Static Game, Water Theft, Willingness to Pay

### JEL Codes

Q25, D74

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## 1. INTRODUCTION

### 1.1. Preliminaries

There is no gainsaying the fact that water is a critical input for agricultural production and therefore it plays a key role in food security. Irrigated agriculture represents 20 percent of the total cultivated land and it contributes 40 percent of the total food produced worldwide.<sup>166</sup> Studies show that on average, irrigated agriculture is at least twice as productive per unit of land as rain-fed agriculture. Therefore, this kind of agriculture permits more production intensification and crop diversification.

A drought is normally defined as a natural hazard caused by a period of abnormally low precipitation.<sup>167</sup> As pointed out by Rey *et al.* (2017), agriculture is one of the sectors that suffers most from the consequences of droughts, which are responsible for the greatest loss of agricultural production in many countries. In fact, the effects of drought on agriculture are becoming an important abiotic stress in temperate and humid regions.

Within the agricultural sectors of many nations, droughts have given rise to abnormal behavior by farmers. In fact, in many nations, the acute scarcity of water during droughts has frequently resulted in farmers turning on each other and, in the process, stealing water. For instance, in 2008, in the drought stricken region of Bundelkhand in India, 2000 farmers were charged with stealing water.<sup>168</sup> Similarly, Pradhan and Pradhan (2000) and Meinzen-Dick (2014) discuss instances in the hills of Nepal where farmers have stolen water from each other. Khokha (2015) points out that in Madera County, California, in the United States, as wells have gone dry and water prices have soared, water theft from farmers has become commonplace. In Muzaffargarh, Pakistan, upstream farmers have been charged with stealing water from canals and thereby disadvantaging downstream farmers.<sup>169</sup> Finally, Viellaris (2019) shows that in Toowoomba, Australia, desperate farmers have turned on each other, stealing water from dams, tanks, and even household taps.

As the above examples and the work of Lowdermilk (1990) demonstrate, during a drought, the phenomenon of water theft by farmers and farmers turning on each other is now quite common. Even so, to the best of our knowledge, this issue has received virtually *no* empirical or theoretical attention in the literature. Focusing first on two empirical studies, Ray and Williams (1999) use a mathematical programming model to analyze water use by upstream and downstream farmers from canals in Maharashtra, India. They show that even though water theft increases the social cost of price policies, these same policies induce upstream farmers to steal water and hence leave downstream farmers with less water and lower incomes. In a later study of a canal in Maharashtra, India, Ray and Williams (2002) once again use a

166 Go to <https://www.worldbank.org/en/topic/water-in-agriculture> for additional details. Accessed on 2 September 2020.

167 Go to [https://www.weather.gov/bmx/kidscorner\\_drought](https://www.weather.gov/bmx/kidscorner_drought) for more details. Accessed on 2 September 2020.

168 Go to <https://www.circleofblue.org/2008/world/hot-water-lands-farmers-in-hot-water/> for more details. Accessed on 4 September 2020.

169 Go to <https://www.dawn.com/news/1484809/farmers-complain-about-canal-water-theft> for more details. Accessed on 2 September 2020.

mathematical programming model to analyze the extent to which farmers voting to cooperate can solve the problem of water theft. Their study shows that because the gains and the losses from cooperation are spatially distributed, voluntary bargaining will rarely achieve an efficient water allocation. Even though the phenomenon of farmers turning on each other and stealing water has a clear strategic aspect to it, there are *no* game-theoretic studies of this phenomenon.

**1.2. Our objective**

Given this lacuna in the extant literature, our objective in this paper is to provide what we believe is the *first* game-theoretic analysis of water use by two geographically proximate farmers in a particular region during a drought. The remainder of this paper is organized as follows. Section 2 describes the theoretical framework in which the two farmers under study each have an endowment of time that can be used to either produce water or to steal water. Section 3 determines the Nash equilibrium of the game-theoretic interaction between the two farmers. Section 4 analyzes how this equilibrium is impacted by a change in the ease with which water can be stolen by either of the two farmers. Section 5 shows how the section 3 equilibrium is affected when there is no water theft and then ascertains the maximum amount that a farmer would be willing to pay to prevent theft. Finally, section 6 concludes and then discusses two ways in which the research delineated in this paper might be extended.

**2. THE THEORETICAL FRAMEWORK**

Consider two geographically proximate farmers who grow the same crop in a particular region during a drought. Each of these two farmers has a total of  $T > 0$  hours to allocate between water production and water theft. For the ultimate purpose of crop cultivation, the input water can be “produced” in a variety of ways. These include the construction of a tube well, the storage of water in tanks that are filled by tankers, and drawing water from one or more canals. Similarly, water can be stolen by illegally using the other farmer’s tube well to draw water, by directly removing water from a tank, and by illegally diverting water from one or more canals. Since these two farmers produce the same crop and they are located close to each other in space, we suppose that they are very similar in terms of their abilities to both produce and steal water. This means that in the ensuing formal analysis, it makes sense to analyze a *symmetric* Nash equilibrium.

The *production* process generates output of water ( $q_p$ ) in accordance with the production function

$$q_p = \log(\tau_p), \tag{1}$$

where  $\tau_p > 0$  denotes the amount of time spent producing water. If time  $\tau_t > 0$  is the time devoted to *stealing* water by one farmer then a fraction  $\zeta\tau_t/T$  of the other farmer’s output of water can be stolen. The parameter  $\zeta > 0$  describes the ease with which water can be stolen by either of the two farmers. Each unit of water has an exogenously given price  $p > 0$ . The goal of both farmers in our model is to maximize their wealth from water production and theft. With this description of the theoretical framework out of the way, our next task is to ascertain the Nash equilibrium of the static game-theoretic<sup>170</sup> interaction between the two farmers.

**3. THE NASH EQUILIBRIUM**

We begin by mathematically delineating the value of the output of water produced by farmer 1. This value is given by

$$pq_p^1 = p \log(\tau_p^1), \tag{2}$$

where the superscript 1 refers to farmer 1. After farmer 2 has stolen water from farmer 1, the value of farmer 1’s output of water is reduced to

$$\left\{1 - \frac{\zeta\tau_t^2}{T}\right\} p \log(\tau_p^1), \tag{3}$$

where the superscript 2 refers to farmer 2. The value of the water stolen by farmer 1 from farmer 2 is

$$\left\{\frac{\zeta\tau_t^1}{T}\right\} p \log(\tau_p^2). \tag{4}$$

Putting the information in equations (2) through (4) together, farmer 1’s wealth ( $W^1$ ) from water production and theft can be written as

$$W^1 = \left\{1 - \frac{\zeta\tau_t^2}{T}\right\} p \log(\tau_p^1) + \left\{\frac{\zeta\tau_t^1}{T}\right\} p \log(\tau_p^2). \tag{5}$$

A line of reasoning similar to that employed thus far in this section for farmer 1 tells us that farmer 2’s wealth from water production and theft is given by

$$W^2 = \left\{1 - \frac{\zeta\tau_t^1}{T}\right\} p \log(\tau_p^2) + \left\{\frac{\zeta\tau_t^2}{T}\right\} p \log(\tau_p^1). \tag{6}$$

The use of time by each of the two farmers is constrained by the fact that the total available time ( $T$ ) is spent either producing or stealing water. In symbols, this gives us

$$T = \tau_p^k + \tau_t^k, k = 1, 2. \tag{7}$$

Let us now substitute the time spent stealing water or  $\tau_t^k$  from equation (7) into the two objective functions given in equations (5) and (6). Doing this, the wealth maximization problems faced by farmers 1 and 2 can be expressed as

$$\max_{\{\tau_p^1\}} W^1 = \left\{1 - \frac{\zeta(T-\tau_p^1)}{T}\right\} p \log(\tau_p^1) + \left\{\frac{\zeta(T-\tau_p^1)}{T}\right\} p \log(\tau_p^2) \tag{8}$$

and

$$\max_{\{\tau_p^2\}} W^2 = \left\{1 - \frac{\zeta(T-\tau_p^2)}{T}\right\} p \log(\tau_p^2) + \left\{\frac{\zeta(T-\tau_p^2)}{T}\right\} p \log(\tau_p^1). \tag{9}$$

170 See Tadelis (2013, pp. 43-126) for a textbook exposition of static games.

When maximizing the objective functions in equations (8) and (9), each farmer takes the choice made by the other farmer as given.

Now, to find the Nash equilibrium of the game between farmers 1 and 2, we differentiate the maximands in equations (8) and (9) and set the resulting expressions equal to zero. The first-order necessary condition for an optimum for farmer 1, for instance, is

$$\left\{1 - \frac{\zeta(T - \tau_p^2)}{T}\right\} \frac{p}{\tau_p^1} - \left\{\frac{\zeta}{T}\right\} p \log(\tau_p^2) = 0. \quad (10)$$

As noted in section 2, the two farmers are very similar in terms of their abilities to both produce and steal water. Therefore, we look for a symmetric Nash equilibrium in which we have

$$\tau_p^1 = \tau_p^2 = \tau_n, \quad (11)$$

where  $\tau_n$  is the Nash equilibrium amount of time spent producing water by each of the two farmers. Substituting the result in equation (11) into the first-order necessary condition in equation (10) gives us

$$(1 - \zeta)T + \zeta\tau_n\{1 - \log(\tau_n)\} = 0. \quad (12)$$

Equation (12) implicitly characterizes the Nash equilibrium amount of time spent producing water by the two farmers under study. We now proceed to discuss how this equilibrium is affected by a change in the ease with which water can be stolen by either of the two farmers.

#### 4. IMPACT OF THE EASE OF THEFT ON THE NASH EQUILIBRIUM

Recall from section 2 that the ease with which water can be stolen by either farmer is described by the parameter  $\zeta$ . So, in symbols, what we want to know is how  $\tau_n$  changes when  $\zeta$  increases by a small amount.

To answer this question, let us totally differentiate equation (12) with respect to  $\tau_n$  and  $\zeta$ . After differentiation and several steps of algebra, we obtain

$$\frac{d\tau_n}{d\zeta} = -\frac{T - \tau_n\{1 - \log(\tau_n)\}}{\zeta \log(\tau_n)}. \quad (13)$$

Let us now use equation (12) to substitute for  $\{1 - \log(\tau_n)\}$  in equation (13). Doing this, the ratio on the right-hand-side (RHS) of equation (13) simplifies to

$$\frac{d\tau_n}{d\zeta} = -\frac{T}{\zeta^2 \log(\tau_n)}. \quad (14)$$

Inspecting equation (14), it should be clear to the reader that there are two cases to consider. To this end, suppose first that the optimal value of  $\tau_n$  that emerges from solving equation (12) is such that  $\tau_n > 1$ . In this case,  $\log(\tau_n) > 0$  and  $d\tau_n/d\zeta < 0$ . This is the intuitively meaningful case. In words, this result tells us that as it becomes easier to steal water ( $\zeta \uparrow$ ), the amount of time allocated to producing water or  $\tau_n$  declines ( $\tau_n \downarrow$ ). However, this is not the only possibility. If, in contrast, the solution of equation (12) gives us  $\tau_n < 1$  then  $d\tau_n/d\zeta > 0$  is possible and counterintuitively, this result would tell us that for a certain region in the parameter space, even though stealing water becomes simpler, it still makes sense to allocate more time to producing and *not* stealing water.<sup>171</sup> Our final task is to show how the section 3 Nash equilibrium is impacted when there is no water theft. We then compute the maximum amount that a farmer would be willing to pay to prevent theft.

#### 5. WILLINGNESS TO PAY TO PRECLUDE THEFT

If there is no theft of water then both farmers will be allocating *all* their time to the production of water. This means that  $\tau_n = T$ . Now, let  $M$  be the maximum that either farmer is willing to pay to avoid water theft. Then, some thought tells us that this maximum is equal to the payoff without water theft ( $M^{wo}$ ) less the payoff with water theft ( $M^w$ ). In symbols, we have  $M = M^{wo} - M^w$ .

Inspecting equations (5) and (6) and keeping  $\tau_n = T$  in mind, it is straightforward to verify that the payoff to either farmer without water theft or  $M^{wo} = p \log(T)$ . In contrast, the payoff with water theft is given by

$$M^w = \left\{1 - \frac{\zeta(T - \tau_n)}{T}\right\} p \log(\tau_n) + \left\{\frac{\zeta(T - \tau_n)}{T}\right\} p \log(\tau_n). \quad (15)$$

Therefore, combining the preceding two results, the maximum willingness to pay to avoid water theft is  $M = M^{wo} - M^w$  or

$$M = p \log(T) - \left\{1 - \frac{\zeta(T - \tau_n)}{T}\right\} p \log(\tau_n) - \left\{\frac{\zeta(T - \tau_n)}{T}\right\} p \log(\tau_n). \quad (16)$$

The expression on the RHS of equation (16) can be simplified further. After a couple of algebraic steps, the simplified form we seek is

$$M = p \log\left(\frac{T}{\tau_n}\right). \quad (17)$$

Inspecting equation (17), we see that the maximum willingness to pay to avoid water theft is an increasing function of the exogenously given price of water ( $p$ ) and a decreasing function of the equilibrium amount of time spent producing water ( $\tau_n$ ). These two results conform well with our intuition. Specifically, the first result tells us that as water becomes more valuable ( $p \uparrow$ ), farmers are willing to pay *more* ( $M \uparrow$ ) to avoid the theft of their water. The second result says that as the amount of time spent producing water by a farmer rises ( $\tau_n \uparrow$ ), there is less time to steal water from the other farmer and hence water theft becomes a less salient issue. As such, farmers are now willing to pay *less* ( $M \downarrow$ ) to avoid water theft. This completes our analysis of a game-theoretic model of water theft during a drought.

<sup>171</sup> We disregard the  $\tau_n = 1$  case for obvious reasons.

## 6. CONCLUSIONS

In this paper, we studied water use by two geographically proximate farmers in a particular region during a drought. The two farmers each had an endowment of time that could be used either to produce water or to steal water. The price of water was exogenously given. The goal of the two farmers was to maximize their wealth from water production and water theft. In this setting, we performed three tasks. First, we determined the Nash equilibrium of the game-theoretic interaction between the two farmers. Second, we analyzed how this equilibrium depended on the ease with which water could be stolen. Finally, we demonstrated how the preceding equilibrium was impacted when there was no water theft and then we determined the maximum amount that a farmer would be willing to pay to prevent theft.

The analysis in this paper can be extended in a number of different directions. Here are two suggestions for extending the research described here. First, the analysis we conducted in this paper assumed that the parameter values were such that a symmetric Nash equilibrium existed. Therefore, in a more exhaustive analysis, one could study the existence of corner solutions and asymmetric Nash equilibria. Second, it would be helpful to explicitly introduce law enforcement into the analysis and to then study how the enforcement of laws designed to preclude water theft influences the behavior of drought affected farmers. Studies that analyze these aspects of the underlying problem will increase our understanding of issues concerning water use by farmers during a time of scarcity brought about by a drought.

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## MODELLING AND EXPERIMENTATION OF OLIVE CAKE THIN-LAYER VACUUM DRYING PROCESS

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### ABSTRACT

The aim of this work is to study the effect of layer thickness (5, 10, 15mm), of pressure under the layer (-130, -200, 250 mbar) and of drying time (20, 60,100 mn) on the olive pomace vacuum drying kinetics, as well as the estimation of the moisture diffusivity coefficient and the activation energy of olive pomace during vacuum drying. Results clearly show the predominance of the depression under the olive pomace thin layer on the drying process with a contribution of 46% followed by the thickness of the thin layer (29%) and the drying time (26%). The results obtained show that the optimal combination minimizing the water content of the olive cake is a 5mm thick layer of pomace, a drying time of 100 min and a depression of -130 mbar, which identified as the most influential factor. The results of the numerical simulation show that the model can be used to improve the functioning of vacuum dryers. However, there is a slight disparity between experimental values and the results of the numerical simulation. This disparity is the consequence of the use of simplification hypotheses, and errors committed during the experiment.

## PATTERNS OF MEDITERRANEAN AGRICULTURAL WATER IMPACTS IN THE CONTEXT OF THE SECOND GLOBALIZATION

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### ABSTRACT

During the twentieth century, the Mediterranean basin experienced an intense integration in global markets, becoming one of the largest agricultural and food suppliers in the world. This expansion was particularly intense during the second wave of globalization, and was possible thanks to the increasing consumption of water resources, hand-in-hand with irrigation development and modernization.

This study aims to evaluate the impacts that the Mediterranean agri-food trade specialization exerted on water resources between 1975 and 2015, focusing on the second globalization. Concretely, we would like to approach to the economic, technological, productive and commercial factors behind the growing pressures on Mediterranean water resources. Likewise, we would like to focus on the divergences between northern, eastern and southern Mediterranean countries, stablishing regional patterns in terms of the socioeconomic drivers of this process. To that aim, we will use bilateral trade time series with a high product disaggregation detail, which combined with decomposition analysis, make up the methodological setting of the study.

Some preliminary results show that most (over 85% of the total growth between 1975 and 2015) of the growth of Mediterranean water consumption associated with agricultural and food exports happened from the beginning of the twentieth century. This expansion was mostly driven by the great increase in extra Mediterranean exports, mainly from southern and eastern areas. These divergences also appear when evaluating the determinants of the flows. In northern European Mediterranean countries, the trade expansion, and a considerable structural change towards the production and trade of water-intensive agri-food products, were essential to explain the consumption of water resources. On the contrary, the pattern in southern and eastern regions was more erratic. We observe a clear scale effect, an increase in the water intensity of exports that would point to a decreasing efficiency in these trade flows, and also, to a strong origin effect, indicating that exports come from the most water-intensive countries in the region.

## **Regular Session: RS19.2 - Green economy and complexity of socio-ecosystems**

**16:00 - 17:15 Thursday, 27th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/86592467076>**

**Chair Alessandro Crociata**

## ECONOMIC VALUATION OF CULTURAL ECOSYSTEM SERVICES: THE CASE OF LANDSCAPE AESTHETICS IN THE AGRITOURISM MARKET

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### ABSTRACT

Natural and agricultural landscapes provide a wide range of ecosystem services, aesthetic landscapes being among them. Since these services have no market value, land-use decisions often ignore them in favour of urban sprawl, resulting with sub-optimal resource allocation. Here we suggest a novel method to evaluate the aesthetic landscape services of natural and agricultural ecosystems using the case of the agritourism market in Israel. We model the agritourism market as an oligopolistic market and formulate an equilibrium model with structural, double nested-logit, demand and pricing equations. The structural equations are expressed as a function of the attributes of the agritourism firm and the ecosystems adjacent to the attractions. We use aggregated market data and Geographic-Information-System (GIS) maps to estimate the model. Counterfactual scenarios of urban sprawl were used to estimate the economic value of aesthetic landscape services. The loss of welfare in the different scenarios ranges between 15 thousand USD to 21 thousand USD per squared kilometre depending on the type of ecosystem and the scope of the urban sprawl. We contend that this welfare loss can be used as the economic value of aesthetic landscape services to the agritourism market. These findings illustrate the potential of this valuation method in guiding decision-making and place ecosystem services on a level playing field with market-priced goods, thereby, contribute to the sustainable use of the Earth's limited resources.

## HUMAN CAPITAL AND SOCIAL CAPITAL AS ANTECEDENT OF THE GREEN DEAL. AN ANALYSIS ON WASTE SEPARATION ACROSS ITALIAN PROVINCES

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### ABSTRACT

Sustainable practices must entice and include a significant part of the population to achieve a significant impact. In this sense, pro-environmental practices start with waste management, which in turn presupposes a wide involvement of consumer households in waste separation. The behavior of individuals is influenced by the level of human capital (HC) and social capital (SC) which should indicate the degree of environmental awareness, knowledge of best practices and understanding of the moral and legal norms they should induce. We study the role of HC and SC in waste separation practices in the 103 Italian provinces controlling for other factors influencing the waste management. Policy implications are derived.

## **Regular Session: RS08.2 - Real estate and housing**

**16:00 - 17:15 Thursday, 27th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/84441830561>**

**Chair Hojune Lee**

## EFFECT OF URBAN RAILWAY NETWORK ACCESSIBILITY ON HOUSING PRICES

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### ABSTRACT

Urban railway is one of key public transits to effectively improve economic and physical accessibility. Along with an expansion of urban territory, easy access to multiple sub-centers becomes important for selection of residential location in real estate market: housing prices accounts for degree of inter-regional accessibility by urban railways in the polycentric housing market. The purpose of this study is to identify the impact of accessibility based on multimodal transport including urban railway network on housing prices in the polycentric city. In this study, the housing price is defined as an average selling prices of apartment complex traded for sale in 2019 in Seoul. To measure the accessibility, Origin-Destination time matrix of railways in 2019 in Seoul and walking time to nearest railway station from the apartments and the employment center of town are calculated. Based on the time distances from the apartments to the employment centers, the accessibility using railways are measured with gravity-based accessibility reflecting the number of jobs by town. This paper reveals that the gravity-based accessibility index which take into account multiple work trips perform better than the physical and time distance from home to employment center. In addition, the accessibility to multiple employment centers has a positive effect on the housing price. This result provides public sectors and urban planners with new perspective to leads to stabilization of the housing price by improving accessibility of remote regions.

## THE MORE INCLUSIVE, THE LESS BENEFICIAL TO THE NEIGHBORHOOD? A QUANTITATIVE ANALYSIS ON INCLUSIONARY ZONING IN SÃO PAULO, BRAZIL

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### ABSTRACT

The regulation of land use to promote inclusive housing can take place through local policies that take advantage of economic gains from the appreciation of the real estate market to create low-cost housing. Thus, at market prices, the construction of new developments is linked to housing construction for low-income families. In the international literature, this type of program is known as inclusionary zoning. In its simplest form, it requires developers to sell a percentage of new residential units to low-income families if the construction is located in specific areas.

Already traditional in developed economies, such as in the USA, this policy began to expand in Brazil in 2001 with the creation of the urban policy instrument for the demarcation of ZEIS - Special Social Interest Zones. In São Paulo city, local regulation instituted the establishment of these zones in 2002. However, with the Master Plan of 2014, this policy took a qualitative leap, with the establishment of new ZEIS in well-located regions along the axes of public transport and the city center.

Due to the inclusiveness of development, this 2014 Master Plan, which established these zones of use, was recognized by the UN as an example for urban planning. But the construction of social housing in prosperous areas also faces a lot of resistance, especially from the residents of the region, who do not want to suffer from the effects of the devaluation of their properties. This work will contribute to this debate, evaluating through spatial statistical modeling if the construction of social housing in well-located areas of the city negatively affects the price of the surrounding properties and the magnitude of these effects.

Despite being a standard policy in developed economies, it has little empirical evidence. It also has very different characteristics between economies. In the USA, for example, it is generally established that a maximum of 25% of the housing units of a development is of social interest. In the ZEIS of São Paulo, this requirement reaches 60%. In addition to filling the gap in quantitative analysis of a policy with a different profile, this work will contribute with an additional view of assessing the impacts of social housing construction on the prices of properties in the immediate surroundings.

### KEYWORDS

Inclusionary zoning; Land use; Market prices; Spatial statistics and modelling.

## **Regular Session: RS12.5 - Spatial implications of climate and environmental change**

**16:00 - 17:15 Thursday, 27th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/82231138454>**

**Chair Karina Simone Sass**

## CLIMATE CHANGE, WATER RESOURCES AND ECONOMIC IMPACTS: AN ANALYSIS FOR THE BRAZILIAN HYDROGRAPHIC REGIONS

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### ABSTRACT

In the context of global climate change, one of the biggest challenges is in the field of water security. In Brazil, the prospect of water scarcity due to long-term climatic anomalies and the regional disparity between supply and demand for water resources point to limitations and risks to various economic and social activities. In view of this scenario, analyzes that integrate the themes of climate change, water availability and economic vulnerabilities are necessary. Considering the complexity of the problem, we built an Interregional Computable General Equilibrium (ICGE) model named Brazilian Multisectoral and Regional/Interregional Analysis Model with Water Extension (BMARIA-WATER), composed of 67 economic sectors and 12 Brazilian hydrographic regions, all this integrated with hydroclimatic modeling. The results show a drop in GDP-expenditure side in most of its components (reduced household consumption, government demand, export volume and increased imports). We conclude that the economic losses resulting from the effect of climate change on water availability are considerable and are equivalent to a reduction in GDP of R\$ 16 billion in the realistic scenario and R\$ 41 billion in the pessimistic scenario. Water-intensive sectors, such as “water and sewage”, “forestry production”, “agriculture” and “livestock” are the main impacted by climate change.

### KEYWORDS

Brazilian hydrographic regions, climate change, ICGE model, water availability

### 1. INTRODUCTION

The global climate warming (from both anthropogenic and natural sources) is associated with changes in a series of components in the hydrological cycle. It is “very likely” that throughout the 21st century we will see a greater frequency of extreme water events characterized by intense and episodic rains with large amounts of runoff interspersed with long periods of drought and evaporation (IPCC 2007, 2014; Bates et al. 2008).

The irregular supply of water resulting from climate change brings limitations and risks to several economic and social activities (IPCC 2014). The cultivation of irrigated crops, forest production, fishing, hydroelectric power generation, industrial production, transport, tourism, water distribution and sewage treatment are examples of affected sectors (Gleick et al. 2009; Rosegrant 2014; Damania et al. 2017; Ritchie & Roser 2017). This reality becomes even more serious when considering the increase in global demand for water-intensive goods and services. (UN 2019).

In view of this scenario, studies capable of integrating the themes of climate change, water availability and economic impacts become necessary, presenting the vulnerabilities and possible mitigation and adaptation measures, thus seeking ways to guarantee the sustainable maintenance of the water supply and the social and environmental well-being (IPCC 2014).

When we argue about the regional management of water resources the concept of virtual water is central (Allan 1998; Hoekstra & Hung 2002, 2005; Chapagain & Hoekstra 2003; Zimmer & Renault 2003; Hoekstra et al. 2011; Hoekstra & Mekonnen 2012). The total volume of water required to produce a good or service includes its direct consumption used in the production process, as well as its indirect consumption, which is embedded in the production of the inputs. This implies that it is not enough to consider only the demand for water captured in the region, it is also necessary to consider the flow of water resources embedded in interregional trade. Thus, water use in a region can influence its use and availability in another location, through the sale of goods and services. This whole analysis of regional and sectoral interdependence around water can be enhanced by the different regional water restrictions imposed by climate change. It is in this context that we find the motivation to develop this work. Our objective is to examine the economic impacts of the change in water availability caused by climate change, focusing on the Brazilian reality. Considering the complexity of the problem, we built an Interregional Computable General Equilibrium (ICGE) model named Brazilian Multisectoral and Regional/Interregional Analysis Model with Water Extension (BMARIA-WATER), composed of 67 economic sectors and 12 Brazilian hydrographic regions, all this integrated with hydroclimatic modeling.

Based on the identification of sectoral and regional vulnerabilities, adaptation and mitigation actions can be taken with a view to meeting some of the Sustainable Development Goals (SDGs) in Brazil. Our work is directly related to SDG 6 “Ensure availability and sustainable management of water and sanitation for all” and SDG 13 “Take urgent action to combat climate change and its impacts”, and indirectly to SDG 2 “End hunger, achieve food security and improved nutrition and promote sustainable agriculture”, ODS 3 “Ensure healthy lives and promote well-being for all at all ages”, SDG 7 “Ensure access to affordable, reliable, sustainable and modern energy for all”, SDG 8 “Promote sustained, including

and sustainable economic growth, full and productive employment and decent work for all” and SDG 14 “Conserve and sustainably use the oceans, seas and marine resources for sustainable development”.

In order to reach our purpose and develop the discussion presented in this introduction, the work is organized as follows. The second section presents an overview of the availability and consumption of water resources in the Brazilian hydrographic regions. The third section presents the details of the ICGE BMARIA-WATER model, including its database, equations and mechanisms. The fourth section presents the main results. The fifth section concludes.

**2. AVAILABILITY AND CONSUMPTION OF WATER RESOURCES**

In a global scenario, Brazil is placed in a privileged condition in terms of availability of water resources, concentrating about 12% of all fresh water available on Earth (SNRH 2006a-l; ANA 2015). Table 1 presents water availability values per capita in different regions of the world for 2015. It is possible to observe that water availability per capita in Brazil is around 41,000 m<sup>3</sup>. This amount is above the average of most continents and is more than double the water availability of the world.

Amid the uneven distribution of water around the world, water-poor regions can compensate for their scarcity through the virtual water trade, that is, water contained in the manufacture of goods and services transacted with water-rich regions (Allan 1998; Hoekstra & Hung 2002; Chapagain & Hoekstra 2003; FAO 2003; Hoekstra et al. 2011; Hoekstra & Mekonnen 2012). Thus, rich and poor in water can mutually benefit from exchanging water-intensive goods, whether profiting from the comparative advantage or easing the pressure on their own water resources (Gil & Kamanda 2015). According to the Water Footprint Network the global volume of international virtual water flows in relation to trade in agricultural and industrial products averaged 2,320 billion m<sup>3</sup> per year during the period 1996–2005 (Mekonnen & Hoekstra 2011). In turn, Brazil performs among the largest exporters of virtual water in the world with an average of 112 Gm<sup>3</sup> per year during the period 1996-2005. The water contained in the production of cereals and animal protein for Asia, Europe and North America represents the highest recorded values (Mekonnen & Hoekstra 2011).

**Table 1: Water resources per capita in selected regions, 2015**

<i>Regions</i>	<i>Value (m<sup>3</sup>/people/year)</i>
Brazil	41,316
Africa	10,326
Americas (with Brazil)	34,732
Americas (without Brazil)	34,544
Asia	9,563
Europe	22,270
Oceania	46,093
World	18,560

Source: AQUASTAT (FAO 2020).

The Brazilian Water Resources Council (CNRH), through Resolution No. 32/2003, defines a section of the Brazilian territory in 12 hydrographic regions. They are shown in Figure 1. They are named as: Amazon hydrographic region (AMZ), East Atlantic (ALT), West Northeast Atlantic (AOC), East Northeast Atlantic (AOR), Southeast Atlantic (ASD), South Atlantic (ASU), Paraguay (PRG), Paraná (PRN), Parnaíba (PNB), São Francisco (SFO), Tocantins/Araguaia (TOC) and Uruguay (URU). These regions are formed by contiguous river basins with similar natural, social and economic characteristics, and their objective is to guide the planning and management of water resources. (SNRH 2006).

Despite the apparent water comfort, there is an uneven spatial distribution of water supply and demand between the Brazilian hydrographic regions. Table 2 provides some data that reinforce this argument. In 2015, about 83.5% of the national water availability was concentrated in the Amazon hydrographic region. Despite this, it is possible to observe low values of water consumption, population and gross production value compared to the region's water potential. This puts this region in a comfortable situation in terms of water availability. On the other hand, the regions of Paraná and Southeast Atlantic, which have respectively 5.5% and 1.6% of the Brazilian water availability, it has rural areas with large agricultural production and urban-industrial areas with high population density, such as the metropolitan areas of São Paulo and Rio de Janeiro. As a result, water consumption in these regions accounts for almost half of the national total. This configuration leaves these areas under water stress conditions. Other examples of dissonance between water supply and demand, occur in the hydrographic regions of the Eastern Northeast Atlantic, East Atlantic and São Francisco. These regions are located in a semi-arid area whose climate of prolonged droughts generates an intense water scarcity. Water availability in these regions represents respectively, 0.2%, 0.3% and 1.1% of the national total. Despite this, there is a significant consumption of water in these regions to produce irrigated agricultural goods, hydroelectric power and manufactures.



**Figure 1: Brazilian hydrographic regions<sup>†</sup>**

<sup>†</sup>AMZ - Amazon, ALT - East Atlantic, AOC - West Northeast Atlantic, AOR - East Northeast Atlantic, ASD - Southeast Atlantic, ASU - South Atlantic, PRG - Paraguay, PRN - Paraná, PNB - Parnaíba, SFO - São Francisco, TOC - Tocantins/Araguaia and URU - Uruguay

**Table 2: Information about the Brazilian hydrographic regions, 2015**

Regions	Water availability		Water consumption		Population		Gross value product	
	Value (m <sup>3</sup> /s)	%	Value (hm <sup>3</sup> )	%	Value (people)	%	Value (BRL R\$ million)	%
AMZ	65,617	83.480	35,871	10.532	10,981,794	5.375	414,585	4.054
ALT	271	0.345	16,809	4.935	16,132,845	7.895	475,671	4.651
AOC	397	0.505	5,003	1.469	6,687,472	3.273	104,477	1.022
AOR	218	0.277	12,738	3.740	25,530,369	12.495	633,486	6.194
ASD	1,325	1.686	19,034	5.589	29,673,749	14.522	1,785,909	17.463
ASU	513	0.653	25,914	7.609	14,240,421	6.969	910,177	8.900
PRG	1,023	1.301	14,169	4.160	2,149,838	1.052	121,799	1.191
PRN	4,390	5.585	143,568	42.153	66,293,628	32.444	4,639,948	45.370
PNB	325	0.413	5,595	1.643	4,190,785	2.051	72,198	0.706
SFO	875	1.113	23,524	6.907	15,298,586	7.487	558,522	5.461
TOC	3,098	3.941	17,246	5.064	9,237,714	4.521	286,570	2.802
URU	550	0.700	21,117	6.200	3,913,806	1.915	223,527	2.186

The knowledge about the availability, abstractions and consumption of water is fundamental for directing planning, regulation, and management actions in hydrographic regions. This information can be obtained through of the Environmental-Economic Accounting for Water (IBGE 2020).

In 1992, the United Nations Conference on Environment and Economic Development (Rio 92) brought an agenda to encourage the monitoring and accounting of natural resources in member countries. Using the stock and flows idea present in the System of National Accounts (SNA), the international statistical community starts to develop the methodological set of the Environmental-Economic Accounts System (SEEA). In 2012, during the Rio+20 Conference, the United Nations Statistics Division (UNSD) recommended that Brazil start the process of building its SEEA. Since then, the country has instituted the Committee for Environmental-Economic Water Accounts (CEEWA) through Interministerial Ordinance No. 236/ 2012, with the objective of elaborating them, observing the recommendations and international practices. Following the methodology recommended by UNSD (UN 2020), the Brazilian Institute of Geography and Statistics (IBGE) provides the System of Environmental-Economic Water Accounts (SEEWA). They are composed of a set of tables with information on the stock and the flows of abstraction of water resources, return and consumption by economic activities. In this way, it is possible to observe the interaction between the environment and the economy, in terms of water.

**Table 3: Brazilian Environmental-Economic Accounting for Water, 2015**

<i>Description</i>	<i>Unit</i>	<i>Account</i>	<i>Value</i>
Precipitation	Million hm <sup>3</sup>	a	13.498
Agriculture, livestock, forestry production, fisheries and aquaculture	Million hm <sup>3</sup>	b	0.255
Extractive industry	Million hm <sup>3</sup>	c	0.001
Manufacturing industry and construction	Million hm <sup>3</sup>	d	0.003
Electricity and gas	Million hm <sup>3</sup>	e	2.978
Water and sewage treatment	Million hm <sup>3</sup>	f	0.033
Other economic activities	Million hm <sup>3</sup>	g	0.000
Water returns from economic activities	Million hm <sup>3</sup>	h=b+c+d+e+f+g	3.269
Other water inputs <sup>†</sup>	Million hm <sup>3</sup>	i	11.272
Addition to water stock	Million hm <sup>3</sup>	j=a+h+i	28.039
Evaporation and evapotranspiration	Million hm <sup>3</sup>	k	9.090
Agriculture, livestock, forestry production, fisheries and aquaculture	Million hm <sup>3</sup>	l	0.586
Extractive industry	Million hm <sup>3</sup>	m	0.001
Manufacturing industry and construction	Million hm <sup>3</sup>	n	0.006
Electricity and gas	Million hm <sup>3</sup>	o	2.978
Water and sewage treatment	Million hm <sup>3</sup>	p	0.019
Other economic activities	Million hm <sup>3</sup>	q	0.000
Water abstraction from economic activities	Million hm <sup>3</sup>	r=l+m+n+o+p+q	3.590
Other water outputs <sup>‡</sup>	Million hm <sup>3</sup>	s	21.940
Reduction to water stock	Million hm <sup>3</sup>	t=k+r+s	34.620
Total consumption of water resources	Million hm <sup>3</sup>	u=aprox. r-h	0.341
Non-raw water	Million hm <sup>3</sup>	v (share of u)	0.003
Raw water	Million hm <sup>3</sup>	w (share of u)	0.337
Total water consumption/GDP	m <sup>3</sup> /BRL R\$	x=u/GDP	0.066

<sup>†</sup> Input of water resources in the Brazilian territory (e.g., water contained in the import of goods). <sup>‡</sup> Output of water resources in the Brazilian territory (e.g., water contained in the export of goods).

Table 3 presents a summary of the Brazilian SEEWA available by IBGE for the year 2015 (IBGE 2020). The accounts “a” to “j” represent water inputs in the system. The main water input occurs naturally and is represented by total precipitation (account “a”). Its value reaches 13.5 million hm<sup>3</sup>/year. Economic activities return part of the water collected (for productive use) to the environment. The account “h” (sum of “b” to “g”) shows the return value of 3.3 million hm<sup>3</sup>/year. In addition, there is the possibility of water resources entering Brazilian territory through the importation of goods and services. This is described in the Other water inputs (account “i”). Its value reaches 11.3 million hm<sup>3</sup>/year. The “h” and “i” accounts represent water inputs of economic source. Thus, the total added to the water stock (account “j”) is 28 million hm<sup>3</sup>/year. In turn, the “k” to “t” accounts represent water abstractions (or withdrawals) from the system. Most of the precipitation returns to the atmosphere through evaporation and evapotranspiration (account “k”). This represents 9.1 million hm<sup>3</sup>/year. This is the main natural cause of water loss. Economic activities collect water to use as an input in their production. This is described in account “r” (sum of “l” to “q”). Its value reaches 3.6 million hm<sup>3</sup>/year. A share of the water can leave Brazilian territory through exports of goods and services. This is described in the account “s” - Other water outputs, the value of which reaches 21.9 million hm<sup>3</sup>/year. The “r” and “s” accounts represent the economy’s abstraction of water resources. In the end, the reduction in the water stock (account “t”) reaches 34.6 million hm<sup>3</sup>/year. The water consumption of economic activities (account “u”) is the difference between the volume collected and the return. This value is 0.3 million hm<sup>3</sup>/year. The main water user sectors are agriculture, livestock and forestry production, fisheries and aquaculture. Together these sectors (considered very water-intensive) represent more than 95% of the total consumed by economic activities, totaling a volume of 334 hm<sup>3</sup>/year. Almost all of this value is raw water, that is, water that comes from environment (account “w”), most likely not charged. The rest is water consumed

from the water and sewage sector (i.e., treated water) (account “v”). In addition, the account “x” indicates that for each monetary unit of GDP (BRL R\$) it is necessary to consume 0.066 m<sup>3</sup> of water.

### 3. MODEL DESCRIPTION

#### 3.1. General aspects

The BMARIA-WATER model is an ICGE model with a water module capable of assessing the economic impacts of changes in water availability caused by climate change. The model files (databases and code) are available at <https://www.aderochoa.com/> and can be implemented in the GEMPACK software (Harrison & Pearson 1996; Harrison et al. 1996). The structure of our model represents a variant of the ORANI-G model (Dixon et al. 1982; Dixon & Parmenter 1996; Dixon & Rimmer 2002; Horridge 2003) and BMARIA model (Haddad 1999, 2004), both well documented and widely used. Furthermore, it takes advantage of insights from the UPGEM model (Van Heerden et al. 2008). With a bottom-up structure (where national results are obtained from regional aggregations) the model recognizes the economy of the 12 Brazilian hydrographic regions. The model version identifies 67 economic sectors and goods/services located in these hydrographic regions - this implies that each sector produces only one good (see Table 4). Economic sectors can interact with domestic or foreign economic agents through the purchase of input and/or the sale of final goods. In production, the sectors can use two types of water: water from the “water and sewage sector” and raw water abstracted from environment. The sectors are divided into four categories of water use. “A” are large users of water and with low charges, where: “A1” agriculture sector, “A2” livestock sector and “A3” the forestry, fisheries and aquaculture sector; “B” indicates users of non-potable water with a relative volumetric charge; “C” are users of potable water with good volumetric change and “D” represents the public utility sectors that use water as an input, where: “D1” electricity, gas and other utilities and “D2” water, sewerage and drainage services. Labor and capital are also used as the primary factor of production (one type). In demand, five groups of users are considered - producers, investors, households, foreign demand and government. Furthermore, in this analysis we consider the payment of taxes and margins.

**Table 4: BMARIA-WATER sectors**

<i>Code</i>	<i>Type<sup>†</sup></i>	<i>Industry</i>
I01	A1	Agriculture, including support
I02	A2	Livestock, including support
I03	A3	Forestry, fisheries and aquaculture
I04	B	Coal and non-metallic minerals
I05	B	Crude oil and natural gas, including support
I06	B	Iron ore, including processing
I07	B	Non-ferrous metals, including processing
I08	C	Meat, milk products and processed fish
I09	C	Refined sugar
I10	C	Other food products
I11	C	Beverage
I12	C	Tobacco products
I13	C	Textiles
I14	C	Clothing
I15	C	Leather and footwear
I16	C	Wood products
I17	C	Cellulose and paper products
I18	C	Newspapers, magazines and electronic publishing
I19	B	Petroleum refining and coke products
I20	B	Biofuels
I21	B	Chemical products, resins and elastomers
I22	B	Pesticides, inks, varnishes and other chemical products
I23	C	Soaps and detergents
I24	C	Pharmaceutical products
I25	B	Rubber and plastic products
I26	B	Non-metallic mineral products
I27	B	Manufacturing of steel and steel alloys
I28	B	Non-ferrous metals
I29	B	Fabricated metal products except machines and equipment
I30	C	Electronic, communication, medical and optical equipment
I31	C	Electric machines and materials
I32	C	Machines and equipment
I33	C	Passenger and light utility vehicles, trucks and busses
I34	C	Vehicle parts
I35	C	Other transport equipment
I36	C	Furniture and other manufacturing
I37	C	Machinery and equipment maintenance
I38	D1	Electricity, gas and other utilities

Code	Type†	Industry
I39	D2	Water, sewerage and drainage services
I40	C	Construction
I41	C	Wholesale and retail trade
I42	C	Land transport
I43	C	Water transport
I44	C	Air transport
I45	C	Storage and postal services
I46	C	Hotels
I47	C	Restaurants
I48	C	Editing and printing activities
I49	C	TV, radio, cinema and sound/image activities
I50	C	Telecommunications
I51	C	Other information services
I52	C	Finance and insurance
I53	C	Property services and hiring
I54	C	Legal, accounting and consulting activities
I55	C	Engineering, technical analysis and R&D services
I56	C	Other scientific and technical activities
I57	C	Intellectual asset management
I58	C	Other administrative activities
I59	C	Security and investigation activities
I60	C	Public administration and social security
I61	C	Public education
I62	C	Private education
I63	C	Public health
I64	C	Private health
I65	C	Creative and entertainment activities
I66	C	Other personal services
I67	C	Domestic services

† "A" are large raw water users with low charges ((1) agriculture, (2) livestock, (3) forestry and other); "B" are users of raw water with a relative volumetric charge; "C" are users of treated water with high volumetric charge; "D" represents the public utility sectors ((1) energy, (2) water and sewage) that use water as an input.

### 3.2. Climate change, water availability and economic impacts

In our model, we classify water in two ways: treated water from the “water, sewerage and drainage services” sector and raw water abstracted directly from the environment. Given this, water cost shocks, resulting from the greater/lesser difficulty in capturing water, will be imputed to the model in different ways. The first shock, related to the effects of climate change on the availability of treated water, will be introduced in basic water prices. This is described by (1):

$$p_j^r = \lambda_j^r + \varepsilon_j^r \tag{1}$$

where the basic prices ( $p_j^r$ ) of the good  $j$  of the hydrographic region  $r$  are formed from a unit cost index ( $\lambda_j^r$ ). An exogenous shock  $\varepsilon_j^r$  is added, which represents the change in the cost of water from climate change. The shock was attributed to the “water, sewerage and drainage services” ( $j = 39$ ) located in the hydrographic regions ( $r = 1, \dots, 12$ ). The economic effects resulting from this disturbance are referred to as “Channel 1”. The second shock, related to the effect of climate change on availability of raw water, will be introduced indirectly through capital expenditures to substitute or save water. This “trick” was used because most of the raw water used in Brazil is not linked to any economic mechanism (charging, taxation, etc.). Following Van Heerden et al. (2008) we used (2):

$$x(k)_j^r = \frac{1}{v(k)_j^r} \psi_j^r \varepsilon_j^r \tag{2}$$

where  $x(k)_j^r$  indicates the amount of capital to substitute or save water adopted by sector  $j$  in the hydrographic region  $r$ ,  $V(k)_j^r$  is the current level of capital used,  $\psi_j^r$  is a price semi-elasticity of demand for water and  $\varepsilon_j^r$  represents the shock of water cost access from climate change. In this case, shocks were imputed to “agriculture, including support” ( $j = 1$ ), “livestock, including support” ( $j = 2$ ), “forestry, fisheries and aquiculture” ( $j = 3$ ) and “beverage” ( $j = 11$ ) present in the hydrographic regions ( $r = 1, \dots, 12$ ). These goods/sectors correspond to more than 95% of the raw water consumed in the Brazilian economy. The economic effects of this disorder are named “Channel 2”.

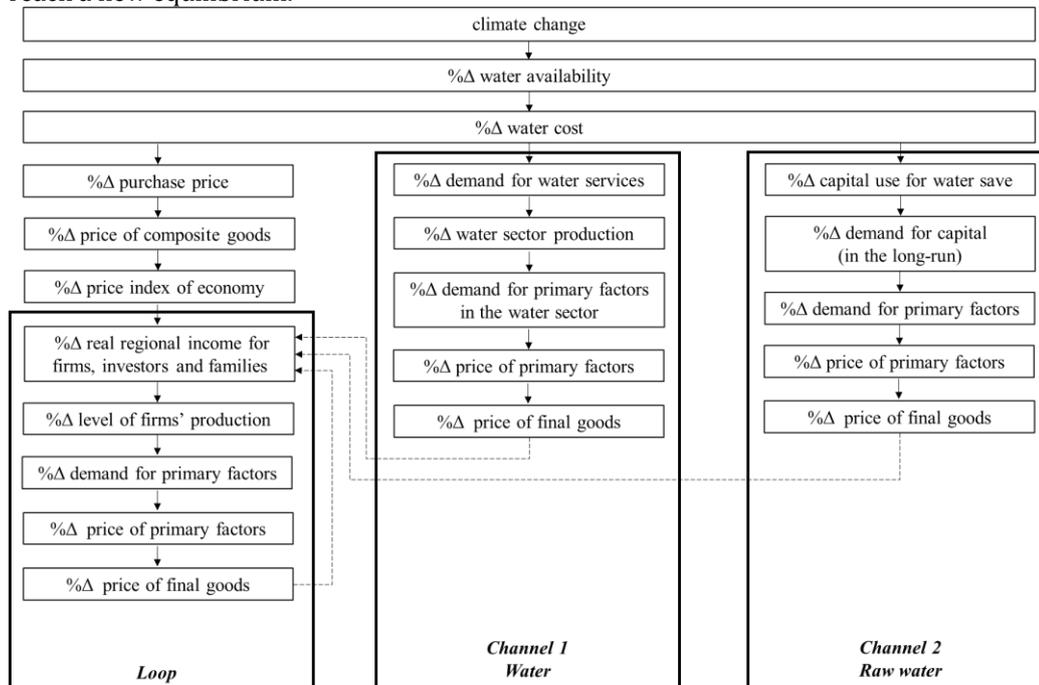
The shock values used in the simulations is described in Table 5. Two steps were taken to calculate the water cost change values: (i) using a hydroclimatic model (precipitation minus evapotranspiration), we calculate the impact of climate change on the water availability of the Brazilian hydrographic regions; (ii) we calculate a coefficient that relates the cost per unit of water and outflow (a measure of water availability); and (iii) we multiply the values from the previous steps.

**Table 5: Changes in the cost of water in the Brazilian hydrographic regions, using SSP4.5 and SSP8.5 (%)**

Regions	SSP4.5	SSP8.5
AMZ	22.273	52.820
ALT	61.755	140.187
AOC	242.775	616.561
AOR	31.976	74.545
ASD	8.070	12.459
ASU	-3.372	-2.435
PRG	230.933	506.834
PRN	8.770	19.401
PNB	49.259	144.238
SFO	52.822	136.068
TOC	54.208	149.974
URU	-3.080	-2.724
Brazil	63.032	153.994

**3.3. Model mechanisms (causal relation)**

The water cost shocks from climate change will be transmitted to the economy through both channels. Figure 2 is a schematic representation of the causal relationships present in the modeling underlying each of these channels. Channel 1 describes the path of the shock in the basic price of water produced by the “water, sewerage and drainage services” sector. This will promote a shift in demand for water and sewage services. The size of this change will depend on the climate shock value and on how important the water factor is for each of the economic sectors located in each of the hydrographic regions, this will be quantified by the Armington substitution elasticity and the price elasticity for water demand parameters. Responding to changes in demand, water-producing sectors will alter their production. This will have consequences on the amount of primary factors (labor and capital) required by the industry and their respective market prices. Consequently, all prices of final goods in the economy are changed. This enters a loop in which the real income of economic agents is altered, which changes the firms' production plans, including their demand for factors of production, leading to another round of price adjustment. This dynamic is repeated until the economy reaches a new equilibrium. Channel 2 describes the path of the cost shock related to raw water access. The change in water availability can lead the sectors to use capital to substitution or save water (i.e., capital that can lead to greater efficiency, less waste or greater storage of water resources). In the long run, this could lead to changes in the quantity demanded by primary factors (labor and capital) and their respective prices. All of these disturbances have an impact on the final price of goods. This channel is also taken to a loop in which the agents' income is altered, the firms reevaluate their production plans including the amount of factors to be used. In the end there are changes in the prices of final goods. This is repeated until reach a new equilibrium.



**Figure 2: Causal relations underlying the simulation results**

**3.4. Model database**

The BMARIA-WATER model uses a hybrid Interregional Input-Output matrix (hybrid IIOA) for the year 2015. The hybrid IIOA is composed of the dimensions: number of commodities (C = 67), number of industries (I = 67), regions of origin

and destination of goods and services ( $S = 13$  and  $R = 12$ , respectively), trade margin ( $M=1$ ) and water types ( $W=2$ ). In addition, we use a wide range of parameters estimated or taken from the literature. Two parameters are considered key: (i) Armington elasticity which refers to the substitution between inputs from different regions (including between domestic and imported goods) and (ii) the price elasticities and semi-elasticities of demand for water that represent the sensitivity of the demand for water by different users/regions given changes in its price.

**4. RESULTS**

Table 6 presents the results of the simulations for the macroeconomic aggregates<sup>172</sup>. The total effects are decomposed into channel 1 (climate change shock on water prices in the “water and sewerage services” sector) and channel 2 (climate change shock on access to raw water that leads to capital demand to substitute or save water). Part “a” of the table shows the drop in real GDP-expenditure side and its components. In the SSP4.5 (realistic) scenario, the negative impact was -0.308%, while in the SSP8.5 (pessimistic) scenario, an impact of -0.785% is projected. In both cases, channel 1 has a greater contribution to these results. The low substitutability of water in most user sectors turns price increases into direct shocks to the economy. Among the GDP components there is a reduction in demand from regional and federal governments (-1.045% and -2.812%), in the export volume (-0.849% and -2.089%) and in household consumption (-0.198% and -0.522%). In this situation, the increase in the water price leads to an increase of the final price of domestic goods and the loss of real income of the economic agents. This explains the reduction in spending of households and governments and the shift in exports. With the increase in domestic prices, there is an increase in the imports volume (0.455% and 1.113%). It is possible to note that the shock related to channel 2 enabled a positive change in real investment (0.006% and 0.022%). In other words, the greater difficulty in accessing raw water in most regions can lead to investments by firms. Part “b” presents results related to the economy’s price indices. Overall, climate change and its effect on the price and availability of water leads to an increase in the GDP price index (0.211% and 0.534%). Decomposing this result, it is possible to notice that the export price index is the most affected (0.343% and 0.862%). We believe this is because the price of water directly affects sectors that produce agricultural goods and livestock, which are typically export-oriented. Part “c” presents results related to the use of primary factors. In both climatic scenarios, there is a reduction in the demand for labor (-0.571% and -1.455%) and an increase in the capital stock (0.002% and 0.007%). In this case, it is interesting to note the effect of each channel. In channel 1, firms receive the shock of water prices and reduce their level of production, consequently they will make less use of primary factors. In channel 2, firms will be able to buy capital to substitute or save water. Indirectly, labor will also be demanded. Part “d” presents information on the amount of water and raw water that will no longer be required. In the SSP4.5 scenario, there is a reduction in the demand for water and raw water by 23 hm<sup>3</sup> and 21,392 hm<sup>3</sup>, respectively. In the SSP8.5 scenario, these values reach 55 hm<sup>3</sup> and 51,828 hm<sup>3</sup>. In the case of treated water that is somewhere around 0.67% to 1% of total water currently demanded. For raw water, this represents somewhere between 6.34% to 15.36% of the total raw water currently demanded. These results show us that channel 2 has a greater potential to reduce water demand than channel 1. Finally, part “e” presents information related to social well-being. The level of national utility is reduced in both scenarios (-2.296% and -5.674%). This negative value comes from the increase in the price of water (channel 1). The acquisition of raw water-saving capital (channel 2) generated an increase in well-being; but its effect was not able to offset the effects of channel 1. We conclude that the economic losses resulting from the effect of climate change on water availability are considerable and are equivalent to a reduction in GDP of R\$ 16 billion in the realistic scenario and R\$ 41 billion in the pessimistic scenario (current values).

Table 7 shows the impacts of climate change on the level of sectoral activity. We categorize the sectors into water use classes. It is possible to note that type “A” sectors had a drop in the level of sectoral activity in both scenarios. This group is composed of large water users, especially raw water with low charges. In this case, the biggest impacts will be perceived in the forestry sector (-1.761% and -4.284%), followed by agriculture (-0.442% and -1.027%) and livestock (-0.126% and -0.261). In their productive structure, these sectors use more raw water than treated water from the water and sewerage sector. This explains the fact that channel 2 predominates over channel 1. Sectorial group “B” is composed of raw water users with relative charging. The mineral and crude oil extraction sectors and some industrial activities are present in this group. The simulations indicate a small positive impact on the level of sectoral activity (0.016% and 0.073%). Group “C” contains sectors that consume treated water with a high volumetric charge. The service sectors are present in this group. The reduction in the level of activity is -0.203% and -0.551%. In this case, given the greater relevance of treated water, the effects of channel 1 predominated over channel 2. Group “D” is composed of public utility sectors that use water as a key input. It contains energy sector (mainly hydroelectric energy) and water and sewerage sector. The energy sector has a projected impact of -0.215% and -0.534%, respectively for the realistic and pessimistic scenario. In turn, the water and sewerage sector has the biggest drop in the activity level among all sectors (-17.806% and -43.173%).

**Table 6: Impacts on selected macroeconomic variables, long run (% change)**

	SSP4.5 (2081-2100)	SSP8.5 (2081-2100)
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<sup>172</sup> The results presented refer to the long-term closing. Other results can be made available upon request.

	Variable	Channel 1 (Water)	Channel 2 (Raw water)	Total	Channel 1 (Water)	Channel 2 (Raw water)	Total
a	Real GDP from expenditure side	-0.294	-0.014	-0.308	-0.754	-0.032	-0.785
	Aggregate real investment expenditure	-0.018	0.024	0.006	-0.037	0.059	0.022
	Real household consumption	-0.124	-0.074	-0.198	-0.338	-0.184	-0.522
	Export volume index	-0.848	-0.001	-0.849	-2.106	0.017	-2.089
	Real government demands (regional)	-0.829	-0.165	-0.994	-2.260	-0.392	-2.652
	Real government demands (federal)	-0.070	0.019	-0.051	-0.211	0.051	-0.160
	Import volume index, CIF weights	0.637	-0.181	0.455	1.565	-0.453	1.113
b	GDP price index. expenditure side	0.327	-0.116	0.211	0.828	-0.293	0.534
	Consumer price index	0.246	-0.087	0.159	0.622	-0.221	0.401
	Investment price index	0.227	-0.102	0.125	0.579	-0.257	0.321
	Exports price index, local currency	0.411	-0.068	0.343	1.035	-0.173	0.862
	Government price index (regional)	-0.597	-0.174	-0.771	-1.409	-0.438	-1.847
	Government price index (federal)	0.390	-0.169	0.221	0.990	-0.426	0.564
c	Aggregate capital stock, rental weights	-0.005	0.007	0.002	-0.011	0.018	0.007
	Aggregate employment, wage bill weights	-0.639	0.069	-0.571	-1.629	0.174	-1.455
d	Water demand (hm <sup>3</sup> )	0.668	-24.512	-23.844	1.749	-57.358	-55.610
	Raw water demand (hm <sup>3</sup> )	-323.831	-21,068.229	-21,392.059	-709.367	-51,119.264	-51,828.633
e	National average utility	-2.717	0.421	-2.296	-6.743	1.069	-5.674
	Real GDP (BRL R\$ billion)	-15.510	-0.727	-16.232	-39.715	-1.665	-41.380

Table 7: Impacts on activity level, by sector group (% change)

Sector group <sup>†</sup>	SSP4.5 (2081-2100)			SSP8.5 (2081-2100)		
	Channel 1 (Water)	Channel 2 (Raw water)	Total	Channel 1 (Water)	Channel 2 (Raw water)	Total
A1	-0.128	-0.315	-0.442	-0.256	-0.772	-1.027
A2	0.520	-0.646	-0.126	1.341	-1.602	-0.261
A3	1.133	-2.893	-1.761	2.845	-7.128	-4.284
B	0.008	0.008	0.016	0.048	0.024	0.073
C	-0.227	0.023	-0.203	-0.611	0.060	-0.551
D1	-0.197	-0.018	-0.215	-0.494	-0.040	-0.534
D2	-17.806	0.000	-17.806	-43.173	-0.001	-43.174

<sup>†</sup> "A" are large raw water users with low charges ((1) agriculture, (2) livestock, (3) forestry and other); "B" are users of raw water with a relative volumetric charge; "C" are users of treated water with high volumetric charge; "D" represents the public utility sectors ((1) energy, (2) water and sewage) that use water as an input.

## 5. CONCLUSION

In this paper we have computed estimates of the economic impacts from climate change and water availability in the Brazilian hydrographic regions. We have used an interregional CGE model calibrated for the Brazilian economy. We evaluated two main channels of shock transmission, namely channel 1 linked to a change in the price of treated water and channel 2 related to the capital demand to replace or save raw water. The general equilibrium approach allows us to make systematic analyzes about the impacts of climate change on the economy.

The results show a drop in GDP-expenditure side in most of its components (reduced household consumption, government demand, export volume and increased imports). We conclude that the economic losses resulting from the effect of climate change on water availability are considerable and are equivalent to a reduction in GDP of R\$ 16 billion in the realistic scenario and R\$ 41 billion in the pessimistic scenario (current values).

This work focuses on the analysis of vulnerabilities. The next steps involve possible improvements in modeling, enabling discussions about adaptation measures such as water pricing and water markets.

## ACKNOWLEDGEMENTS

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## IDENTIFYING THE ATMOSPHERIC AND ECONOMIC KEY DRIVERS OF GLOBAL AIR POLLUTION CHANGE: A COMBINED SDA APPROACH

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### ABSTRACT

The transmission of pollution across countries has been studied through the lens of atmospheric chemical transport or through its content in international trade, but only a handful of studies consider both channels concurrently. Yet, the rare exceptions do not highlight the economic sector(s) at the origin of the problem and thus fail to identify effective abatement strategies. In this paper, we integrate environmentally extended input-output trade linkages with physical pathways of carbon monoxide atmospheric transport to uncover the key drivers of the changes in intercountry pollution transmission. Based on a five-region model, the results indicate that most of the CO experienced in a country comes from its own production which is primarily destined to the domestic market; yet, emissions due to upwind producers are not negligible. It is especially true for South Korea which received from China a flow of CO emissions above the level it produced itself. By providing new insights into the interconnected economic and geographic sources of air pollution, this paper suggests more nuanced global emission abatement policies than the consumer-focused or producer-focused approaches currently used.

## THE REGIONAL ECONOMIC IMPACTS OF CLIMATE CHANGE ON FAMILY FARMING AND LARGE-SCALE AGRICULTURE IN BRAZIL: A COMPUTABLE GENERAL EQUILIBRIUM APPROACH

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### ABSTRACT

This paper analyzes the regional economic impacts of climate change on the agricultural productivity of crops linked to family farming and large-scale agriculture in Brazil. Variations in agricultural productivity estimated according to scenarios RCP 4.5 and RCP 8.5 (IPCC, 2014), between 2021 and 2050, were used as inputs in the Computable General Equilibrium Model (CGE) called Agriculture Regional Model - AGRO-BR. The model presents regional configuration composed of the 27 Federation Units and 42 agricultural sectors, disaggregated into family farming and large-scale agriculture sectors. The results, in terms of economic impacts, indicate that the North and Northeast regions would be negatively affected, Midwest and Southeast would suffer moderate impacts, while the South region would benefit mostly. São Paulo, Paraná, and Rio Grande do Sul would show economic growth, softening the negative impacts on national GDP, which would show a decline of 0,01% in both scenarios. The phenomenon could contribute to the increase of regional disparities and the deterioration of food security conditions in Brazil.

### KEYWORDS

Climate Change, Family Farming, Agricultural Productivity and Computable General Equilibrium Models.

### JEL Code

R15, R22, Q12

### 1. INTRODUCTION

Global Climate Change (CC) greatly affects life on Earth. Its impacts on ecological, economic and social systems, amplifies externalities and uncertainties along an extensive time horizon. The phenomenon is spatially heterogeneous and historically unprecedented in humanity, which elevates the complexity of its understanding. The immediate effects of climate change are verified by changes in average temperature and precipitation levels, key variables for determining agricultural productivity. Thus, changes in world agricultural production are expected (Mendelsohn and Schlesinger, 1999; Cline, 2007; Rosenzweig *et al.*, 2014). In Brazil, the scenarios projected by the Brazilian Panel on Climate Change, indicate changes in precipitation levels between +5% to -50%, temperature rise between 1°C to 5.5°C and increased occurrence of extreme events (PBMC, 2014). In this scenario, a new geography of agricultural production may be configured, with possible implications on food supply and consequently on food security (FAO, 2005; Assad; Pinto, 2008; Calzadilla *et al.*, 2013).

Brazil, a country of great territorial extension and whose agricultural sector plays an important economic role, may be severely affected by the phenomenon, with possible impacts on the supply, price, and stability of international food trade. The country stands out as one of the largest producers and exporters of soybeans, sugar, corn, orange juice, coffee, cotton, as well as poultry, pork, and beef (FAOSTAT, 2020). Internally, the sum of goods and services related to agribusiness corresponded to 21.4% of GDP in 2019, with 68% of this participation related to agriculture and 32% to livestock (CNS, 2020).

The literature related to the impacts of climate change on Brazilian agriculture indicates considerable losses, especially for commodities. Assad; Pinto (2008), assess that losses in 2020 would reach R\$7.4 billion, with a significant reduction in the production of corn, rice, soybeans, and beans. Feres *et al.*, (2009); Massetti *et al.*, (2013); Assunção; Chein (2016) and De Paula (2018) indicates that, on average, there would be a decrease in agricultural productivity in low latitudes, with negative impacts in the North, Northeast and Midwest regions, precisely the least developed regions of the country. Moraes (2010) and Margulis; Dubeux (2011) project GDP accumulated decline between 0.2% and 2.3% in 2070. Regarding the effects on international trade, Nazareth *et al.*, (2020) indicates an economic downturn in regions that demands Brazilian agricultural products, such as the rest of Mercosur, the rest of the Americas, and China.

Despite the relatively extensive literature, it focuses on commodity studies and makes no distinction between types of producers. It should be emphasized that the Brazilian agricultural production structure is heterogeneous. Producers are distinguished in the use of inputs, productive factors, types of crops and in the linkage to the domestic and foreign markets. Family farming is largely linked to food security and food production for the domestic market, while large-scale

agriculture stands out in commodity production and the foreign market. The analysis of the impacts of CM on agriculture and its potential economic effects should address the productive and regional specificities of farmers.

In this sense, the objective of this work is to analyze the regional economic impacts of climate change on agricultural production of family farmers and large-scale agriculture in Brazil, as well as to analyze its indirect economic effects, according to scenarios RCP 4.5 and RCP 8.5 (IPCC, 2014), between the years 2021 and 2050. The study seeks to answer: i) What are the economic, direct, and indirect impacts triggered by the effects of climate change on agriculture? ii) What are the effects on the production of family farmers and large-scale agriculture? iii) What are the regional effects of the phenomenon? Thus, the work seeks to indicate the direction and magnitude of the economic impacts arising from climate change on Brazilian agriculture, through explicit modeling of the family farming and large-scale agricultural sectors, considering its productive and regional specificities.

The study differs and, therefore, seeks to contribute to the literature on the impacts of climate change on agriculture by incorporating a disaggregated analysis, considering the impacts on the production of family farming and the production of large-scale agriculture. Adopts a General Computable Equilibrium model (CGE) called AGRO-BR (Tanure, 2020), the first CGE model in Brazil to address in a disaggregated way the producing sectors related to family farming and large-scale agriculture. It is an inter-regional CGE model with recursive dynamics mechanisms for 27 Federation Units (UF) and capable of analyzing regional and sectoral economic impacts resulting from the effects of climate change in Brazil over time. Its theoretical structure originates from the TERM model (Horridge; Madden; Wittwer, 2005).

The methodology used in this study has been more indicated for the analysis and economic projections of the impacts of climate change, because the dynamics of regional economic variables observed, in addition to being affected by climate change is also affected by conjuncture and structural factors, such as demographic, macroeconomic, and public policy aspects. Nevertheless, the effects of climate change on agricultural productivity and consequent economic effects are heterogeneous among the types of producers and regions. This chain of interrelations is captured by the CGE model. Thus, the results of the research could complement the information available on the theme, helping policymakers and producers, especially family farmers, to carry out a better planning to face the phenomenon, since the existing literature prioritizes studies involving commodities and the economic effects related to agribusiness.

The study is divided into 5 sections, including this introduction. Section 2 presents a brief literature review on the economic impacts of CC on Brazilian agriculture. Section 3 presents the methodology and data used. In section 4, the results of the simulations and discussions are presented, and finally, in section 5, the final considerations.

## 2. LITERATURE REVIEW

One of the first studies in Brazil to project the impacts of climate change on the economy through CGE modelling was developed by Domingues *et al.*, (2008; 2016). The study analyzed the impact of climate change on the economy of the Northeast region, based on estimates of areas suitable for agricultural cultivation, using the TERM-Cedeplar model. The estimates of land aptitude for rice, beans, corn, cotton, cassava, soybean, sugarcane, and sunflower crops, were used in the model, with the A2 and B2 climatic scenarios. Reductions in the land production factor, by Federation Units (FUs), were used as a shock in the agricultural sector of the model and represent a proxy for the effects of climate change on the region's economy between 2005 and 2050. The results indicate high economic losses, especially for the poorest states, with potential effects on migratory flows. The study projected a 13.1% decline in regional GDP and a decrease in employment levels by 5.95% in 2050.

The study by Moraes (2010) evaluated the economic effects of climate change scenarios A2 and B2 on Brazilian agriculture through the TERM-BR model. The policy scenarios implemented in the model were based on estimates of the aptitude of areas for the cultivation of beans, corn, soybeans, cotton, rice, sugar cane, cassava and coffee provided by Embrapa, considering two-time horizons: 2020 using scenario B2 and disregarding social and economic changes, and 2070 using scenario A2, with social and economic adaptations. The results of the simulation with scenario A2 indicate greater negative impacts in the states of the Northeast region, in addition to Mato Grosso and Mato Grosso do Sul, as a result of the reduction of the area suitable for soybean cultivation. The Southeast region would benefit from the increase of areas suitable for sugarcane cultivation. In scenario B2, the results indicate negative impacts for the Northeast and Midwest regions, and reduction of the positive impact in the Southeast region with the intensification of climate warming. The projections of impact on national GDP indicate a reduction in both scenarios, being 0.28% in 2020 in scenario A2, and 1.12% in 2070 in scenario B2.

Ferreira Filho and Horridge (2010) analyzed the impacts of climate change on agriculture and internal migration in Brazil using the TERM-MIG model. The simulations used changes in production and land availability for a group of crops, calculated according to scenarios A2 and B2 of the IPCC, for the years 2020 and 2070, respectively. The results showed that the economic downturn of the Northeast and Midwest regions could reverse the migratory flow, increasing the emigration of less qualified workers to the South and Southeast regions, resuming the migratory pattern observed before the 1980s in Brazil. The results indicate that the national GDP could retract by 0.8% in 2070, considering scenario B2.

In the study by Margulis; Dubeux (2011), the impacts of climate change verified through changes in river basin flows, sea level rise and changes in agricultural productivity have been quantified and analyzed. The study used the EFES (Economic Forecasting Equilibrium System) CGE model integrated with other impact projection models, adopting IPCC scenarios A2 and B2 as a reference. The results of the EFES were incorporated into the B-MARIA CGE model to carry out regional and sectoral macroeconomic projections. The results indicated reductions of 0.5% (Scenario A2) and 2.3% (Scenario B2) of national GDP in 2050, and large losses of areas of low risk of agricultural production for soybean crops (30% to 34%), corn (15%) and coffee (17%).

Farias (2012) developed an CGE model with detailed specification of land use in Brazil and evaluated the economic impacts of climate change in the country. The implemented shocks were calculated through the estimated sensitivity of land use changing, considering the climatic scenarios A2 and B2 of the IPCC, and the periods of 2010/2039, 2040/2069 and 2070/2100. In scenario A2, the results indicated an accumulated reduction in national real GDP by 0.02% in 2039, 0.05% in 2069 and 0.11% in 2099. For scenario B2, projections indicate a 0.02% decline in 2039, 0.04% in 2069 and 0.07% in 2099. In sectoral terms, the greatest losses would occur in agricultural activities, especially the retraction of the wheat and cereal producing sectors, Coffee in Grain and Soybean grain. The Sugarcane and Herbaceous Cotton sectors would benefit from the projections.

Miyajima (2018) evaluated the impacts of climate change on agricultural production in the regions of the Brazilian Legal Amazon, using the EGC model, REGIA. The shocks used as a proxy for the effects of CM were established through estimates of agricultural productivity calculated for 11 crops, with scenarios RCP 4.5 and RCP 8.5 as reference. The results indicated heterogeneous economic losses in both scenarios, with greater loss in the RCP 8.5 scenario. The regions with the highest agricultural participation in GDP were the most negatively impacted. For the GDP of the Legal Amazon region, projections indicate accumulated decline of 1.68% in the RCP 4.5 and 1.92% in the RCP 8.5 scenario in 2080.

Souza (2018) measured the economic impacts of climate change on Brazilian regions through changes in agricultural productivity of soybean, sugarcane, corn, beans, coffee, and orange crops and established a regional vulnerability indicator to climate change impacts. The climatic scenarios analyzed are RCP 2.6 and RCP 8.5, between 2020 and 2100. The results point to a variation in agricultural losses from 9.7% to 55.6% by 2100, with negative impacts on GDP in the order of 0.05% in the optimistic scenario and 0.26% in the pessimistic scenario. São Paulo, Paraná, and Minas Gerais would be the most affected states in terms of losses.

Nazareth *et al.*, (2020) analyze the economic effects of the reduction of agricultural productivity resulting from climate change on Brazilian regions and consequent impacts on international trade using the PAEGDyn model, derived from GTAP. They find that the economic effects are negative, especially in less developed regions, such as North, Northeast and Midwest of Brazil, whose GDP could be up to 4% lower in contrast to a scenario without climate change. The negative impacts also affect the rest of Mercosur, the rest of the Americas, the rest of the world and China, regions characterized by low income and dependence on agricultural products. The other regions would be negatively impacted via indirect economic effects. A positive impact on GDP would be observed only in southern Brazil, characterized by increases in agricultural productivity.

It is verified that use the CGE methodology to analyze climate change in Brazil began after the disclosure of the Fourth Assessment Report (IPCC, 2007), with more detailed climate projections, and which allowed the estimation of variables used as input in the CGE models. Those who analyzed direct impacts on agriculture basically used three approaches as a parameter for calculating the shocks used in the simulations: i) changes in areas suitable for agricultural cultivation; ii) land use changes; and iii) changes in agricultural productivity. Of these, the use of agricultural productivity is recent in the literature, being verified in Souza (2018), Miyajima (2018) and Nazareth *et al.* (2020). This approach is also used in the present study, however, we advanced in the regional and sectoral disaggregation, analyzing 21 agricultural crops for each type of producer, family farmers and large-scale agriculture, in the 27 Brazilian Federation Units.

### 3. METHODOLOGY AND DATA

AGRO-BR (Tanure, 2020) is an interregional CGE model with recursive dynamics mechanisms for 27 Federation Units (UF) in Brazil and large sectoral disaggregation for agricultural products, capable of analyzing regional and sectoral economic impacts resulting from the effects of climate change in Brazil over time. Its theoretical structure originates from the TERM model (Horridge; Madden; Wittwer, 2005). It is a bottom-up type model, whose national results come from aggregations of regional results. Moreover, it is the first model of CGE in Brazil, to adopt in a disaggregated way, sectors<sup>173</sup> related to family farming and large-scale agriculture. The i) agricultural; ii) livestock and other animal production, iii) forestry and iv) vegetal extraction sectors, are disaggregated into family farming and large-scale agriculture sectors, totaling 48 sectors. The AGRO-BR database is composed of the latest Input-Output table available by IBGE (2018), for the year 2015 and the latest Agricultural Census (IBGE, 2017).

#### 3.1 Agricultural sector disaggregation

The process of disaggregation of agricultural sectors uses a set of data to differentiate family farming production from large-scale agriculture production, which is heterogeneous in terms of the use of inputs, productive factors, types of crops and linkage to the internal and external market. For example, following the IBGE Agricultural Census (2017), 23.2% of agricultural producers are large-scale, employ 33% of agricultural workers, occupy 77% of the area of the establishments and are the largest responsible for the production of Soybeans, Corn, Sugarcane and Cotton. Family farmers, represents 76.8% of the producers, employ 67% of the agricultural workers, occupy only 23% of the area and are the main producers of Cassava, Pineapple, Tobacco, Onion, Cashew nuts and Grapes, Coffee and Banana.

The definition of family farming, used to guide the configuration of the model sectors, is established by Law 11,326 of 2006, created to guide public policies aimed at the category in Brazil. Family farmers are considered to be individuals who simultaneously meet the following requirements: i) does not have an area greater than 4 fiscal modules<sup>174</sup>; (ii)

<sup>173</sup> Table A1 in the Appendix section presents the sectors of the AGRO-BR model.

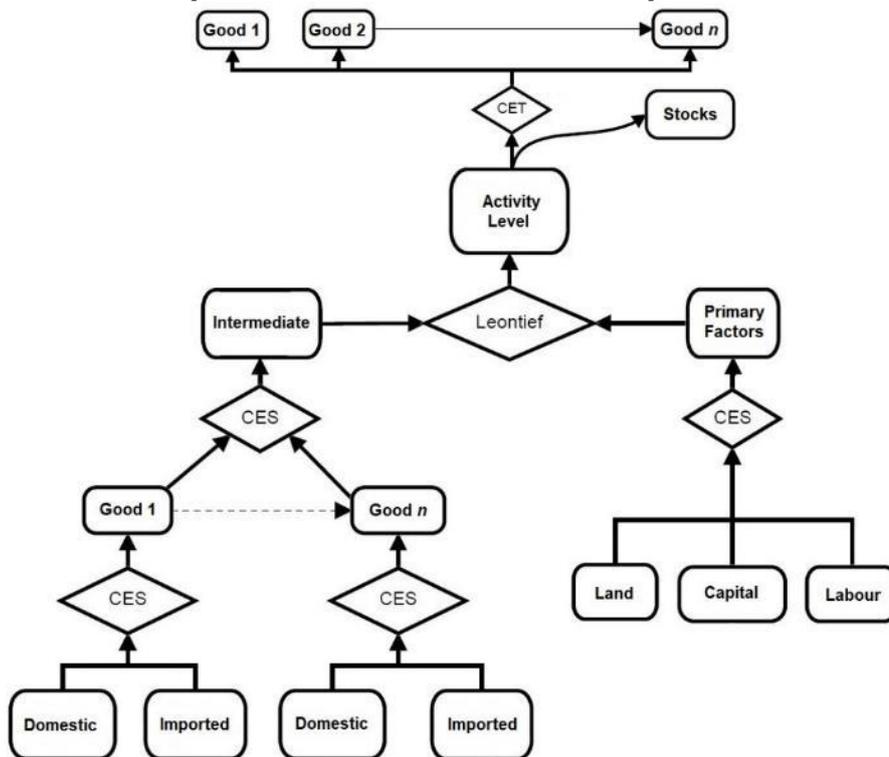
<sup>174</sup> The size of the fiscal module varies from 5 to 110 hectares among Brazilian municipalities.

predominantly use family labor; iii) obtain a minimum percentage of family income originated from economic activities of your establishment; iv) direct your establishment with your family (BRASIL, 2006).

Data from the Brazilian Agricultural Census (IBGE, 2006; 2017) were used to establish the sector shares related to land use, labor, machinery, and equipment (proxy for capital), internal consumption, exportation, and production value. Data from Agriannual (2018) and AnualPec (2018) were used to measure the participation of family farmers and large-scale producers in terms of the use of intermediate inputs: i) Fertilizers, ii) Pesticides; iii) Diesel; iv) Inorganic chemicals; (v) Electricity, Gas, and others; vi) Cargo Transport; and vii) Financial and Insurance Institutions, for representing together about 70% of the total inputs consumed by the agricultural sectors.

### 3.2 Structure of Production Technology

In the AGRO-BR model, the productive sectors operate in perfect competition, obtaining zero profit, and each sector produces only one product on a constant scale of production. Producers choose a combination of intermediate, domestic, or imported, and primary factors, capital, land, and labor, in order to minimize production costs, subject to production functions (Leontief and CES), as illustrated in Figure 1. The functional structures of optimization correspond to the figures in the form of trapezoid, the other structures refer to the products, factors, and inputs.



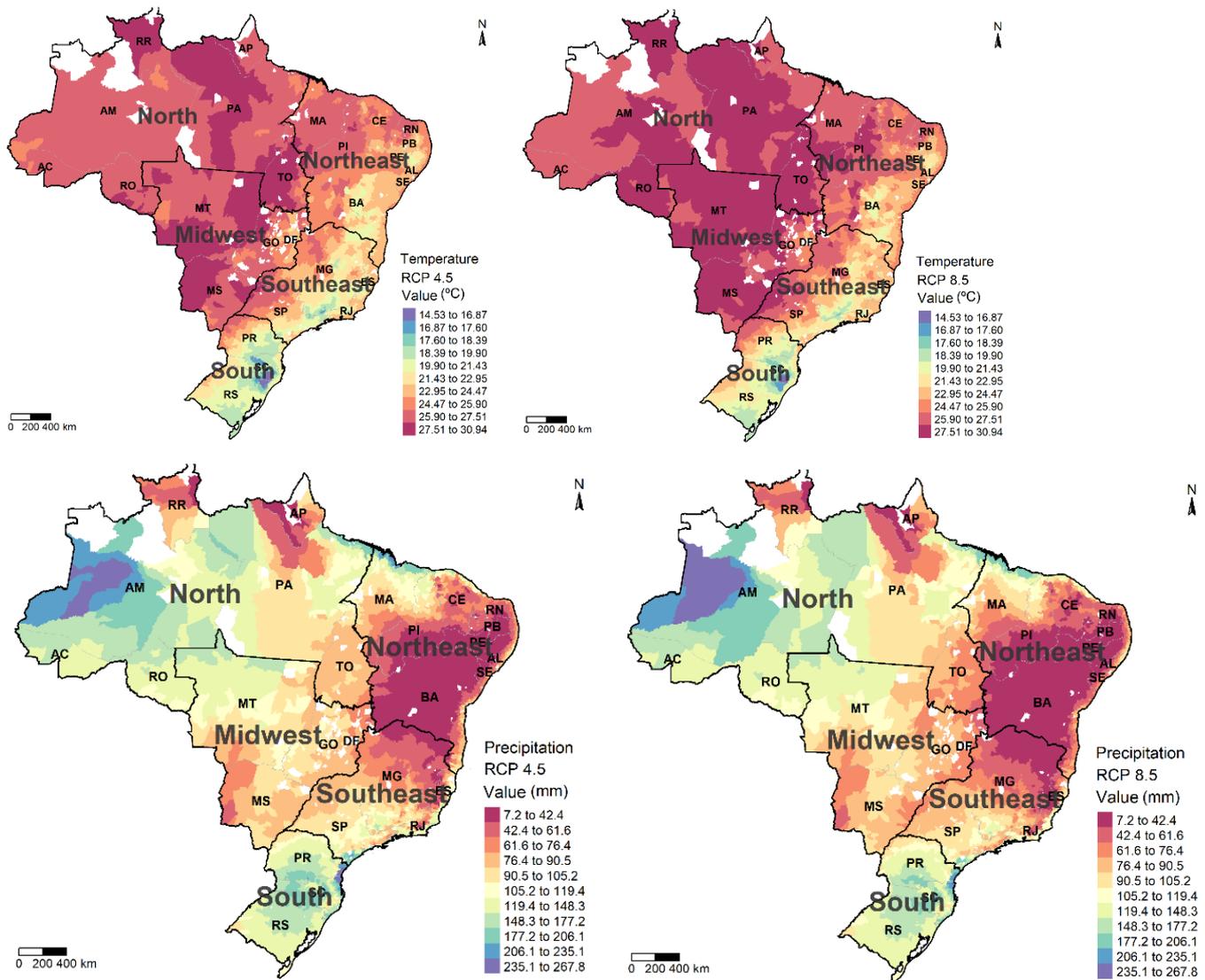
**Figure 1: Production structure of the AGRO-BR model**

Source: Adapted from Horridge (2011)

In the production process, the primary factors and intermediate inputs are demanded in fixed proportions, following a Leontief production function. That is, it is necessary to use the intermediate inputs and primary factors together, and it is not possible to replace them, as verified in the second level of Figure 1. At the level below, capital, land and labor factors are demanded through a CES-type production function. It is emphasized that the land factor is demanded only by the sectors producing agricultural products, cattle, other animals, forestry, vegetal extraction, and aquaculture. The demand for intermediate inputs is structured by a CES-type function, which allows replacement between different products. The source is also structured by a CES-type function, allowing the product to be replaced between the source regions.

### 3.3 Shocks and Scenarios

The policy scenarios, RCP 4.5, and RCP 8.5, used in the simulations of the AGRO-BR model, start from the projections of loss (or gain) of agricultural productivity estimated in Tanure (2020). The productivity changes, used as proxy to climate change in the model, were estimated with temperature and precipitation projections elaborated by INPE (Chou *et al.*, 2014) according to RCP 4.5 and RCP 8.5 scenarios (IPCC, 2014) and presented in Figure 2. The scenarios represent a plausible (RCP 4.5) and a pessimist (RCP 8.5) path in terms of GHG emissions.



**Figure 2: Average Temperature and Precipitation Projected by RCP 4.5 and RCP 8.5 (°C) (mm) (2050)**

Source: Own development based on Chou *et al.*, (2014).

The North, Northeast, and Midwest regions, typical of high temperature, has the highest projected temperature elevations, while the Northeast, region characterized by low rainfall levels, has the highest projected rainfall reduction, compared to historic levels. Then, on average, an increase in agricultural productivity is projected on high latitudes, comprising the states in southern regions, while a decrease is projected in northern and northeast regions according to Tanure (2020).

The RCP 4.5 and RCP 8.5 policy scenarios are distinguished by the land productivity shocks applied to agricultural sectors. In RCP 8.5 policy scenario, the average land productivity variation is greater (in module) than the values verified in the RCP 4.5 policy scenario. In the baseline scenario, the growth rates of macroeconomic variables are exogenous and follow the recent performance verified by the Brazilian economy. In policy simulations, land productivity is exogenous to allow the implementation of the estimated shocks. The behavior (deviation from the baseline scenario) of the main macroeconomic aggregates, such as national GDP, household consumption and investment, are endogenous.

The period used in the simulations respects the climatological periodization of 30 years, established to cover all-natural climatic variability that can influence the mean of the variables analyzed. In this sense, the variations in agricultural productivity estimated in Tanure (2020), by cultivation and by type of producer, represent projections of variation for 30 years, carried out between the years 2021 to 2050. For the construction of the shocks in the model, these productivity variations were transformed into five-year rates. Section B in the Appendix presents the data used as shock in the simulations.

The agricultural sectors are directly affected by climate shocks. The land productivity shock alters the cost of the land factor, causing the sectors to refocus their primary production factors in order to minimize costs. Sectors with land productivity gain (positive shocks), will replace labor and capital by land, reducing costs. Sectors with productivity decrease (negative shocks) will replace land with labor and capital, resulting in rising costs. The magnitude of

substitution is determined by the substitution elasticities<sup>175</sup> of primary factors and by the intensity of use of each factor. The size of this substitution effect between primary factors is guided by the productive structure extracted from the model database, being distinct between family farming and large-scale agriculture sectors and regions.

## 4. RESULTS AND DISCUSSION

The results of the simulations performed with RCP 4.5 and RCP 8.5 policy scenarios are interpreted as deviations from the baseline scenario, in which the shocks of land productivity caused by climate change are not considered. The projections in 2050 represent the accumulated results related to the productivity shocks between the years 2021 and 2050.

### 4.1 Sectorial results

Table 1 presents the results of simulations for national sectoral production in RCP 4.5 and RCP 8.5 scenarios. Climate change directly affects agricultural sectors, via productivity shock, and indirectly other sectors of the economy. The greater the proximity to the agricultural sectors, the greater the indirect effects of the phenomenon. Moreover, the effects of CM on sectoral production, on average, intensify over time and in the RCP 8.5 scenario. Tables C1 and C2, in the Appendix section, shows the level of economic activity of the agricultural sectors, by UF. 3

**Table 1: National Sectoral Production (Accumulated % variation in relation to baseline scenario)**

Sector	RCP 4.5			RCP 8.5		
	2025	2040	2050	2025	2040	2050
Family Farming Rice	-0,02	-0,07	-0,10	0,00	0,03	0,07
Large-scale Rice	-0,10	-0,43	-0,67	-0,16	-0,69	-1,10
Family Farming Wheat and Cereals	0,20	0,83	1,28	0,05	0,24	0,39
Large-scale Wheat and Cereals	0,96	3,83	5,67	0,97	3,92	5,87
Family Farming Corn	0,03	0,12	0,18	0,02	0,10	0,15
Large-scale Corn	-0,97	-4,38	-7,13	-1,21	-5,47	-8,91
Family Farming Cotton Fiber	0,01	0,06	0,11	0,01	0,07	0,14
Large-scale Cotton Fiber	-0,71	-3,29	-5,46	-1,12	-5,25	-8,74
Family Farming Sugarcane	0,00	0,02	0,05	0,00	0,03	0,08
Large-scale Sugarcane	0,67	2,71	4,04	1,02	4,00	5,85
Family Farming Soybeans	-0,01	-0,02	-0,03	-0,01	-0,01	-0,01
Large-scale Soybeans	0,07	0,32	0,51	0,10	0,45	0,72
Family Farming Cassava	-0,34	-1,83	-3,26	-0,45	-2,43	-4,30
Large-scale Cassava	0,04	0,12	0,14	0,00	-0,04	-0,09
Family Farming Tobacco Leaf	0,20	0,67	0,97	0,19	0,66	0,96
Large-scale Tobacco Leaf	0,03	0,12	0,20	0,03	0,13	0,21
Family Farming Tomato	0,00	0,00	0,00	0,00	0,00	0,00
Large-scale Tomato	-0,01	-0,05	-0,07	-0,01	-0,06	-0,08
Family Farming Potato	0,00	0,01	0,02	0,00	0,02	0,03
Large-scale Potato	-0,01	-0,03	-0,05	-0,01	-0,06	-0,09
Family Farming Onion	0,00	-0,02	-0,03	-0,01	-0,03	-0,06
Large-scale Onion	-0,01	-0,03	-0,05	0,00	-0,02	-0,03
Family Farming Peanuts	0,01	0,02	0,04	0,01	0,02	0,04
Large-scale Peanut	0,08	0,25	0,31	0,08	0,26	0,32
Family Farming Pineapple	0,00	0,00	0,00	0,00	-0,02	-0,03
Large-scale Pineapple	0,00	-0,02	-0,03	-0,01	-0,03	-0,04
Family Farming Banana	-0,25	-1,39	-2,62	-0,43	-2,40	-4,49
Large-scale Banana	-0,16	-0,68	-1,05	-0,39	-1,59	-2,39
Family Farming Beans	-0,20	-1,09	-1,94	-0,35	-1,92	-3,46
Large-scale Beans	-0,32	-1,29	-1,94	-0,49	-2,00	-3,02
Family Farming Cashew Chestnut	0,02	0,04	0,04	-0,20	-1,05	-1,88
Large-scale Cashew Chestnut	0,22	0,89	1,36	-0,08	-0,36	-0,61
Family Farming Grape	-0,07	-0,34	-0,60	-0,07	-0,35	-0,63
Large-scale Grape	0,03	0,12	0,18	0,07	0,26	0,37
Family Farming Out. temp crop.	0,12	0,48	0,70	0,30	1,17	1,71
Large-scale Out. temp crop.	0,01	-0,11	-0,32	0,11	0,30	0,30
Family Farming Orange	-0,08	-0,38	-0,67	-0,11	-0,52	-0,90
Large-scale Orange	-0,74	-3,32	-5,26	-0,86	-3,88	-6,18
Family Farming Coffee Grains	-0,44	-2,09	-3,55	-0,54	-2,54	-4,25
Large-scale Coffee Grains	-0,23	-1,06	-1,75	-0,25	-1,18	-1,97
Family Farming Out. perm crop.	0,07	-0,17	-0,79	0,15	0,04	-0,59
Large-scale Out. perm crop.	0,04	0,01	-0,14	0,38	1,34	1,79

175 Domingues *et al.* (2009) provides the substitution elasticities of primary factors. Table A2, in the Appendix section, presents the other elasticities used in the study.

Sector	RCP 4.5			RCP 8.5		
	2025	2040	2050	2025	2040	2050
Family Farming Cattle Other Animals	-0,01	-0,03	-0,05	-0,01	-0,05	-0,07
Large-scale Cattle and Other Animals	-0,01	-0,04	-0,07	-0,01	-0,06	-0,09
Family Farming Forestry	0,00	-0,01	-0,01	0,00	-0,01	-0,01
Large-scale Forestry	0,00	0,00	0,00	0,00	0,00	0,00
Family Farming Vegetal Extraction	0,00	-0,01	-0,01	0,00	0,00	-0,01
Large-scale Vegetal Extraction	0,00	0,00	0,01	0,00	0,01	0,02
Fishing and Aquaculture	0,00	0,00	0,00	0,00	0,00	0,00
Extractive Industry	0,00	0,01	0,02	0,00	0,01	0,02
Industries	0,01	0,06	0,09	0,02	0,07	0,12
Electronic	0,00	0,01	0,01	0,00	0,01	0,01
Food and Drink	0,01	0,03	0,03	0,01	0,05	0,07
Diesel Fuel	0,00	0,00	0,00	0,00	0,01	0,01
Inorganic Chemicals	0,00	0,01	0,01	0,00	0,01	0,02
Fertilizer	0,00	-0,04	-0,11	0,01	-0,03	-0,11
Pesticides	0,01	-0,01	-0,04	0,02	0,01	-0,04
Electricity and Gas	0,00	0,00	0,00	0,00	0,00	-0,01
Financial and Insurance Institutions	0,00	0,00	0,00	0,00	-0,01	-0,01
Trade	0,00	-0,02	-0,03	0,00	-0,02	-0,04
Cargo Transport	0,00	0,00	0,00	0,00	0,01	0,01
Services	0,00	0,00	0,00	0,00	0,00	0,00
Public Sector	0,00	0,00	0,00	0,00	0,00	0,00
Construction	0,00	0,00	0,00	0,00	0,00	0,00

Source: Own elaboration based on model results.

In the RCP 4.5 scenario, economically relevant sectors for family farming would perform negatively. The Cassava, Coffee, and Banana sectors would accumulate losses of 3.26%, 3.55%, and 2.62%, respectively, in 2050. Soybean production would also be negatively affected, in lower magnitude. On the other hand, Tobacco, Other sectors of temporary tillage, and Corn sectors would show a production increase of 0.9%, 0.7%, 0.18% in 2050. As part of the production originated from family farming is consumed on the property, the negative impacts on the production of cassava, beans, orange, banana, coffee, grape and others of permanent farming, could deteriorate the food security of producers, and consequently increase their condition of vulnerability. This pattern deteriorates in the RCP 8.5 scenario.

Among the large-scale agricultural sectors with the highest share of domestic production, Corn, Cotton and Orange would tend to be negatively affected with a reduction in production by 8.91%, 8.74%, and 6.18%, respectively, in 2050. These sectors, together with Coffee, also with negative performance, have relevant participation in the foreign market, which could contribute to the retraction of supply and increase in international prices, as also verified by Calzadilla *et al.*, (2013) and Nazareth *et al.*, (2020). Among the beneficiaries, we highlight the producers of Wheat and Sugarcane, with projections of a production increase of 5.8% in the year 2050. It is also noteworthy the positive impacts, even if minor, on the Soybean sector, relevant in economic terms. The national performance of soybeans would be guaranteed by the increase in productivity in large producing regions, such as SP, MT, MS, PR, SC, and RS, however, the projections for the MATOPIBA region, the current frontier of crop expansion, are negative, as verified in Zilli *et al.*, (2020). These effects would be intensified in the RCP 8.5 scenario.

Climate change would indirectly affect other economic sectors, with the most pronounced impacts on sectors close to the agricultural sectors. The Cattle and Other Animals, Forestry and Vegetal extraction sectors, by competing for production factors, would be negatively impacted. The replacement of land by capital and labor in the agricultural sectors would reduce the availability of these factors for the others. The Cattle and Other Animals sector, the main responsible for the meat production of beef, pork, and poultry, would be negatively impacted, with possible effects for international trade, since Brazil has the largest cattle herd in the world, being the largest exporter of beef and poultry, and the third-largest exporter of pork (FAO, 2020). Nevertheless, the economic downturn of the agricultural sectors would negatively affect the Pesticides and Fertilizers sectors since these are the main suppliers for the agricultural sectors.

#### 4.2 Regional Results

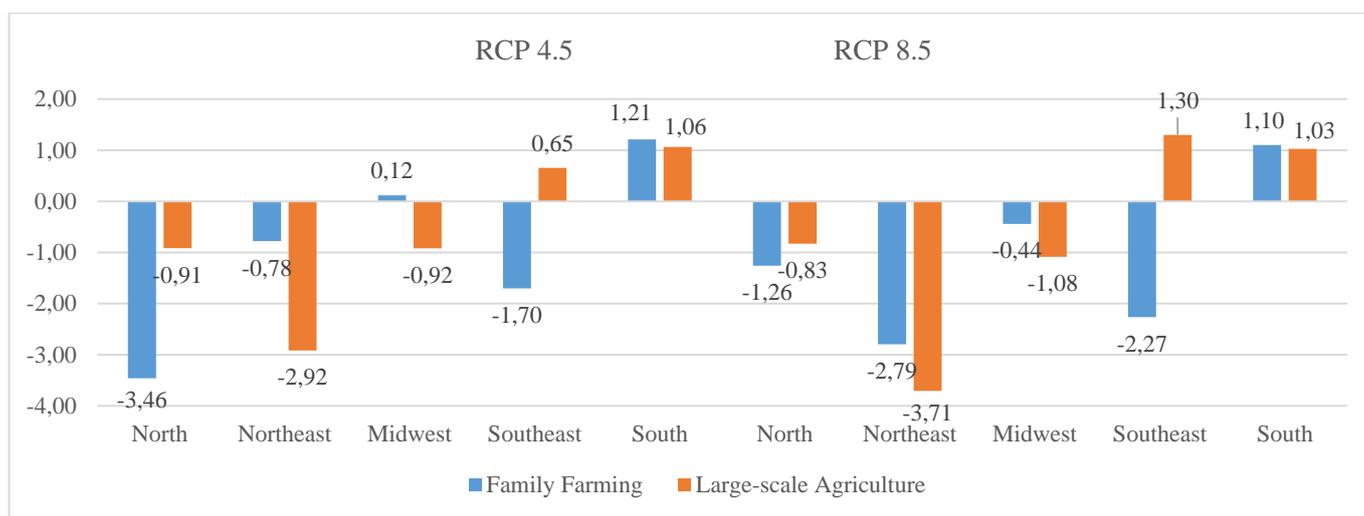
The impacts of CM on productivity and its consequent economic effects are heterogeneous between sectors and regions. The aggregate performance of the family farming and large-scale agricultural sectors by UF, presented in Table 2, is the net result of the effects on the activity of all agricultural sectors and allows us to evaluate the direction of impacts in regional terms and by type of producer. The family farming sectors of Cassava, Tobacco Leaf, Coffee and Soybean, and the large-scale agriculture sectors of Sugarcane, Soybeans and Coffee, have great economic relevance and therefore play a decisive role in regional results. The results for the RCP 8.5 scenario would indicate higher losses compared to the RCP 4.5 scenario.

**Table 2: Aggregate production variation of the family farming and large-scale agriculture sector in 2050 (Accumulated % variation in relation to the baseline scenario)**

Scenario	RCP 4.5		RCP 8.5	
	Family Farming	Large-Scale Agriculture	Family Farming	Large-Scale Agriculture
Federal Unit / Agricultural Sector				
Rondônia (RO)	-2,13	-1,13	-0,87	-1,21
Acre (AC)	-2,31	-1,6	-2,41	-1,97
Amazonas (AM)	-1,14	-0,36	-0,62	-0,18
Roraima (RR)	-2,31	-3,1	-0,51	-3,27
Pará (PA)	-4,88	-1	-1,36	-0,53
Amapá (AP)	-8,64	5,44	-7,91	5,57
Tocantins (TO)	0,15	-0,77	-0,03	-0,96
Maranhão (MA)	2,14	-1,7	0,25	-2,24
Piauí (PI)	3,55	-2,92	2,59	-3,66
Ceará (CE)	0,47	1,36	-1,79	-1,62
Rio Grande do Norte (RN)	-2,45	2,94	-3,33	-2,09
Paraíba (PB)	-1,27	-2,37	-3,43	-3,19
Pernambuco (PE)	-2,04	-0,68	-4,13	-0,97
Alagoas (AL)	-2,45	-3,59	-4,29	-4,73
Sergipe (SE)	-3,72	-3,68	-5,67	-5,44
Bahia (BA)	-1,26	-4,19	-3,45	-4,57
Minas Gerais (MG)	-2,24	-1,5	-2,55	-1,4
Espírito Santo (ES)	-4,01	-2,77	-5,47	-3,87
Rio de Janeiro (RJ)	-1,68	-3,22	-3,27	-4,76
São Paulo (SP)	0,91	2,42	0,62	3,59
Paraná (PR)	0,68	1,3	0,54	1,17
Santa Catarina (SC)	1,32	0,17	1,19	-0,01
Rio Grande do Sul (RS)	1,47	0,98	1,4	1,05
Mato Grosso do Sul (MS)	-2,2	-0,74	-2,27	-0,25
Mato Grosso (MT)	-0,96	-1,09	-0,68	-1,95
Goiás (GO)	2,76	-0,71	0,9	0,09
Distrito Federal (DF)	0,56	0,04	0,91	0,05

Source: Own elaboration based on the results of the AGRO-BR model.

The aggregate sector results, by type of producer, reflect the magnitude of the productivity shock and the economic importance of each sector. Thus, crops with great economic participation can contribute positively to the aggregate performance of the sector. In the family farming sector, the states of Maranhão, Piauí, Ceará, São Paulo, Goiás, as well as the states of the Southern region and the Federal District would show growth. All the others would show a fall in the level of economic activity in relation to the baseline scenario. In the large-scale agriculture sector, the states of Amapá, Ceará, Rio Grande do Norte, and São Paulo and all in the Southern region would show growth in the level of sectoral activity. The positive performance in both scenarios of the Southern region is due to the positive shock of agricultural productivity, caused by the increase of the average levels of temperature and precipitation. The region is characterized by milder temperatures. This explains the increase in the level of activity in the pessimistic scenario, with higher temperatures in the region. The positive performance of the state of São Paulo is due to the increase in productivity of sectors whose participation in the state GDP is relevant, such as Soybeans, Coffee, Sugarcane and Cotton for the large-scale agriculture sectors, and Beans, Coffee and Grapes for the family farming sectors. From the perspective of aggregate regions in the RCP 4.5 scenario, the activity of family farming would be negatively affected in the North, Northeast, and Southeast regions of the country. These regions concentrate the largest share of family producers in Brazil. Only the Midwest and South regions would show an increase in the level of activity. Large-scale agriculture production would be negatively affected in the North, Northeast, and Midwest. The Southeast and South regions would benefit in terms of economic activity. These results could contribute to the increase of regional inequalities in Brazil since the negative impacts affect regions that concentrate family farmers with a less developed profile and a focus on subsistence production, while positive impacts would affect the South region, which in turn concentrates mechanized family farmers well established in the market. The simulations of the RCP 8.5 scenario indicate possible intensification of the effects over time, for all regions, except the North region, which would have the negative effects mitigated. Figure 3 shows the effects of climate change in RCP 4.5 and RCP 8.5 scenarios.



**Figure 3: Regional Economic Activity Level in RCP 4.5 and RCP 8.5 scenarios in 2050 (Accumulated % variation in relation to baseline scenario)**

Source: Own elaboration based on the results of the AGRO-BR model.

The relevance of the participation of the state of São Paulo to the level of activity in the Southeast region would explain the positive performance of the large-scale agriculture sector in the region, given that in the states of Minas Gerais, Espírito Santo, and Rio de Janeiro (the other states that compound the southeast region) the economic performance would be negative in both scenarios. São Paulo stands out in the large-scale production of Cotton, Sugarcane, Wheat, and Others of the Permanent Crop. Some economically expressive sectors would show a decline in the level of activity, such as the large-scale production of Corn and Orange, however, the net effect in terms of activity is positive.

### 4.3 Macroeconomic results

The impacts of climate change projected by the AGRO-BR model would imply a negative impact on GDP in both scenarios. The retraction would be gradual over time, reaching -0.01% in 2050. Considering the nominal GDP of 2019 in the amount of R\$7 trillion, the climate change represented in the model by the RCP 4.5 scenario could generate, roughly, accumulated losses of R\$105 billion over 30 years, in current values, with annual losses of R\$3.5 billion, reaching R\$243 billion (R\$8.1 billion annually) in the RCP 8.5 scenario. Table 3 presents the projected macroeconomic results.

**Table 3: Macroeconomic Results in 2050 (accumulated % variation in relation to the baseline scenario)**

Variables / Scenarios	RCP 4.5	RCP 8.5
Household Consumption	-0,010	-0,010
Investment	-0,001	-0,002
Exports	-0,129	-0,154
Imports	-0,092	-0,121
GDP	-0,010	-0,010
Family Farming Production	-0,490	-0,830
Large-Scale Agriculture Production	-0,590	-0,920

Source: Own elaboration based on model results.

Compared to other studies, such as Margulis; Dubeux (2011), the estimated magnitude in terms of impacts on GDP is lower due to being due only to the net result of land productivity changes, while other studies that project larger impacts consider other aspects related to climate change. In the present study, although projections indicate that most crops would be negatively impacted, crops relevant in terms of representativeness in GDP were positively impacted, especially in commodities producing regions such as SP, PR, and RS states, minimizing the aggregate negative effects. Nevertheless, the final impact is negative, for both types of producers in the RCP 4.5 scenario, with a 0,49% accumulated decrease in family farmer's production and a 0,59% decrease in large-scale agricultural production in 2050. The results deteriorate in the RCP 8.5 scenario.

The results presented are similar to studies with similar approaches. Farias (2012) projects the impacts of CC on the economy through the integration of Monash and B-MARIA models and estimates of land-use change according to scenarios A2 and B2, for a group of eleven crops. With projected a accumulated reduction in national GDP between 0.02% in 2039 and 0.11% in 2099 considering scenario A2, and between 0.02% in 2039 and 0.07% in 2099 in scenario B2. The results are also close to those observed by Silva (2018), who estimates the agricultural productivity of five crops and projected a negative impact of 0,05% on GDP considering the RCP 2.6 scenario and a decrease of 0.26% in the RCP 8.5 scenario, accumulated in 2099. Our study advances by providing up-to-date estimates with the most recent scenarios for a higher number of crops and for distinct groups of family farmers and large-scale producers.

On household consumption performance, projected results indicate possible retraction in the same magnitude of GDP. The impact on household consumption would be more intense in the RCP 8.5 scenario. This performance is determined by the closing of the model, with the aggregate consumption following the variation of income and, therefore, GDP. Regarding investment, it is verified that at the aggregate level there is no retraction related to the decline of economic activity in the national economy. In sectoral terms, agriculture would increase the level of investment, especially in sectors with a retraction of land productivity, through the incorporation of capital and labor.

Sectors directly affected by productivity shocks, especially large-scale agriculture sectors, are, on average, exporters. The net effect of shocks on the level of activity is negative, and positive on their costs. In this sense, exports would be negatively affected and would show a sharp decline over time. The decrease in the level of economic activity would determine the reduction in imports. The use of imported productive inputs would be reduced due to decreased production. Moreover, the reduction of income of factors would negatively affect the consumption of families and the volume of imported goods. Therefore, negative impacts on Brazilian trade with the foreign market, as pointed by Calzadilla *et al.*, (2013) and Nazareth *et al.*, (2020), are expected.

Table 4 presents the GDP results at the Federation Units level for RCP 4.5 and RCP 8.5. The performance of each FU, in terms of GDP, reflects the economic importance of agricultural sectors affected by land productivity shocks. Projections indicate heterogeneity of results. On average, there would be a reduction in GDP in most FUs and of greater magnitude in the pessimistic scenario RCP 8.5. The States of the North, Northeast and Midwest regions would be the most affected, meeting the results of Ferreira Filho; Horridge (2010), Moraes (2010) and Farias (2012). It should be emphasized that such regions are the least developed in Brazil. The only FUs that would present positive growth in both scenarios would be RR, TO, AL, RJ, SP, PR and RS.

**Table 4: GDP per Federation Unit (Var. % Accumulated in 2050)**

Regions	Federation Units / Scenarios	RCP 4.5	RCP 8.5
North	Rondônia	-0,04	-0,03
	Acre	-0,06	-0,07
	Amazonas	-0,01	-0,02
	Roraima	0,16	0,28
	Pará	-0,2	-0,07
	Amapá	-0,09	-0,08
	Tocantins	0,14	0,21
Northeast	Maranhão	-0,05	-0,08
	Piauí	-0,15	-0,21
	Ceará	0,03	-0,02
	Rio Grande do Norte	0,0	-0,08
	Paraíba	-0,04	-0,07
	Pernambuco	-0,01	-0,01
	Alagoas	0,05	0,08
	Sergipe	-0,1	-0,14
Southeast	Bahia	-0,13	-0,16
	Minas Gerais	-0,1	-0,11
	Espírito Santo	-0,13	-0,18
	Rio de Janeiro	0,0	0,0
South	São Paulo	0,03	0,04
	Paraná	0,07	0,05
	Santa Catarina	0,0	-0,02
Midwest	Rio Grande do Sul	0,12	0,14
	Mato Grosso do Sul	-0,05	0,03
	Mato Grosso	-0,19	-0,36
	Goiás	-0,06	0,01
	Distrito Federal	-0,01	-0,01

Source: Own elaboration based on model results.

Therefore, the simulated macroeconomic results show that the average impacts of land productivity shocks, used in the model as a proxy for the effects of climate change on agricultural productivity, would be negative on the Brazilian economy. However, the effects are heterogeneous. The Southern region would be the least negatively affected in economic terms, with the state of RS as a positive highlight. It is emphasized that part of the UF benefited from economic growth, such as SP, PR and RS, are the most developed in the country. Thus, the advent of CC could widen regional disparities in Brazil.

## 5. FINAL CONSIDERATIONS

There is a consensus that the impacts of climate change on agriculture in Brazil will be mostly negative, but there are few analyses that assess how the effects would be distributed in sectoral terms and by type of producer. This study is the first to provide projections of how the effects would be distributed over the 27 FUs, considering 21 crops produced by family farmers and large-scale agriculture sectors. We found that family farming production in less developed regions would be

negatively affected, while developed regions would benefit from CC. Therefore, the phenomenon could deteriorate the situation of vulnerability and inequality conditions in the country.

The sectoral results projected for family farming indicate that the production of Cassava, Banana, Soybean, and Coffee would be affected by reduction over time, with negative implications on food security, while Tobacco, Corn, and Others from the Temporary Crop would be affected with increased production. On the part of the large-scale agriculture production, Corn, Cotton, and Orange would decrease, while Sugarcane, Soybeans, and Wheat would benefit from increased production. The pattern of results is similar between scenarios, however, the magnitude of the effects in RCP 8.5 would, on average, be more intense. Table 5 presents the synthesis of the results.

**Table 5: Summary of the results**

Producers	Family Farming		Large-scale Agriculture	
	Positive	Negative	Positive	Negative
Impacts				
Sector Highlights	Tobacco Leaf, Peanut, Grape, Other. Temporary	Cassava, Coffee, Corn, Banana and Beans	Sugarcane, Grape and Tobacco Leaf	Corn, Cotton, Beans, Coffee
Federation Unit	MA, PI, CE, SP, SC, PR, RS, GO, DF	All the rest of FUs	AP, CE, RN, SP, PR, SC, and RS	All the rest FUs
Regions	South	North, Northeast, Midwest and Southeast	South and Southeast	North, Northeast and Midwest

Source: Own elaboration based on the results of the AGRO-BR model.

In the indirectly affected sectors, the effects on the level of activity of Cattle and Other Animal, Forestry and Vegetal extraction sectors would be negative since they compete for inputs and production factors with the agricultural sectors. As Brazil stands out as one of the world's leading meat exporters, the phenomenon of climate change could bring instability to international meat trade. In addition, the sectors that concentrate their activity on supplying inputs to the agricultural sectors, such as Fertilizers and Pesticides, would also be affected with production retraction in 2050, in both scenarios.

Finally, macroeconomic results would be negative. The magnitude of the variation is small, due to the heterogeneity of the effects, which despite being on the average negative, would be positive for important Federation Units in terms of participation in national GDP, such as SP, PR, and RS. Since the regions benefited are the most developed, such results could contribute to the widening of regional disparities in Brazil. The effect of climate change would generate a negative accumulated impact on GDP of around 0.01% in 2050, in both scenarios. In relation to the GDP of the Federation Units, the greatest variations would be verified in states whose share of agriculture in GDP is more relevant. Mato Grosso, Mato Grosso do Sul, Pará, Bahia, Minas Gerais, Piauí, and Maranhão, are negative highlights, while Tocantins and Rio Grande do Sul, Paraná and São Paulo are positive highlights in both scenarios.

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## APPENDIX A - Sectors and elasticities of the AGRO-BR Model

**Table A1: AGRO-BR model sectors**

1	Family Farming Rice	23	Family Farming Peanuts	45	Family Farming Forestry
2	Large-scale Rice	24	Large-scale Peanut	46	Large-scale Forestry
3	Family Farming Wheat and Cereals	25	Family Farming Pineapple	47	Family Farming Vegetal Extraction
4	Large-scale Wheat and Cereals	26	Large-scale Pineapple	48	Large-scale Vegetal Extraction
5	Family Farming Corn	27	Family Farming Banana	49	Fishing and Aquaculture
6	Large-scale Corn	28	Large-scale Banana	50	Extractive Industry
7	Family Farming Cotton Fiber	29	Family Farming Beans	51	Industries
8	Large-scale Cotton Fiber	30	Large-scale Beans	52	Electronic
9	Family Farming Sugarcane	31	Family Farming Cashew Chestnut	53	Food and Drink
10	Large-scale Sugarcane	32	Large-scale Cashew Chestnut	54	Diesel Fuel
11	Family Farming Soybeans	33	Family Farming Grape	55	Inorganic Chemicals
12	Large-scale Soybeans	34	Large-scale Grape	56	Fertilizer
13	Family Farming Cassava	35	Family Farming Out. temp crop.	57	Pesticides
14	Large-scale Cassava	36	Large-scale Out. temp crop.	58	Electricity and Gas
15	Family Farming Tobacco Leaf	37	Family Farming Orange	59	Financial and Insurance Institutions
16	Large-scale Tobacco Leaf	38	Large-scale Orange	60	Trade
17	Family Farming Tomato	39	Family Farming Coffee Grains	61	Cargo Transport
18	Large-scale Tomato	40	Large-scale Coffee Grains	62	Services
19	Family Farming Potato	41	Family Farming Out. perm crop.	63	Public Sector
20	Large-scale Potato	42	Large-scale Out. perm crop.	64	Construction
21	Family Farming Onion	43	Family Farming Cattle Other Animals		
22	Large-scale Onion	44	Large-scale Cattle and Other Animals		

Fonte: Own elaboration.

**Table A2: Elasticity parameters in the AGRO-BR model**

Parameter	Dimension	Description	Value
EPS	COM	Elasticity of family's expenditure	0 to 1.65
EXP_ELAST	IND	Elasticity of demand for exports	1
FRISCH	DST	Frisch parameter	-2,48
DPRC	IND	Depreciation Rate	0,5
QRATIO	IND AND DST	Investment/capital ratio (maximum trend)	4
RNORMAL	IND AND DST	Gross normal rate of return	12%
GOTREND	IND AND DST	Investment/capital ratio (trend)	0.06 to 0.15
ALPHA	IND AND DST	Investment elasticity	5
SIGMA1LAB	IND	Work replacement elasticity	0,02
SIGMA1PRIM	IND	Elasticity of substitution of primary factors	0.63 to 1.0
ARMSIGMA	IND	Substitution elasticity of intermediate goods	0.04 to 2.42
SIGMADOMDOM	IND	Region Substitution elasticities	0.8 to 2.37
SIGMAMAR	IND	Substitution elasticity between margin regions	0,2
SIGMA1OUT	IND	CET transformation elasticity	0,5

Source: Own elaboration based on Domingues *et al.* (2009); Hofmann (2010); Faria; Haddad (2014).

APÊNDICE B - Productivity Shocks

Table B1: Five-year Land Productivity Shocks in Family Farming Sectors (%) (RCP 4.5 Scenario) (2021-2050)

FU / Sector	Banana	Coffee	Cashew Nuts	Orange	Grape	Others. Perm.	Pineapple	Cotton Fiber	Peanut	Rice and Cereals	Potato	Sugarcane	Onion	Beans	Tobacco Leaf	Cassava	Corn	Soybeans	Tomato	Wheat	Others. Temp.
AC	-6,07	-2,78	0,00	-3,48	0,00	-4,66	-0,35	-0,97	1,67	0,66	11,45	2,78	0,00	-2,02	-3,95	-3,40	-2,11	0,00	0,00	0,00	-3,82
AP	1,08	0,00	0,00	4,50	0,00	-7,77	2,19	0,00	0,00	8,55	0,00	1,34	0,00	-7,67	0,00	-9,61	-9,41	0,00	0,00	0,00	-8,00
AM	-3,52	1,68	0,00	6,61	0,00	-4,66	2,15	0,00	3,49	1,29	11,96	-2,87	0,00	-1,72	-7,71	-3,92	-3,36	0,00	0,00	0,00	3,59
PA	-2,18	-5,50	-6,61	4,50	0,00	-7,33	1,56	-9,66	2,91	2,27	3,31	1,08	-2,24	0,72	5,97	-7,54	-3,53	-3,54	4,83	0,00	-2,27
RO	-7,42	-1,38	0,00	4,60	0,00	-5,84	0,23	0,00	5,35	1,09	11,50	2,16	9,58	-0,51	0,00	-6,09	-2,23	-6,05	-6,20	0,00	-1,58
RR	1,76	-8,03	0,00	4,50	0,00	-9,12	-8,77	0,00	-9,89	5,99	0,00	3,43	0,00	1,46	0,00	-7,47	-0,01	0,00	4,02	0,00	6,14
TO	-2,85	0,00	-6,02	-9,70	0,00	11,15	-1,13	0,00	9,78	0,27	7,55	-6,69	0,00	4,52	0,00	-7,33	-1,36	-3,59	0,00	0,00	5,74
AL	3,04	-6,24	-1,85	-3,27	0,00	-7,67	0,76	-9,37	-2,81	0,21	-5,97	4,97	0,00	-4,17	-6,85	-4,36	-5,44	0,00	2,02	0,00	-3,35
BA	0,34	-6,51	-5,38	-10,14	-9,28	-3,44	3,34	-10,03	5,77	2,63	-5,66	-2,61	-5,94	-4,81	-4,28	-4,28	-5,87	-4,09	5,94	0,00	1,47
CE	-0,45	-5,19	0,18	-7,96	0,00	-4,25	1,00	2,01	2,74	0,39	-1,31	0,23	3,51	-0,22	-3,72	4,11	-1,34	0,00	0,59	0,00	-2,37
MA	0,09	-6,47	9,07	1,75	0,00	1,45	-0,28	0,00	3,39	1,11	0,00	-1,00	0,00	-0,65	0,00	0,05	-1,99	-4,87	0,00	0,00	5,24
PB	-2,23	-5,18	-4,01	-9,94	-9,03	-4,76	0,57	-5,03	1,25	-0,71	-0,32	2,86	6,35	-3,11	-7,36	-3,05	-4,44	0,00	0,99	0,00	-0,23
PE	-0,46	-5,04	-5,42	-9,84	-7,02	-2,23	3,41	-10,07	6,43	0,76	-3,56	5,12	-1,17	-4,11	-6,32	-4,61	-5,20	-1,22	4,02	0,00	-1,81
PI	4,25	0,00	4,42	6,51	0,00	8,53	3,05	-7,57	8,52	0,44	0,00	-3,11	0,00	1,66	-4,25	-1,22	-1,48	-5,24	-0,75	0,00	8,48
RN	0,29	-3,50	-2,29	-9,38	0,00	-7,71	0,28	6,91	1,99	-1,50	0,00	3,67	6,35	-2,08	-6,65	-2,57	-3,43	1,82	-0,67	-11,91	-3,98
SE	3,53	0,00	5,28	-8,23	0,00	-7,26	-0,72	0,00	-3,61	0,06	-6,92	3,96	-0,18	-4,67	-7,30	-4,88	-6,38	0,00	8,84	0,00	-4,85
ES	-5,32	-4,26	0,00	-6,48	-7,81	-2,19	-4,73	0,00	6,58	2,36	-5,97	1,18	-7,68	-5,13	0,00	3,23	-6,44	0,00	3,63	0,00	-4,18
MG	-3,91	-2,78	0,00	-2,46	-6,75	0,63	0,85	-7,10	12,10	2,92	0,56	-1,15	-6,60	-4,42	-2,57	-4,28	-4,42	-5,79	-0,83	0,00	1,49
RJ	-6,25	-4,05	0,00	2,55	0,00	0,29	-4,77	0,00	0,00	2,83	4,60	1,74	-6,14	-5,57	0,00	3,03	-4,38	0,00	-1,89	0,00	-5,55
SP	-7,92	8,99	0,00	-7,55	12,25	4,73	-8,03	0,46	9,13	1,20	7,22	-6,48	-5,66	0,60	8,77	-3,76	2,89	-1,72	-6,64	6,15	5,74
GO	0,95	-3,21	0,00	-0,46	0,00	3,80	10,03	0,00	11,90	1,24	7,55	-3,37	10,39	1,69	-1,73	-6,62	-2,94	-5,82	-9,03	0,00	11,73
MT	-8,34	1,34	-7,32	-1,83	0,00	0,00	-3,80	-3,09	7,01	0,10	7,55	-6,12	0,00	2,92	0,00	-7,62	0,56	-6,51	-4,06	0,00	5,74
MS	-10,23	6,39	0,00	-11,30	0,00	4,73	-7,59	-5,72	6,77	1,02	7,55	-9,66	-5,29	2,02	0,00	-8,48	4,27	0,32	-7,63	6,15	5,74
PR	-9,24	6,39	-0,38	-7,46	2,53	4,73	2,09	6,29	6,77	0,64	5,32	-7,24	-0,18	-1,55	12,24	-3,99	2,96	0,21	-5,17	6,15	5,74
RS	-7,83	11,63	0,00	-2,72	-7,60	7,82	2,40	0,00	10,85	-0,71	7,91	-5,49	-1,38	0,92	5,50	2,45	2,71	0,89	-5,70	6,15	5,74

Table B2: Five-year Land Productivity Shocks in Family Farming Sectors (%) (RCP 8.5 Scenario) (2021-2050)

FU / Sector	Banana	Coffee	Cashew Nuts	Orange	Grape	Others. Perm.	Pineapple	Cotton Fiber	Peanut	Rice and Cereals	Potato	Sugarcane	Onion	Beans	Tobacco Leaf	Cassava	Corn	Soybeans	Tomato	Wheat	Others. Temp.
AC	-7,10	-2,45	0,00	-6,85	0,00	-3,99	-1,45	1,54	3,53	-0,12	9,15	3,00	0,00	-1,27	-0,82	-4,36	-1,38	0,00	0,00	0,00	0,15
AP	0,54	0,00	0,00	5,60	0,00	-6,20	0,33	0,00	0,00	8,24	0,00	-0,50	0,00	-7,11	0,00	-9,85	-9,20	0,00	0,00	0,00	-5,58
AM	-4,19	3,21	0,00	4,03	0,00	-3,18	2,91	0,00	4,99	0,61	9,15	-2,65	0,00	0,31	-5,31	-4,43	-2,59	0,00	0,00	0,00	6,46
PA	-3,02	-3,72	-8,44	3,51	0,00	-3,94	-1,58	-9,55	6,16	2,57	8,97	-2,00	-3,34	2,35	-3,30	-8,49	-3,39	-4,00	3,78	0,00	6,81
RO	-8,31	-0,35	0,00	-2,40	0,00	-4,54	-1,69	0,00	7,83	0,28	9,15	1,10	11,05	1,16	0,00	-7,26	-1,22	-7,16	-5,65	0,00	7,38
RR	9,27	-7,75	0,00	3,51	0,00	-9,84	-9,56	0,00	-10,06	4,29	0,00	6,31	0,00	3,22	0,00	-7,70	2,55	0,00	7,48	0,00	6,24
TO	-6,06	0,00	-7,13	-10,58	0,00	7,44	-5,72	0,00	7,68	0,90	9,15	-7,68	0,00	6,83	0,00	-8,72	-0,72	-5,31	0,00	0,00	6,24
AL	-4,62	-6,77	-4,74	-8,87	0,00	-8,27	-1,62	-11,00	0,35	1,37	-8,32	8,23	0,00	-6,79	-2,48	-4,12	-6,52	0,00	11,10	0,00	-7,89
BA	-6,78	-6,54	-7,45	-11,11	7,06	-5,44	1,31	-11,47	9,77	3,40	-7,91	-0,49	-9,87	-7,14	2,92	-4,66	-6,94	-6,28	7,48	0,00	-4,80
CE	-1,11	-6,25	-5,38	-9,57	0,00	-1,51	2,59	-7,07	7,05	1,70	-3,48	0,29	-7,81	-3,01	6,23	3,01	-3,36	0,00	8,68	0,00	-4,02
MA	-0,98	-6,71	-6,28	-4,18	0,00	9,48	-0,19	0,00	7,96	2,27	0,00	-3,86	0,00	-0,53	0,00	-3,02	-3,02	-6,71	0,00	0,00	6,24
PB	-5,46	-6,88	-4,87	-10,82	7,06	-4,44	-0,48	-9,85	5,14	0,79	-5,40	4,87	-3,77	-5,88	-3,09	-2,43	-5,92	0,00	9,88	0,00	-4,86
PE	-5,76	-5,70	-6,79	-11,14	7,06	-3,78	1,53	-11,45	11,46	1,59	-6,63	6,94	-8,49	-6,68	-2,88	-4,67	-6,64	-4,80	7,48	0,00	-6,17
PI	-0,69	0,00	2,55	0,57	0,00	7,44	-0,49	-10,56	7,68	1,71	0,00	-4,99	0,00	-0,64	2,91	-3,40	-2,84	-7,02	7,98	0,00	12,06
RN	-2,85	-5,25	-3,60	-10,95	0,00	-7,05	-0,49	-5,53	6,67	-0,03	0,00	5,19	-0,78	-4,82	-1,69	-2,17	-4,88	-1,99	8,53	1,81	-6,48
SE	-4,83	0,00	-0,21	-10,03	0,00	-8,17	-1,95	0,00	-1,03	1,12	-9,04	7,58	-8,28	-7,04	-2,65	-4,55	-7,12	0,00	7,48	0,00	-8,60
ES	-9,32	-5,00	0,00	-9,01	9,24	-4,92	-5,50	0,00	11,89	3,90	-6,88	4,23	-9,76	-6,92	0,00	0,73	-7,35	0,00	8,18	0,00	-7,63
MG	-6,81	-2,91	0,00	-4,11	-4,22	1,46	-2,56	-10,57	7,68	4,10	-0,64	-0,41	-9,00	-6,33	1,06	-5,07	-5,18	-7,01	6,51	0,00	2,59
RJ	-9,07	-4,94	0,00	-5,21	0,00	-2,02	-5,34	0,00	0,00	4,31	-5,57	4,37	-9,17	-7,23	0,00	0,14	-6,03	0,00	0,87	0,00	-8,32
SP	-9,84	3,38	0,00	-9,62	7,06	7,44	-9,71	-3,20	7,68	2,03	11,67	-8,07	-7,03	0,75	5,86	-5,81	3,36	-2,42	-7,38	1,81	6,24
GO	-3,98	-2,47	0,00	-6,04	0,00	7,93	7,76	0,00	7,68	1,61	9,15	-4,54	1,87	0,01	5,18	-7,83	-2,73	-6,81	-8,69	0,00	6,24
MT	-9,46	3,56	-8,69	-3,71	0,00	8,77	-6,22	-1,72	9,40	-0,19	9,15	-7,41	0,00	5,65	0,00	-8,73	2,54	-7,45	-3,38	0,00	6,24
MS	-11,15	3,38	0,00	-11,84	0,00	7,44	-9,47	-6,79	7,68	0,23	9,15	-10,49	-5,80	2,51	0,00	-9,57	7,61	1,68	-8,22	1,81	6,24
PR	-10,50	3,38	-2,78	-9,20	4,62	7,44	-0,78	2,14	7,68	1,19	6,36	-8,47	-2,02	-1,90	11,74	-6,10	3,38	0,48	-6,08	1,81	6,24
RS	-10,21	3,38	0,00	-4,34	-7,91	9,55	11,43	0,00	12,03	-0,01	10,73	-6,64	-3,46	1,11	6,01	-0,05	2,65	1,52	-6,85	1,81	6,24
SC	-11,16	3,38	0,00	-6,52	-2,86	6,39	11,40	0,00	7,68	-0,56	7,57	-5,06	-1,07	-2,79	8,81	3,78	0,12	0,46	-7,10	1,81	6,24

Source: Own elaboration based on Tanure (2020).

**Table B3: Five-year Land Productivity Shocks in Large-scale Agricultural Sectors (%) (RCP 4.5 Scenario) (2021-2050)**

FU / Sector	Banana	Coffee	Cashew Nuts	Orange	Grape	Others. Perm.	Pineapple	Cotton Fiber	Peanut	Rice and Cereals	Potato	Sugarcane	Onion	Beans	Tobacco Leaf	Cassava	Corn	Soybeans	Tomato	Wheat	Others. Temp.
AC	-8,22	-1,40	0,00	-9,33	0,00	2,99	0,23	0,00	0,58	0,50	0,00	0,37	0,00	-3,55	-0,12	-6,47	-1,52	0,00	0,00	0,00	1,17
AP	0,00	0,00	0,00	-9,07	0,00	-3,66	5,06	0,00	0,00	-1,58	0,00	0,00	0,00	0,00	0,00	-9,83	-8,64	0,00	0,00	0,00	4,76
AM	-5,38	1,90	0,00	6,94	0,00	-1,62	11,35	0,00	0,00	-0,96	0,00	-1,87	0,00	-3,03	0,00	-4,92	-2,28	0,00	0,00	0,00	-3,60
PA	-3,44	-6,34	6,87	6,49	0,00	-4,30	3,10	0,00	-2,00	-1,72	-6,30	2,09	0,00	-0,18	-5,92	-8,03	-4,99	-1,51	-9,95	0,00	2,95
RO	-10,25	-0,02	0,00	-9,20	0,00	0,38	1,18	0,00	-8,06	-0,56	0,00	1,33	0,00	-3,56	0,00	-8,22	-4,22	-0,11	3,25	0,00	1,59
RR	5,43	0,00	0,00	6,94	0,00	-5,62	-8,38	0,00	0,00	-1,89	0,00	2,15	0,00	-3,16	0,00	-7,09	-6,73	-5,15	0,00	0,00	4,76
TO	-5,40	0,00	-12,00	-5,16	0,00	4,41	-7,98	0,00	2,91	-2,02	0,00	7,89	0,00	-1,49	0,00	-1,55	-6,89	-0,96	0,00	0,00	8,60
AL	5,43	0,00	-2,61	-6,45	0,00	-7,25	8,81	-8,52	-4,95	-1,59	2,85	-1,71	0,00	-4,61	-3,46	-5,16	-2,91	0,00	0,00	0,00	4,76
BA	3,70	-4,95	-1,79	-6,28	0,00	0,80	5,06	-11,03	3,76	2,74	-11,17	0,84	9,20	-5,61	4,25	-4,10	-7,05	-2,33	-3,16	0,00	-4,78
CE	1,53	-4,72	6,87	6,94	0,00	-5,12	2,75	6,69	-5,87	-0,39	0,00	-1,11	4,06	0,08	11,61	0,26	1,07	-1,45	5,71	0,00	-3,04
MA	-1,90	0,00	8,02	-3,21	0,00	6,52	0,09	0,00	1,88	-0,53	0,00	5,46	0,00	-1,06	0,00	2,16	-4,37	-1,44	0,00	0,00	5,34
PB	-0,36	-0,95	-0,68	-6,01	10,16	-0,53	8,23	-5,71	2,47	-1,27	-3,39	-1,18	1,31	-3,75	-5,21	-4,32	-1,91	0,00	7,44	2,27	-2,13
PE	2,18	-2,40	-5,19	-8,06	-2,13	1,92	5,06	-10,79	3,58	1,19	1,83	0,37	6,45	-5,18	0,00	-4,90	-3,39	0,00	11,25	0,00	-3,08
PI	8,10	-1,55	-5,89	11,07	0,00	7,59	0,00	-8,38	-1,74	0,09	0,00	-0,70	0,00	-0,77	0,00	3,25	-4,47	-1,95	-4,17	0,00	-1,95
RN	4,21	0,00	5,66	0,00	0,00	-5,34	5,06	0,16	0,00	-1,65	0,00	-1,41	-4,98	-2,28	-5,13	-4,65	1,61	0,00	9,03	1,96	5,23
SE	11,14	0,00	0,00	-5,17	0,00	-6,33	5,06	0,00	6,00	-0,98	-2,75	-1,99	0,00	-5,53	-5,29	-5,05	-3,61	0,00	0,00	0,00	-1,46
ES	-5,54	-3,24	0,00	6,10	2,34	-0,77	-8,73	0,00	5,54	1,96	-8,80	-0,31	5,45	-6,87	0,00	0,71	-5,48	0,00	-2,04	0,00	-3,55
MG	-3,27	-1,88	0,00	-6,74	6,32	7,27	-8,53	-4,20	3,70	-0,25	3,94	3,95	-7,48	-4,58	-3,76	-4,29	-6,10	-0,64	-6,30	10,73	-2,97
RJ	-6,81	-4,82	0,00	2,06	0,00	2,18	-8,07	0,00	0,00	2,19	-3,54	-2,04	0,00	-4,27	0,00	-1,08	-3,29	0,00	-7,32	0,00	-4,30
SP	-8,03	2,37	0,00	-6,16	6,32	4,41	-11,99	11,67	8,39	1,81	-3,16	6,17	-1,15	0,00	8,24	3,58	-5,13	1,68	-5,77	0,79	9,84
GO	-2,56	-3,75	0,00	-7,82	0,00	8,16	9,99	-5,58	-1,25	-0,26	-1,44	5,53	-11,58	-4,68	0,00	-3,92	-6,59	-0,64	-7,23	9,80	0,29
MT	-10,70	0,67	0,00	8,92	0,00	4,41	-8,45	-4,58	-5,86	-1,56	2,89	9,22	0,00	-4,63	0,00	-7,76	-4,40	0,19	7,07	0,00	4,76
MS	-10,90	10,78	0,00	-1,92	0,00	4,41	-11,92	-8,09	7,50	-3,94	0,00	4,25	0,00	1,83	0,00	5,09	-8,47	0,72	0,00	6,15	4,76
PR	-10,45	9,32	-5,10	-1,37	6,32	4,41	-10,82	-2,16	4,40	-2,72	-1,95	7,87	5,45	1,06	8,24	6,67	-5,65	2,20	7,44	9,71	5,74
RS	-6,65	0,00	0,00	-2,37	5,74	-1,57	0,50	0,00	4,40	-0,73	-3,05	3,36	5,45	2,81	8,24	9,99	-2,51	1,94	7,44	5,21	-2,59
SC	-10,30	0,00	0,00	5,92	-5,21	-2,90	-5,90	0,00	4,40	3,65	-3,08	-0,33	5,45	1,37	8,24	0,01	-2,02	2,48	7,44	-0,39	-6,38

Source: Own elaboration based on Tanure (2020).

**Table B4: Five-year Land Productivity Shocks in Large-scale Agricultural Sectors (%) (RCP 8.5 Scenario) (2021-2050)**

FU / Sector	Banana	Coffee	Cashew Nuts	Orange	Grape	Others. Perm.	Pineapple	Cotton Fiber	Peanut	Rice and Cereals	Potato	Sugarcane	Onion	Beans	Tobacco Leaf	Cassava	Corn	Soybeans	Tomato	Wheat	Others. Temp.
AC	-9,24	-0,23	0,00	-10,89	0,00	7,93	-3,37	0,00	2,12	-0,10	0,00	2,15	0,00	-3,67	6,48	-7,09	-2,55	0,00	0,00	0,00	4,71
AP	0,00	0,00	0,00	-10,10	0,00	0,23	6,27	0,00	0,00	-1,90	0,00	0,00	0,00	0,00	0,00	-9,75	-9,16	0,00	0,00	0,00	4,89
AM	-6,00	3,86	0,00	6,77	0,00	0,74	4,60	0,00	0,00	-1,61	0,00	-0,34	0,00	-2,92	0,00	-5,41	-3,33	0,00	0,00	0,00	-0,90
PA	-4,87	-5,45	-2,52	0,96	0,00	1,55	-5,55	0,00	-3,64	-1,46	-9,29	5,20	0,00	-2,54	-9,24	-8,13	-6,95	-1,22	-10,13	0,00	3,01
RO	-10,78	1,59	0,00	-10,87	0,00	6,23	-4,00	0,00	-7,94	-1,36	0,00	3,86	0,00	-3,71	0,00	-8,70	-5,25	-0,05	4,47	0,00	6,81
RR	2,61	0,00	0,00	5,88	0,00	-3,79	-9,49	0,00	0,00	-3,16	0,00	3,42	0,00	-2,27	0,00	-7,89	-6,68	-5,11	0,00	0,00	4,89
TO	-8,77	0,00	-12,14	-7,65	0,00	3,60	-11,03	0,00	0,60	-1,84	0,00	11,51	0,00	-2,78	0,00	-3,75	-8,45	-0,78	0,00	0,00	4,89
AL	4,05	0,00	8,36	-7,33	0,00	-5,25	5,01	-7,55	-4,78	1,18	7,46	-1,98	0,00	-6,93	0,36	-7,50	-3,81	0,00	0,00	0,00	4,32
BA	-6,78	-5,53	8,36	-7,92	0,00	3,57	9,42	-11,21	3,58	4,48	-11,00	0,17	7,38	-7,61	11,43	-7,42	-7,86	-2,49	-2,78	0,00	-5,92
CE	-0,08	-5,90	-3,04	6,75	0,00	-1,39	-0,44	11,08	-3,47	2,26	0,00	-0,30	8,77	-3,40	6,48	-1,71	-3,21	-1,61	-1,51	0,00	-5,16
MA	-4,83	0,00	-6,55	-5,03	0,00	3,60	-6,89	0,00	2,54	0,96	0,00	8,32	0,00	-2,91	0,00	-0,03	-6,88	-1,53	0,00	0,00	7,91
PB	-5,19	-3,57	9,27	-7,94	-10,14	3,32	2,59	-8,78	3,58	1,44	-2,32	-1,27	10,53	-6,37	5,40	-6,19	-4,72	0,00	7,74	10,35	-4,64
PE	-4,91	-2,98	7,00	-8,42	-11,47	5,98	10,89	-10,75	6,07	3,48	1,37	-0,08	7,38	-7,31	0,00	-7,09	-5,24	0,00	9,96	0,00	-5,13
PI	1,05	-2,86	-3,87	10,31	0,00	3,60	0,00	-10,42	-1,65	1,61	0,00	1,99	0,00	-3,77	0,00	0,84	-6,98	-2,21	-8,35	0,00	-1,23
RN	-0,65	0,00	8,76	0,00	0,00	-2,77	7,97	-4,12	0,00	0,84	0,00	-1,41	-1,31	-5,11	5,36	-6,19	-2,27	0,00	1,33	10,43	-1,82
SE	-2,70	0,00	0,00	-7,33	0,00	-5,12	6,27	0,00	-6,04	2,14	4,80	-2,76	0,00	-7,38	-2,47	-7,63	-4,14	0,00	0,00	0,00	-4,35
ES	-10,02	-4,50	0,00	9,19	-9,98	0,94	-9,06	0,00	5,37	3,82	-8,37	-1,48	7,38	-8,26	0,00	-6,07	-6,52	0,00	-2,66	0,00	-5,99
MG	-7,51	-2,11	0,00	-8,33	11,54	3,60	-10,62	-7,57	4,61	0,89	3,42	6,41	-6,29	-6,38	2,82	-6,87	-7,43	-0,58	-7,39	7,20	-1,41
RJ	-10,02	-5,42	0,00	0,59	0,00	4,01	-8,07	0,00	0,00	4,25	-3,96	-2,97	0,00	-6,68	0,00	-6,44	-4,96	0,00	-7,94	0,00	-6,53
SP	-10,65	4,05	0,00	-7,06	8,98	3,60	-12,16	11,08	8,90	3,09	-5,68	9,58	1,91	-1,60	6,48	2,45	-6,75	1,81	-6,72	4,64	4,89
GO	-6,86	-3,63	0,00	-9,81	0,00	3,60	1,71	-9,44	-0,35	-0,16	-2,55	8,90	-11,45	-5,86	0,00	-6,01	-7,82	-0,47	-7,88	7,20	5,71
MT	-11,37	2,86	0,00	2,60	0,00	3,60	-10,39	-9,39	-6,14	-2,07	4,38	6,39	0,00	-4,71	0,00	-8,42	-5,78	0,46	10,75	0,00	4,89
MS	-11,54	4,92	0,00	-3,36	0,00	3,60	-12,15	-10,65	7,26	-5,44	0,00	6,39	0,00	3,39	0,00	4,36	-9,10	1,33	0,00	7,20	4,89
PR	-11,26	10,90	-6,08	-0,95	8,98	3,60	-11,16	-7,11	4,60	-3,91	-2,38	11,40	7,38	-0,32	6,48	5,97	-7,11	2,41	10,54	7,20	4,89
RS	-10,21	0,00	0,00	2,11	11,94	-0,62	-4,82	0,00	4,60	-1,25	-4,09	4,60	7,38	2,20	6,48	8,66	-4,09	2,02	7,74	7,67	1,00
SC	-11,61	0,00	0,00	10,56	2,09	-2,75	-8,02	0,00	4,60	4,57	-3,14	-0,62	7,38	-0,17	11,17	-4,30	-3,59	2,65	7,74	1,60	-6,43

Source: Own elaboration based on Tanure (2020).

APPENDIX C - Level of economic activity of the agricultural sectors per Federation Unit

Table C1: Activity Level of agricultural sectors by Federation Unit in 2050 (accumulated % change over baseline scenario) (RCP 4.5)

Sector / FU	RO	AC	AM	RR	PA	AP	TO	MA	PI	CE	RN	PB	PE	AL	SE	BA	MG	ES	RJ	SP	PR	SC	RS	MS	MT	GO	DF	
Family Farming Rice	0,31	0,19	0,39	1,55	0,55	2,04	0,16	0,32	0,14	0,12	-0,39	-0,15	0,23	0,29	0,04	0,74	0,81	0,68	0,81	0,33	0,22	-0,35	-0,13	0,34	0,11	0,39	0,05	
Large-scale Rice	-0,52	0,62	-0,93	-1,91	-1,79	-1,63	-2,08	-0,47	0,19	-0,32	-1,70	-1,28	1,35	-1,63	-0,98	2,95	-0,19	2,15	2,39	1,95	-2,87	3,81	-1,75	-4,21	-1,58	-0,19	0,10	
Family Farming Wheat and Cereals	-0,72	-0,73	-0,72	-0,72	-0,72	-0,74	-0,72	-0,72	-0,72	-0,72	-0,72	-0,72	-0,72	-0,72	-0,69	-0,72	-0,65	-0,72	-0,70	-0,72	1,31	1,30	1,33	1,29	1,37	-0,68	-0,72	-0,73
Large-scale Wheat and Cereals	-1,49	-1,48	-1,48	-1,48	-1,47	-1,46	-1,48	-1,44	-1,43	-1,44	0,82	1,20	-1,42	-1,43	-1,46	-1,44	9,82	-1,50	-1,51	-0,61	8,70	-1,77	4,20	5,20	-1,49	9,02	-1,51	
Family Farming Corn	-0,77	-0,71	-1,15	-0,02	-1,31	-3,53	-0,42	-0,60	-0,47	-0,37	-1,09	-1,33	-1,63	-1,59	-2,07	-1,99	-1,71	-2,40	-1,65	0,88	0,86	0,25	0,78	1,28	0,18	-1,07	-0,02	
Large-scale Corn	-5,33	-2,02	-3,34	-8,81	-6,11	-11,28	-8,60	-6,08	-5,68	1,30	2,01	-2,10	-4,14	-3,48	-4,39	-8,51	-7,56	-7,41	-4,79	-7,01	-7,52	-3,06	-3,09	-10,94	-5,88	-8,43	-0,18	
Family Farming Cotton Fiber	0,12	0,12	0,14	0,14	0,07	0,12	0,15	0,14	0,10	0,14	0,13	0,10	0,06	0,09	0,13	0,11	0,05	0,16	0,11	0,04	0,06	0,07	0,07	0,10	0,15	0,13	0,13	
Large-scale Cotton Fiber	0,06	0,06	0,08	0,09	0,10	0,12	0,16	0,25	-7,32	5,74	0,65	-4,65	-9,64	-7,49	0,21	-10,05	-3,79	-0,01	-0,21	9,90	-2,04	-0,13	0,07	-7,43	-4,15	-5,14	0,00	
Family Farming Sugarcane	0,38	0,47	0,27	0,77	0,06	0,29	0,14	0,20	0,11	0,27	0,38	0,24	0,36	0,88	0,42	0,17	0,13	0,36	0,29	-0,17	-0,22	0,01	-0,07	-0,21	0,10	0,09	0,31	
Large-scale Sugarcane	-0,75	-2,01	-4,87	0,27	0,43	-2,43	7,68	4,63	-3,09	-3,71	-3,96	-3,30	-1,51	-4,18	-4,81	-1,15	2,62	-2,73	-5,16	5,02	7,09	-3,04	1,75	3,03	9,01	4,51	-2,44	
Family Farming Soybeans	-0,96	0,06	0,07	0,10	-0,55	0,02	-0,43	-0,75	-0,81	0,06	0,33	0,08	-0,14	0,08	0,06	-0,56	-0,93	0,09	0,06	-0,28	0,04	0,14	0,17	0,11	-0,99	-0,88	0,07	
Large-scale Soybeans	-0,10	0,03	0,04	-5,78	-1,70	0,03	-1,03	-1,63	-2,19	-1,64	0,06	0,07	0,05	0,06	0,04	-2,58	-0,71	0,03	0,02	1,90	2,51	2,83	2,23	0,85	0,26	-0,69	0,04	
Family Farming Cassava	-0,17	-2,36	-3,10	-8,21	-8,37	-11,38	-7,65	2,40	4,48	6,66	-1,18	-1,84	-4,10	-3,78	-4,40	-3,71	-3,56	6,49	6,62	-2,81	-1,35	10,20	4,67	-9,12	-8,30	6,90	2,53	
Large-scale Cassava	-2,10	-1,71	-1,29	-1,84	-2,11	-2,63	-0,36	0,44	0,61	0,04	-1,07	-1,03	-1,13	-1,31	-1,24	-1,07	-1,11	0,11	-0,31	0,73	1,28	-0,09	2,07	1,02	-2,08	-1,00	-0,03	
Family Farming Tobacco Leaf	0,53	0,37	0,16	0,55	0,58	0,49	0,37	0,36	0,16	0,15	0,08	0,08	0,02	0,03	-0,15	0,62	0,45	0,42	0,56	0,91	1,32	1,06	0,84	0,50	0,57	0,45	0,52	
Large-scale Tobacco Leaf	0,20	0,20	0,21	0,20	0,16	0,19	0,17	0,18	0,18	0,21	0,15	0,15	0,17	0,14	0,11	0,13	0,15	0,16	0,17	0,19	0,21	0,21	0,20	0,18	0,19	0,18	0,17	
Family Farming Tomato	-0,04	-0,01	0,01	0,01	-0,05	0,00	-0,03	-0,01	0,00	0,00	-0,02	0,00	0,01	-0,01	0,04	0,06	0,00	0,03	-0,03	-0,12	-0,08	-0,09	-0,09	-0,07	-0,04	-0,06	-0,01	
Large-scale Tomato	-0,11	0,04	0,04	0,04	-0,22	0,04	0,05	0,04	-0,06	0,16	0,22	0,20	0,27	0,04	0,04	-0,02	-0,10	0,00	-0,13	-0,11	0,18	0,18	0,18	0,04	0,20	-0,13	0,05	
Family Farming Potato	0,15	0,19	0,22	-0,01	-0,06	-0,01	0,11	0,01	0,01	-0,03	-0,01	-0,04	-0,07	-0,13	-0,14	-0,09	-0,01	-0,12	-0,12	0,05	0,02	0,05	0,09	0,09	0,09	0,13	-0,01	
Large-scale Potato	0,02	0,02	0,03	0,03	-0,54	0,01	0,03	0,02	0,03	0,03	0,03	-0,26	0,18	0,27	-0,18	-0,95	0,28	-0,75	-0,25	-0,24	-0,12	-0,22	-0,21	0,02	0,26	-0,10	0,03	
Family Farming Onion	0,38	0,06	0,06	0,05	-0,03	0,06	0,06	0,08	0,02	0,19	0,29	0,29	0,02	0,07	0,07	-0,13	-0,23	-0,24	-0,22	-0,26	-0,02	0,02	-0,02	-0,18	0,06	0,40	0,05	
Large-scale Onion	0,03	0,03	0,03	0,03	0,02	0,02	0,03	0,02	0,02	0,14	-0,14	0,05	0,20	0,02	0,03	0,28	-0,21	0,19	0,03	-0,03	-0,17	0,17	0,17	0,03	0,04	-0,36	0,03	
Family Farming Peanuts	0,04	-0,02	0,02	-0,26	0,00	-0,06	0,12	0,03	0,09	0,01	-0,02	-0,02	0,07	-0,09	-0,11	0,10	0,12	0,09	-0,06	0,03	0,00	0,10	0,08	0,07	0,07	0,13	-0,05	
Large-scale Peanut	-1,23	-0,24	-0,30	-0,29	-0,54	-0,32	-0,04	-0,13	-0,50	-0,95	-0,29	-0,03	0,07	-0,80	-0,91	0,01	0,01	0,22	-0,32	0,33	0,18	0,14	0,12	0,31	-0,99	-0,44	-0,31	
Family Farming Pineapple	0,06	0,04	0,17	-0,45	0,11	0,17	0,08	0,04	0,20	0,08	0,02	0,02	0,15	0,06	-0,03	0,17	0,08	-0,16	-0,21	-0,48	0,10	0,14	0,16	-0,36	-0,19	0,43	0,06	
Large-scale Pineapple	0,04	0,03	0,18	-0,11	0,07	0,10	-0,06	0,03	0,01	0,07	0,08	0,13	0,09	0,14	0,09	0,07	-0,12	-0,14	-0,11	-0,21	-0,18	-0,08	0,03	-0,19	-0,13	0,15	0,03	
Family Farming Banana	-6,26	-4,36	-1,37	4,36	-0,91	3,30	-0,79	1,65	5,09	1,15	1,80	-0,75	1,08	4,91	4,52	1,50	-1,59	-3,29	-4,40	-6,50	-8,37	-0,05	-6,40	-10,61	-7,08	2,68	6,66	
Large-scale Banana	-4,96	-3,59	-2,15	2,96	-1,39	0,48	-1,99	-3,39	3,85	1,04	2,04	0,21	1,34	2,83	4,77	2,06	-0,93	-1,99	-2,76	-3,25	-4,75	-4,55	-2,72	-5,21	-4,96	-7,77	0,64	
Family Farming Beans	0,51	-2,16	-2,07	4,09	2,35	-12,99	9,48	0,38	4,78	1,34	-2,11	-4,06	-5,86	-5,92	-6,63	-6,75	-6,17	-7,68	-8,89	2,72	-1,35	-2,66	2,63	4,98	6,24	4,72	1,54	
Large-scale Beans	-3,34	-3,30	-2,69	-2,77	0,60	0,84	-0,88	-0,51	-0,19	0,73	-1,78	-3,55	-5,25	-4,54	-5,63	-5,13	-4,20	-7,21	-4,05	0,84	1,72	2,11	3,94	2,82	-4,47	-3,77	0,92	
Family Farming Cashew Chestnut	-0,05	-0,04	-0,03	-0,04	-6,03	-0,11	-5,46	6,14	2,66	0,11	-1,84	-3,26	-4,59	-1,41	4,28	-3,95	-0,03	0,08	0,09	0,06	0,31	0,04	0,03	0,02	-6,77	0,03	0,05	
Large-scale Cashew Chestnut	0,01	0,01	0,01	0,02	2,59	-0,01	-5,43	2,93	-2,47	2,51	2,09	-0,34	-2,23	-1,11	-0,01	-0,73	0,06	0,00	0,02	-1,16	-2,18	0,03	0,02	0,02	0,04	0,02	0,01	
Family Farming Grape	0,90	0,90	0,90	0,88	0,89	0,88	0,91	0,94	0,92	0,92	0,90	-0,99	-0,66	0,89	0,89	-1,04	-0,52	-0,72	0,87	0,73	1,24	0,48	-0,69	0,90	0,93	0,89	0,90	
Large-scale Grape	0,00	0,00	0,00	0,01	0,00	0,01	0,03	0,03	-0,04	-0,01	0,37	-0,08	-0,03	-0,01	0,01	0,26	0,11	-0,02	0,23	0,22	-0,29	0,22	0,00	0,01	-0,01	0,00	0,00	
Family Farming Out. temp crop.	-1,40	-5,09	0,26	8,25	-2,85	-10,18	10,11	9,42	15,68	-5,29	-8,77	-1,28	-1,99	-7,53	-10,69	0,61	0,19	-8,42	-12,40	4,49	8,35	8,86	5,90	1,68	9,84	18,93	-2,02	
Large-scale Out. temp crop.	2,18	0,75	-0,28	7,76	1,82	8,12	20,18	11,50	-4,54	-5,90	12,20	-4,34	-2,39	11,21	-1,26	-4,62	-5,10	-3,68	-6,46	6,65	12,67	-13,84	-5,53	10,92	10,10	0,56	-0,13	
Family Farming Orange	1,58	-0,03	2,02	1,74	1,46	1,70	-1,76	1,29	2,39	-1,25	-1,65	-1,90	-1,81	0,25	-1,13	-1,46	0,42	-0,56	1,41	-0,99	-1,03	-0,61	-0,17	-2,28	0,56	0,86	0,11	
Large-scale Orange	-10,44	-10,62	12,89	12,93	12,48	-10,42	-4,33	-1,51	18,48	13,12	3,27	-8,87	-8,94	-6,43	-4,53	-6,07	-6,34	12,08	6,52	-5,60	11,19	11,61	-0,13	5,23	15,71	-8,40	3,40	
Family Farming Coffee Grains	-2,22	-3,20	0,43	-8,68	-6,11	-0,90	-1,05	-6,76	-8,66	-5,63	-3,89	-5,31	-5,41	-6,61	-0,99	-6,46	-3,80	-5,14	-5,16	5,80	4,01	3,92	7,53	4,05	0,19	-4,15	-1,10	
Large-scale Coffee Grains	-2,22	-1,40	1,08	-0,34	-5,49	-0,29	-0,33	-0,26	-1,47	-4,05	-0,25	-0,94	-2,14	-0,28	-0,32	-4,22	-1,88	-2,94	-4,33	1,36	5,99	-4,00	6,91	1,14	-3,24	-0,34		
Family Farming Out. perm crop.	-10,00	-8,36	-8,19	-17,01	-11,87	-14,29	19,76	3,71	14,63	-7,16	-13,20	-7,99	-3,29	-13,77	-12,47	-5,40	1,01	-3,52	0,29	7,48	6,82	7,20	9,62	8,90	-0,16	7,31	0,11	
Large-scale Out. perm crop.	0,39	4,56	-2,58	-9,23	-6,70	-6,08	6,76	10,08	11,62	-8,09	-8,51	-1,03	2,80	-11,64	-10,19	0,99	10,77	-1,38	3,12	6,36	6,67	-4,61	-1,45	6,70	6,73	12,42	-0,25	
Family Farming	-2,13	-2,31	-1,14	-2,31	-4,88	-8,64	0,15	2,14	3,55	4,47	-2,45	-1,27	-2,04	-2,45	-3,72	-1,26	-2,24	-4,01	-1,68	0,91	0,68	1,31	2,47	-6,20	7,92	0,56	0,56	
Large-scale Agriculture	-1,13	-1,60	-0,36	-3,10	-1,00	5,44	-0,77	-1,70	-2,92	1,36	2,94	-2,37	-0,68	-3,59	-3,68	-4,18	-1,50	-2,77	-3,22	2,42	1,30	0,17	0,98	-0,74	-1,09	-0,71	0,04	

Source: Own elaboration based on the results of the AGRO-BR model

Table C2: Activity Level of agricultural sectors by Federation Units in 2050 (% change over baseline scenario) (RCP 8.5)

Sector / FU	RO	AC	AM	RR	PA	AP	TO	MA	PI	CE	RN	PB	PE	AL	SE	BA	MG	ES	RJ	SP	PR	SC	RS	MS	MT	GO	DF
Family Farming Rice	0,05	-0,05	0,15	1,14	0,62	1,93	0,29	0,56	0,40	0,38	-0,06	0,20	0,39	0,63	0,26	0,88	1,05	1,02	1,13	0,47	0,31	-0,14	0,02	0,10	0,00	0,43	0,01

**ECONOMIC IMPACTS OF DROUGHTS UNDER FUTURE PROJECTIONS  
OF CLIMATE CHANGE: A CASE STUDY FOR SÃO PAULO  
METROPOLITAN AREA**

**Karina Simone Sass, Eduardo Amaral Haddad**

University of São Paulo, Brazil

**ABSTRACT**

Drought is one of the biggest challenges climate change can impose on cities. It can cause serious socio-economic problems by affecting water supply, industrial production, the price of food and energy, and actual income. Despite the importance of the evaluation of such impacts, there is a lack of evidence on the effect of climate change and droughts on urban areas, especially on industrial activities. This work aims to fill this gap by evaluating the socioeconomic impacts of projected droughts on the São Paulo Metropolitan Area (SPMA), in Brazil. Currently, this region is in highly critical conditions of water availability and it is subject to the occurrence of hydrological droughts.

The method of the work comprises three stages. Firstly, we estimate a dynamic panel data model to evaluate the direct effect of droughts on the added value of twenty-one industrial sectors. An Annual Weighted Cumulative Drought Severity Index represents the drought conditions in the regressions. Secondly, a frequency analysis identifies the frequency and intensity of future critical drought events using climate change scenarios. Lastly, we combine the result from previous stages to build scenarios representing future drought direct economic impacts. Then, a Spatial Computable General Equilibrium Model (SCGE) performs simulations with those scenarios to measures the economy-wide effects of the projected droughts.

The results show severe droughts are likely to occur soon in SPMA, and they can impose negative impacts on the production of water-intensive sectors, such as food production and metallurgy. Those effects spread through the economy, affecting several other economic activities. The results from the simulations also allow the construction of a local economic vulnerabilities index, which can be useful for implementing climate change adaptation strategies and economic development policies.

## **Special Session: SS40.2 - The productivity gap and the re-launch of productivity in Europe**

**16:00 - 17:15 Thursday, 27th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89993853386>**

**Chair Roberta Capello**

**TOWARDS AN INTERPRETATION OF LABOUR PRODUCTIVITY  
GROWTH: PATTERNS OF REGIONAL COMPETITIVENESS IN  
EUROPEAN REGIONS**

**Roberto Camagni, Roberta Capello, Giovanni Perucca**

Politecnico di Milano, Italy

**ABSTRACT**

The increase of labour productivity induced by technological progress is typically interpreted as the main determinant of regional competitiveness. In the last decades, however, the empirical verification of this mechanism provided contradictory results. We claim that labour productivity growth is just one of the sources on which regional competitiveness relies, being increasingly dependent on output quality improvements and that the combination of the different indicators is useful to produce different patterns of regional competitiveness. We offer a methodology for their measurement and an application to European regions. Our analysis shows that, even if structural differences persist, several regions in Eastern countries moved towards competitiveness strategies analogous to those of Western Europe.

## REGIONAL REINDUSTRIALIZATION PATTERNS AND PRODUCTIVITY GROWTH IN EUROPE

**Roberta Capello, [Silvia Cerisola](#)**

Politecnico di Milano, Italy

### ABSTRACT

In recent times, and especially after the 2008-2009 economic crisis, we have witnessed a decline in productivity growth in the EU and the literature has often been referring to productivity paradox and/or productivity gap. However, the situation is in fact highly diversified at the regional level. In particular, the industrial structure of GVA has substantially changed over the last two decades and although a decrease in the share of manufacturing VA is a general (almost physiological) trend in advanced economies, it has been recognized that the EU needs to reverse the declining role of industry within its boundaries, strengthening industrial competitiveness to enable the transition to a low-carbon and resource-efficient economy (reindustrialization).

Starting from the critical issues related with the deindustrialization process, the present paper aims at highlighting different possible ways of reindustrializing and at highlighting their role in productivity growth. In more details, a regional reindustrialization may occur either reinforcing those sectors in which the areas were already specialized; or increasing the presence into more dynamic sectors and acquiring new know-how; or exploiting the pre-existing knowledge to reindustrialize in local core sectors, although without strengthening the specialization in those specific sectors; or, finally, reindustrializing in non-core sectors (niches) without improving the specialization in those sectors. After identifying reindustrializing NUTS2 regions in the EU and the associated reindustrialization patterns, this work provides an econometric application meant at highlighting the effects of the different reindustrialization typologies on regional productivity growth at the sectoral, manufacturing, and aggregated level, also considering specialization features in advanced rather than traditional manufacturing sectors.

## WHEN YOUR CLIENT MOVES ABROAD: FORCED UPGRADING AND SUBCONTRACTORS' PERFORMANCES IN THE MANUFACTURING SECTOR

[Jacopo Canello](#), [Nicoletta Giudice](#)

University of Groningen, Netherlands

### ABSTRACT

The aim of this contribution is to assess how small local subcontractors operating in low-tech manufacturing industries accomplish upgrading strategies in response to economic and structural shocks. The main assumption is that, when the local environment becomes more vulnerable as a result of disruptions, subcontractors' upgrading often occurs out of necessity. In such circumstances, local actors are forced to change their status quo operations to survive global competition.

The empirical analysis will focus on the 2008-2015 period and will exploit novel firm-level data extracted from the Italian Ministry of Economics and Finance Annual Survey (IMEFAS), using a sample of Italian subcontractors operating in the clothing and footwear industry. In this research, the shock is represented by production relocation decisions of client firms in the regions where subcontractors are operating. The analysis focuses both on captive offshoring (investments in existing or new production facilities abroad) and on offshore outsourcing (establishment of new subcontracting relationships with foreign suppliers). The aim is to assess whether 'forced' upgrading (i.e. upgrading in response to production relocation) has the same beneficial effects on subcontractors' performance as the standard upgrading processes identified by the literature.

This research aims to integrate the literature on economic resilience and that on Global Value Chains (GVCs), providing a novel perspective on upgrading. Moreover, the IMEFAS database allows to shed light on a 'grey area' of the manufacturing industry which has been overlooked by previous empirical research. This lack of contributions is surprising, considering small subcontractors represent a significant share of manufacturing employment in several European regions. These firms are particularly vulnerable to global transformations: therefore, their ability to cope and react to sudden changes is crucial to increase the resilience of the economic systems in which they operate.

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# PARALLEL SESSIONS (15)

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## National Session: SS63 - Chilean Regional Science



**17:30 - 18:45 Thursday, 27th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/85253483318>**

**Chair Yasna Cortés Garriga**

## PUBLIC SPENDING AND ECONOMIES OF SCALE IN PARTIAL FISCAL DECENTRALIZED GOVERNMENTS: THE CASE OF CHILE

[Alicia Chavez](#), [Dusan Paredes](#)

Universidad Catolica del Norte (UCN), Chile

### ABSTRACT

Economies of scale derived from over-urbanization could affect the average cost of public spending in some cities and, as a consequence, undermine the equal access to local public goods among municipalities. Those that reach economies of scale would be able to supply the basic required local public goods plus other additional benefits and opportunities, while those that do not achieve them would face problems to even provide the basic ones, causing an unequal supply between cities. Under such setting, there should exist redistributive spatial policies that compensate this inequality; if not, people that live in less concentrated regions could see their rights affected. This paper presents a framework for the assessment of economies of scale in local public spending in Chile, which is an interesting case because of its well-known particular geographical features as well as its high fiscal heterogeneity. Chile is characterized by a partial fiscal decentralization model, in which all municipalities receive funds from the central government to satisfy the minimum acceptable standard of living, but they can also complement with own funds generated by local collection to offer additional goods and services.

Empirical evidence of economies of scale has focused on centralized economies, but this issue must also be considered in decentralized economies. The behavior of local governments under a centralized model could differ from the ones under a partial fiscal decentralization model. While the latter, who receive funds from the central government and are in charge of the provision of local public goods, may be interested in achieving economies of scale to use efficiently their resources; the former may not be interested in doing so because the central government is who controls the provision of local public goods. In this sense, it is important to address the presence of economies of scale in local public spending in non-centralized governments; that is, either in decentralized or partial fiscal decentralized governments. Therefore, for the purposes of this paper, we estimate the population level in which a reduction in the average cost of provision of local public goods occurs and we differentiate between municipalities with high and low fiscal dependence from the central government. Furthermore, we follow a theoretical model of cost efficiency that takes into account spatial interactions and spillover effects among neighboring jurisdictions.

Our preliminary results show that Chilean municipalities reach an optimum population level around 700,000 inhabitants, which is very high; in fact, only 2 municipalities would fall into this level. Once we control for the fiscal heterogeneity of Chile, we obtain that municipalities with high fiscal dependence reach their optimum population level around 45,000 inhabitants, while the ones with low fiscal dependence reach it around 700,000 inhabitants. This fact highlights the importance of considering territorial differences when addressing public financial issues and the local provision of local public goods.

## THE EFFECT OF SUBWAY EXPANSION ON TRAVEL TIMES IN SANTIAGO-CHILE. EVIDENCE FROM UBER DATA MOVEMENT

[Ariel Arcos](#)<sup>1</sup>, [Bernardo Lara](#)<sup>2</sup>, [Dusan Paredes](#)<sup>1</sup>

<sup>1</sup>Universidad Catolica del Norte, Chile. <sup>2</sup>Universidad de Talca, Chile

### ABSTRACT

According to the INRIX 2020 report, 3 of the 5 cities with the highest traffic congestion problems belong to Latin America. These problems are related to high urban primacy and lack urban planning characteristic of underdeveloped countries. For example, in the case of Santiago de Chile, Frost & Sullivan estimate economic losses by around 2.5 billion dollars by 2018, in relative terms it exceeds seven times the local public budget the city. To solve the problems of traffic congestion, many of the Latin American countries, including Chile, have implemented transport policies. However, as Yañez-Pagans et al (2018) indicates, in Latin America there is a deficient culture of impact evaluation of transport policies. In this sense, the objective of this research is to evaluate the impact of the expansion of Metro line 6 on travel times to the main employment centers of the city. To achieve the objective, the four main destinations for work reasons are considered according to the SECTRA 2011 origindestination survey. Then, from Uber's vehicular transport services we obtain georeferenced daily travel time information between origin and destination for a period of 20 days prior to and 20 days after the opening date of Metro line 6. Using the opening of the new Metro line as an exogenous shock that modifies travel patterns and that allows evaluating its causal impact on traffic congestion through an interrupted time series regression estimate (ITSR).

The research hypotheses are that the new Metro line had an impact on the reduction of travel times and that this impact follows a spatial pattern. The results show that travel times are reduced after the opening of the new Metro line, but significant only for three of the four main employment centers with reductions of around 7% and 14%. Similarly, it is obtained that the impact of line 6 is spatially heterogeneous, which is reflected in the clusters formation of benefited areas and affected areas with increases in travel times, which are close to the employment centers.

## COOPERATIVES AS AN ALTERNATIVE TO REDUCE THE HIGH TERRITORIAL CONCENTRATION OF CAPITAL OWNERSHIP IN THE CHILEAN CASE

**Juan Pedro Eberhard, Patricio Aroca**

CEPR, Business School, Universidad Adolfo Ibáñez, Chile

### ABSTRACT

Many countries struggled with high levels of inequality. Territorial inequality is sometimes overlooked as an important source of inequality. Differences in the territory are associated with the distribution of capital both human and physical. However, a more nuanced source of inequality may play an important role in how to develop local economies.

Studying the value chain of dairy products in Chile, this paper shows how cooperatives can promote redistribution of profits from upstream links (manufacturing) to downstream links (agricultural), which have a territorial impact given that manufacturing ownership is highly concentrated around the Chilean Metropolitan Region.

In addition, the cooperative allows its associates to be more resilient to face an economic downturn, due to this allows the associates to receive revenues from the manufacturing activities of the cooperatives, given that manufacturing profits are larger than the ones generated by agricultural dairy production.

Using an input-output framework, it is shown that the impact is even larger when the indirect and induced effects are taking into account, especially because most of the induced effects are spent in the territory, while in the case of the large company this amount is concentrated around the Metropolitan Region.

## National Session: SS61 - Brazil Regional Science



**17:30 - 18:45 Thursday, 27th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/83942885151>**

**Chair Terciane Sabadini**

## EFFECTS OF WIND ENERGY INPUT ON THE SECTORS OF ECONOMIC ACTIVITY IN THE SEMIARID REGION OF BAHIA

[Carolina Ribeiro, Gilca Oliveira](#)

Federal University of Bahia, Brazil

### ABSTRACT

Renewable energies have been growing rapidly and gaining more and more space in the world electrical matrix in recent years. The accelerated deployment of energy from wind sources contributes to the annual reductions in CO<sub>2</sub> emissions. In the Brazilian electric matrix, wind energy already represents an 8% share in the country. From 2011 to 2018, 31 billion dollars have already invested in the wind sector. In 2017, investment in the sector represented 58% of the total invested in renewable energy. The State of Bahia has already received a large volume of investments in wind energy. The state's wind generation is located in the semi-arid region. The region has experienced the worst drought in its history in recent years. Therefore, the semi-arid region lacks policies that encourage regional development, the generation of jobs and income and actions to assist in living with the semi-arid region. In this context, it is questioned how the investments in wind energy affect the sectors of economic activity in the semi-arid region of Bahia, promoting development? Thus, the present study aims to investigate how the sectors of economic activities in the region react to investments made in the wind sector. For this purpose, it uses the input-output matrix of the semi-arid region of Bahia for the year 2015 with 40 sectors, prepared from the matrix Bahia 2015, of GERI-UFBA. The analysis uses classic indicators, economic multipliers of employment and production and hypothetical extraction of input-output sectors, in order to investigate the effects on job creation and production. The results show that the effect of wind energy contributions in the economic activity sectors of the Bahian semi-arid region, it was observed that around 18 billion BRL in wind energy has the possibility of influencing the total production of the semi-arid by more than 28 billion BRL in direct impacts and indirect. As expected, the Civil Construction sector had the highest profile. Regarding the generation of jobs, the effects of the contribution can lead to the creation of more than 3,300 jobs. The most impacted sectors were civil construction and others in the extractive industry with the possibility of generating 548 and 348 total jobs, respectively. From the above, given the progress of the wind sector in the region and the contributions made, it is observed that these positively affect several economic sectors, encouraging development. However, even with the effects of the contributions on the sectors being positive, public policies are necessary to provide a more significant development for the region. In addition, these, in turn, must consider the social and economic inequalities present in the semi-arid.

## EASING THE EFFECTS OF AUSTERITY WITH REFORMS: A REGIONAL CGE EXPERIMENT ON BRAZILIAN LABOR PRODUCTIVITY

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### ABSTRACT

This article aims to project the variation in labor productivity in response to structural reforms in Brazil necessary to offset the contractionary impacts of this agenda, considering regional heterogeneities. For this, a dynamic interregional general equilibrium model is used for 27 Brazilian federative units, allowing a bottom-up analysis. The main results show that the increase in labor productivity necessary to mitigate the contractionary effects of fiscal consolidation varies considerably between the Federation Units, relatively more onerous to the Northeast region. Macroeconomic results also follow the same pattern of regional heterogeneity. The increase in labor productivity in the states most affected by the contractionary impacts of austerity is hardly feasible due to the low prospect of household consumption, falling investment and high unemployment in a sectoral composition that has little benefit from the austerity and reforms agenda.

### KEYWORDS

Computable General Equilibrium; Fiscal Austerity; Labor Productivity; Structural Reforms.

### 1. INTRODUCTION

In the current Brazilian public debate, in parallel to the Federal Government's austere measures on the expenditure side and the attempt to adopt fiscal consolidations in the Federative Units (states) via the Federal Government's Tax Recovery Plan, there is a discussion regarding the need to approve structural reforms, such as the liberalization of the labor market, increase in the average time for workers' social security contributions and modification of the tax structure.

According to the extensive compilation of theories and empirical evidence presented in Alesina et al. (2019), fiscal consolidations can achieve expansionary results. For OECD countries, Bouis et al. (2012), Alesina et al. (2018) and Annicchiarico et al. (2013) find, to a greater or lesser extent and time to maturity, the achievement of fiscal consolidations in periods of economic stagnancy. This conclusion, supported mainly by the role of expectations, opposes the Keynesian argument that fiscal consolidations would have a contractionary effect on aggregate demand in the short-run. Thus, expansionist austerity (or expansionary fiscal contraction) can be defined as the positive correlation between fiscal adjustment, either through cutting public spending or increasing taxation, and private consumption and investment.

As this literature argues, one of the contexts that would allow expansionary results due to fiscal consolidations is the one marked by accompanying policies. These policies vary from the concomitant adoption of contractionary monetary policy and the liberalization of the capital market, according to the pioneering analysis of Giavazzi and Pagano (1990), to structural reforms in the labor market and the productive sectors (product market).

For Brazil, the impacts of fiscal austerity are still uncertain, whether at the macroeconomic and sectoral level or on the social spectrum, on the well-being of households and income distribution. Although the implementation of Constitutional Amendment (AC) 95/2016<sup>176</sup> had the goal of anchoring the expectations of economic agents, limiting the growth of public spending in a context of fiscal insolvency, as pointed out by Salto and Barros (2018), some argue on its flexibilization, given the persistence of high idle capacity and unemployment, as well as the lack of public investment in sectors such as health, education and infrastructure (GIAMBIAGI, 2019).

<sup>176</sup> Constitutional Amendment No. 95 (AC 95), of December 15, 2016, established the New Fiscal Regime (NRF) within the scope of the Federal Government's Fiscal and Social Security Budget, which will be in force for twenty financial years. The NRF sets individual limits for the Executive, for the bodies of the Other Powers, the Public Ministry of the Union - MPU and the Public Defender's Office of the Union (DPU) (MINISTRY OF FINANCE, 2018).

The history of reforms in the Brazilian state is wide and old (COSTA, 2008). These reforms, however, differ considerably from one another. If in the 1950s and 1960s they were marked by developmentalism - from the 1980s and, mainly, 1990s, it was influenced by the global liberalism (CARDOSO, 2021). Currently, reforms are constantly brought to the public debate as an essential agenda for the resumption of Brazilian growth, justified by the fact that they act to liberalize and cooperate to the private sector, in order to mitigate the eventual short-run negative impact on economic activity. due to fiscal consolidation, as part of the literature argues.

According to Anderson, Hunt and Snudden (2014), the reforms positively affect labor productivity and the level of employment through the liberalization of the labor and product market. According to Bouis (2012), flexibilities in labor laws, for example, reduce restrictions on hiring and firing employees, which, in turn, can increase labor productivity, despite the reduction in the bargaining power of the worker and increase, most of the time, precariousness and social costs (RUBERY and PIASNA, 2016; SHIN, 2012). Even social security reforms that promote an increase in the retirement age and actuarial neutrality, raise the labor force participation rate to a new balance in about 10 years according to estimates by Bassanini and Duval (2006; 2009), who, from the point of view of view of the worker, are also liable to adverse effects (BOERI et al., 2002; KODAR, 2004).

Less optimistic arguments regarding the achievement of structural reforms can be found in Rodrik (2017), who highlights the fact that despite the goal of raising the potential output of the economy in the long-run, reallocating factors to more productive sectors, its impacts are usually overestimated. For Bardaka et al. (2020), unless structural reforms are carefully planned to support productive sectors (high value-added), these policies may fail even in the long-run.

Discussions on the effects of austerity and structural reforms are scarce of regional analyzes. This is an important feature, in face of heterogeneities common to space, especially in Brazil, a continental country with great regional, social, economic and structural inequalities. These inequalities mean that the importance of public spending for the economies and well-being of households and the dynamics and productive structure itself vary considerably between regions.

For different countries, Caraveli and Tsionas (2012); Beatty and Fothergill (2013); Cabrera, Lustig and Moran (2015); Pearce (2013); Murphy (2017); Green and Lavery (2015); and Tupy and Toyoshima (2013) highlight the central role of public sector performance and government income transfers to households with regard to interregional income inequalities. The greater dependence of smaller and poorer regions on public sector action, either directly, in the administration and provision of services, or indirectly, via income transfers, is a stylized fact in the literature of regional economics, they are the so-called "economies without production".

Regarding fiscal consolidations and their regional effects, Cardoso et. al. (2019) assess the direct and indirect impacts of a fiscal austerity agenda of the Brazilian government on the country's regional and sectoral inequalities. The authors project austere scenarios for the growth of public spending in the Brazilian economy, without and with the recovery of private investment (ie, considering the hypothesis of expansionary fiscal austerity) and conclude that, even if the recovery of private investment was sufficient to offset the negative impacts of the spending cutting on economic growth, there would be worsening macroeconomic and inequality indicators between municipalities and states in the North and Northeast, relative to the rest of Brazil.

Considering the literature favorable to the positive effect of structural reforms, through labor productivity, and the one that discusses the role of the Government in regional inequalities, this article proposes to measure the increase in labor productivity necessary to offset the contractionary effect of the public spending cut on GDP, stemming from the deepening and regional extension of the fiscal austerity agenda in Brazil in the coming years. Still, considering the Brazilian regional structure, it seeks to assess the heterogeneity of eventual productivity gains in the states of the country. For this, a computable general equilibrium model (EGC) with recursive dynamics is used, calibrated for the Brazilian twenty-seven states (Federative Units). The model is based on 2015 data published by the System of National Accounts (SCN) of Brazil (IBGE, 2019) and allows a bottom-up analysis from the state to the national level.

This paper innovates when investigating the regional productivity gain to compensate the contractionary effects of fiscal austerity in Brazil, through the EGC model. Its results are in accordance with the literature on regional convergence in the Brazilian productive structure, as well as regional inequalities. Despite not considering the influence of the pandemic caused by COVID-19, the themes brought here are closely linked to this problem, both in coping with and overcoming the multisystem crisis caused by the virus.

In addition to the present introduction, the work is divided into four more sections: the first, presents the main studies related to structural reforms and their consequences on labor productivity and regional inequalities as well as the recent literature on the Brazilian productivity; then, we describe the methodology, which presents the structure of the model applied to this work, its database and the simulation strategy. In section 4 we present the results and, at last, the final remarks.

## 2. LITERATURE REVIEW

Assessments of the relation between structural reforms, labor productivity and regional inequalities are also scarce and lack consensus. For Colombia, Eslava et al. (2004) investigate the effects of product market reforms, such as removing import restrictions and foreign direct investment, introduced in Colombia in the early 1990s. Based on longitudinal data at the firm level for the period 1982-1998, they find evidence that the reforms are associated with an increase in general productivity, largely driven by the reallocation of low- and high-productivity companies. These changes had no effect on the persistent history of regional inequality in the country, as assessed by Fergusson et al. (2017). In this sense, for India, Unni, Lalitha and Rani (2001) find that liberal reforms in industry and international trade throughout the 1980s and 1990s only benefited the Gujarat region, which was already the most industrialized in the country before the reforms, in terms of value added, employment, capital and productivity. The authors also observe a general post-reform worsening in the informal sector in relation to the formal sector across the country.

To understand the recent evolution of labor productivity in Brazil, in sectorial and regional terms, as well as an international comparison, we present the following references.

Silva et al. (2016) present an international comparison of the evolution of total productivity in the period from 1965 to 2010 between Brazil, South Korea, the United States and other countries in Latin America, considering the technological effects and structural changes. According to the authors' explanation, this decomposition reveals to us whether the growth of a given economy was due to structural changes - the reallocation of labor from less productive sectors to more productive ones - or technological advances, that is, the fact that the economy is able to produce more with the same amount of inputs. The authors note that, despite the huge total discrepancy between South Korea and other countries, this evolution presents different trajectories when analyzed in shorter periods. If, until 1980, Brazil and South Korea had similar productivity growth, they find that, from the 1980s on, the technological effect was largely responsible for the fall in Brazilian productivity. In the Korean economy, on the other hand, there was a growth of 65.7% in productivity, guided by the outstanding technological effect. For the United States, they observed very low growth in the period 1965-1980, compared to other countries (7%); relative increase in the 1980s (12%); and a considerable recovery in the years extending from 1990 to 2010 (28%).

At the sectorial level, based on data from the National Accounts and the National Household Sample Survey, Veloso et al. (2015) updates the trajectory of the evolution of labor productivity in Brazil over the 1990s and 2000s. The authors show that the average labor productivity grew at a rate of 1.3% p.a. (1995-2013), with a considerable difference between the three main sectors of the economy: Agriculture (6.1% p.a.); Industry (-0.4% p.a.); and Services (0.6% p.a.).

Regionally, Galeano and Feijó (2013) analyze the decomposition of the evolution of labor productivity in industry between 1996 and 2007, considering its participation in national employment using the shift-share method. Of interest to the present study, the regional rates are: Southeast, -12.4%; South, 14.6%; North, 58.3%; Northeast, 23.9%; and Midwest, 55.5%. According to the authors, the general results show that there was a certain rearrangement of some sectors of industry between regions. However, less developed regions are still unable to absorb that portion of the declining sectors in the Southeast region, due to the low representativeness of industrial activities in the regions. With the exception of the Southeast region, the authors argue that the growth in labor productivity in the analyzed years was due more to the residual regional component, that is, to the competitiveness of the sectors themselves in the regions, than to structural changes in the sectorial composition.

In this way, Cruz and Santos (2011) analyze the dynamics of Brazilian industrial employment between 1990 and 2009 and highlight that, despite the regional spillover of industrial employment, the regions that had a relevant industrial base have moved towards specialization in industrial sectors with greater technological content, as a consequence of the externalities of these places, which, according to the authors, was more important than the tax incentives offered for the dispersion. Mendes et al. (2019) evaluate the spatial reorganization of the Brazilian manufacturing industry after 2008 and suggest a spillover of the activity towards low quality jobs, with a greater dispersion of sectors with less technological intensity and jobs with lower educational levels. The authors assume a strong correlation between sectorial technological intensity and the labor level of education and observe the prominence of the Southeast region, mainly in the state of São Paulo, with regard to employment generation of masters and doctors, in sectors of higher technological intensity. In addition to the sectorial issue, the results still suggest a possible productive transition in seek of lower labor costs.

It is important to emphasize that the dynamics of labor productivity over time, in general, was closely related to the countries' growth of product and income. For Brazil, it is worth remembering that this regional convergence has historically resulted from factors related to the action of economic policy and the economic logic of competition and location. As Ferreira and Diniz (1995) point out, the convergence of per capita income between Brazilian states in the 1970s and 1980s, the period of greatest effectiveness for industrial decentralization in the country, was associated with the development and expansion of basic infrastructure; the movement of agricultural and mineral borders; the direct

action of the State in terms of investments and the granting of subsidies and tax incentives; the crises and reversals of industrial polarization in large urban centers like Rio de Janeiro and São Paulo; and migratory movements and changes in the regional distribution of the population. These conditions are in line with the investigations made, more recently, for the Brazilian industry, as indicated by the previously mentioned works.

### 3. METHODOLOGY, DATABASE AND SIMULATION STRATEGY

The model used for the simulations is a dynamic recursive CGE model calibrated for Brazil. It follows the theoretical structure of The Enormous Regional Model (TERM), which is a model developed by the Center of Policy Studies (CoPS), in Australia, with several applications for the Brazilian economy such as Ferreira Filho and Horridge (2014); Carvalho et al. (2017); Ribeiro et al. (2018); Cardoso et al. (2019). As the following discussion present, this method differs by the version of the database and by the regional details of technological change, improving its analytical potential at the regional level.

#### 3.1 The Enormous Regional Model (TERM)

TERM is a bottom-up Computable General Equilibrium model, which means that each region in the model is considered as a separate economy and the results at the national level are aggregations of regional results. Although demand, supply, price and quantity are computed for each region separately, spatial interdependence is considered in the model through interregional trade. Therefore, the TERM approach is appropriate for analyzes in which the industrial and regional details have a relevant role. The theoretical structure of TERM follows basic neoclassical assumptions. For each Federative Unit (state), a representative household chooses a consumption basket that maximizes the Stone-Geary utility function subject to a budget constraint. Consumption is allowed to be divided between the subsistence and luxury component (supernumerary), in which only expenditures above the subsistence level affect the per capita utility (PETER et al., 1996; STONE, 1954). All economic agents (households, firms, government and investors) are allowed to choose between domestic goods (from different regional sources) and imported goods using a CES specification (Armington hypothesis), based on the differences in the purchase price of each source. The market-clearing condition is valid for all markets in all periods, adjusting prices and quantities each year.

The equation that models the production technology is the main transmission mechanism of the exercise presented in this study. Its structure defines the production of each industry and region by minimizing the production costs, following a production function in fixed proportions (Leontief type), which establishes the use of intermediate inputs and primary factors (1). Hierarchically combined with the production function, a function of constant elasticity of substitution (CES) defines the composition of the primary factors, labor and capital, employed in production (2). Associated with the inputs, intermediate or primary factors, the variables of technological change are the ones that make it possible to capture the effects of gains or losses in productivity. In this sense, productivity gains can be understood as savers of inputs / factors.

$$tot_{ir}^q = \frac{1}{tot_{ir}^t} \times MIN \left\{ \frac{int_{ir}^q}{int_{ir}^t}, \frac{prim_{ir}^q}{prim_{ir}^t}, \frac{oth_{ir}^q}{oth_{ir}^t} \right\} \quad (1)$$

$$prim_{ir}^q = CES \left\{ \frac{lab_{ir}^q}{lab_{ir}^t}, \frac{cap_{ir}^q}{cap_{ir}^t} \right\} \quad (2)$$

Where  $q$  is for quantity;  $t$ , for technology;  $i$ , for industry and  $r$ , for region.  $int$ ,  $prim$ , and  $oth$  indicates the intermediate inputs, primary factors and other production costs, respectively;  $lab$  and  $cap$  indicate the use of labor and capital factors, respectively;  $tot_{ir}^q$  denotes the total production of industry  $i$ , in region  $r$ ; and  $tot_{ir}^t$  is the technological variation in the total use of inputs in industry  $i$  in region  $r$ .

The dynamics adjustment is based on the accumulation of investments and capital stock at the regional and industry levels. According to Dixon and Rimmer (2002), for each year of the simulation, it is assumed that the rates of capital growth are determined by the willingness of investors to invest resources in an industry based on the expected rate of return. Basically, if the rate of return expected by investors is higher than the pre-established normal rate of return, the capital accumulation will be above the normal rate (Dixon and Rimmer 2002).

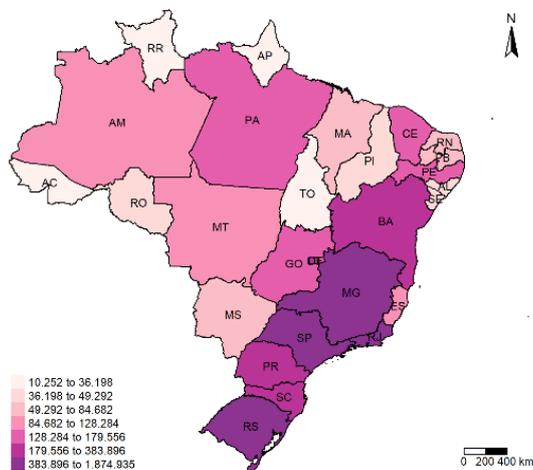
In this sense, the proposed exercise is favored by the ability of the method to capture, over the time, the effects of differentiated technological changes at the regional level on the economic system, as well as by the possibility of decomposing its effects among the main macroeconomic aggregates such as consumption, investment, employment, exports and imports.

#### 3.2 Database

The model's database is made up of 27 regions, corresponding to the Brazilian's states, and 127 sectors, listed in the Input-Output Matrix of 2015 released by the Brazilian Institute of Geography and Statistics (IBGE) (IBGE, 2018). The model's database was regionalized through a method developed by Horridge (2012), in addition to information from the System of National Accounts (SNA) of Brazil. Information on consumption is from the Brazilian 2008–2009 Household

Budget Survey (IBGE, 2011); on employment, from the Annual Report of Social Information (RAIS) (BRASIL, 2020); and on international trade, from the Comex Stat (2019), from the Foreign Trade System (SISCOMEX).

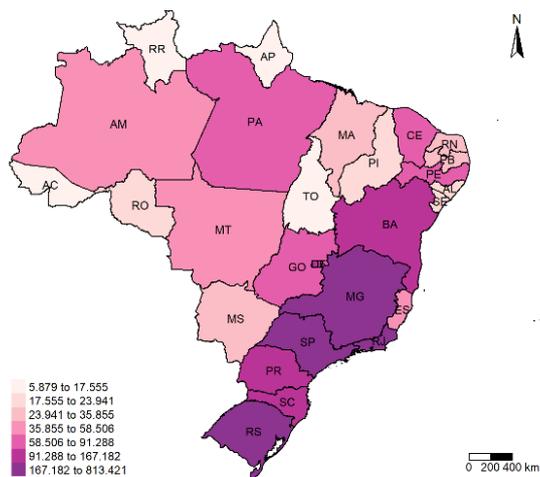
Next, we exhibit some variables from the database that are important for this study: the Gross Regional Product (GRP), by state (Figure 1), the wage bill of the labor factor in the states (Figure 2) and the representativeness of Government expenditure, by government sector, in relation to GRP in each state (Figures 3 and 4).



**Figure 1: Gross Regional Product (R\$ million), Brazil, 2015**

Source: Model's database.

Average exchange rate in 2015: 1 US\$ = 3,33 R\$.

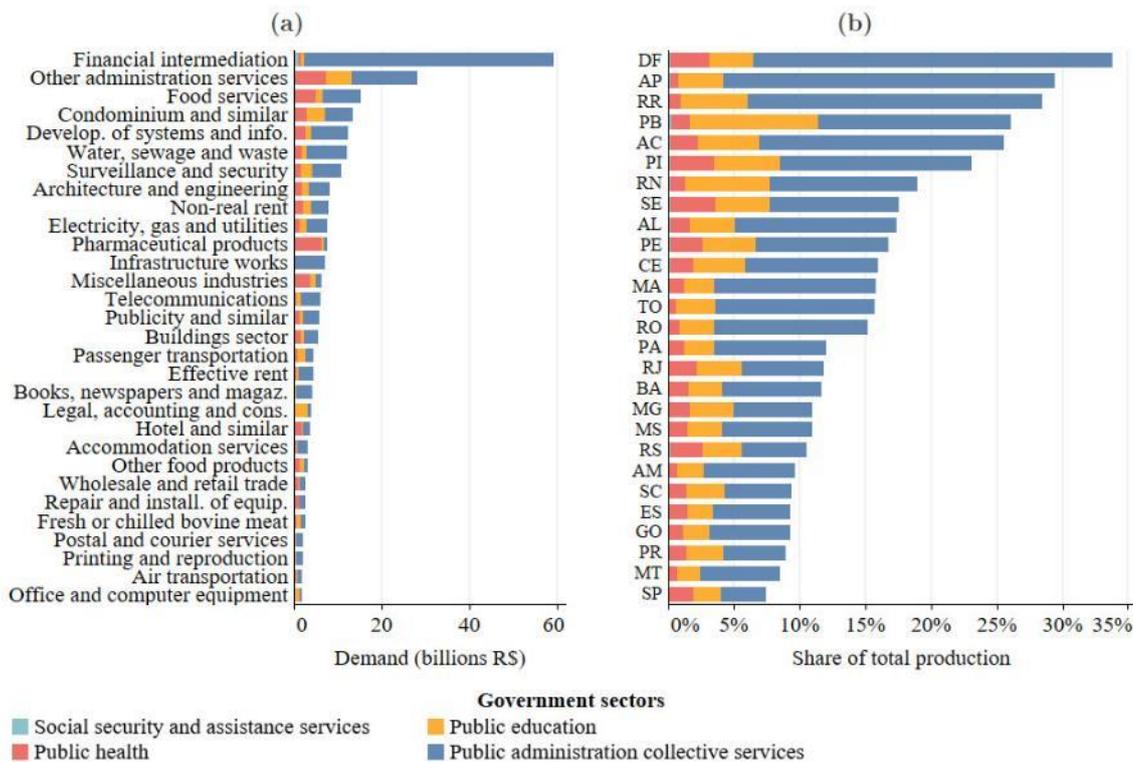


**Figure 2: Labor force remuneration on each state (R\$ million), Brazil, 2015**

Source: Model's database.

Average exchange rate in 2015: 1 US\$ = 3,33 R\$.

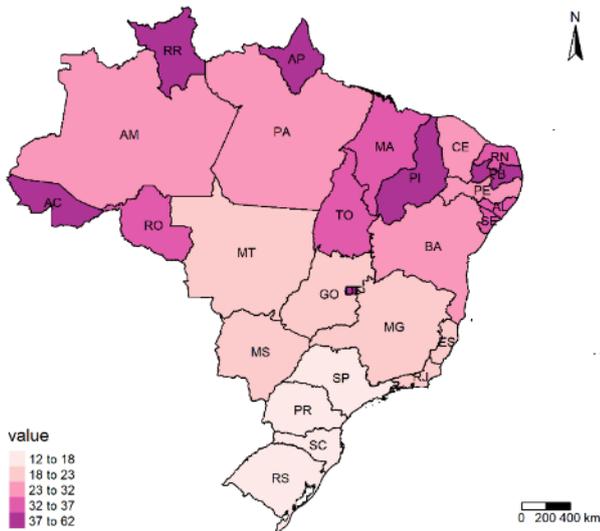
Figure 3 provides an overview of the Government's general role. In our model, public expenditure is taken under the concept of General Government, that is, it represents the total expenditure at the Federal, State and Municipal levels. Part (a) illustrates the composition of the main purchasing flows of the government sectors; in (b), we show the weight of spending on GRP of each, by sector.



**Figure 3: Main demands of Government sectors for products (a) and the share of Government sectors expenditures in the total production of the states (b)**

Source: Model's database.

It is notable that, while Government spending has a greater share in the total production of the North and Northeast of the country the wage bill is concentrated in the states with the highest GDP, mainly in the South and Southeast regions. Figure 4 illustrates the share of the General Government expenditure component in the GRP of each state.



**Figure 4: Representativeness of General Government expenditure on each Federative Unit (% of GRP), Brazil, 2015**

Source: Model's database.

In general, the illustrations indicate that the greater share of public sector consumption (spending on goods and services) in these regions makes their economic dynamics more dependent on this component of final demand. In addition, the

Government sector has a high influence in employment and consequently in the wage bill of these regions, which also affects the dynamics of the economy of these states.

### 3.3 Simulation Strategy

In order to assess the response of labor productivity required to offset the contractionary impact of the Government's shrinkage, influenced by the lasting fiscal austerity agenda currently adopted in the country, the simulation is divided into a base scenario (baseline) and a policy scenario. The simulation of the baseline updates the database as follows: for the observed period (2016–2019), we use the main official macroeconomic data for real GDP, investment, household consumption, government spending, exports, import prices and consumer price index. For the 2020-2021 period, we used a homogeneous scenario of growth at 1% and 1.5%, for these years, respectively, and, from 2022 onwards, we assumed a scenario of stationary growth of 2.5% per year. From 2020, the hypothesis that the growth of government spending follows the growth rate of household consumption is also adopted in the base scenario.

For the policy simulation, the growth in real Government consumption, exogenous, was set at a zero-percentage change, exactly representing the commitment of the fiscal adjustments initiated in 2017, according to the Constitutional Amendment (CA) 95/2016. In other words, there is no real growth in government spending on the policy scene. This assumption is kept constant throughout the simulation period (2019 to 2030). The policy scenario does not intend to strictly simulate the performance of the CA 95/2016, but of a hypothetical austerity agenda, represented by the absence of real growth in General Government spending. This implies that the General Government institutional sector loses its share in the regions' GRP over the simulation period.

The fiscal concept of the General Government gathers the intermediate consumption expenditures of the Government and personnel from the Federal, State and Municipal spheres. The policy scenario therefore represents an illustrative scenario for reducing the size of the state in relation to the economy, since states and municipalities are not, at first, under the expenditure ceiling.<sup>177</sup>

In addition to the database, the operation of CGE models depends on a large system of equations, which establishes the behavior of the variables and their interrelations. The main equation involved in the policy shock to be studied is simple:

$$GRP_r = C_r + G_r + I_r + X_r - M_r \quad 3)$$

As previously explained, the simulation consists of a relative reduction in Government spending (G) compared to the baseline, for each region  $r$ . However, to assess the reaction of labor productivity in face of such a contraction, we modify the closure of the model.

The closure is the set of hypotheses of the model, in which is defined the exogenous and endogenous variables of the system of equations. In order to simulate the expected effect of the structural reforms adopted in parallel to the fiscal consolidation, we modify the closure of the policy scenario in order to exchange the real GDP of each state, exogenous, with the respective labor productivity, endogenous, while we kept the growth of the first variable unchanged (in relation to that observed in the baseline).

In other words – we avoid an ad hoc definition by endogenously calculating the labor productivity necessary to maintain GDP growth as projected in the baseline. So, according to equation 3, the policy scenario establishes zero growth in Government spending (G) and zero deviation of GDP in relation to the baseline, supported by the other components of the equation that adjust to the expected increase in productivity described in equations 1 and 2.<sup>178</sup>

It is important to emphasize that, intrinsic to this methodology, the details of the dynamics of the labor market and real wages, referring to the recursive dynamics of the model, indicate that the intertemporal adjustment of real wages responds to fluctuations in current employment, in face of an employment trend defined by projections of the workforce growth, present in the baseline. Another important issue is that, in this CGE model, the mere announcement of this policy has only the effect of changing aggregate demand, but not expectations regarding interest and investment rates. Therefore, it can be said that our policy scenario simulates what would happen if the government maintained its commitment to zero growth in real spending, but families and companies, however, did not change their expectations regarding the future.

177 There was pressure for States to adhere to the ceiling in exchange for the postponement of payment of debt maturities with the Union. The Tax Recovery Plan, for example, was being proposed by the Union to States in exchange for negotiations regarding federal aid to the fiscal situation of the States. This plan basically followed the CA 95/2016 strategies, such as the zero real growth of the expenses. However, given the difficulty of decision by the States' legislature and the arrival of the Covid-19 pandemic crisis, nothing concrete has been established. On March 3rd of 2021, Proposal of Constitutional Amendment 189 (Emergency PCA) was approved, which sets out austerity rules for States and municipalities, which must be taken if the current expenses of this entity in relation to current revenues exceed 95%.

178 According to Cardoso (2019) and Cardoso et al. (2019), due to the relative contraction of aggregate demand, a policy scenario with Government spending growing below that projected in a baseline leads to the negative deviation of GDP and its components, with the exception of Exports, in a long-run result. In the baseline, the Government's expenditure component follows the GDP dynamics in each region.

4. RESULTS

In this section, we organize the results from three perspectives: i) at the national and regional macroeconomic level, showing the cumulative impact on the final demand and employment (2019-2030); ii) labor productivity at the state level; and iii) sectoral results at the state level. All the results are exhibited as the accumulated percentage deviation from the baseline scenario, in which the policy of austerity is not applied. Figure 5 shows the results of the national GDP and its components over the projection. Figure 6 shows the evolution of other macroeconomic variables, important for the interpretation of the results of Figure 5.

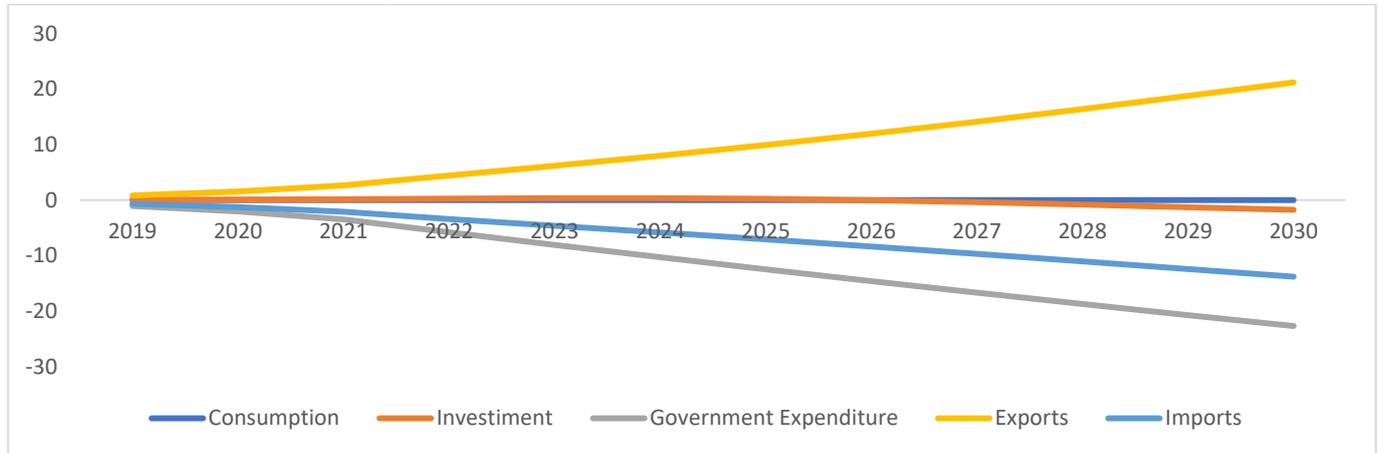


Figure 5: Macroeconomic Results - Policy Scenario - Accumulated deviation (%) to the Baseline (2019-2030)

Source: Own elaboration based on the simulation results.

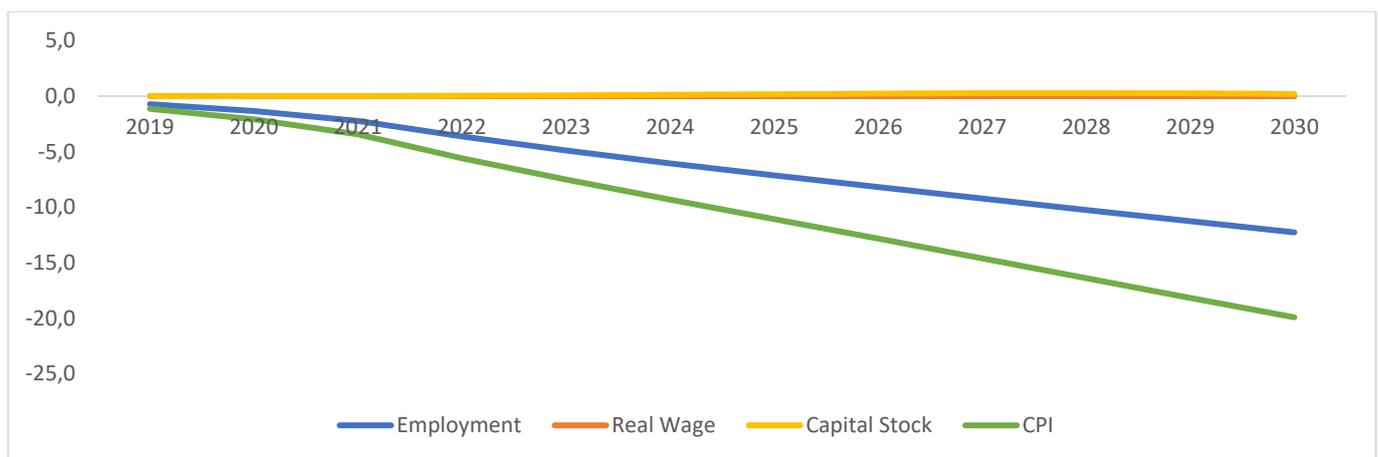


Figure 6: Other macroeconomic results - Policy Scenario - Accumulated deviation (%) to the Baseline (2019-2030)

Source: Own elaboration based on the simulation results.

As shown in the previous graphs, a shock of retraction of total government demand (Figure 5) would contribute to the fall in aggregate demand. To adjust to this fall, domestic prices adjust. This reduction in prices has two consequences: On the one hand, there is a reduction in the remuneration of factors, which generates a reduction in household consumption, contributing to amplify the contractionary effect of the cut in public spending and, on the other hand, given that international prices do not change and that exports demand responds negatively to the exchange rate (local currency/\$world), there is a change in relative prices favorable to Brazilian exports, leading to an increase in this aggregate in GDP. Here, it is assumed that the country has no influence on the global market prices, this means that Brazil has a terms of trade decline, which leads to export growth relative to imports and a trade surplus. To this condition, it is also added the fact that the increase in labor productivity contributes to the reduction of production costs.

As we can observe in Figure 5, however, household consumption remains almost equivalent to that projected in the baseline (final accumulated deviation of -0.02%), despite the employment fall (Figure 6). This result is due to the fact that the gain in labor productivity sustains the average level of wages each year, detaching them from the level of domestic prices (Figure 6).

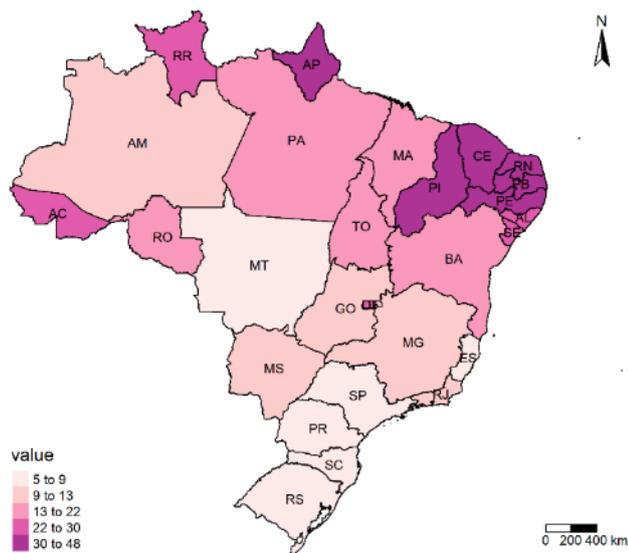
The real constraint of the public expenditure with a positive response of the labor productivity also does not drive significant growth in investment (Figure 7). Thus, even with cheaper inputs and growth in exporting sectors, the levels of income and consumption influence the rate of return on capital and contribute to keeping investment at levels similar to the base scenario, although there is a small negative deviation in the final years of the simulation. The state level results in Table 1 show that the variables vary considerably between them.

**Table 1: Macroeconomic Results by Federative Unit - Policy Scenario - Accumulated Deviation (%) from the Baseline (2030)**

Federal Unit	C	I	G	X	M	Employment
1 RO	0	-8	-23	28	-18	-12
2 AC	-12	-14	-23	29	-24	-23
3 AM	1	-1	-23	21	-10	-11
4 RR	-9	-13	-23	31	-21	-20
5 PA	-4	-3	-23	25	-17	-16
6 AP	-15	-14	-23	31	-24	-26
7 TO	-3	-10	-23	26	-20	-15
8 MA	-9	-8	-23	24	-20	-20
9 PI	-19	-15	-23	31	-26	-29
10 CE	-15	-16	-23	41	-25	-25
11 RN	-20	-23	-23	44	-29	-30
12 PB	-31	-33	-23	56	-36	-40
13 PE	-24	-26	-23	42	-31	-34
14 AL	-15	-14	-23	38	-24	-26
15 SE	-15	-10	-23	23	-19	-26
16 BA	-3	-3	-23	25	-14	-15
17 MG	2	1	-23	22	-13	-10
18 ES	3	0	-23	20	-12	-10
19 RJ	-1	0	-23	21	-13	-13
20 SP	6	2	-23	20	-11	-7
21 PR	4	1	-23	21	-12	-8
22 SC	4	0	-23	22	-12	-9
23 RS	3	1	-23	20	-12	-9
24 MS	0	1	-23	23	-15	-12
25 MT	2	1	-23	22	-14	-10
26 GO	1	-4	-23	25	-17	-11
27 DF	-14	-17	-23	29	-25	-25

Source: Own elaboration based on the simulation results.  
Sections: North; Northeast; Southeast; South and Center-West.

At the state level, the results in Table 1 indicate a significant worsening in household consumption and investment in states in the North region, such as Acre (AC), Roraima (RO) and Amapá (AP), and in the Northeast, which, with the exception of Bahia (BA), have significant numbers below 9% of accumulated negative deviation from the baseline. As can be seen, the real stagnation of Government expenditure is of equal magnitude between states; however, its impacts are different given the different share of the public sectors (public education, public health and public administration and social security) in each one, as indicated in the previous section. Exports grow more in the states most affected by the policy, in which unemployment and the fall in consumption and investment are also greater, inducing a fall in domestic prices and, therefore, in export prices. The regional heterogeneities of the results imply that the response of the labor productivity necessary to keep GDP constant is also heterogeneous in the country's states, as shown in Figure 7.



**Figure 7: Labor productivity accumulated growth, by Federative Unit (%) - Policy scenario (2030)**

Source: Own elaboration based on the simulation results.

In the model structure, the increase in productivity is given in negative values, which implies the need for less work to produce a certain quantity of product. In a similar way, we can interpret the positive values as an increase in the quantity of product that the same number of workers will be able to produce.

As can be seen in Figure 7, the results of the simulation show that the labor productivity necessary to sustain GDP in the face of reduced government spending is heterogeneous in the country. The low magnitude of accumulated growth in the states of the South, Southeast and Center-West (with the exception of the Federal District - DF) and high in most of the North and especially the Northeast regions, points out that, in relative terms, the limitation of the real growth in Government expenditure in São Paulo (SP) and Piauí (PI), for example, it is more expressive in the second, because the representativeness of Government expenditure in its GDP is much higher than in the former, in order to demand even greater growth in labor productivity in those regions most affected by fiscal austerity.

As described in the mechanisms of the shock, the positive impacts in terms of variation in production, employment and investment must occur in the sectors whose production is mainly export-oriented, especially commodities sectors. Thus, another justification for the regional heterogeneity of the results is supported by the regional distribution of the industries.

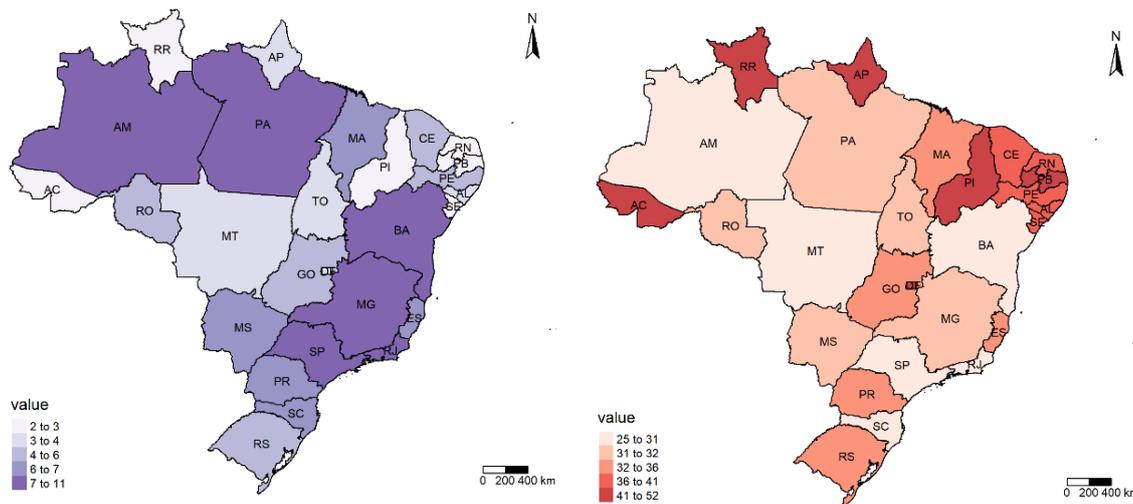
Table 2 highlights the 20 industries with the highest and lowest accumulated growth after the implementation of the policy. The list of industries that have benefited the most from the policy is more diversified and presents sectors predominantly oriented to the foreign market, with the majority belonging to the extractive and processing industries. The industries with the worst accumulated result, on the other hand, have activities aimed at the domestic market, such as public services, infrastructure, rents and other services and supply goods.

**Table 2: Industrial Results - Policy scenario - Accumulated deviation (%) compared to the baseline (2030)**

Top 20 Industries		Bottom 20 Industries	
Non-ferrous metal minerals	28,3	Public administration collective services	-21,6
Hotel and similar accommodation	28,3	Public education	-17,7
Non-ferrous metallurgy products	28,1	Social Security and Assistance Services	-16,6
Naphtha for petrochemicals	26,9	Public health	-13,6
Mineral coal	25,5	Buildings sector	-5,4
Cellulose	25,4	Infrastructure works	-4,2
Iron ore	24,7	Private health	-3,8
Pesticides and household disinfectants	24,6	Imputed rent	-3,5
Organic chemicals	24,2	Research and Development	-2
Fabrics	23,7	Employers' organizations, trade unions and other	-1,7
Electronic components	23,3	Gasalcohol	-0,7
Pig iron and ferroalloys	22,6	Trucks and buses, including cabins, bodies and trailers	-0,6
Inorganic chemicals	22,1	Water transportation	-0,3
Non-real estate rentals and	21,4	Other dairy products	-0,1
Motor vehicle parts and accessories	21,2	Other food products	-0,1
Resins, elastomers and artificial and	20,9	Food services	0
Machinery for mineral extraction and	20,8	Furniture	0,5
Legal, accounting and consulting	20,7	Other products and services of temporary crops	0,9
Aviation fuels	20,5	Specialized construction services	1
Storage and auxiliary transport services	19,9	Products derived from wheat, cassava or maize	1,1

Source: Own elaboration based on the simulation results.

The representativeness of the production of these selected sectors in each state before the implementation of the policy is an important indicator to justify the different levels of labor productivity necessary to sustain economic activity, as shown in the previous result. Figure 8 shows the share of the two groups of sectors in the matrix that considers the entire production of the economy, in the model database, for each state (highest growth and lowest growth, respectively).



**Figure 8: Representativeness of the post-policy 20 Top/Bottom industries on each Federal Unit (% of the total Output) – 2015**

Source: Model's database, own elaboration.

As can be seen, the distribution of the share of the two groups has some important differences. While the activities that benefited most after the policy simulation were already relatively more important in the states of São Paulo (SP), Rio de Janeiro (RJ), Minas Gerais (MG), Bahia (BA), Amazonas (AM) and Pará (PA), the most affected industries appear with greater representation in the Federal District (DF), Piauí (PI), Rio Grande do Norte (RN), Paraíba (PB), Acre (AC), Amapá (AP) and Roraima (RO). While the group of industries most benefited from the policy scenario reaches up to 10% of production in some states, those less benefited can reach representativeness of up to 50% - a representative result of the inequality of diversification between the economies of the states.

Overall, the results are consistent with the literature. Since the 1970s, a convergence of income and productive activities can be observed in parallel with the increase in labor productivity in the North, Northeast and, mainly, Midwest regions above that observed for the South and Southeast regions, the most industrialized ones. This result can be explained by the rearrangement of some industrial sectors between regions. However, as authors such as Galeano and Feijó (2013) and Mendes et al., (2019) argue, the less developed regions would not be able to absorb the share of the declining sectors in the Southeast region, due to the low representativeness of the most technological activities in these regions, once the dispersion of activities has occurred in search of lower labor costs in the country.

In the current scenario, as demonstrated in this exercise, the level of labor productivity required to supply fiscal consolidation is relatively more feasible for regions where Government expenditure is less relevant and the productive structure is more diversified and more abundant, in terms of job creation; or more benefited by the fall in relative prices (or both). However, such a gain in productivity does not seem feasible in regions where the opposite occurs: the states of the North and Northeast regions, along with the Federal District, are the ones that suffer most from the cumulative drop in household consumption, unemployment and, mainly, investment - key factor in the history of convergence of production and income between the country's regions.

## 5. FINAL REMARKS

The present work aimed to measure the increase in labor productivity necessary to offset the contraction of public spending in Brazil arising from the current agenda of fiscal austerity and structural reforms. The objective is supported by the hypothesis that structural reforms can mitigate the effect of austerity by increasing labor productivity. On the other hand, there was a need to consider Brazilian regionalities, since the productive structure - quite uneven in the country - plays an important role in the reaction and recovery of economies in the face of multidimensional shocks such as those seen in fiscal consolidations.

The economic literature is permeated by arguments in favor of and against the achievement of structural reforms in terms of labor productivity and the level of production in the economy. Factors such as the difficulty in planning and orienting reforms, as well as the slow process of growth recovery in periods of austerity, are the main obstacles listed in the literature. At the regional level, there are also arguments that value the State's development and investment strategies with regard to the convergence of production and productivity. In Brazil, these were the factors that marked the industrialization of historically less developed regions, such as the North, Northeast and Center-West of the country. In this sense, the ability to sustain convergence is a common alert among the authors, who highlight the low infrastructure and education necessary to consolidate the high-tech industry in these emerging regions.

The results of the simulation strategy are consistent with the literature. The labor productivity required to sustain GDP in face of the reduced government spending is spatially heterogeneous in the country.

In addition to the justification supported by the heterogeneity of the representativeness of Government spending in the GDP of each state and the distribution of labor in the country, sectoral performance is also an important factor for the uneven results of the productivity response in each state. The list of sectors that would most benefit from the simulated policy is more diversified, with most activities belonging to the extractive and manufacturing industry, and most representative in the states where the need for compensating labor productivity is less. As for the sectors with the worst accumulated performance, which presents, in general, activities more directed to the domestic market, they are more representative in the states most affected, negatively, by politics.

The rearrangement of production and labor between the regions of the country has been historically related to the action of economic policy and the economic logic of competition and location. More recently, for the Brazilian industry, it can be said that the pre-existing economies of agglomerations and industrial bases were fundamental for its expansion, biasing possible deconcentrations of the economic activity to low jobs of worse quality. Therefore, the low perspective of household consumption coupled with the combination of lack of investment and high unemployment in a sectoral composition that has little benefit from the austerity and reforms agenda makes such an increase in labor productivity in some of the states unviable, suggesting a worsening of Brazilian regional inequality.

To the extent that austerity has an effect on variables such as interest rates, inflation and debt control, according to part of the literature, the results presented here show regional vulnerability due mainly to the productive structure - combined with high unemployment and falling consumption of families. Thus, the conclusion of the present study joins those of those who defend the flexibility of austerity policies regarding public investment aimed at sectoral diversification and expansion of infrastructure, especially in the North and Northeast regions of the country. In addition, it suggests the need to maintain income generation policies through social assistance and formal jobs.

It is worth mentioning some limitations of the work. The CGE model used does not have a fiscal module. Therefore, we do not have transfers between governments and institutions (such as households) and local governments. In addition, there is no direct connection between tax revenues and public expenditure, which are determined exogenously. Due to

the specificities of the statistics of the System of National Accounts, the model also does not capture the direct effects of cuts in public services in the household consumption basket, only the indirect effects, via economic activity. Therefore, it is not considered an extended income concept, as proposed in Atkinson (2016), in which the consumption of public goods is counted in the families' income. This can be a starting point for future work.

Finally, we emphasize the fact that the current crisis caused by the pandemic COVID-19 has exposed the vulnerabilities of countries whose role of the State has been mitigated by austerity policies is highlighted. The effects of the pandemic are systemic, but require special attention in relation to the already fragile labor market and labor productivity in some peripheral economies, as well as access to basic health services and public policies to deal with adverse situations.

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## PROBABILITY OF PUBLIC WORKS SHUTDOWN: SPATIAL INFLUENCES AND THE IMPACT OF COUNTERPARTS RECEIVED FROM FISCAL DECENTRALIZATION

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### ABSTRACT

This work sought to identify the factors that influence the stoppage of public works carried out in the municipalities of Pernambuco in the years 2016 to 2018. For this, it was proposed the use of a Probit Spatial model, and its extensions, in order to investigate the effects of various controls used and possible spatial spillover. The main variable of interest was the value of the contributions received voluntarily by the municipal governments of the governments of the other spheres of public power through the signing of an agreement from the perspective of fiscal decentralization. However, as a way to control the endogeneity present in the data, instrumental variables were used based on the hypothesis of vertical interaction between governments, which would lead local governments with the same party affiliation as state and federal governments to receive higher values through agreements and, thus, have less chance of suffering work stoppages. The results showed that works located in municipalities that receive greater compensation from other governments are less likely to be paralyzed when party affiliation in common between governments is used as instruments. Additionally, there was a spillover effect of stoppage of public works, where works located in municipalities surrounded by others with a large number of paralyzed works tend to have an increase in their chances of stoppage.

### KEYWORDS

Public works shutdown. Spillover effect. Instrumental variable.

### 1. INTRODUCTION

A government concern is to provide public goods and services in order to maximize social welfare. For this, it is necessary that the government seeks efficiency in the provision of such services. This efficiency will ensure that the government will provide public goods at the lowest possible expense.

In Brazil, governments are hierarchically distributed from the federal to the state, and finally to the municipal. The latter, according to the theory of fiscal decentralization, has several advantages when providing public goods, because, being closer to the population in a given location, it knows its demands and priorities. In addition, it is recognized that the local government can use public resources more efficiently, since such resources do not have to go a long way within the public bureaucracy to reach their final destination. In this way, fiscal decentralization would be an effective way to promote the efficient use of public resources (AMARAL FILHO, 2001).

Several empirical evidence has shown that the simple decentralization of resources does not guarantee the maximization of social well-being, as efficiency in the use of public resources is not always achieved (GUCCIO; PIGNATARO; RIZZO, 2014). Specific characteristics of the localities can be decisive in the good management of public money.

The local government, based on the decentralization of resources, carries out several public works with resources originating from the state and federal governments. However, this occurs in an asymmetric environment in terms of information, since the governments of higher spheres have no information about the contracted companies or about the social benefits of the works (BESFAMILLE, 2003). In this way, the central governments can influence the execution of a public work, at the municipal level, through the amount of compensation that they make available to the municipal governments so that they can execute the work according to the agreement agreed between them.

The availability of resources from central governments to the positions of local managers does not always translate into greater efficiency in the use of such resources. In this way, the simple fact that there are additional resources coming from the higher entities may not be decisive for the completion of a work (SOUSA; CRIBARI-NETO; STOSIC, 2005).

Several works are simply paralyzed because they do not meet different technical and legal criteria. Corruption acts during the bidding and execution phases of the work are also responsible for the several stoppages that occurred (CHEAITOU; LARBI; HOUSANI, 2019; SALOMÃO et al., 2019; OHASHI, 2009).

Another effect investigated by several empirical studies concerns the spillover effect of public spending on works, where local governments look at the behavior of neighboring governments to make a decision on the amount of works they should carry out in their municipality (BRUECKNER, 2003; MADIES; PATY, 2008; LEROUX; CARR, 2007).

In view of the above, this research sought to investigate which factors explain the probability of stopping public works, with emphasis on the influence of the amounts voluntarily received from the state and / or federal governments as a counterpart for carrying out the works. For this, the party affiliation in common between the local government and the higher governments was used as instruments for the values received through an agreement through a two-stage estimation process under the hypothesis of an interaction strategy between the governments of the different spheres of public power (vertical interaction) (BRUECKNER, 2003; KELLY, 2000).

Additionally, we investigated the occurrence of a spillover effect in the stoppage of public works, because, in this case, the behavior of a given local government, with regard to the execution of works, can be influenced by the actions of the governments of the neighboring localities. This control at the spatial level proved to be a significant predictor of the chance of a work stoppage, and contributed to obtain consistent estimates of the various estimated parameters, given that its absence implies bias of the omitted spatial variable.

The results obtained showed that the probability of paralysis of a work performed by the government decreases for a given increase in the values of the counterparts received from the state and federal governments when instrumented by the party affiliation in common between the governments. The estimation of the spillover effect was also statistically significant, indicating that public works located in municipalities surrounded by others with a large number of paralyzed public works suffer an increase in their chance of paralysis.

This article is divided into 5 more sections in addition to this introduction. In section 2, the empirical evidence that guided this research is discussed. Section 3 presents the proposed methodology and the data used in the investigation of the research problem mentioned above. Section 4 presents the results obtained from the estimation of the proposed econometric models. Section 5 presents the discussion about the main findings of this work, comparing them with other findings in the recent literature. Finally, in section 6, the research conclusion is made.

## 2. EMPIRICAL EVIDENCE

The efficiency of the public sector in the provision of goods and services has been investigated from the most diverse perspectives, since an efficient allocation of public resources generates significant impacts on the population's quality of life. Thus, efficiency in the allocation of public resources implies maximizing the public services offered or, to put it another way, it implies minimizing public expenditure for a given level of public service offered (SOUZA; RAMOS, 1999). One way to achieve efficiency in the allocation of public resources is through fiscal decentralization, where the central government delegates to the local government the task of providing certain public goods with the argument that the local government, due to its proximity to the population, takes advantage of the supply of such goods, as it knows the needs and preferences of the population better (AMARAL FILHO, 2001).

A counterpoint to the argument of effectiveness of the use of public resources by fiscal decentralization and made by Guccio, Pignataro, Rizzo (2014) for the case of carrying out public works in Italy where they showed that local governments are less efficient in the execution phase, vis - vis-à-vis the central government, as they suffer greater delays. They also emphasize that the case becomes more evident the smaller the size of the municipality and the greater the external value received for the execution of the work. A similar result was observed in Souza and Ramos (1999) that the decentralization of resources per se does not generate efficiency in the use of public resources and that inefficiency is greater in municipalities with less than 15 thousand inhabitants.

The decision to carry out public works by local governments occurs in an environment of asymmetric information for the central government, since the local government has information about the contracted company and about the potential benefits of public works for the locality. The central government, in turn, will only finance part or all of the project without prior knowledge of the benefits for the population (BESFAMILLE, 2003).

The realization of public works has a double benefit for the population, as it has the power to transfer income to the poorest strata while creating an improvement in public infrastructure. Thus, the realization of public works, being used as a variable of fiscal policy, achieves the objective of increasing the level of income, bringing the salaries of the private sector to equilibrium levels and the improvement of infrastructure has effects on economic growth (GEHRKE; HARTWIG, 2018). A similar conclusion is reached by Berg et al. (2018) which showed that the public works program in India (National Rural Employment Guarantee Scheme of India (NREGS)) increased the average levels of the growth rate of agricultural income by 4.3% per year.

The interaction between governments occurs both between governments of different spheres, as in the case of central government and local government, and between governments of the same sphere. In this sense, strategies for interactions between governments may arise (BRUECKNER, 2003). In this case, government spending in neighboring locations may

influence government spending in a given location, characterizing a spillover effect of public works (FRIGIO; KOPLIN; REID, 1999). The interdependence of public spending, when verified, leads to the conclusion that there is “imitation of behavior” of the mayors in relation to the fiscal and tax policy according to Foucault, Madies and Paty (2008) who verified this effect in the French municipalities, while Leroux and Carr (2007) verified this interaction of local governments in the cities of the state of Michigan in the United States.

The stoppage of a public work is due to the non-compliance with the laws that regulate this matter, in addition to the lack of compliance with technical procedures that may or may not be due to acts of corruption such as fraud in tenders, changes in rules, changes in technical specifications, among other things (SALOMÃO et al., 2019).

Ohashi (2009) examined the effect of greater transparency in the bidder's qualification process. He found that improved transparency reduces the acquisition cost by a maximum of three percent, as transparency in the bidding process weakens collusion between bidders.

In Brazil, there are six types of bidding modalities: competition, price taking, invitation, auction and auction. The bidding modality may imply greater or lesser probability of a work stoppage because, according to them, the efficiency in the execution of a public work can be influenced by the bidding modality, concluding that the competition modality can reduce the waste of public resources by reducing the acts of corruption inherent in the bidding processes (CASTRO; GUCCIO; PIGNATARO, 2018). For Cheaitou, Larbi and Housani (2019), the choice of who will carry out the work is crucial for the success of the efficient use of public resources. Therefore, they argued that the price-taking at the “lowest price” may be responsible for low quality and delays in public works.

Efficiency in the use of public resources can be influenced by several socioeconomic characteristics of the localities such as the population's educational level (AFONSO, SCHUKNECHT; TANZI, 2010), urbanization rate and number of residents, among others (SOUSA; CRIBARI-NETO; STOSIC, 2005). Thus, these characteristics, in addition to those inherent to the work, can be important predictors of the probability of a public work stoppage (CAMPOS; COSTA, 2017).

### 3. METHODOLOGY

#### 3.1 Data

For this research, data from public works that took place in the municipalities of Pernambuco, in the years 2016 to 2018, from the Court of Auditors of the State of Pernambuco (TCE-PE) will be used. The socioeconomic data of the municipalities of Pernambuco originate from Condepe Fidem and the Brazilian Institute of Geography and Statistics (IBGE): unemployment rate, demographic density, urbanization rate, municipal human development index (MHDI), Gini index, proportion of people with higher education, household income per capita. The party affiliation data of the mayors of the municipalities of Pernambuco come from the Superior Electoral Court (TSE), while the data referring to public works such as number of stoppages, contracted amount, counterpart amount and bidding modality are from the TCE-PE. The FIRJAN Tax Management Index (IFGF) was also used by the Federation of Industries of the State of Rio de Janeiro with the data declared by the municipalities to the National Treasury Secretariat (STN).

#### 3.2 Descriptive Statistics

**Table 1 - Descriptive statistics of socioeconomic variables in the municipalities of Pernambuco.**

Variables	Description	Mean	S. errors	Min.	Max.
Paralyzed	Dummy = 1 if public works were stopped	0.0609	0.101	0	0.476
Valcont	Per capita value of contracted works	31.15	84.93	0	1,116
Contpart	Per capita amount of consideration received from the federal and state governments	1.686	12.58	0	169.3
Tipo_Licit	Dummy = 1 if the type of bidding for the work was taken at a price	0.412	0.228	0	0.920
IFGF	Municipal tax management FIRJAN index	0.265	0.148	0.022	0.671
Por_Ens_Sup	Percentage of people with higher education	3.653	2.049	1.040	19.11
Partgov	Dummy = 1 if the mayor is from the same political party as the state governor	0.343	0.377	0	1
Partpres	Dummy = 1 if the mayor is from the same political party as the president of the republic	0.122	0.273	0	1
Income	Per capita household income	296,0	104,5	155,5	1.144
Txdesoc	Unemployed rate	9.417	4.694	1.450	23.61
Dens	Demographic density in km2	247,0	906,0	7,790	9.068
Txurban	Urbanization rate	61,79	20,28	12,38	100
Gini	Gini Index	0,520	0,0452	0,420	0,680
Reelei	Dummy = 1 if the mayor is in the second term	0.207	0.406	0	1
Sex_Pref	Dummy = 1 if the mayor is male	0.885	0.252	0	1
P_vot_pref	Proportion of votes of the mayor	0.538	0.118	0.026	0.806
P_ver_pref	Proportion of councilors from the same party as the mayor	0.218	0.137	0.014	0.727

Total Municipalities: 184

Source: Own elaboration.

**3.3 Econometric strategy**

**3.3.1 Spatial Models for Qualitative Data**

To test empirically what are the factors that affect the probability of a public work being paralyzed in the municipalities of Pernambuco, the *Spatial Lag Probit Model* (SAR) model was used. The justification for the use of this is due to the fact that the dependent variable is qualitative, assuming the value one (1) if the work was paralyzed and zero (0), otherwise (BALTAGI; EGGER; KESINA, 2018; ELHORST, 2017; ARIMA, 2016; WANG; IGLESIAS; WOOLDRIDGE, 2013).

$$Y^* = \rho WY + X\beta + \varepsilon \tag{1}$$

$Y^*$  is a binary variable that assumes a value equal to one (1) if public works  $i$  were paralyzed in municipality  $j$  and zero (0) otherwise;

$WY$  is the average proportion of public works paralyzed in the municipalities neighboring the municipality  $j$  where the construction work  $i$  takes place.

$X$  is the vector of the explanatory variables used as controls.

Another fact to consider is the existence of spatial spillover of the covariables included in the model. To verify this hypothesis, the *Spatial Durbin Probit Model* (SDM) model was used, which includes the first order spatial lags of the independent variables represented by the term  $WX$  (LACOMBE; LESAGE, 2015; LESAGE; PACE, 2009).

$$Y^* = \rho WY + X\beta + WX\theta + \varepsilon \tag{2}$$

The vertical interaction between governments - the one where there is interaction between governments at different levels of administrative hierarchy - when it is analyzed at the level of public works, occurs through the signing of agreements. These are characterized as a tool that aims to discipline the transfer of resources and the execution of the expense object. The rendering of accounts must be carried out by the municipalities that receive the resources, proving, even, the fulfillment of the deadlines and other formalities agreed in the agreement. Thus, there may be a strong correlation between the party affiliation of the municipal manager, when it is the same as that of the state and federal governments, and the amount of resources obtained through the signing of agreements. In this case, party affiliation will affect the likelihood of a particular public work stoppage only because it affects the amount of resources available to the local government to carry out the work. In this way, party affiliation between governments at different levels of public power was used as an instrument for the value of the consideration received through the estimation of the two-stage probabilistic model (KELLY, 2000).

Thus, the model in equation (2) will be modified so that the party affiliation variables are included in the first stage of the regression.

$$Y^* = \gamma contpart + \rho WY + X\beta + WX\theta + \varepsilon \tag{3}$$

$$\gamma contpart = \rho WY + X\beta + WX\theta + \lambda part\_gov + \pi part\_pres + v \tag{4}$$

**4. RESULTS**

The results with the instrumental variables are shown in Table 1. In all the proposed models, the value of the consideration received from the state and/or federal governments has a negative and statistically significant effect, showing that increases in the value of the consideration received cause a decrease in the probability public works come to a standstill and that the mayor's party affiliation is decisive for the value of the consideration received.

The decrease in the probability of stopping public works due to the compensation received by the local government, from the state and federal governments, is due to the fact that the failure to provide the public good can cause the population to associate the party affiliation of the heads of the government. executive at each administrative level to the poor provision of public service. In addition to this, compliance with the legislation is also another factor that forces the local government to strive for the work to be effectively delivered within the scheduled schedule so that it does not suffer the sanctions provided for in the laws governing the signing of agreements.

The occurrence of the effect of work stoppages across space was verified through the variable  $Wparalysed$  which had the value of its estimated coefficient positive and significant in all proposed models, indicating a spillover effect of work stoppage across space, that is, works located in cities surrounded by others with a large number of paralyzed public works tend to have an increased probability of suffering paralysis, which shows an "imitation of behavior" among neighboring governments (FOUCAULT, MADIES; PATY, 2008; LEROUX; CARR, 2007; BRUECKNER, 2003; FRIGIO; KOPLIN; REID, 1999).

A usual test for measuring the spatial autocorrelation between the shutdown of works in a given municipality and the shutdowns that occurred in neighboring municipalities is done through the Moran Index. The result of this positive index (Moran's  $I = 0.1512$  and  $p\text{-value} < 1\%$ ) points out that public works located in municipalities surrounded by others with a large number of paralyzed works are more likely to also be paralyzed.

Among the models proposed in Table 2, the SDM model with IV (column 3) was the model selected according to the Akaike selection criterion, as it presented the lowest value of this statistic. The Wald test was performed under the null hypothesis of exogeneity of the regressors, which was rejected in all models proposed at the usual level of 5%, indicating that the use of instruments was adequate to solve the problems of endogeneity present in the data.

According to the SDM model in Table 2, works of higher value and those whose bidding was carried out using the price taking modality have a greater chance of stoppage, since there is a positive relationship between the variables *logvalcont* and *tipo\_licit* with the dependent variable. Works carried out in municipalities with a higher number of unemployed people, greater income inequality, as measured by the Gini index, and higher per capita income are more likely to stop, while works located in municipalities with a higher rate of urbanization, a higher proportion of people with higher level and where the mayors were reelected, are male, had a higher percentage of valid votes and have a higher percentage of councilors from the same party as the city mayor suffers a reduction in their probability of stoppage. The tax management index prepared by Firjan, on the other hand, was not statistically significant in any of the years in which it was measured. The first order spatial lags of the covariates that were shown to be statistically significant to explain the average probability of stoppage of public works were those related to the urbanization rate and the proportion of votes that mayors had in the elections, which were negatively correlated with stoppage of works public, while those referring to the unemployment rate in the population of cities, the sex of the mayor were positively correlated indicating an increase in the probability of stoppage of government works.

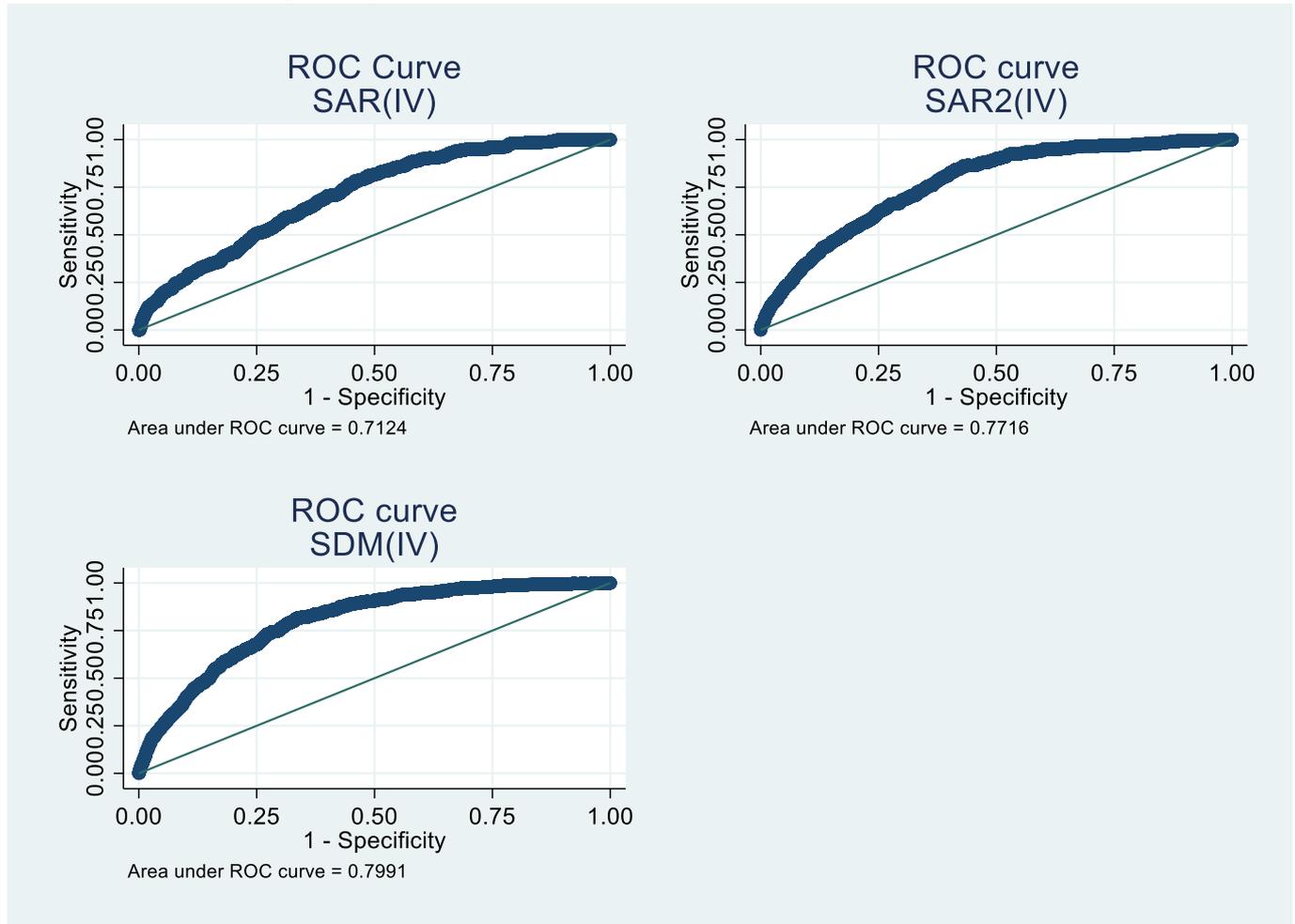
**Table 2. Results of the estimations of the probabilistic spatial models with instrumental variables.**

	Dependent Variable: Paralyzed		
	(1) SAR(IV)	(2) SAR2(IV)	(3) SDM(IV)
<i>logcontpart</i>	-0.929*** (-11.42)	-0.949*** (-5.33)	-0.921*** (-3.68)
<i>WParalyzed</i>	0.0438*** (8.84)	0.0252* (2.25)	0.0369** (2.73)
<i>logvalcont</i>	0.297*** (21.33)	0.309*** (19.63)	0.319*** (16.60)
<i>Tipo_licit</i>	0.256*** (4.50)	0.300** (3.08)	0.322* (2.55)
<i>Txdesoc</i>		0.0233*** (3.55)	0.0204** (2.64)
<i>Dens</i>		0.0000923** (3.05)	0.0000372 (0.78)
<i>Txurban</i>		-0.00409* (-2.35)	-0.00416* (-2.34)
<i>Gini</i>		2.431*** (3.81)	3.037** (3.18)
<i>Prop_ens_sup</i>		-0.0983** (-2.97)	-0.0686* (-1.98)
<i>dsex_pref</i>		-0.160** (-2.67)	-0.0509 (-0.98)
<i>Reelei</i>		-0.222*** (-3.84)	-0.192** (-3.04)
<i>logincome</i>		0.727*** (3.38)	0.532* (2.53)
<i>IFGF</i>		0.167 (0.87)	0.00250 (0.01)
<i>dt2IFGF</i>		-0.230 (-1.02)	-0.181 (-0.80)
<i>dt3IFGF</i>		0.332 (1.55)	0.368 (1.69)
<i>P_vot_pref</i>		-0.223 (-1.58)	-0.315* (-2.06)
<i>P_ver_pref</i>		-0.344* (-2.38)	-0.362* (-2.38)
<i>Intercept</i>	-1.938*** (-11.16)	-6.592*** (-4.34)	-13.96* (-2.39)
<i>WX</i>	No	No	Yes
<i>F.E. Year</i>	No	Yes	Yes
<i>F.E. Region</i>	No	Yes	Yes
<i>AIC</i>	32852.67	32332.74	32275.58
<i>Wald Test</i>	41.73***	8.31***	4.46***
<i>N</i>	11588	11588	11588

**Note:** [i] log - natural logarithm of the variables contracted value, counterpart value, municipal revenue and per capita income; [ii] E. F. Year - vector of dummy variable of year k, assumes value equal to one (1) if it is of year k and zero (0) otherwise. Where k assumes values between 2016 to 2018 and 2016 is used as a reference; [iii] E. F. Region - vector of dummy variable that represents the development region of the i-th

municipality. Assumes value equal to one (1) if it belongs to region g and zero (0) otherwise. g represents the development regions: Agreste Meridional, Agreste North, Mata Norte, Mata Sul, Metropolitana, Pajeú, Sertão Central, Sertão de Itaparica, Sertão do Araripe, Sertão do Moxotó, Sertão do São Francisco being Agreste Central being used as a reference; [iv] t-statistic in parentheses; [v] \*, \*\*, \*\*\* indicates statistically significant levels at 5%, 1% and 0.1%, respectively.  
Source: Own elaboration.

In Figure 1, the ability of the model to discriminate the categories of the slope variable was measured using the Receiver Operating Characterist (ROC) curve. If the area under the curve is less than or equal to 0.5, the model cannot discriminate between the categories of the variable explained. The results show that the models SAR (IV), SAR2 (IV) and SDM (IV) discriminate acceptably the categories of the dependent variable, since the values under the ROC curve were in the order of 0.71, 0.77, and 0.79, respectively.



**Figure 1. ROC curve of the SAR (IV), SAR2 (IV) and DURBIN (IV) models**

Source: Own elaboration.

The quality of the adjustment between the estimated average probability of stoppage of the works carried out by the government and the amount received from the state and federal entities is shown in Figure 2. Here, we have a view of the negative relationship between the value of the consideration received by the local government for carrying out public works and the probability of their stoppage.



**Figure 2. Dispersion graph of the relationship between the value of the counterparts and the probabilities of stoppage estimated in the models SAR (IV), SAR2 (IV) and DURBIN (IV), respectively**

Source: Own elaboration.

The hypothesis raised in this paper is that the party affiliation of the mayor of the municipalities of Pernambuco affects the amounts received as a counterpart from the federal and state governments for carrying out public works and this would lead to an effect on the probability of stopping such works. Table 3 shows the result of the reduced form of the SAR (IV), SR2 (IV) AND SDM (IV) models. It is possible to see a positive correlation between the party affiliation of the mayors and the value of the consideration received, indicating that mayors who are from the same parties as the state governor and/or the president of the republic receive, on average, greater voluntary transfers of resources to public works.

**Table 3. Results of the first stage estimates.**

	Dependent Variable: <i>logcontpartpc</i>		
	(1) SAR1(IV)	(2) SAR2(IV)	(3) SDM(IV)
Partgov	0.159*** (12.20)	0.0730*** (4.90)	0.0648*** (4.39)
Partpres	0.129*** (6.80)	0.0923*** (5.09)	0.0657*** (3.46)
Controls of works	Yes	Yes	Yes
City controls	No	Yes	Yes
Spatial Controls	No	No	Yes
F.E. Year	No	Yes	Yes
F.E. Region	No	Yes	Yes
AIC	4416.445	4219.963	4166.984
Pseudo R2	0.0667	0.1193	0.1348
N	11588	11588	11588

**Note:** [i] log - natural logarithm of the variables contracted value, counterpart value, municipal revenue and per capita income; [ii] E. F. Year - vector of dummy variable of year k, assumes value equal to one (1) if it is of year k and zero (0) otherwise. Where k assumes values between

2016 to 2018 and 2016 is used as a reference; [iii] E. F. Region - vector of dummy variable that represents the development region of the i-th municipality. Assumes value equal to one (1) if it belongs to region g and zero (0) otherwise. g represents the development regions: Agreste Meridional, Agreste North, Mata Norte, Mata Sul, Metropolitana, Pajeú, Sertão Central, Sertão de Itaparica, Sertão do Araripe, Sertão do Moxotó, Sertão do São Francisco being Agreste Central being used as a reference; [iv] t-statistic in parentheses; [v] \*, \*\*, \*\*\* indicates statistically significant levels at 5%, 1% and 0.1%, respectively.  
Source: Own elaboration.

**4.1 Robustness**

To test the relevance of the hypothesis that governments at different levels of power use a vertical interaction strategy, which would imply greater transfers of resources to municipalities where mayors have common party affiliation with other government officials, it was considered that mayors are political parties different from those of the state and federal government, which implies the absence of vertical interaction between the governments of the different spheres of public power through party affiliation.

Table 4 shows the results of the estimations of the spatial probabilistic models, considering the absence of partisan interaction between local governments and the higher spheres. In all the proposed models, there was no statistical significance of the effect of the values of the counterparts received on the probability of stopping public works in the municipalities of Pernambuco. The contagion effect, which occurs when the probability of a work being paralyzed in a given region is affected by the number of works paralyzed in neighboring regions, was only significant in the first model proposed, where there was no control of the other variables that affect the probability of occurrence. work stoppage.

**Table 4. Results of the estimations of the probabilistic spatial models.**

	Dependent Variable: Paralyzed		
	(1) SAR1	(2) SAR2	(3) SDM
<i>Logcontpartpc</i>	-0.00872 (-0.48)	-0.00499 (-0.25)	-0.00254 (-0.13)
Controls of works	Yes	Yes	Yes
City controls	No	Yes	Yes
Spatial Controls	No	No	Yes
F.E. Year	No	Yes	Yes
F.E. Region	No	Yes	Yes
AIC	4416.445	4219.963	4166.984
Pseudo R2	0.0667	0.1193	0.1348
<i>N</i>	11588	11588	11588

**Note:** [i] log - natural logarithm of the variables contracted value, counterpart value, municipal revenue and per capita income; [ii] E. F. Year - vector of dummy variable of year k, assumes value equal to one (1) if it is of year k and zero (0) otherwise. Where k assumes values between 2016 to 2018 and 2016 is used as a reference; [iii] E. F. Region - vector of dummy variable that represents the development region of the i-th municipality. Assumes value equal to one (1) if it belongs to region g and zero (0) otherwise. g represents the development regions: Agreste Meridional, Agreste North, Mata Norte, Mata Sul, Metropolitana, Pajeú, Sertão Central, Sertão de Itaparica, Sertão do Araripe, Sertão do Moxotó, Sertão do São Francisco being Agreste Central being used as a reference; [iv] t-statistic in parentheses; [v] \*, \*\*, \*\*\* indicates statistically significant levels at 5%, 1% and 0.1%, respectively.  
Source: Own elaboration.

**5. DISCUSSION**

The provision of public goods and services by government officials aims to provide a higher level of social welfare, observing the principle of efficiency in the allocation of public resources. This allocative efficiency implies a decrease in public expenditure with the performance of the various services provided by governments to the population.

Under the argument of allocative advantage, local governments receive public resources from the state and federal governments to carry out works of common interest, as they know the needs of the region better than the hierarchically superior governments. Thus, due to informational asymmetry, central governments delegate to local governments the mission of offering public goods and services according to local needs and preferences (BESFAMILLE, 2003; AMARAL FILHO, 2001).

The impacts of carrying out public works in a given location go beyond the provision of the service that underlies the execution of the work. There is an improvement in the infrastructure of the sites that receive the works and the poorest people achieve an improvement in their income levels (BERG et al., 2018). However, the execution of a public work must obey several technical and legal criteria for its realization. Failure to comply with these criteria will result in work stoppages and the waste of public money, in addition to failure to reach the objective of offering the public service (SALOMÃO et al., 2019).

The results obtained showed that the compensation received in each public work decreases its probability of paralysis when instructed by the party affiliation of the mayors, indicating that the voluntary transfer of resources between

governments vertically distributed in the structure of the public power affects the amounts received in compensation for the realization of the actions. works and, consequently, the chance of them being paralyzed (KELLY, 2000). This stems from a possible strategy of vertical interaction between governments, indicating that local governments receive, on average, a greater amount of resources when they have the same party affiliation as higher hierarchical governments, as shown in the first stage of regression (BRUECKNER, 2003).

The results also showed the existence of a spatial interaction based on a spillover effect of paralysis of public works, indicating that the chance of a public work being paralyzed increases in places where the neighboring municipalities have large amounts of paralysis of these works. This result indicates that the behavior of public managers, with regard to public works, can be influenced by the behavior of managers in neighboring municipalities (FOUCAULT; MADIES; PATY, 2008; LEROUX; CARR, 2007).

Other factors inherent to public works also affect its probability of stoppage, such as, for example, the bidding modality where it was verified that the price taking is a modality that increases the chance of a work being paralyzed. This result is in line with other findings, such as in Cheaitou, Larbi and Housani (2019) and Castro, Guccio and Pignataro (2018).

Municipalities' characteristics were also shown to be relevant in predicting the probability of stoppage of the works carried out by the local government. Municipalities with higher income inequalities and a higher percentage of unemployed people are more likely to have government works paralyzed, while municipalities with higher percentages of people with higher education and a higher rate of urbanization are less likely (AFONSO, SCHUKNECHT; TANZI, 2010; SOUSA, CRIBARI-NETO; STOSIC, 2005). The characteristics of local government officials also made up the list of variables that affect the likelihood of stopping public works. Works located in a city where the mayors are male, are in the second term, had a higher proportion of votes and have a higher percentage of councilors from the same party as yours, are less likely to suffer stoppages (CAMPOS; COSTA, 2017).

## 6. CONCLUSION

The present research sought to investigate the factors that may contribute to a public work being paralyzed, which results in delays in the supply of the public good or objective service of that work and in waste of public resources. For this, a spatial probabilistic model was used in order to control overflowing effects of the shutdown of such works. Among the various factors that affect the likelihood of a public work being paralyzed, the highlights were the amounts passed on voluntarily by the state and federal governments through agreements for the mayors under the argument of fiscal decentralization that advocates that the local government, for knowing better, the needs and preferences of your region, would use public resources more efficiently and, therefore, generate a higher level of social well-being.

This work contributes to the economics literature of the public sector by identifying a causal effect of the values passed on voluntarily by the state and federal governments to the local governments, through the signing of agreements, on the probability of stoppage of public works destined to the supply of goods and services to the population. In order to measure the impact of the amounts received in return from the hierarchically superior governments on the chances of work stoppage, the party affiliation of the mayors was used as an instrument, on the grounds that there is vertical interaction between governments of different hierarchies. In this case, mayors with the same party affiliation as the state and/or federal governments would receive a greater volume of voluntary resources from these governments to use in public works, thus decreasing the likelihood of their paralysis. The results showed that the probability of a work being paralyzed in a given municipality decreases when the values received in return from central governments are increased, using common party affiliations as instruments.

To test the validity of the hypothesis of a vertical interaction strategy between governments, it was considered that the mayors no longer had the same party affiliation as the state and / or federal governments, which in this case would result in a transfer of voluntary resources from arbitrary way. The results obtained showed that the values of the consideration received through agreements were not statistically significant to affect the chances of stopping a public work.

Additionally, the spatially correlated factors were controlled under the hypothesis that a "behavior imitation" effect could occur between local governments, which, in this case, occurs when the probability of a work being paralyzed in a given city is affected by the amount of works paralyzed in neighboring cities. The results showed that an increase in the number of works paralyzed in neighboring cities increases the probability of a work being paralyzed in a given city.

Other controls were added as a way to measure the effects of several factors that can affect the likelihood of stopping public works. Public works carried out in cities with higher rates of urbanization and a higher proportion of people with higher education are less likely to be paralyzed, while increases in income inequality and the unemployment rate of the population are factors that increase the chances of paralysis of public works. Already works located in cities where mayors are in the second term, received a higher proportion of votes and have a greater number of councilors affiliated to their parties, have less chance of being paralyzed.

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## BRAZILIAN EXPORTS AND INCOME DISTRIBUTION: AN INPUT-OUTPUT ANALYSIS FOR 2002-2014

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### ABSTRACT

The impacts of international trade on income distribution have presented conflicting results. Empirical studies found that the direction and magnitude of this relation differ for each country and time, depending on factors such as development and income level, productive, social and institutional structure, and trade reforms specificities (GOLDBERG and PAVKNIK, 2007; MESCHI and VIVARELLI, 2008; BERGH and NILSSON, 2010; ÇELIK and BASDAS, 2010; BENSIDOUN, JEAN and SZTULMAN, 2011; ATIF et al.; 2012). These papers, like most of the literature, used econometric approaches. Otherwise, Alsamawi et al. (2014) used input-output analysis to calculate the inequality footprint, i.e., the income distribution (measured by Gini index) that each country produces elsewhere in the world, for importing goods. Their main finding was that most developed countries (more egalitarian) import from developing countries (more unequal). Brazil presents the fourth highest Gini index of upper-middle-income countries (World Bank, 2020), which makes the matter especially relevant for the country. An important question remains unanswered: what is the inequality footprint of Brazilian exports? To answer that, this paper aims to assess the domestic income inequality linked to Brazilian exports. That is, how the income yielded, direct and indirectly, from exports, is distributed among households. To this end, we adapted the approach proposed by Los et al. (2016), based on "hypothetical extraction". We consider a hypothetical world where Brazil does not export anything to region n (Extraction I). We used the World Input-Output Database (WIOD) 2002-2014, which covers 43 countries plus the "Rest of the World" and 56 sectors. Additionally, we disaggregated the vector of wages in the input-output table into ten income classes based on the National Household Sample Survey (PNAD), for the same period.

Considering total exports demand (all countries available in the WIOD table), we found an income Gini index of 0.304 for 2014, which is lower than the generated from domestic demand (0.376). This shows that, in general, the income required to satisfy all external demand is more egalitarian than the income created by domestic demand. Evaluating the exports to each trading partner separately, the only country whose demand generates more inequality than the domestic demand is India, presenting a 0.464 Gini index. Thus, we did not find evidence that production for international trade worsens Brazilian income inequality. Otherwise, it could be improving the country's economy, by creating jobs with less unequal wages.

The next steps of this study include creating a relative measure that considers the volume of trade. Moreover, these results will be explicit by sector, which could allow us to understand which industries from each country are responsible for such results. Thus, we propose another extraction (Extraction II), considering a hypothetical world where Brazil does not export anything to sector s from region n. Finally, the results will be extended to the 2002-2014. Thus, we will be able to observe how the income inequality in exports behaved over the time, given the changes that Brazil's export agenda has undergone.

## **Regular Session: RS01.2 - Entrepreneurship**

**17:30 - 18:45 Thursday, 27th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/87555502007>**

**Chair Heather Stephens**

## TRIGGERING THE INTEGRATION OF MINORITIES RESIDING IN A DEMOGRAPHICALLY MIXED REGION INTO HIGH-TECH ACTIVITIES

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### ABSTRACT

This study attempts to identify the conditions necessary to promote the integration of very low socioeconomically disadvantaged minorities in mixed majority-minority regions into technological entrepreneurship and high-tech activities. We also look at how the smart specialization model can be adapted to these situations.

This experimental study was conducted in Israel and focused on the mixed region of Beersheva-Rahat and the surrounding Bedouin dispersion, where the minority population is ranked extremely low on the socioeconomic scale – on the lowest level.

The current study is a continuation of an earlier study conducted in the mixed region of Haifa-Nazareth, where the minority is ranked higher on the socioeconomic scale. The findings in that case show that smart specialization in mixed regions requires a pre-phase of social-relationship and business-network building between the majority and minority populations.

The findings of the present study indicate that in mixed regions with a minority population that is ranked very low on the socioeconomic scale and has low level of readiness for technological entrepreneurship and high-tech activities, a pre-preliminary-phase is needed in order for smart specialization to work – a phase in which educational and training infrastructures are improved and the population gains awareness of its own potential for future integration in the high-tech sector. This phase constitutes an addition to the smart specialization model.

The study findings also point to the important role of the local and regional entrepreneurial initiatives in improving the minority population readiness to take part in that technological entrepreneurship and high-tech activities.

The study employs qualitative methodology. Primary and secondary data were gathered and analyzed, and in-depth interviews conducted.

The study findings have a theoretical and practical contribution by expanding the smart specialization model for implementation in mixed majority-minority regions with a population that ranks very low on the socioeconomic scale, while showing the need for preliminary phases and for governmental policy tools that promote these pre-phases.

## INDUSTRIES, OCCUPATIONS, AND ENTREPRENEURSHIP IN RURAL REGIONS

Zachary Keeler, [Heather Stephens](#)

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### ABSTRACT

Economic development strategies aimed at fostering regional growth through entrepreneurship are increasingly important in lagging regions. While previous research suggests that having more entrepreneurs or self-employed can lead to higher levels of economic growth in rural and distressed regions, not all entrepreneurs are created equally. Some people may become self-employed due to a lack of other opportunities, while others may be more innovative, exploiting new opportunities and contributing to growth. Additionally, entrepreneurship in certain industries may be more beneficial to growth than in other industries. At the same time, another strain of research has linked industrial and occupational diversity to entrepreneurship and regional growth, especially in urban areas, due to the cross-fertilization of ideas. However, rural regions may lack agglomeration economies and other factors conducive to growth that make the relationship between industrial and occupational diversity and entrepreneurship in rural areas less clear. Therefore, a clear understanding of the linkages between industries, occupations, and entrepreneurship in rural regions is needed. Unfortunately, the publicly available data on detailed industry-level employment are often suppressed in small and rural counties. Thus, to examine these relationships in the United States, we have obtained detailed county-level and industry-level data from Economic Modeling LLC (EMSI) on employment and self-employment. We first estimate models where we look at local economic growth in terms of growth in employment and population and assess whether entrepreneurs from certain industries contribute more to growth. We also use these detailed data to construct measures of industrial diversity to see how that affects economic growth. We estimate models for the entire United States, for rural and urban areas separately, and also separately for distressed regions, such as the Appalachian Regional Commission Region in the eastern United States. Our models include controls for historic economic performance and industrial composition, as well as controls for other factors that have been shown to influence regional economic growth. Finally, we estimate models where our dependent variable is the share of self-employed (overall) and the share of self-employed in key industries that initial analysis suggests may be important to regional growth. In these models, we are especially interested in whether the propensity to be self-employed is affected by industrial diversity and may explain why some regions have more self-employment (or more self-employment in industries that support growth) than others. Initial results suggest that self-employment in some industries does matter more for growth and that places with more industrial diversity have more self-employed. When complete, our analysis will provide guidance to help rural regions better target scarce resources in order to support regional prosperity.

## ARE THERE MARSHALLIAN INDUSTRIAL DISTRICTS IN PORTUGAL? REVISITING THE CANELLO AND PAVONE ALGORITHM

João Leitão, Joaquim Ferreira

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### ABSTRACT

Mapping and classifying Industrial Districts is an important instrument of analysis of industrial activity and regional competitiveness, which allows identifying the nature of the specialization of the manufacturing activity, as well as the current state of industrialization of the regions. In this line of analysis, the present study makes an attempt to map, identify and classify the Industrial Districts in Portugal, making use of an adaptation of the Canello & Pavone (2016) algorithm, which allow finding that only 20 of the municipalities in Portugal show an organization model of the Industrial District type, among which, 13 are located in the North region, 6 in the Centre region and, only, 1 is in the Alentejo region. The evidence obtained reveals that the manufacturing activity with higher specialization focuses on the clothing industry. In turn, the transformative activity that denotes, in average terms, a greater concentration of employed population and production units, is that of the leather industry. These results unveil weak and dispersed industrialization of the Portuguese industry, still focused on activities of low value-added, based on a passive outsourcing mode targeted to international corporate clients, which constrains the competitive scale and internationalization capacity to the national companies distributed, in a very unbalanced way, in the Portuguese regional space.

## DETERMINANTS OF ENTREPRENEURIAL BEHAVIOR: AGRICULTURAL AND NON-AGRICULTURAL HOUSEHOLDS IN INDONESIA

Evi Noor Afifah, Vitriyani Tri Purwaningsih, Ririn Nopiah

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### ABSTRACT

Entrepreneurship is the greatest employment opportunity that can be entered by all groups of young and old alike. To have an entrepreneur may be a diploma and academic performance is not the main prescription. This sector can become a type of formal work if the business undertaken develops by involving permanent employees in it. However, the work done by most people tends to be informal work because it is done without permanent employees or even the business is done alone. Many factors are behind a person to open a business or become an entrepreneur, so this research was conducted to see the determinants of entrepreneurial behavior. Using data from the fifth wave of the Indonesia Family Life Survey (IFLS) in 2014, this study looked at two business models namely agricultural and non-agricultural businesses. The unit of analysis of this research is households in Indonesia with a lot of involving variables related to the Head of the Household. The model used is a cross section with logistic regression and marginal effects.

For the agricultural business model, this study uses several dummy variables such as gender, the main employment status variable whether having a job as an employee / laborer in the government/private sector. Health variables which is health/physical care, then ownership of mobile phones, ownership of internet access, ownership of electricity in the household, and location of residence whether in the village or city. It also uses the variables age, marital status, ethnicity whether Bugis, Minang, Chinese, Javanese, or others, and length of education and number of household members. In the second model, the model for non-agricultural businesses, the variables used are more similar to the agricultural business model, only slightly different by adding the ownership of the building/other buildings occupied.

## **Regular Session: RS07.3 - Migration and regional labor markets**

**17:30 - 18:45 Thursday, 27th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/86592467076>**

**Chair Raquel Simón Albert**

## REASSESSING THE PENALTY IN COMMUTING FOR IMMIGRANTS: NEW EVIDENCE FROM SPAIN

José Manuel Casado Díaz, [Raquel Simón Albert](#), [Hipólito Simón](#)

University of Alicante, Spain

### ABSTRACT

This article examines the differences in commuting length between native and immigrant employees in Spain, a relevant issue since immigrants' longer commuting times may reflect an imperfect spatial matching of their labour supply and demand with negative implications for their relative labour outcomes and their individual well-being. The research differentiates immigrants according to their origin and is based on a rich, nationally representative database, the Survey on Quality of Life at Work (in Spanish Encuesta de Calidad de Vida en el Trabajo) that covers the period 2007 to 2010. One of the main novelties, as regards previous studies on the topic, is the novel use of decomposition econometric techniques, the Oaxaca-Blinder decomposition, that allow quantifying the joint and individual influence of a wide range of explanatory factors. This is relevant insofar they permit quantifying which part of the raw differences in commuting times between immigrant and natives is explained by their different characteristics and which part remains unexplained, reflecting actual differences in the patterns of commuting for individuals otherwise observationally similar. The evidence obtained shows that, although a relevant part of the explanation of the greater commuting observed for immigrants is related to observed elements such as a different use of modes of transport, they make overall significantly longer journeys when comparing with observationally similar natives. This commuting penalty occurs yet only in the case of immigrants from emerging countries as it does not exist for those from advanced economies, which are more similar to natives. Although the penalty is overall rather similar along several sociodemographic and occupational lines, it is much more pronounced for individuals living in large municipalities and in the region of Madrid, respectively, which implies that the vast majority of previous studies on the commuting of immigrants focused in specific highly populated geographical environments could offer a biased perspective and could not be nationally representative. To conclude, we offer additional novel evidence about the potential explanations of the commuting penalty of immigrants by testing the hypothesis that the unexplained differences in the commuting times between immigrants and natives are due to contrasting attitudes towards this phenomenon. Given that commuting has a similar negative impact on satisfaction in different domains of life for immigrants and natives, immigrants' longer commutes are not apparently associated to a greater tolerance to commuting, which helps to discriminate against potential competing explanations of the phenomenon.

## SPATIALIZATION OF MIGRATION IN THE CONCEPT OF TRANS-LOCALISM

Ahmet Türel, Sinan Mert Şener

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### ABSTRACT

The concepts of space and displacement are in constant development in the globalizing world. Migration mobility that comes with globalization also increases the interaction between space and subject. Thus, it causes displacements to be visible from the outside. Today, migration is the movement of displacement that occurs in different forms all over the world. Reasons and results of migration are influenced by many other variables: sociological, economic, political, environmental, etc. Migration research has been carried out on many different concepts, such as identity, belonging, ethnicity, culture, and financial.

Along with these concepts, migration has a spatial/locational dimension that is often overlooked. With the ideas of transnational migration and transnational migration space, discussions on migration have started. In the study context, the spatiality of migration is discussed within transnational spaces and translocal places. Within the framework of daily life practices put forward by Certau, migrants' positions in the city and their experiences until reaching the endpoint are deciphered. Also, the resistance and reactions of immigration mobility against the city are questioned. While migration is localized in a sense, on the other hand, it is the situation of being a non-places, as Auge mentioned.

The migration spaces caused by environmental interactions occurring in immigrant memory during the migration process are essential issues. The study discussed how migration space is affected by forced migration and how migrants create solutions to these changes. However, the migration process is reconsidered in adaptation to the migrated location and dependence on the origin region. The study aims to propose a changing and developing place and place setup for potential immigrants or potential immigrants by creating an algorithm of migration and immigration. Here, physical preferences and social and the networks that come with digitalization, which has a game-changing effect today, will be included as an input, and the location selection criteria will be deciphered in depth.

Turkey, a "border gate" country between Europe and Asia, is strategically positioned geographically and symbolically. Turkey, which has evolved from the most immigrant country to a migrant country, has become the most desired European side country in recent years. In this context, Istanbul, which has been the most attractive city to migrants because of the cosmopolitan city, was chosen as a suitable case study for this study. In addition to the literature research, migration and spatial relations are deciphered through the migration route with the cognitive mapping method and in-depth interviews with immigrants in Turkey.

The study aims to create new perspectives on migration and evaluate migration as "multiple places" beyond the destination or origin. It also intends to increase added value regionally by transforming forced migration into an input that contributes to the labour market and social and social structure. Additionally, it enables the creation of urban and regional projections through the role of migration spaces that come with migration in creating trans-local spaces at the intersection of temporality and permanence.

## CLUSTER ANALYSIS OF ONLINE VACANCIES BASED ON ATTRIBUTE ASSOCIATIONS

**[Carlos Usabiaga](#)<sup>1</sup>, [Fernando Núñez](#)<sup>2</sup>, [Lukasz Arendt](#)<sup>3</sup>, [Ewa Gałecka-Burdziak](#)<sup>4</sup>, [Robert Pater](#)<sup>5</sup>**

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### ABSTRACT

This paper develops a new smoothing procedure for contingency tables which is based on models of partial association. Our methodology is tested on a database of online job offers published on selected Polish job portals in the period 2017-2019. First, we build a contingency table by cross-classifying some descriptive variables of the job vacancies (for example, region, occupation and activity). Second, we use our methodological proposal to smooth the contingency table, correcting in this way the sparsity problem which affects highly segmented tables. Third, we use the smoothed table as an input to generate a table of association factors between rows and columns that can be clustered on both sides giving rise to a bicluster "heatmap". Our application allows to contrast the existence of polarisation in the Polish labour market by using data on online job offers, an interesting proposal given that most of the studies on the polarisation hypothesis are based on employment data. The study reveals that a cluster of semi-transversal skills – self-organisational, technical, interpersonal and availability skills – constitutes an important requirement in most of job offers. Since these skills are mainly developed within the educational system, these results put even more pressure on this system, which is not sufficiently effective in providing skills in line with labour market needs. We also show that office skills do not offer a particular advantage in the labour market, in accordance with the polarisation hypothesis, while ICT skills and communication skills seem to have a positive effect on employability in times of accelerating automation.

### KEYWORDS

Contingency table, Labour polarisation, New smoothing algorithm, Online job offers.

## **Regular Session: RS17.1 - Globalization and territorial intelligence**

**17:30 - 18:45 Thursday, 27th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/84441830561>**

**Chair Rafael Garduño-Rivera**

## THE GEOSTRATEGIC POSITION OF ROMANIA FROM THE PERSPECTIVE OF ENERGY RESOURCES

[Alexandra Colcer](#)<sup>1</sup>, [Mihail Paduraru](#)<sup>2</sup>, [Irimuş Ioan Aurel](#)<sup>1</sup>

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### ABSTRACT

The conflict from Ukraine created increasingly tense relations between the states of the European Union amid an energy crisis. For this reason, the article aims to demonstrate how energy resources have become a key element in the security architecture of a state. Therefore, the dynamics of international economic relations require a careful analysis of the geographical position of Romania from the natural resources perspective. It should be mentioned that the authors come from different fields, so the study will have different approaches. The purpose of the research is to demonstrate the importance of energy resources in the security architecture of Romania. In the context of a constantly changing international security architecture, energy resources are still a basic element in ensuring security. Due to the geopolitical and geostrategic events happened on the international stage, the states increased the importance of possession, capitalization, and access to the energy resources. The present study is an interdisciplinary one, carried out by a mixed team, between a geographer and an intelligence practitioner, which makes the subject to be approached from several angles. The objectives of this paper are the evaluation of the resources from the qualitative and quantitative point of view, and the way these resources are capitalized. Also, we will analyze the trade with resources and the policies in the field. In addition, we will also emphasize how the resources are strategically capitalized. The documentary sources were verified for a high degree of credibility and aimed at scientific works of geography, economy, law; visual materials (maps, graphs, sketches), legislative documents and public statements of the people in the field. The statistical data were collected from the website of the National Institute of Statistics and EUROSTAT. We used bibliographic methods for collecting information from both printed (books, scientific papers) and electronic formats (scientific articles, online newspapers). For texts, we used the method of semantic analysis and the message contained, according to criteria such as credibility, relevance, objectivity, accuracy, completeness. Also, the cartographic method was used to make the cartograms. The research started from the premise that the development and stability of a state depends exclusively on the management of these resources. Given the importance of the energy resources from Romania, the present study will highlight how this advantage can be enhanced depending on the way they will be used.

## THE EFFECT OF A FREE TRADE AGREEMENT WITH THE UNITED STATES ON MEMBER COUNTRIES' PER CAPITA GDP: A SYNTHETIC CONTROL ANALYSIS

**Esteban Colla-de-Robertis, Rafael Garduno-Rivera**

Universidad Panamericana, Mexico

### ABSTRACT

This article aims to evaluate the impact of signing a free trade agreement (FTA) on per capita gross domestic product (GDPPC). Although the immediate objective of a FTA is to increase trade between the signatory countries (Dür et al. 2014), from the perspective of evaluating public policy, it is important to evaluate its impact on citizens' well-being, and the GDPPC is a better measure of said impact than measures that pertain to trade alone.

In particular, we focus on the GDPPC of the 20 countries that have signed a FTA with the United States. This focus is motivated by the fact that the U.S. is the biggest, most developed economy in the world and has signed the most extensive trade agreements of any country. North-South agreements tend to be the most extensive, whereas South-South agreements tend to be the least far-reaching (Dür et al. 2014). Hence, this study helps shed light on the development effects of North-South agreements for Southern (developing) countries.

The United States has been an ardent supporter of trade liberalization. Since President Roosevelt's administration, the U.S. has assumed that trade openness guarantees stable economic growth. In that line, during the last century, the U.S. has traded with a variety of countries across the globe, becoming a leader and a role model on trade openness in this era of global economic integration.

The main trade agreement explosion occurred during the early 2000s, after agreements with Israel (1985), Canada (1988) and Canada and Mexico (1994). At the time of this study, the United States had signed FTAs with 20 countries. Two of these FTAs were multilateral (NAFTA and CAFTA); NAFTA includes Canada and Mexico, while CAFTA includes countries in Central America and the Caribbean (2004). The rest of the agreements were bilateral.

This study employs the synthetic control method (SCM) to estimate the economic effects of signing free trade agreements (FTAs) with the United States. This method allows for a counterfactual –the country's per capita GDP had it not signed a FTA–, which can be compared with the observed per capita GDP. This difference speaks to the causal impact of the FTA. We principally find that FTAs seem to have a heterogeneous impact. In particular, there is evidence that signing a FTA with the U.S. had a positive effect on the per capita GDP of Chile and Jordan and that NAFTA had an adverse impact on Mexico's per capita GDP. In several other cases, no significant economic impact is discernible. In addition, the more a country depends on the U.S. for its trade, the less beneficial signing a FTA with the U.S. is.

This article contributes to the debate on the effectiveness of trade as a development strategy. In particular, the SCM opens up the possibility of a "case-by-case" analysis, ultimately revealing that a free trade agreement with the U.S.–a country situated at the world's technology frontier–has heterogeneous outcomes and, by itself, does not guarantee economic development (obtained through a higher per capita GDP).

## REGIONAL AND GLOBAL PATTERNS OF PARTICIPATION IN VALUE CHAINS: EVIDENCE FROM BRAZIL

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### ABSTRACT

The main objective of this paper is to verify Brazil's role in global value chains considering its participation in global and regional trade blocs. The hypothesis is that Brazil has different roles in global value chains and regional value chains. Brazil carries out international trade with several countries, regions and trade blocs. However, the country's trade with the other Mercosur members has a different pattern compared to other countries and trade blocs. Thus, this paper intends to verify the trade pattern differences between Brazil and South America and Brazil and other regions and trade blocs. We also seek to verify the role of Brazil as a reference center for conducting international trade in South American countries, that is, the role of Brazil as a regional hub in international trade. To achieve these stated goals, we perform a spatial decomposition of foreign value-added content, by taking into account the upstream and downstream segments of value chains. The regional and global participation patterns in the value chains are analyzed through the geographic extension of the stages of production. These patterns are assessed using indicators of global and regional fragmentation of global value chains. To measure the linkages of global value chains, the value-added content is decomposed using the inter-country input-output model over the period from 1990 to 2015. We use the full Eora Global Supply Chain Database's multiregional input-output table (MRIO), which contains data for 190 countries and specifies 26 activity sectors. The chosen period of investigation allows us to evaluate Brazil's participation in global value chains relative to different scenarios and changes in its commercial and industrial policies. Thus, we assess if Brazil's integration process with internationally fragmented production chains follows a worldwide trend or presents a pattern distinct from other economies. Our findings suggest that between 1990 and 2015 Brazil's production became more fragmented internationally and consequently its participation in global value chains increased. However, its regional insertion increased more than its global insertion. Although South America has a small share in value-added trade, it was found that Brazil operates both as a regional hub and serves as a reference for international trade in that region. In the global context, Brazil has the role of supplier of intermediate inputs, while in the regional context, Brazil plays the role of an important production center. This regional production center proved to be well integrated with the principal hubs of the global value chains.

### KEYWORDS

International fragmentation; Global value chains; Global and regional fragmentation; Input-output; Brazil.

### 1. INTRODUCTION

Since the 1970s, Brazil's commercial and industrial policies have been oriented towards the formation of a vertically-integrated national industrial park and the establishment of all stages of production. These policies have been formulated to preserve Brazil's limited exposure to imports, with a strong protectionist tendency (Veiga and Rios, 2017). The main instrument of this trade policy is the collection of high import tariffs (Messa and Oliveira, 2017). Tariff barriers have a significant effect on blocking trade in value chains, as intermediate inputs cross national borders many times before they become final products.

The initial and limited trade policies of the Brazilian economy arising since the 1970s were the creation of the Southern Common Market (Mercosur) in 1991 (agreement between Brazil, Argentina, Paraguay and Uruguay), the trade agreement between Mercosur, Chile and Bolivia in 1996 and extended to include Colombia, Ecuador, and Peru in 2003. Since then, Brazil has been relatively closed to new trade agreements (Thorstensen and Ferraz, 2014).

Given this context, commercial opening in Brazil began in the early 1990s, such that changes in the structure of production and international trade in the Brazilian economy necessarily changed its role in global value chains. The growth of the Brazilian economy since then, mainly in the 2000s, has attracted foreign investments and made the Brazilian economy more heterogeneous in terms of sectors compared to prior periods. In fact, the existence of Mercosur had a spillover effect on the development of international trade in other South American countries also. Many companies

sought to obtain or expand access to South American markets, which led to an increase of foreign investments in Brazil and the region in recent decades.

The main objective of this paper is to verify Brazil's role in global value chains considering its participation in global and regional trade blocs. The hypothesis is that Brazil has different roles in global value chains and regional value chains. Brazil carries out international trade with several countries, regions and trade blocs. However, the country's trade with the other Mercosur members has a different pattern compared to other countries and trade blocs. Thus, this paper intends to verify the trade pattern differences between Brazil and South America and Brazil and other regions and trade blocs. We also seek to verify the role of Brazil as a reference center for conducting international trade in South American countries, that is, the role of Brazil as a regional hub in international trade (Baldwin and Lopez-Gonzalez, 2015).

To achieve these stated goals, we perform a spatial decomposition of foreign value-added content, by taking into account the upstream and downstream segments of value chains. The regional and global participation patterns in the value chains are analyzed through the geographic extension of the stages of production. These patterns are assessed using indicators of global and regional fragmentation of global value chains. To measure the linkages of global value chains, the value-added content is decomposed using the inter-country input-output model over the period from 1990 to 2015. We use the full Eora Global Supply Chain Database's multiregional input-output table (MRIO), which contains data for 190 countries and specifies 26 activity sectors. The chosen period of investigation allows us to evaluate Brazil's participation in global value chains relative to different scenarios and changes in its commercial and industrial policies. Thus, we assess if Brazil's integration process with internationally fragmented production chains follows a worldwide trend or presents a pattern distinct from other economies.

Some relevant prior studies conducted on the Brazilian economy are focused on discussing value chains based on evidence supported by gross export statistics, even though such statistics are not appropriate in this context (Johnson and Noguera, 2012a; Koopman, Wang and Wei, 2014). Dietzenbacher, Guilhoto and Imori (2013), Guilhoto and Imori (2014), Ferraz, Gutierrez and Cabral (2015), Callegari et al. (2018), Magacho et al. (2018), Perobelli et al. (2019), Haddad (2019) and Haddad and Araújo (2020) analyze the insertion of Brazil into global value chains based on the trade of value-added content. This paper differs from the existing literature in that we analyze the role that Brazil can play in the trade relations of global value chains from two perspectives – global and regional. As such the paper contributes to the literature by explaining the differences that the Brazilian economy plays in relative terms in the international fragmentation of production both globally and regionally – that is, we focus on the geographic extension of its value chains.

Our findings suggest that between 1990 and 2015 Brazil's production became more fragmented internationally and consequently its participation in global value chains increased. However, its regional insertion increased more than its global insertion. Although South America has a small share in value-added trade, it was found that Brazil operates both as a regional hub and serves as a reference for international trade in that region. In the global context, Brazil has the role of supplier of intermediate inputs, while in the regional context, Brazil plays the role of an important production center. This regional production center proved to be well integrated with the principal hubs of the global value chains (United States, China and Germany).

The paper is structured as follows. Section two presents a literature review about vertical specialization and the challenges of measuring the participation of countries in global production chains. Section three presents the vertical specialization measures used in this study. Section four provides the source of the data used in the analysis. Section five presents and discusses the results. Finally, section six provides conclusions and suggestions for policymaking.

## 2. DECOMPOSING PARTICIPATION IN GLOBAL PRODUCTION CHAINS

Foreign value-added content is used to evaluate integration into global value chains. The method used in this paper to measure the value-added content of trade follows that of Johnson and Noguera (2012a) and Los, Timmer and de Vries (2016), which is adapted to assess the integration in upstream and downstream segments of supply chains, emphasizing the regional and global participation patterns in these chains.

The contribution of each country in the production chain can be broken down using an inter-country input-output table. This table contains the values of the flows of intermediate inputs and final goods among all the countries' industries – i.e., the  $s$  industries ( $s = 1, \dots, S$ ) in each of the  $n$  countries ( $n = 1, \dots, N$ ). By combining information on the values of transactions of intermediate inputs ( $\mathbf{Z}$ ), final demand ( $\mathbf{F}$ ), sectoral production ( $\mathbf{x}$ ), and remuneration of primary production factors ( $\mathbf{w}$ ), it is possible to estimate the value generated in each of the  $SN$  industries. The intermediate inputs required per unit of production are defined in the matrix  $\mathbf{A} = \mathbf{Z}(\hat{\mathbf{x}})^{-1}$ , and the value added per unit of product is defined in the vector  $\mathbf{v} = \mathbf{w}(\mathbf{x})^{-1}$ . The term  $\hat{\mathbf{x}}$  corresponds to the diagonal matrix formed by the vector  $\mathbf{x}$ .

To produce the good  $(i, s)$ , a combination of local primary inputs and national and imported intermediary inputs from different sectors and countries is required. Then, the good  $(i, s)$  is absorbed in the final demand or used as an intermediate input in production. To break down its value, it is necessary to find the product levels associated with the good  $(i, s)$  at each stage of production, measured through inter-country input-output tables. To do so, the value chains are identified by the last stage of production of the final good  $f_{ij}(s)$ . The participation of each country in the international fragmentation of production is measured by its value-added content inserted in the value chains, following the formulation proposed by Los, Timmer and de Vries (2015). Thus, the value generated in the production of the good  $(i, s)$  is derived from the remuneration of capital and labor in the country-industry of production. This is equivalent to

identifying the extent to which the country of completion of the final good  $f_{ij}(s)$  contributes to the production of that good, which can be decomposed as follows:

$$\mathbf{g} = \hat{\mathbf{v}}(\mathbf{I} - \mathbf{A})^{-1}\mathbf{F} \quad (1)$$

where the matrix  $\hat{\mathbf{v}}$  is formed by the diagonalization of the value added per unit of product. The use of the Leontief inverse matrix,  $(\mathbf{I} - \mathbf{A})^{-1}$ , ensures that value-added contributions at all stages of supply through direct and indirect requirements in the productive chain structure are taken into account. The final demand vector ( $SN \times 1$ )  $\mathbf{F}$  has its real values only in the cells that represent the final demand for the country-industry  $(i, s)$ , while all other values in the final demand are set to zero. The vector  $\mathbf{F}$  is equal to the final internal and external demand for the final products  $f_{ij}(s)$ . The choice of a specific vector  $\mathbf{F}$  by country of origin of the production of final goods determines the value chain being analyzed.

The vector ( $SN \times 1$ )  $\mathbf{g}$  contains the value-added contributions generated in each of the country-industries that can be assigned to the value chains of the final products  $f_{ij}(s)$ .<sup>179</sup> To obtain the origin of the value added to the final good  $f_{ij}(s)$  in the production chain by country, the elements of  $\mathbf{g}$ , which correspond to the industries in each country, are added to each other. Los, Timmer and de Vries (2015) show that the main result of this calculation is the possibility of decomposing the value of a final product by the value-added contributions made in any country.

### 2.1. Downstream integration into global chains

The integration of countries into global production chains may occur differently when considering the downstream or upstream tracking of such production chains. Therefore, this study measures the downstream integration into global value chains, defined as Sourcing<sub>s</sub>. This measure is calculated taking as a starting point the proposed decomposition by Los, Timmer and de Vries (2015).

The Sourcing<sub>s</sub> measure is calculated using the vector  $\mathbf{g}$ , defined in Equation (1), from its replication for each country of completion of the final good  $f_{ij}(s)$ . Value added from the country of completion in vector  $\mathbf{g}$  is set to zero. The sum of the value-added contributions provided by each country  $i$  for the other completion country  $j$  is defined as:

$$SVA_s = \sum_{j \neq i} VA_{ij}(s), \forall j \quad (2)$$

The participation of each country in the supply of value-added content for the global production chains, from Equation (2), is defined as follows:

$$\text{Sourcing}_s = \frac{SVA_s}{\sum_i \sum_{j \neq i} VA_{ij}(s)} \quad (3)$$

where  $\sum_i \sum_{j \neq i} VA_{ij}(s)$  is the sum of the foreign value added in global production. The sum of Sourcing<sub>s</sub> for each country  $i$  belonging to the global production chain is equal to 1.

### 2.2. Upstream integration into global chains

The upstream integration in global chains focuses on the provenance of the value added for the last stage of production, that is, the country-of-completion. In this regard, the value added in the final goods produced in Brazil is decomposed, per the approach developed in Los, Timmer and de Vries (2015). Thus, the vector  $\mathbf{F}$  of Equation (1) includes the final demand values only for Brazil, with the other cells specified as zero. The value of the final good produced by industry  $s$  in Brazil is indicated by FINO<sub>s</sub>. The value added from country  $j$  is defined by  $VA_{(j)}(s)$ . The vector  $\mathbf{g}$  contains the corresponding levels  $VA_{(j)}(s)$  for each final good produced in Brazil  $f_{ij}(s)$ , such that:

$$\text{FINO}_s = \sum_s VA_{(j)}(s) \quad (4)$$

The contribution of all countries to the value added in the production of  $(i, s)$  is equal to the value of the final product  $(i, s)$ . The FINO<sub>s</sub> measure allows for the definition of the value added throughout the production chain in which Brazil is integrated, minus the value-added content produced in Brazil:

$$\text{FVA}_s = \sum_{j \neq \text{Brazil}} VA_{(j)}(s) = \text{FINO}_s - VA_{(\text{Brazil})}(s) \quad (5)$$

The term FVA<sub>s</sub> measures the international fragmentation of production chains.<sup>180</sup> FVA<sub>s</sub>, unlike SVA<sub>s</sub>, defined in Equation (2), is the sum of the value added from the  $N$  countries in the production of country  $i$ . SVA<sub>s</sub>, in turn, is the sum of the contribution of country  $i$  to the value added inserted in the production of the  $N$  countries belonging to the global production chain. To measure the importance of foreign value added, FVA<sub>s</sub> is expressed as the share of value added in the production of  $s$ :

$$\text{FVAS}_s = \text{FVA}_s / \text{FINO}_s \quad (6)$$

The foreign value-added share (FVAS) is used to measure the extent of the international fragmentation of the value chains in which Brazil is inserted. This share is an index that varies between zero and one. FVAS assumes zero value when all value added is produced internally, assuming larger values as international fragmentation increases.<sup>181</sup> FVAS includes the value added at each stage of production. Thus, this measure does not pose the problem of double counting, defined by Koopman, Wang and Wei, (2014), which is present in the other vertical specialization metrics that use intermediate inputs imported into production.

179 The final demand for the good  $(i, j)$  includes household and government consumption as well as the demand for investment in domestic and foreign markets.

180 The approach to international fragmentation measuring from FVA<sub>s</sub> is based on tracking the value chain, starting from the final product and tracing the added value, at all stages, needed to produce the final good.

181 By definition, FVAS cannot be equal to one, because the final stage of production must involve some activity in the country of completion of production.

### 3. DATABASE

The regional and global fragmentation of value chains is analyzed using the data provided by the full Eora MRIO. The construction of this database is described in Lenzen et al. (2012a) and Lenzen et al. (2013a). The full Eora MRIO contains data for 190 regions of the world, specifying 26 sectors of activity,<sup>182</sup> and covers the period from 1990 to 2015.<sup>183</sup> The data for the construction of the Eora MRIO database derive from national statistical offices. Bilateral trade data comes from the UN Comtrade Database and UN Service Trade Database. The Eora database assumes that its regional specification sufficiently covers the global economy.

Changes in the national accounts system may cause interruptions in the continuity of the input-output tables of Brazil estimated by Eora. However, Lenzen et al. (2013b) show that this does not generate imbalances in sectoral aggregated analyses – which are the focus of this study. A detailed description of the price corrections and of all the discontinuities and corrections implemented in the input-output tables for the Brazilian economy, used in the estimation of the full Eora MRIO, is found in Lenzen et al. (2012b) and Lenzen et al. (2013b).

The choice of using the Eora other than other databases of inter-country input-output tables is motivated by its complete regional specification for the South American countries. This allows us to measure the geographical origin of all regional trade flows in Brazil. In addition, the historical series of the full Eora MRIO makes it possible to evaluate the evolution of Brazil’s participation into global value chains.

### 4. RESULTS

The measures of foreign value-added share (FVAS) and Sourcing are used to quantify the Brazilian economy participation in regional and global trade blocs. FVAS is a measure of upstream integration into global chains, that is, in terms of the purchase of inputs. The Sourcing measure, defined by the share of value added produced by Brazil in relation to total foreign value added in all value chains, evaluates the downstream integration into production chains.

Table 1 shows the distribution of value added in the final goods produced in Brazil in two groups: for all activity sectors and for the sectors related to agriculture, mining, manufacturing and tradable services.<sup>184</sup> The regional and global foreign value-added share (FVAS) in the final goods produced in Brazil increased from 1990 to 2015. This suggests that production in Brazil became more internationally fragmented. Brazil ranks 157<sup>th</sup> out of 188 countries<sup>185</sup> in terms of FVAS in final products (Table A1 in the Appendix).<sup>186</sup> South American countries have a small share in the production of final goods in Brazil – the regional trade bloc provided 2.06% (RFVAS) and the global trade bloc contributed 8.98% (GFVAS) of the foreign value added in Brazilian production in 2015.

**Table 1. Origin of value added in final goods produced in Brazil (%)**

	All sectors		Agriculture, mining, manufacturing and tradable services	
	1990	2015	1990	2015
Domestic value added	93.731	92.014	92.004	88.957
Foreign value added (FVAS),	6.269	7.986	7.996	11.043
of which				
Regional (RFVAS)	0.646	1.476	0.858	2.059
Global (GFVAS)	5.623	6.510	7.138	8.985

Source: Authors' calculations.

The downstream integration of Brazil into value chains in regional and global trade blocs is measured by Regional Sourcing and Global Sourcing. The Sourcing measure assesses the importance of the Brazilian economy for the production chains, that is, the value added with origin in Brazil in relation to the foreign value added included in the final goods produced anywhere in the world. Table 2 shows Brazil’s share in world exports of value added and its regional and global participation between 1990 and 2015. In 2015, Brazil contributed 1.39% of foreign value added in the final products of all production chains – 0.24% for the production of South American countries (Regional Sourcing) and 1.14% for the

182 The Eora MRIO provides data from the inter-country input-output table with the breakdown of 56 sectors of activity into the Brazilian economy. However, this matrix does not have a harmonized version for all world economies, making it impossible to aggregate foreign value-added results at the industrial level.

183 Owen et al. (2016), Steen-Olsen et al. (2016) and Owen (2017) analyzed the results of economic indicators constructed from the Interregional Input-Output Tables of the Global Trade Analysis Project (GTAP), World Input-Output Database (WIOD), Multi-region Input-Output Table (EORA) and Inter-country Input-Output (OECD-ICIO) and found that global added value accounts are similar between these databases, although differences exist at the country and individual sector levels.

184 Non-transactional services are not included in the analysis because their production is not traded internationally. These sectors are characterized by services rendered locally.

185 The Eora MRIO database has information on 190 regions, including one called "statistical discrepancy" and another for the former USSR. Thus, the ranking has information on 188 countries.

186 One of the reasons for the low FVAS in the Brazilian economy is the high import tariffs practiced in the country. They have been aimed at intensifying the protection of the national industry (Veiga and Rios, 2017a) and increasing domestic content in production. However, we cannot merely analyze the FVAS to assess participation in value chains. For example, the United States and Japan also have low FVAS. The FVAS is influenced by the stage of technological development and its dependence on imports of foreign technologies, and the linkages of the industrial structure with the rest of the world—that is, the industrial specialization in the country and the stages of production that are outsourced abroad.

production in the rest of the world (Global Sourcing). Brazil is 20<sup>th</sup> of 188 countries in a ranking which assesses shares in the supply of value added for global production chains, (Table A2 in the Appendix).

**Table 2. Share of value added with origin in Brazil in relation to total foreign value added in all value chains (%)**

	All sectors		Agriculture, mining, manufacturing and tradable services	
	1990	2015	1990	2015
Sourcing, of which	0.963	1.373	0.985	1.386
Regional Sourcing (RS)	0.096	0.240	0.099	0.244
Global Sourcing (GS)	0.867	1.133	0.886	1.142

Source: Authors' calculations.

Table 3 shows Brazil's regional and global patterns of participation in value chains through the decomposition of the geographical origin of the value-added trade by industry. The participation of the Brazilian economy in international trade is marked by distinct characteristics when considering its global or regional integration. Agriculture (13.56%) and mining (17.49%) make up 31.05% of the regional foreign value added (RFVAS), while manufacturing represents 46.8% of global foreign value added (GFVAS) in 2015. Brazilian value-added exports to South America (Regional Sourcing) consisted mainly of manufacture (44.49%) and services (46.36%), whereas Global Sourcing has become resource-intensive and agriculture and mining increased participation from 12.82% in 1990 to 16.70% in 2015. Table 4 also shows the importance of services in value-added exports in both Regional Sourcing (46.36%) and Global Sourcing (45.22%). Haddad and Araújo (2020) found that the value added to services in exports account for 48.23% of Brazilian exports of value added, despite the fact that services represent only 17.39% of total gross exports in 2015.

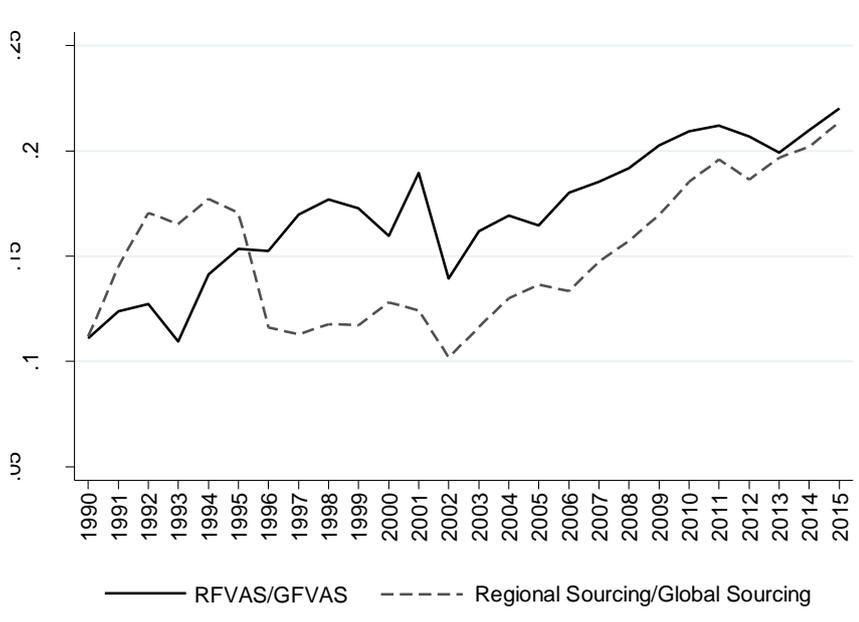
Figure 1 shows the relative importance of regional insertion in relation to global insertion for the tradable activity sectors between 1990 and 2015. These results allow us to identify the change in the pattern of international fragmentation over time. The RFVAS and Regional Sourcing have increased in relation to the global share. Therefore, although Brazil's participation in the value chains has been driven mainly by the global fragmentation of production, its regional insertion has increased more than its global insertion. This result may have been driven by trade agreements signed during this period, which Brazil prioritized to conclude with neighboring countries. Johnson and Noguera (2017) show that participation in bilateral free trade agreements positively affects countries' vertical specialization.

**Table 3. Regional and global patterns of participation in value chains: Brazil**

		Year	Agriculture	Mining	Manufacture	Services	Total
Foreign Value Added	Regional	1990	15.317	12.554	27.524	44.605	100.000
		2015	13.560	17.495	28.238	40.706	100.000
	Global	1990	1.806	4.403	35.218	58.574	100.000
		2015	1.798	8.472	46.938	42.791	100.000
Sourcing	Regional	1990	4.168	5.844	35.701	54.287	100.000
		2015	3.499	5.650	44.492	46.358	100.000
	Global	1990	7.012	5.807	26.995	60.187	100.000
		2015	6.722	9.980	38.079	45.219	100.000

Source: Authors' calculations.

**Figure 1. Trend of regional and global fragmentation of Brazilian production**



Source: Authors' calculations.

5.1 Comparison between Brazil and other economies

The fragmentation of production occurs differently at the regional or global level of value chains. In this context, Baldwin and Lopez-Gonzalez (2015), Lejour et al. (2017) and Li et al. (2019) identify the hubs in the global trading system. Lejour et al. (2017) show that value-added trade follows supply lines between groups of regions specialized in specific stages of global value chains. These supply lines are formed by groups of geographically close and highly integrated regions that provide value-added to other groups of regions defined as global production centers.

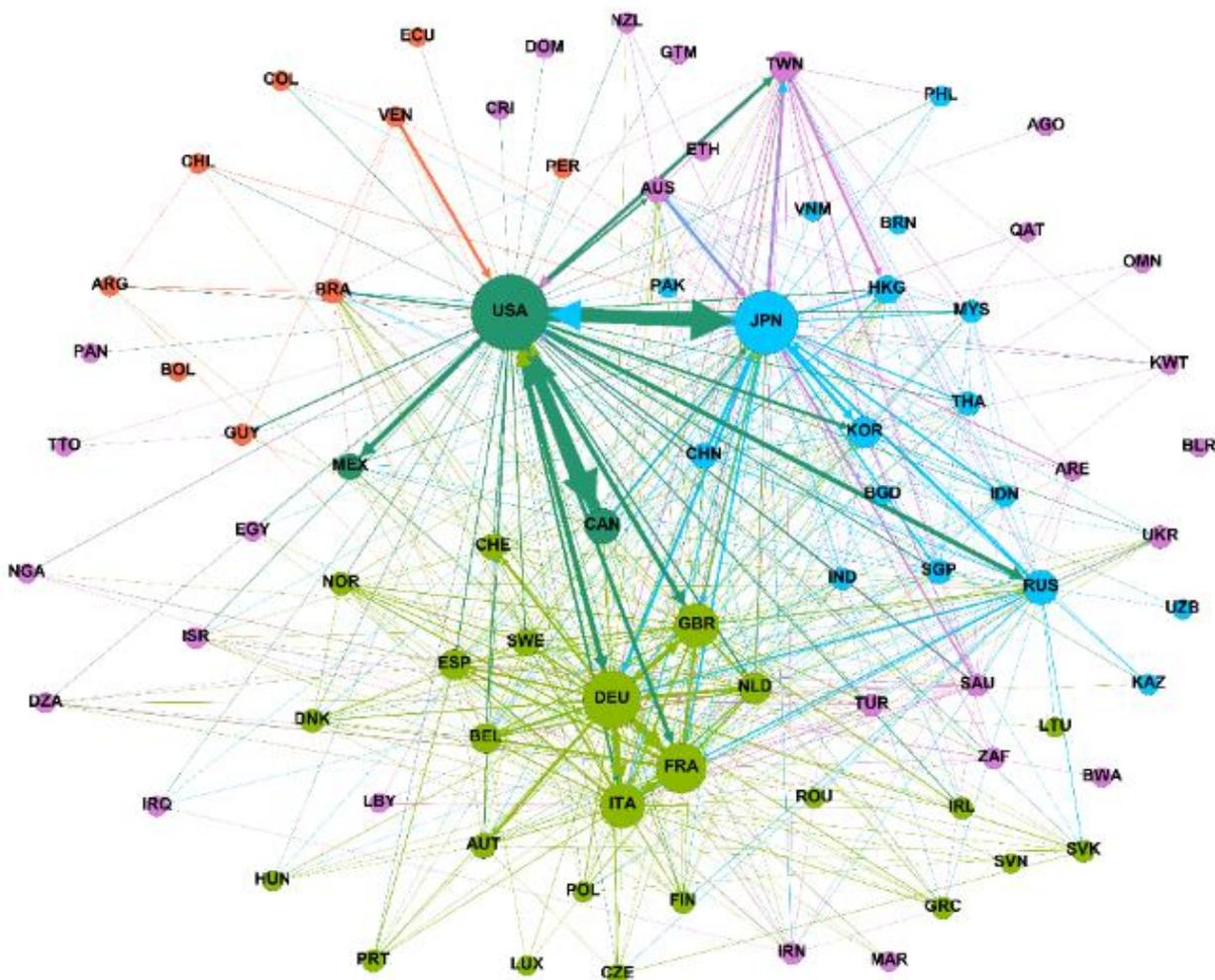
To identify the main regional value chains and global production hubs, the value-added trade flow, measured using Equation (4), is shown in Figure 2. The size of the circle represents the amount of foreign value added in the production of final goods. The width of the arrows represents the flow of value added between countries. The colors represent the regional production chains: South America (orange), North America (dark green), Asia-Pacific region<sup>187</sup> (blue), Europe (light green) and the rest of the world (lilac). The link arrow shows the direction of the value-added flow. The figure shows only the main value-added flows. This figure allows for visualization of the supply chains highlighting the main production hubs.

The structural pattern of the production chains is maintained between 1990 (Fig. 2a) and 2015 (Fig. 2b). Production chains have become more integrated, reflected in the increased share of foreign added value in production. Li et al. (2019) also show that value chains still remain largely regional; China is increasingly playing a relevant role as a hub in simple global value chain networks, although the United States and Germany are still the main hubs in complex global value chain networks.

Even though they are poorly integrated, South American countries act as a regional production center for Brazil, which in turn is more interconnected with the main hubs of the global value chains. Brazil is the main trade reference for these countries. This regional production center mainly supplies the production chain in North America and Europe, which serve as global production centers. Brazil at the global level plays a role as a supplier of intermediate inputs, while at the regional level it plays a role as a main production center. We should note that Brazil has the potential to significantly affect the economies of neighboring countries, assuming a position of regional leadership (Adler and Sosa, 2014).

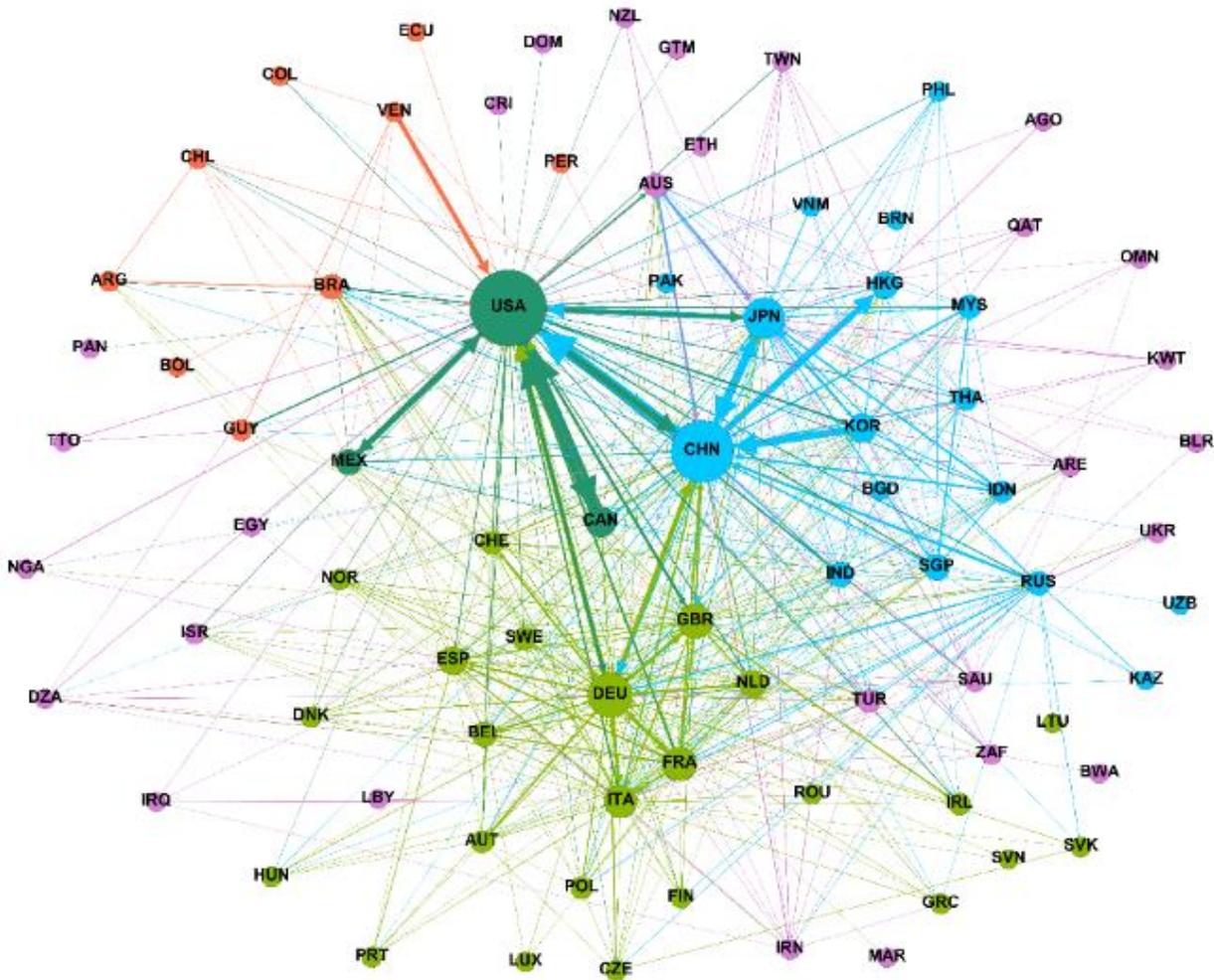
Figure 2. Main value-added trade flows in production chains

Fig. 2.a. 1990



187 The Asia-Pacific region includes China, East Asia and Southeast Asia.

Fig. 2.b. 2015



Note: The circle size represents the amount of foreign added value used in the production of final goods. The width of the arrows represents the flow of added value between countries. The colors represent the regional production chains: South America (orange), North America (dark green), Asia-Pacific region (blue), Europe (light green) and rest of the world (lilac). The link arrow shows the direction of the value-added flow.

Source: Authors' calculations.

Table 4 shows FVAS and Sourcing in product value chains for Brazil and the major global manufacturing hubs (United States, China, and Germany).<sup>188</sup> Columns (3) and (6) present the difference between 2015 and 1990. All countries increased their foreign value-added share (FVAS). Meanwhile, the United States and Germany have lost share in Sourcing (column 6). In the 1990s and 2000s, there was a relocation of global manufacturing from the United States, Europe, and Japan toward Southeast Asia (Baldwin and Lopez-Gonzalez, 2015); column (6) shows that the main beneficiary of this process is China (7.82%).

**Table 4. FVAS and Sourcing in product value chains by country, 1990 and 2015**

	FVAS			Sourcing		
	1990	2015	2015-1990	1990	2015	2015-1990
	(1)	(2)	(3)	(4)	(5)	(6)
Brazil	7.996	11.043	3.047	0.985	1.386	0.401
United States	6.593	11.932	5.339	15.435	9.799	-5.637
China	8.093	12.629	4.536	2.635	10.460	7.825
Germany	13.575	21.894	8.319	10.475	7.880	-2.595

Source: Authors' calculations.

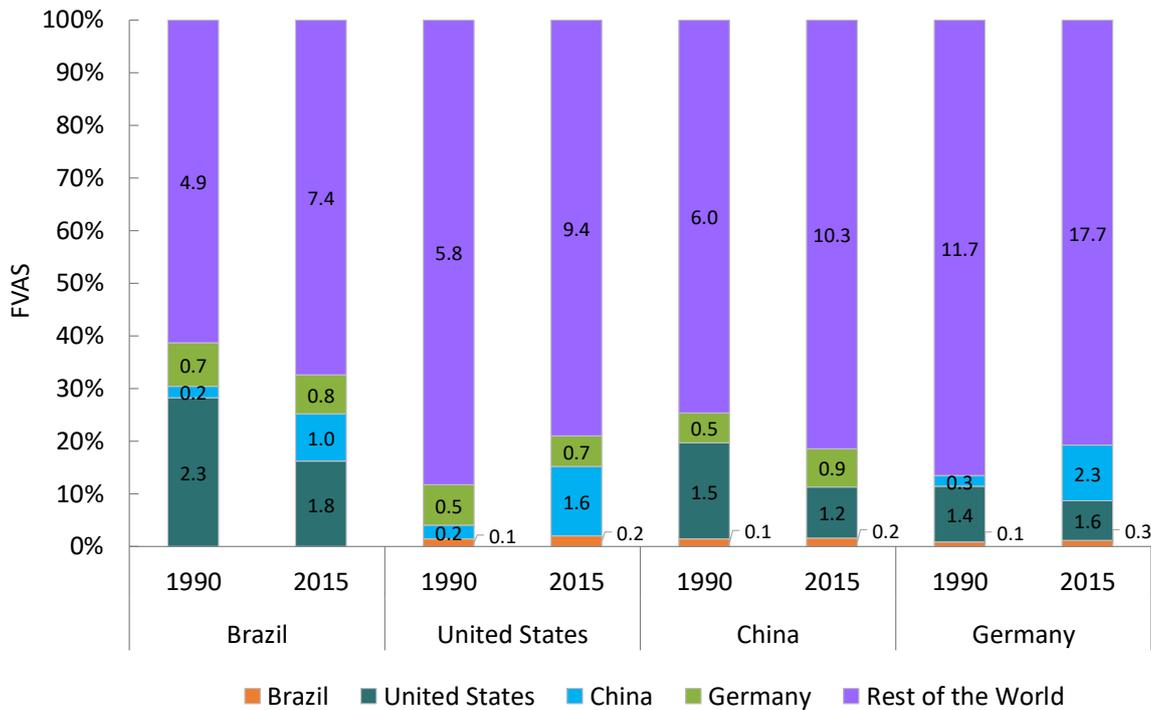
Geographic proximity is crucial in global value chains because the trade is intensified between economies that share a border. Brazilian participation in global value chains occurs mainly by trade with geographically distant countries. China and Germany mostly have regional trade. These countries are hubs in the global value chain and have a trade pattern for hub-and-spoke networks with their neighboring countries (Baldwin, Lopez-Gonzalez, 2015). Thus, there is an intense

<sup>188</sup> Tables A1 and A2 in the Appendix present FVAS and Sourcing in product value chains by country of completion for the 188 countries specified in the Eora MRIO database.

trade of intermediate inputs in regional production chain, with Chinese and German firms performing some intermediate stages of production in neighboring countries.

Figure 3 shows the origin of the foreign value added in the final products of Brazil as well as for the major production hubs (United States, China, and Germany). Brazil's share of total value-added exports increased from 0.98% in 1990 to 1.38% in 2015. Although the Brazilian economy occupies a prominent position in South America, its participation in global production chains is still discreet. Brazil contributes only a small share of the foreign value added in the final products of global hubs. Between 1990 and 2015, there was an increase in the interdependence between global hubs, although this interdependence has remained small. Baldwin (2020) also shows that the interdependence of the three global manufacturing hubs – China, Germany and the US – has increased with respect to international supply chains.

**Figure 3. Global manufacturing hubs' interdependence**



Source: Authors' calculations.

The value-added originating in South America represented 4.22% (1.38% only in Brazil) of the global trade in 2015. The small size of the economy of the countries in the region justifies Brazil's greater dependence on foreign value added with global origin. Brazil and other South American countries depend heavily on trade with countries that are geographically distant. Poor integration between South American countries potentially reduces the benefits that they could obtain from global trade, since the geographic distance still matters in globally fragmented production (Li et al., 2019).

**5. CONCLUSIONS**

This study has undertaken a spatial decomposition of foreign value added in the downstream and upstream segments of value chains. The focus of the analysis is the Brazilian economy, since its pattern of participation in international trade has distinct characteristics with reference to its global or regional integration. This analysis presents evidence with respect to the position that Brazil occupies in the value chains and the spatial extent of this productive fragmentation. The main results show that the participation of the Brazilian economy in value chains occurs differently when considering their geographic scope and downstream and upstream production stages. We find that the downstream and upstream participation of Brazil in value chains is driven mainly by the global fragmentation of production. However, its regional insertion has increased more than its global insertion. The results also suggest that Brazil operates as a regional hub, as it is a reference for international trade in in this region. This regional production center proved to be more integrated with the main hubs of the global value chains (United States, China and Germany). Additionally, in the global context, Brazil plays the role of supplier of intermediate inputs, while in the regional context, Brazil plays the role of an important production center.

The Brazilian economy is relatively closed to international trade and minimally inserted in value chains. Protectionist policies have been directed for all stages of production in the national territory. Thus, Brazilian industry has remained minimally integrated into the international fragmentation of production. Additionally, the reduced number of trade agreements hinders the country's participation into value chains. However, the results also indicate that Brazil plays a strategic role in the fragmentation of South American production. This role, if well explored, could be a strategic mechanism to increase its participation in global fragmentation.

One of Brazil's greatest challenges in the context of international trade, as well as with reference to some developing countries, is to break the prevailing policy of protecting domestic industry. A greater integration with international trade

through openness, trade agreements, and other measures that reduce tariffs and barriers, in the short term can be expected to cause a reduction in the level of activity, employment and income generated by some sectors of the economy. However, over the long term the same sectors are expected to achieve gains in industrial competitiveness. In the context of growing international outsourcing, the formulation of policies should take into account that the production processes are increasingly fragmented in different territories. Mapping the dimensions of value chains is crucial to an increased understanding of Brazil's participation in the international fragmentation of production, which can be useful for the formulation of external and industrial policies. Hence, the evaluation of the productive structure considering the geographic extension of the value chain may bring objective elements to support the discussion of new trade agreements. The results of this study provide information that can be considered in planning policies that aim to increase Brazil's participation in global value chains. A strategy that could be used for this would be via greater regional insertion considering the negotiation of unilateral agreements (via Mercosur or not) with other countries in South and Central America.

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## **Regular Session: RS11.3 - Rural development**

**17:30 - 18:45 Thursday, 27th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/82231138454>**

**Chair Guilherme Asai**

## CAPITAL INCREASE AND LAND PRICES: AN ESSAY AMONG BRAZIL AND UNITED STATES OF AMERICA

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### ABSTRACT

In the past decade, Brazil and the USA take turns in the position of the largest producers of agricultural commodities, such as soybeans. One way to reach this position was to increase the planted area. The need for more areas of plantation caused an increase in the value of land, which caused an increase in the capital employed (invested capital). Therefore, all agriculture and livestock were affected by this increase in land values. In this scenario, this paper aims to quantify the influences in import, export, prices, and production value by the increase in invested capital, due to an increase in land prices. The methodology used was based on computable general equilibrium. The results indicated that there was a positive influence in all analyzed variables (importations, exportations, commodity prices, and production value). Thus, this paper deals with a current and important theme, that can help making efforts and decisions by measure the impacts in increasing the planted area in the medium and long term.

### KEYWORDS

Agriculture, Computable General Equilibrium; Land market; Land values; PAEG.

### 1. INTRODUCTION

Over time, agriculture has played an important role in the globalized world as one of the most important sectors in the economy, as reported by Gilis et. al. (1992) the agriculture sector is responsible for food security and international trades. Despite the fact of nutrition question, the benefit of this sector could provide economic development for regions, countries, nations, and even people.

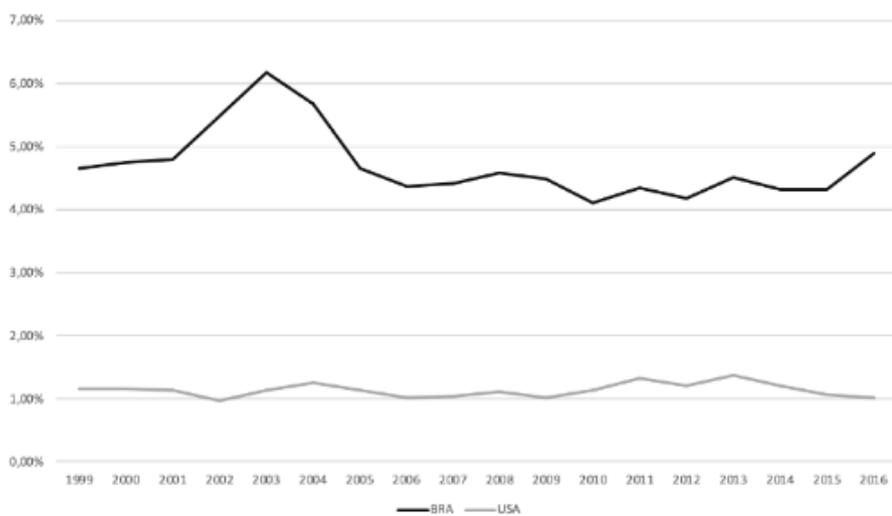
In some cases, larger producer of agriculture commodities previously develops their economies build primarily in the agriculture sector, like the United States of America (USA). Others, with emerging markets, like Brazil, structure their net trade balance based on the export of agriculture commodities. Besides, the export of agricultural commodities is responsible for keeping the trade balance in surplus, and employment in the countryside is important to maintain a stable employment level and ensure food security for the country.

By 2015 years the Brazilian agriculture has undergone several changes and raised the agribusiness sector to one of the most important in Brazil. According to the Federation of Industries of the State of São Paulo (FIESP, 2017), Brazil has the second-largest soybean production in the world with more than 104 million tons for the 2016/2017 crop, only behind the USA, which, according to United States Department of Agriculture (USDA, 2018) the production in 2016/2017 crop was about 107 million tons of soybeans.

Regarding the exportation of soybeans, Brazil is the main exporting country with around 59 million tons, while the US export was about 50 million tons for the 2016/2017 crop. As the main destination for these exports was China that received more than 92 million tons of soybeans across the globe, consolidating itself as the largest soybean importing country (FIESP, 2017; USDA, 2018b).

All this increase in grain production and export reflects the Brazilian economy in positive ways. The agribusiness sector, which includes all the livestock and agriculture, is responsible for more than 21% of the total Gross Domestic Product (GDP) in 2017 (CENTER FOR ADVANCED STUDIES ON APPLIED ECONOMICS, 2017). Likewise, the US agriculture and food sector had a 5.5% in weight in the composition of the GDP, which represents US\$ 992 billion in 2016 (USDA, 2016). However, the importance of the agriculture sector for Brazil and the US remains always the same over the years. Concurring with the World Bank (2018) the valued added percentage of the GDP for the agriculture, forestry, and fishing sectors are almost the same during the past 20 years for Brazil and the US, in terms of 4.70% and 1.14%, respectively. In terms of currency production value, both nations grew up to 5% per year between 2000 and 2015.

Figure 1 indicates the percentage of agriculture and forestry valued added in total country value-added comparing US and Brazil.



**Figure 1: Percentage of agriculture and forestry value-added for US and Brazil**

Source: Research data.

Note: data extract from World Bank (2018).

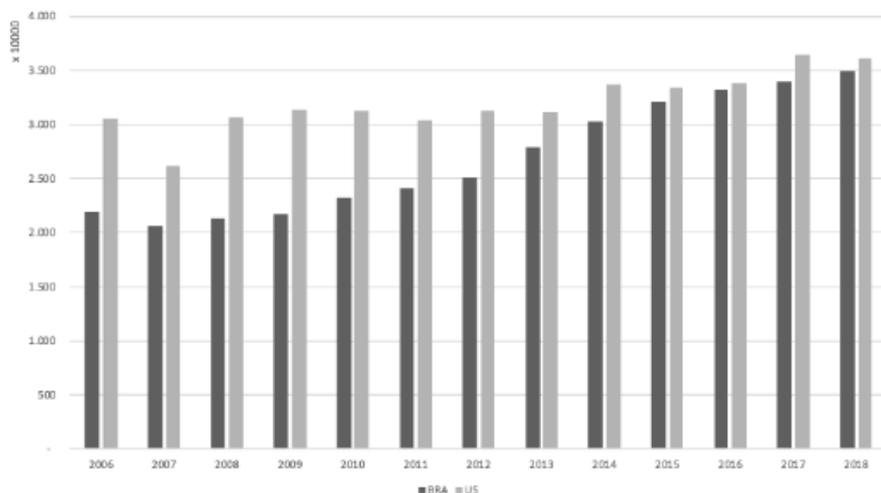
For those countries with a strong economy, the weight of the agribusiness sector must be not larger due to the third sector, where most of GDP is concentrated. Nevertheless, in emerging markets, like Brazil, the agribusiness sector has an important weight in GDP's composition.

The expansion of agricultural and livestock production goes together with an increase of planted area in all Brazilian regions. This increase in the area planted leads to the need to expand new areas of cultivation and new agricultural frontiers (Sampaio, Sampaio & Bertrand, 2012). Not only the soybeans and the corn beans had their area planted increase, but the area for agriculture was raised in all regions of Brazil.

In the meantime, the USA also increased its soybean planted and harvested area. According to the USDA (2018), the USA increases the planted area by more than 20% from 2000 to 2018. This was a prerogative to become the largest soybean producer in the world. However, unlike Brazil, the USA increased its production also based on the use of high technology, research, public policy, and crop substitution (DABERKOW & MCBRIDE, 2003; MASUDA & GOLDSMITH, 2009).

By mutual agreement, the fastest way to increase agriculture production is an increase in fields and expanded agricultural crop area. This happened on a larger scale in Brazil which raises the country as one of the top producers and exporters for these grains. To reach this position, was necessary to increase the planted area, by doing this the grain production expanded for unexplored areas that create a new agricultural frontier between the States of Maranhão, Piauí, Tocantins, and Bahia, all in the Brazilian Northeast, region known as Mapitoba. At the same time, consolidated grains planting areas were modernized and consolidated in Midwest and South.

As a fair comparison between the USA and Brazil of the growth in soybean planted area, Figure 2 demonstrates what happened to the level of the total planted area over the last years.



**Figure 2: The planted area between 2006 and 2018**

By analyzing Figure 2 the gap of soybean planted area between those countries is decreasing, going from up to 8.5 million hectares to less than 1.5 million difference. Thus, the increase of soybean planted area is visible over the years and this could indicate how Brazil approached USA soybean production.

Parallel to the increase in soybean production, export, and planted area, there is an increase in the price of land due to the need to obtain more areas for planting. Some authors as Ferro & Castro (2013) and Asai & Piffer (2016) indicate that land has been appreciated in the last decades, both in areas of traditional soybean cultivation areas and in the new agricultural frontier.

As Plantinga, Lubowski & Stavins (2002) land prices reflect more than just the land use proposes. There are a series of variables, among them can be cited, for example, the potential use of the expected net returns obtained by allocating the land to its most profitable use, the potential development of the land in that region, or even the rent of them. The authors indicated that is important to how the land prices for public policies and prevent loss of productive agricultural land and even loss incapacity to produce food.

Although, the increase in land price appreciation forces the farmers to produce more with the same quantities of output due to the maintain profitability (FLOYD, 1968). The land prices impact in a negative way when the returns taxes were calculated, as more the land costs, more returns were expected. Thereby, Floyd (1968) and Alston, Beddow & Pardey (2009) indicate that more capital and labor are needed in agriculture.

Therefore, agriculture and livestock are affected by this increase in land values. In this scenario, what are the economic impacts (commodity prices, production value, and quantity exported and imported) that the increase in the land value causes in the agriculture sector for the USA and Brazil?

To answer this question, the present paper will use a Computable General Equilibrium (CGE) model, simulating three scenarios: (i) capital increase in land value for Brazil only; (ii) capital increase in land value for the USA only; and (iii) capital increase in land value for both countries. Hence, this paper deals with a current and important theme that can help to make efforts and decisions by measure the impacts in increasing the planted area in the medium and long term. The paper is structured into four main chapters include this one introduction. The second one is to introduce de CGE model which will be used to capture the influences in the agriculture sector due to land appreciations. The third part is dedicated to present the results of the CGE model and describe the economic impacts caused in agriculture. To the end, the fourth chapter is the final considerations.

## 2. METHODOLOGY

The Computable General Equilibrium Model is the ability to represent the economy of a country and your commercial relationships with others inside a set of algebraic equations or accounting identities. To Sadoulet & De Janvry (1995) and Partridge & Rickman (1998), CGE models can capture the relationships among economic agents through the macroeconomic and microeconomic aspects present in the Input-Output Table.

To fulfill the objective of this paper the CGE model chosen was the PAEG which uses part of the GTAP model and its database. The next session will introduce a brief description of the PAEG model.

### 2.1 General Equilibrium Analysis Project for the Brazilian Economy – PAEG

The General Equilibrium Analysis Project for the Brazilian Economy is a static, multi-regional, and multi-sector model, structured to represent the Brazilian economy and its interactions with other economies around the globe (GURGEL et al., 2011).

PAEG's structure is based on the *GTAPinGAMS* (Rutherford & Paltsev, 2000; Rutherford, 2005), adopting a nonlinear complementarity problem in the General Algebraic Modeling System (GAMS) developed by Brooke et al. (1998), and uses a Modeling Programming System for General Equilibrium syntax (MPSGE).

The database used is the Global Trade Analysis Project (GTAP) and was disaggregated to portray the Brazilian economy in its five different macro-regions – Center-West, North, Northeast, South, and Southeast. However, the GTAP database has been preserved the other countries and of trade flows identically to the original ones. The regions, sectors, and the factors of production considered in the PAEG are described in Figure 3.

Sectors	Acronym	Regions	Acronym
Rice	(pdr)	Brazil	BRA
Corn and cereals	(gro)	Rest of Mercosur	RMS
Soy and other oils	(osd)	Venezuela	VEM
Sugar cane, sugar beet, and sugar industry	(c_b)	United States	USA
Meat and livestock	(oap)	Rest of Nafta	RNF
Milk and dairy products	(rmk)	Rest of America	ROA
Agribusiness products	(agr)	Europe	EUR
Foods	(foo)	China	CHN
Textile Industry	(tex)	Rest of the world	ROW
Clothes and shoes	(wap)		
Wood and furniture	(lum)		
Cellulose and graphic industry	(ppp)		
Chemical, plastic and rubber industry	(crp)		
Manufactured	(man)		
Gas, electricity, and water distribution	(siu)		
Building	(cns)		
Sales	(trd)		
Transport	(otp)		
Service and Public administration	(adm)		

Factors of Production	Acronym
Capital	cap
Labor	lab

Figure 3: Regions and sectors present in the PAEG model

As Gurgel et al. (2011) and Teixeira et al. (2013) defines, PAEG model represents the way goods and services are produced in Brazilian and world economies. The regions are represented by a final demand structure and the behavior of the players is that of an optimizer in that they maximize their welfare.

To combine the database, regions, and sectors is created some variables to represents the regional economy into the model. The variables of the economic model are  $Y_{ir}$ , as production of good  $i$  in region  $r$ . The  $C_r$ ,  $I_r$ , and  $G_r$ , are private consumption, investment, and public consumption in region  $r$ . The  $M_{jr}$  represents the importation of good  $j$  by the region  $r$ , as well the  $HH_r$  is the variable for representative consumers. The public sector or government in region  $r$  is the variable  $GOVT_r$  and the activity through which specific inputs are allocated to private sectors is the  $FT_{sr}$ .

To exemplify how the regional economy is structured in PAEG model the Figure 5 illustrated the structure and the economic flows.

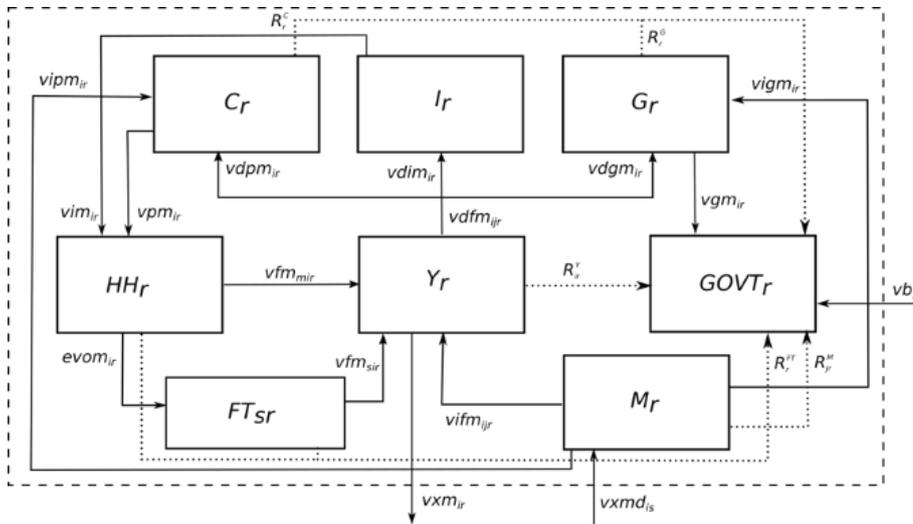


Figure 4: Regional economic structure and economic flow of the PAEG model

Source: Pinto, et al. (2016).

In Figure 4, the dashed line defines a region  $r$ , the solid line indicates the flows of the variables and the dotted lines determine the tax flow. Besides that, it is possible to see the variables -  $Y_i$ ,  $C_r$ ,  $I_r$ ,  $G_r$ ,  $M_{jr}$ ,  $HH_r$ ,  $GOVT_r$ , and  $FT_{sr}$  - and the other parameters. These other parameters are the indirect taxes represents for the letter "R" and affects production ( $R_{ir}^Y$ ); consumption ( $R_r^C$ ); public demand ( $R_r^G$ ); factors of production ( $R_{jr}^{FT}$ ); and imports ( $R_{jr}^M$ ). The base accounting identity for the variables in the model is indicated in Equation 1 through 7.

$$Y_{ir}: \quad \sum_f vfm_{fir} + \sum_j (vifm_{jir} + vdfm_{jir}) + R_{ir}^Y = vom_{ir} \quad (1)$$

$$M_{ir}: \quad \sum_s (vxmd_{isr} + \sum_j vtwr_{jisr}) + R_{ir}^M = vim_{ir} \quad (2)$$

$$C_r: \quad \sum_i (vdpm_{ir} + vipm_{ir}) + R_{ir}^C = vpm_r \quad (3)$$

$$Gr: \quad \sum_i (vdgm_{ir} + vigm_{ir}) + R_{ir}^G = vgm_r \quad (4)$$

$$I_r: \quad \sum_i v \dim_{ir} = vim_r \quad (5)$$

$$FT_{fr}: \quad evom_{fr} = \sum_i vfm_{fir} \quad f \in s \quad (6)$$

$$YT_j: \quad \sum_r vst_{jr} = vt_j = \sum_{irs} vtwr_{jirs} \quad (7)$$

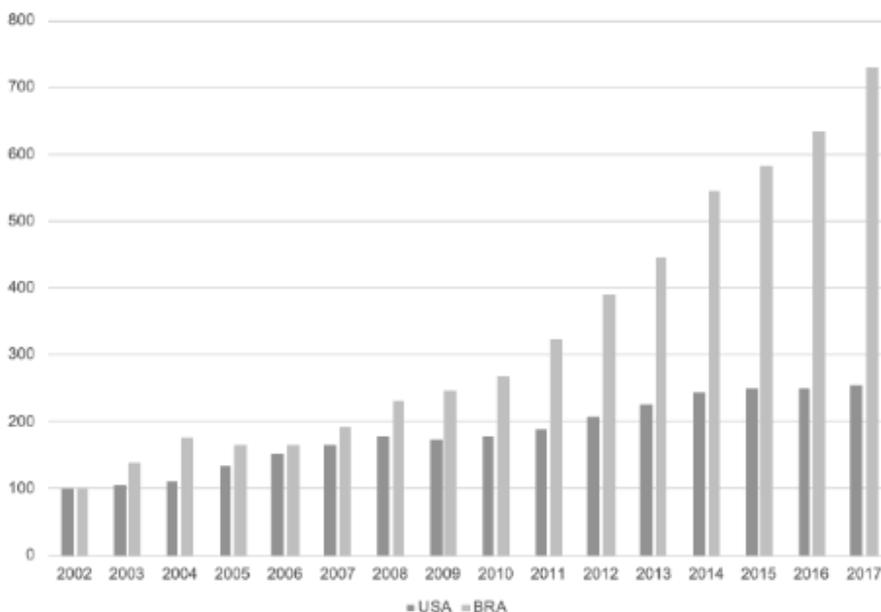
Gurgel et al. (2011) describes step by step each how these accounting identities are calculated which are composed of: domestic production ( $vom_{ir}$ ); exportation ( $vxmd_{irs}$ ); international transportation services ( $vst_{ir}$ ); intermediate demand ( $vdvm_{ijr}$ ); private consumption ( $vdpm_{ir}$ ); government consumption ( $vdgm_{ir}$ ); investment ( $v \dim_{ir}$ ); imported goods ( $vim_{ir}$ ); goods used in the intermediate consumption ( $vifm_{ijr}$ ); private consumption ( $vipm_{ir}$ ); government consumption ( $vigm_{ir}$ ); consumption of public agent ( $vigm_{ir}$ ); exportation of good i by region r ( $vxm_{ir}$ ); importations of good i by region r ( $vxmd_{irs}$ ); international transport services ( $vt_j$ ); a value of transport service exportation ( $vst_{jr}$ ); bilateral transport service flows acquired in the importation of goods ( $vtwr_{jirs}$ ); budget constraint of government ( $vgm_r$ ); and budget constraint of representative agent ( $evom_{fr}$ ).

Presented the basic structure of the model and its accounting identities, the main use of the CGE occurs through simulation and scenario analysis. In this paper, scenarios of an increase in invested capital in agriculture will be simulated, due to the increase of land prices during the last year. This scenario is possible because the land is considered a productive factor and is exclusively for agriculture in PAEG model.

### 2.2 Land prices data overview

The historical data used as an assumption in growth capital into de CGE model were obtained from secondary sources like Informa Economics FNP (FNP, 2002 – 2017); Instituto Brasileiro de Economia (IBRE, 2017), and USDA (2018), which was selected only the agricultural and livestock land prices, despite the other land uses, such as urban area. In this form, there were encounter a homogeneous type for comparison between USA and Brazil.

Those raw data have been distributed as agricultural and livestock land prices for each region and, but for the analyses, all data were aggregate as an average of all. Figure 5 illustrated an index for the average for 2002 until 2017.



**Figure 5: Index base 100 in 2002 for average agricultural and livestock land price in Brazil between 2002 and 2017**

The index was constructed due to currency difference and for observed the behavior with the land prices in those countries through time. Note that the land prices increase even in the USA and Brazil, between 150% and 630%, respectively. However, even with the highest growth in Brazil may not directly reflect an increased production which will be investigated throughout the paper.

To verify the adherence between the two historical data some statistical analyzes were performed and the result is indicated in Table 1.

**Table 1: Stats for the land prices data**

	USA	BRA
Average	5.450	22.878
Median	5.337	17.635
Std deviation	1.586	13.572
Minimum	2.990	6.862
Maximum	7.611	50.034
Stat t	0.008	
Stat t critical	1.753	
Pearson correlation	0.937	

Through this brief statistical analysis, it is observed that there is no significant difference between those historical data and there is a high correlation mid them. Thus, the data can provide statistical information to the CGE model leading to a more reliable scenario modeling.

### 2.3 Scenarios: increase on invested capital in agriculture

To reach the objective of this paper and quantify the influences of land appreciation in Brazilian agriculture, a scenario is simulated through a productivity shock by capital increase into agriculture sectors. Through the scenario simulation, it will be possible to quantify the changes in imports, exports, and agriculture and livestock prices.

The increase in land prices will reflect in the expansion of the cultivated area since it will be necessary a superior investment in the purchase of new areas for openness and planting. The expansion of the agricultural frontier and, both planted and harvested area, indicates the need to acquire new areas by farmers from all macro-regions. If the land prices grow up, more expensive is to expand the agricultural areas by the acquisition of new ones. Thus, a scenario of increased invested capital inland brings the possibility of analyzing the impacts of the agricultural sector by the CGE.

Meanwhile, the land is considered a production factor. Authors such as Pindyck & Rubinfeld (2009), Belik (2014), and Hoffmann & Ney (2016) comments that in agriculture the land is a productive input, such as capital and labor, whose land is a determining factor for Brazilian agricultural production according to Rahal (2003). Also, Gardi et al. (2015) indicate that the land is a natural resource that is a multifunctional and non-renewable natural resource and carries out multiple functions, including the support of food production.

In the classical microeconomic theory, the value of the land can also be interpreted by the theory of fixed factors. In the long run, Varian (2003) places that certain factors are fixed for the economy. In the agriculture sector, the field of plantation is limited by the amount of land available and is fixed in the long term, since there is no way to produce more land artificially.

Consequently, the demand for new arable areas increases the price of land as occurs over the last decades. The Compound Annual Growth Rate (CAGR<sup>189</sup>) for agricultural lands in the USA is around 6.02% and for Brazil is about 13.23%, which is established in Table 2.

**Table 2: CAGR for agricultural land price in Brazil between 2002 and 2017.**

	USA (US\$/acre)	BRA (R\$/ha)
2002	1,210	1,828
2003	1,270	2,533
2004	1,340	3,226
2005	1,610	3,036
2006	1,830	3,027
2007	2,010	3,497
2008	2,170	4,202
2009	2,090	4,499
2010	2,150	4,896
2011	2,300	5,919
2012	2,520	7,128
2013	2,730	8,148
2014	2,950	9,969
2015	3,020	10,659
2016	3,010	11,607
2017	3,080	13,327
<b>CAGR</b>	<b>6.02%</b>	<b>13.23%</b>

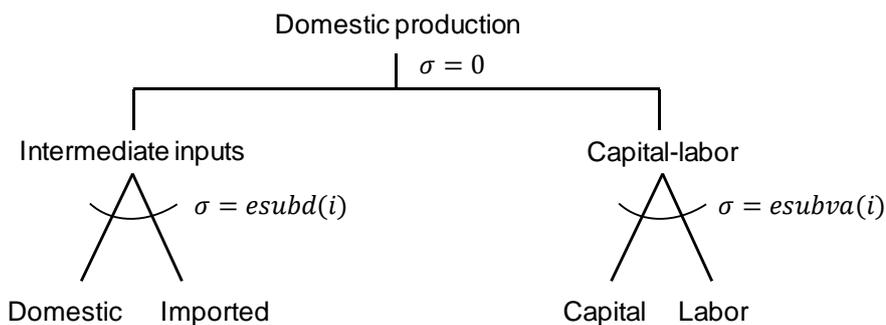
189 The CAGR is calculated by equation  $CAGR = \left( \frac{value_t}{value_{t-n}} \right)^{\frac{1}{n}} - 1$ .

To simulate the scenario with the shock on invested capital into the agriculture sector, the CAGR will be considered imputing these values of Table 2 in the PAEG model. The incidence of the capital increase will occur into a factor of production named capital (cap) in the agricultural sector.

This scenario is justified with the ideas of technical change and the aggregate production function. The capital increase will affect directly the  $Y_{ir}$  where the region  $r$  (USA and Brazil) and goods  $i$  which is the selected agricultural products (pdr, gro, osd, c\_b, oap and agr). Therefore, those depends on the interaction of capital (K) and labor (L) over time (t), following the Solow's (1957) idea which the aggregate production function is calculated by Equation 8.

$$Q = F(K, L; t) \tag{8}$$

At this point, the technologic structure to produce some amount of agriculture goods required a fixed combination of intermediate inputs, even domestic or imported, and primary factors as capital and labor. An increase in capital Figure 7 illustrated the structure to produce on PAEG's model.



**Figure 7: Structure to produce with a production function**

In Figure 7, the intermediate inputs are a combination of domestic and imported under elasticity of substitution  $esubd$ , and the primary factors are combined under elasticity of substitution  $esubva$ , calculated by Cobb-Douglas function. Satisfying all the conditions above, the PAEG model creates the scenario with an increase of invested capital in the USA and Brazilian agriculture.

According to Goodman et al. (1985) and Frederico (2013), the agriculture is considered a capital-intensive sector. Under these circumstances and following the production function of Solow (1957), the productivity shock into the PAEG's model will respect the newer conditions of the production function for each region and each selected good indicated in Equations 9 and 10.

$$\text{USA: } Y_{ir\_USA} = F(1.0602 * K, L; t) \tag{9}$$

$$\text{BRA: } Y_{ir} = F(1.1323 * K, L; t) \tag{10}$$

Through this land appreciation, a simulated scenario will show an increase of invested capital in the formation and expansion of the agricultural area (harvested and planted area) for the USA and Brazil. The need for this capital is due to the increase in land prices and required 1.06 more capital for the USA and 1.123 times more for Brazil.

Therefore, will be simulated three different scenarios for comparison: (i) capital increase in land value for Brazil only; (ii) increase in land value for the USA only; and (iii) increase in land value for both countries.

Thus, with this CGE simulation will be possible to know and quantify the influences of the increase in land prices for the USA and Brazilian economy. Through the productivity shock directly affecting the agricultural sector that resulted in effects on the entire world economic balance.

### 3. IMPACTS OF LAND APPRECIATION IN AGRICULTURE SECTOR FOR ECONOMY

Over the years, land appreciation and its determinants have been studied. To contribute to the discussion of the topic, this work aims to represent the land value appreciation as a capital invested in agriculture sectors for the economy in the USA and Brazil by simulating scenarios through a GCE model which will represent the behavior of these countries in the world economy. The results for the simulated scenarios are presented in Table 3.

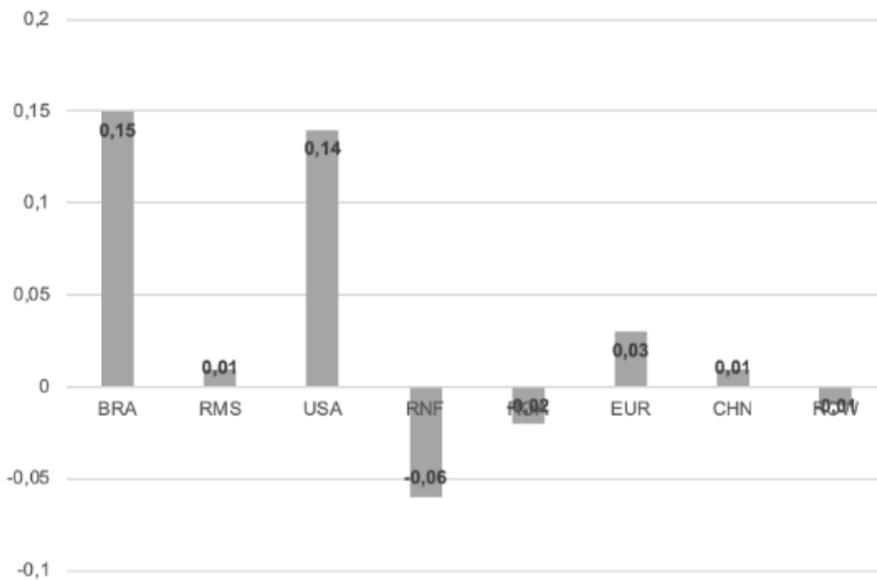
**Table 3: Results on equilibrium after GCE's simulated scenario of capital increase in the agriculture sector (%)**

Parameter	Sector	Scenario 1	Scenario 2	Scenario 3	
				USA	BRA
Production value	pdr	0.06	0.01	0.06	0.02
	gro	0.01	0.10	0.02	0.10
	osd	0.11	0.12	0.14	0.15
	c_b	0.02	0.01	0.02	0.01
	oap	0.01	0.04	0.01	0.04
	rmk	0.06	0.01	0.01	0.01
	agr	0.17	0.08	0.18	0.08
Exportation	pdr	0.18	0.02	0.18	0.01
	gro	0.02	-0.13	0.03	-0.14
	osd	0.25	0.18	0.32	0.22
	c_b	0.37	0.03	0.39	0.02
	oap	0.03	-0.05	0.03	-0.05
	rmk	0.08	0.15	0.09	0.14
	agr	0.36	-0.18	0.38	-0.20
Importation	pdr	-0.22	0.10	-0.23	-0.10
	gro	-0.01	-0.06	-0.01	-0.06
	osd	-0.15	-0.09	-0.15	-0.09
	c_b	-0.18	-0.09	-0.18	-0.10
	oap	-0.01	-0.08	-0.01	-0.08
	rmk	0.03	0.14	0.04	0.14
	agr	-0.15	-0.03	-0.17	-0.03
Commodity price	pdr	-0.01	0.10	0.00	
	gro	-0.03	0.08	0.00	
	osd	-0.11	0.11	0.10	
	c_b	-0.01	0.09	0.10	
	oap	-0.07	0.10	0.00	
	rmk	0.00	0.12	0.00	
	agr	-0.01	0.08	0.60	

Analyzing the change in production value for the agriculture sectors before the shock in the equilibrium the only negative change was in rice production in Scenario 2. This could be justified because Brazil imported a portion of their consumption of rice, there was a compensation in the volume of rice imported, as observed by an increase in 0.10% in import rate.

In Scenario 3, the USA only decreases the production value of the sugar cane sector, in contrast to Brazil, in which the value falls in the corn and rice sectors. Notes that the decrease or even increase in the sectors had a greater impact than in Scenarios 1 and 2, which indicates that the two countries together are stronger and can move the world economy more than separated.

Nevertheless, the increase in soybean production value has an important change when the USA and Brazil increase their capital invested in agriculture because these countries have the largest soybean production and hold the highest export rates as well. The increased amount of 0.14% (USA) and 0.15% (BRA) is sufficient to keep the two in their positions. To prove this, Figure 7 indicates the rates for all regions present in the model for the soybean production value for Scenario 3.



**Figure 7: Structure to produce with a production function**

The behavior on exports and imports was predictable. In most cases occur fall in imports and the increase in exports in all three scenarios. The only exceptions were in the exportation of corn and livestock, also in importations for rice and milk sectors, in both cases for Brazil during the simulated Scenarios 2 and 3.

In general terms, it can be inferred that the greater production of the agriculture and livestock sectors succeeds, even more, the need for domestic consumption of these products, reducing the need to import. The search for self-sufficiency can be interpreted as a positive point since the dependence on food imports can cause an imbalance in the region's trade and supply. Be self-sufficiency in agriculture and livestock products, also, can provide food security. Through this, it becomes important to the development of these regions by reducing the poverty as Shiferaw et al. (2011) indicate in their study.

The rice, soybean, sugar industry, and milk sectors had an increase in exports both in the USA and Brazil. The sectors that had an increase in exports are those that are prominent in those countries' export agenda. As commodity-exporting soybean, livestock and sugar stand out among agricultural commodities obtains prominence in exports, placing Brazil among the largest players in the international market.

Leading to commodity prices an opposite movement was found in equilibrium. In every analyzed sector in Scenario 1 the prices have decreased, except in milk and dairy products that maintain stability. Nevertheless, in Scenario 2 all prices have increased. There is another controversy in prices when the results of Scenario 3 are presented. The price stability in practically all sectors can be justified because the commodity prices are governed by numerous factors of which, land value is one of its determinants, and more variables make the price oscillation.

At this level, it can be inferred that agriculture price gains can be derived from other variables against land price, such as employment of technology or improvement in the field. Because they are commodities, price is governed by global demand and supply, which in the long term, there is a balance in prices due to international market regulation.

The way the model is structured, it is possible to evaluate the set of scenarios in terms of microeconomy relating production value and commodity prices. With the scenarios, supply and demand curves move, causing a new equilibrium. In Scenario 1 increase in production value allied with a decrease in commodity price indicates supply curve shift right and static demand curve. In Scenarios 2 and 3, an increase in production value and prices causes a shift right in both demand and supply curves.

By shifting the right demand and supply curves in these scenarios, it can be said that there is more production and consumption of agriproducts in Brazil and the USA. It can be taken to a level of consumption that maintains or increase the population welfare in both countries, however, this cannot be verified in this research.

Generally, the impacts of land appreciation in the agriculture sectors are positive. There is an increase in export and decrease in importation goods which indicates a positive balance trade, which is beneficial to the economy of the country attracting foreign exchange. The rise of commodity prices implies a greater number of resources for Brazil being a commodity exporter.

Therefore, the production values of agriculture and livestock were harmed by an increase in invested capital. This fact is comprehensive because the needed more investment to maintain the agriculture production, or even maintain the same level of welfare state which cause, and effect is not analyzing in this paper.

#### 4. FINAL REMARKS

This paper aims to investigate what are the impacts on Brazil and the USA economy due to an increase in land values, especially in the agribusiness sector. To verify and compare both countries, a CGE model to simulated scenarios was used in: (i) increase in land value for Brazil only; (ii) increase in land value for the USA only; and (iii) increase in land value for both countries.

In all these three scenarios the impacts in the agribusiness sector are positive, in both Brazil and the USA. The production value increases which means there are more intensive economic activities for the agribusiness sector. Even the need for more capital in agriculture and livestock production, for land expansion, for example, the land prices interfere so as not to negatively impact the economy.

By increasing the import and exports, it means that more international trades are being made, especially with increased production (higher production value in simulated scenarios). Still, with the increase in production, there was an increase in consumption as observed in the results of scenarios 2 and 3.

Thus, the land market influences agribusiness in Brazil and the USA. Increasing the land prices causes the need to increase the use of capital in agricultural activities, however, this higher capital is positively reflected with the increase in exports, the value of production, and the increase in prices. From the microeconomics point of view, there is an increase in demand and consumption of agricultural products.

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## IMPACTS OF AGRICULTURAL CARGO TRANSPORTATION ON THE BRAZILIAN ECONOMY

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### ABSTRACT

For years, many studies point that cargo transportation services were responsible for the loss of efficiency of several sectors of the Brazilian economy, including agriculture. The Brazilian agriculture sector is dependent on transportation services for the flow of production from the point of origin to the final consumer, as well as the distribution of inputs and implements, such as fertilizers and agricultural machinery. However, some bottlenecks shrink the transport and cause inefficiency. The objective of this paper is to investigate the impacts for the Brazilian economy given some change efficiency at agricultural cargo transportation service. The main hypothesis that guide this paper was: cargo transportation is a limiting factor for the development of the Brazilian economy. Using a computable general equilibrium model which represents the interactions of the five Brazilian macro-regions with other regions around the globe. As a result, it was found that the agricultural cargo transportation service influences the economic growth and regional development of the country through the increase in GDP and the well-being of the population. However, the simple improvement in the transport service does not bring significant growth or development to the country, showing that there are other factors that limit this development.

### KEYWORDS

Agriculture; cargo transportation; computable general equilibrium; transportation services.

### 1. INTRODUCTION

In a globalized world, the flow of goods, people and services is increasingly active. In the world economy, Ballou (2010) indicates that logistics is a part of this economy by encompassing activities related to the flow of goods and services, such as transportation, storage, and communication.

Logistics may be understood as the link between producers and consumers, or vice-versa, that uses resources and activities to plan, implement, control and assure, efficiently, the flow and storage of services and goods all the way to the consumption point, being essential to all business. The entire process of goods management and follow up, services and information for the distribution of goods and services is considered part of logistics (RUTNER e LANGLEY, 2000; MOURA, 2006; BOSONA and GEBRESENBET, 2013; CROUCHER and BAKER, 2014; NOVAES, 2016).

In Brazil, where the agribusiness has been increasingly important over the last few years, logistics represent the main communication and production market of the agricultural and cattle ranching production, becoming important for the flowing of agricultural goods and services. Beyond that, logistics are an important topic for the rural sector, given that the logistics costs and losses throughout the system have high weight in the cost of agricultural production, according to studies by Martins et al. (2005), Martins (2011), Kussano and Batalha (2009; 2012) and Costabile et al. (2016).

In the Brazilian country, countless logistics infrastructure bottlenecks are found. Capdeville (2010) lists a few, such as those caused by the organizational environment, by the road structure status, by the facilities status, by the lack of environmental permits, by the deficiencies of the energy sector, by the elevated costs – of operation, transactions, and capital – and by the employed technology.

The existence of bottlenecks in the infrastructure of the logistics system in Brazil cause efficiency loss and a rise in the costs for the entire national productive chain, in addition of being a barrier for the competitiveness of the Brazilian goods in the international market (BARAT, 2009; PONTES et al., 2009; CAPDEVILLE, 2010; SOUZA, 2012).

With this perspective, the objective of this paper is to investigate the impacts for the Brazilian economy given some change efficiency at agricultural cargo transportation service. To complete this purpose, there is a main hypothesis: cargo transportation is a limiting factor for the development of the Brazilian economy.

To fulfill the proposed objective and answer the hypothesis, the present paper will use a computable general equilibrium (CGE) model with the main data input as a Brazilian input-output table for the five macro-regions of Brazil and those interactions around the globe. With this model is possible to capture the impacts in agricultural cargo transportation due

to efficiency shocks. Through the transport efficiency, shocks will be possible to indicate the impacts in the GDP, welfare, and value of production.

Therefore, this study is organized in five main sections, being this the introduction. The second section is dedicated to contextualizing the limiting factors in Brazilian agricultural cargo transportation; the third addresses the analytical referential, introducing the CGE model used in the analysis of the transportation services in the five Brazilian macro-regions; the fourth bring the results of the efficiency shocks; and lastly, the fifth lists the final considerations.

## **2. BRIEF OVERVIEW OF THE LIMITING FACTORS IN BRAZIL'S CARGO TRANSPORTATION**

The limiting factors, or bottlenecks, in logistic sector are characterized by Bacarat (2009) and Capdeville (2010), as a difficult or even prevent logistics to happen in an efficient way, similar to the definition found at the Council of Supply Chain Management Professionals (2013), where the bottleneck is "a constraint, obstacle or planned control that limits throughput or the utilization of capacity" (CSCMP, 2013, p.22).

The inefficiency of the transportation services caused by the bottlenecks in the logistics system may negatively interfere with the logistics cost, with the loss of comparative advantage and with the increase in inefficiency that hurts the economy of a country (BALLOU, 2001; RODRIGUES, 2008; BARAT, 2009; KUSSANO and BATALHA, 2009; CAPDEVILLE, 2010; FERNANDES, 2011; KATO, 2016).

When it comes to the agricultural sector, Caixeta Filho (2010) and Mascarenhas et al. (2014) remark the difficulty in achieving a cost compatible with the spatiality in production, given that Brazil has continental proportions and there is a certain difficulty in the transportation of supplies from region to region.

The dependence of a single transportation mode was subject of a study by Ledyard et al. (2002), a case study in which cost is a factor of competitiveness to the transportation services, especially for truck freight. In this study, authors indicate that a solution to reduce costs is to promote auctions with a combined price per route, offering options to the suppliers that are economically beneficial to both buyers and sellers.

This dependency or unbalance in the transportation matrix is regarded by Keil and Young (2008), Kawano et al. (2015), Pacheco and Pereira Jr (2015), Lima (2015) e Branco et al. (2016) as harmful to the transportation services, as the market of the production to reach the consumer markets gets harmed and may directly affect the comparative and competitive advantage achieved in certain goods. As a way of attenuating the effects of dependency, Kawano et al. (2015) also explores the possibility of using multimodal to diversify the transportation matrix of a production region.

Regarding the logistics infrastructure, the works of Fujita et al. (2000), Castro (2002), Kussano and Batalha (2009; 2012), Capdeville (2010), Mitsutani (2010), Freitas et al. (2011), Lopes (2015), Schalch (2016) and Aritua (2016) are unanimous to point deficiencies, lacks or failures in the transportation infrastructure. The logistics and transportation infrastructure emphasized by the authors range from accesses to roads or drainage issues (for example, holes, poor road signs and access difficulties) to failures in the communication system (information technology), damaging the logistics system as a whole and not only the transportation system.

The importance of the freight services in the transportation of agricultural goods is even more critical when considering the time sensitivity of these. According to Behar and Venables (2011), Attavanich et al. (2013) e Redding and Turner (2014), the perishability of vegetable and animal origin goods increase the transportation costs, requiring a greater care and service quality in transportation, turning this service narrower when compared with the transportation of other goods.

The political questions are also limiting factors to logistics. Laws, regulations, institutional policies and organizational environment are pointed by Correa and Ramos (2010), Capdeville (2010); Machado (2013); Cruz (2015) as an obstacle to the logistics system. Such factors are not limited to Brazil, but also appear in other locations, as in the Netherlands, where political questions regarding the implementation of roads in Rotterdam became an obstacle to de development of logistics (DREWELLO e GÜNTHER, 2012).

Finally, social dilemmas start to affect the transportation services. Psaraftis (2015) e Proskurina et al. (2016) report the concern with environmental characteristics, such as pollution and environment degradation, barriers to improve the logistics infrastructure of a region.

Consequently, the limiting factors or bottlenecks negatively affect the competitiveness, interfere with the acquired comparative advantages and mitigate the logistics and freight services development. However, measures can be taken, for example, investments to reduce said bottlenecks.

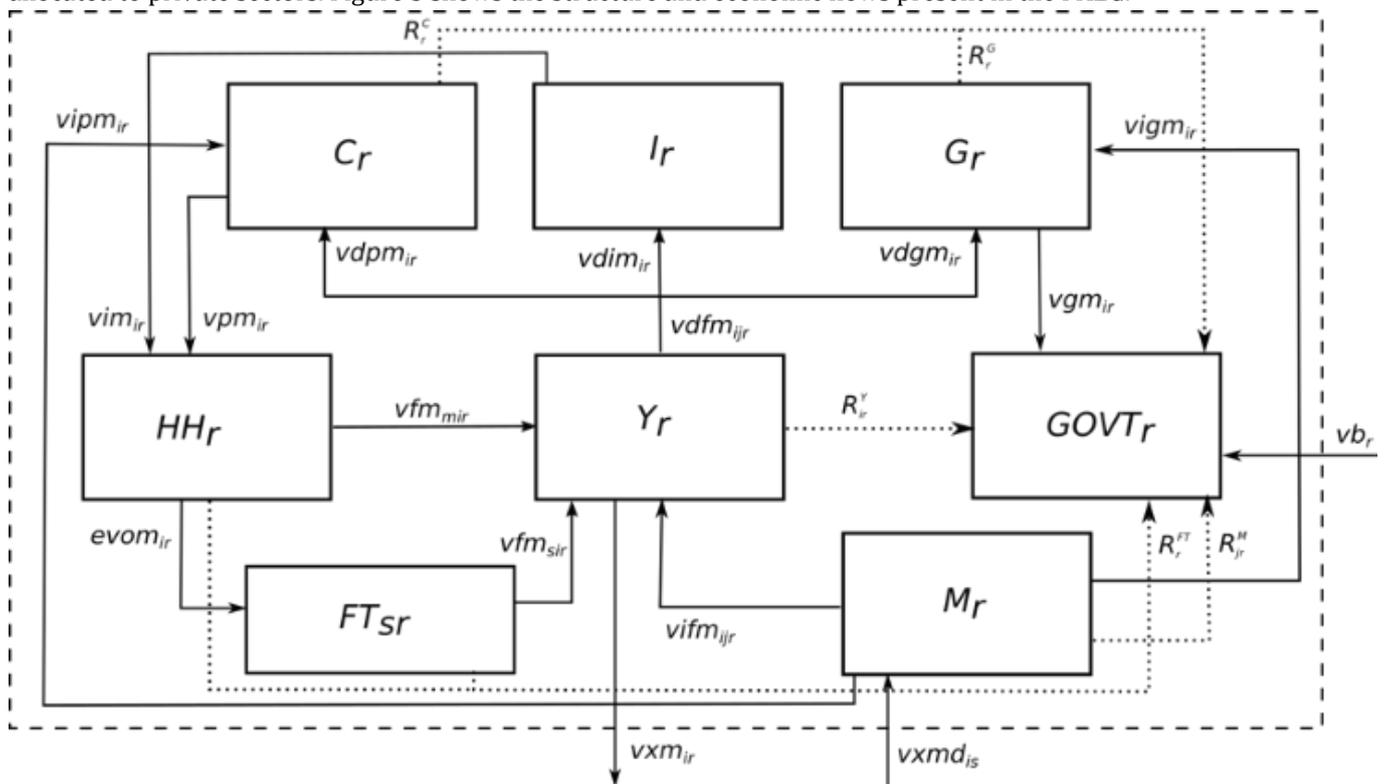
## **3. ANALYTICAL APPROACH**

Computable general equilibrium models have, in their essence, conditions to capture all the relationships present in a hole economic system. The CGE combining macroeconomic models and their interactions present in the input-output matrix.

In the literature, there are CGE models for different purposes, and types. For this paper, the CGE model chosen is the Project of Analysis of General Equilibrium of the Brazilian Economy (PAEG) that bring an analytical set of static, multiregional and multisectoral general equilibrium to the Brazilian economy.

The PAEG is an economic model capable of representing the economies of large Brazilian regions and their partner countries, examining trade flows and trade protections, considering the interrelations of the various sectors, markets, and agents (families, governments, companies) of economies, besides allowing complementarity between diverse sectors to be captured. The PAEG model also allows the calculation of aggregate effects on well-being and factor markets. Therefore, for these reasons, the PAEG model is in the class of models applied as general equilibrium (GURGEL, PEREIRA and TEIXEIRA, 2011).

The representation of the PAEG's regional economy is given by the following parameters: (i)  $Y_{jr}$  is the production of good  $i$  in region  $r$ ; (ii)  $C_r, I_r, G_r$  are private consumption, investment and public consumption in region  $r$ , respectively; (iii)  $M_{jr}$  represents the import of good  $j$  by region  $r$ ; (iv)  $HH_r$  is the representative consumer variable; (v) public sector or government in region  $r$  is the variable  $GOVT_r$ ; and (vi)  $FT_{sr}$  represents the activity through which specific inputs are allocated to private sectors. Figure 3 shows the structure and economic flows present in the PAEG.



**Figure 1: Regional economic structure and economic flow of the PAEG model**

Source: Pinto et al., 2016.

To analyze the efficiency gains in the transport of agricultural cargo the PAEG model was structured to support the agricultural cargo transportation sector whose sector will receive efficiency shocks.

By dissociate the cargo transport service of the traditional PAEG model, the PAEG Transportation (PAEG-T) was structured and this description, with the accounting identities, can be found in the Asai (2019). The PAEG-T assemble the transportation service across Brazilian regions was conducted out of a new productive sector in  $Y_{jr}$  that refers to transportation services across regions and countries worldwide. Table 1 indicates all the regions and sectors presents in the model.

**Table 1: Regions and sectors present in the PAEG model**

Regions	Sectors
1. Brazil-Northern region	1. Rice
2. Brazil-Northeast region	2. Corn and other cereals, grain
3. Brazil-Midwest region	3. Soybeans and other oilseeds
4. Brazil-Southeast region	4. Sugarcane, sugar beet
5. Brazil-Southern region	5. Meat and live animals
6. Rest of Mercosur	6. Milk and dairy products
7. United States	7. Other agricultural products – wheat, fiber, fruits, vegetables etc.
8. Rest of NAFTA	8. Food products - Other food, beverages and tobacco products
9. Rest of America	9. Textile industry
10. European Union	10. Clothing and footwear
11. China	11. Wood and furniture
12. Rest of the World	12. Paper, cellulose and ind. Graphics
	13. Chemicals, ind. rubber and plastics
	14. Manufactured: non-metallic minerals, metal mechanics, mining, various industries
	15. SIUP
	16. Construction
	17. Trade
	18. Transport
	19. Services and public administration (being)

Source: Teixeira, Pereira and Gurgel, 2013.

Being regarded as a new sector in the model, the parameter in the PAEG-T that will guide the shocks is the  $ytbr(j)vtwbr(j)$ , where the  $ytbr(j)$  sector only will be created to model calculations when the parameter  $vtwbr(j)$  is present, that is, regarding the transportation margins across Brazilian regions that characterizes a flow present in the model according Diagram 1.

$\$prod: ytbr(j)vtwbr(j) s: 1$

$o: ptbra(j) \quad q: vtwbr(j)$

$i: py(j, r) \quad q: vstbr(j, r)$

Diagram 1

The Diagram 1 illustrates the production of transport services in Brazil, combining supplies of the sector  $j$  in the different regions  $r$ , precified by  $py(j, r)$ , the initial value of which is given by  $vstbr(j, r)$  to the production of the supply of interregional transportation services, precified by  $ptbra(j)$ , the initial value of which in the database is given by  $vtwbr(j)$ . The  $vstbr(j, r)$  e  $vtwbr(j)$  parameters only exist for the transportation  $j$  sector.

The accounting identity of the parameters may be observed in Equations 1 and 2.

$$vtwbr_j = \sum_r vstbr_{jr} \tag{11}$$

$$vtwbr_j = \sum_j vtwr_{jisr} \tag{12}$$

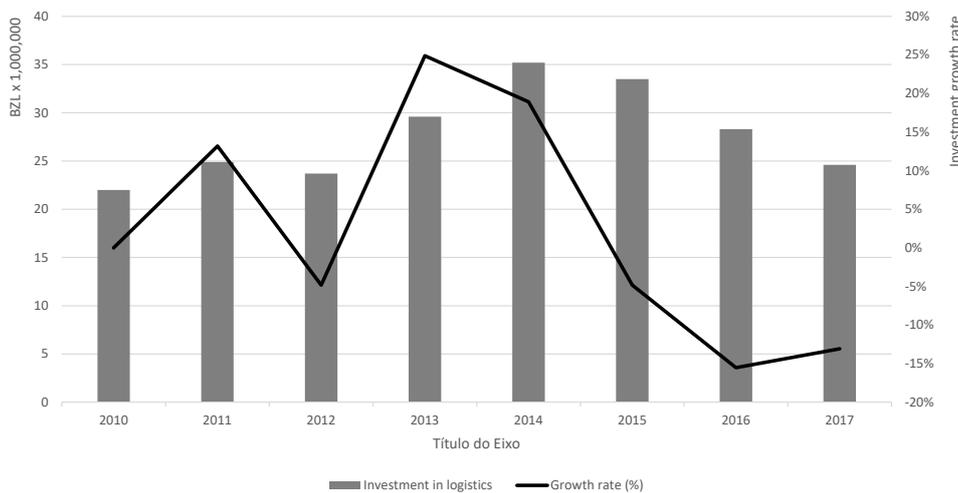
For these identities,  $vtwbr_j$  is the total offer of interregional transport services, the  $vstbr_{jr}$  is quantity that each Brazilian region contributes to the total supply, and the  $vtwr_{jisr}$  is the service demanded for bilateral trade in each region.

### 3.1 Shock level and simulated scenarios in PAEG-T

To simulate a scenario that exemplifies the efficiency of the transportation services, the efficiency shocks will be applied under the parameter  $vtwr_{jirs}$ . Therefore, a shock in the cost of transportation. The  $vtwr_{jirs}$  parameter has the following configuration in the model:  $vtwr(otp, agro, bra, r)$ . Where  $j$  and  $i$  are the transportation services (otp) and the agribusiness sector (agro), respectively;  $s$  is the Brazilian macroregions (bra); and  $r$  means all other regions.

The shock determination occurs in the transportation cost of agricultural commodities, produced in the Brazilian macroregions, that will be transported to other regions, comprehending the rest of the country and the further regions present in the model.

To restrict the agricultural sector (agro) eight activities will be impacted due to efficient gains in transportation. These sectors are: (i) rice (pdr); (ii) corn and other grain cereals (gro); (iii) soybeans and other oleaginous fruits (osd); (iv) sugar cane, sugar beet, sugar industry (sgr); (v) meat and living animals (oap); (vi) milk and dairy (rmk); (vii) other agricultural products such as wheat, fibers, fruits, vegetables, etc. (agr); and (viii) food products, liquor, and tobacco (foo). The shock was defined in 2.7% in efficiency gains, this magnitude is based on the variation of the infrastructure investment during 2010 and 2017, which has an average annual growth of roundly 2.7% as show in Figure 2.



**Figure 2: Investment in transportation sector**

Source: National Transport Confederation (2020).

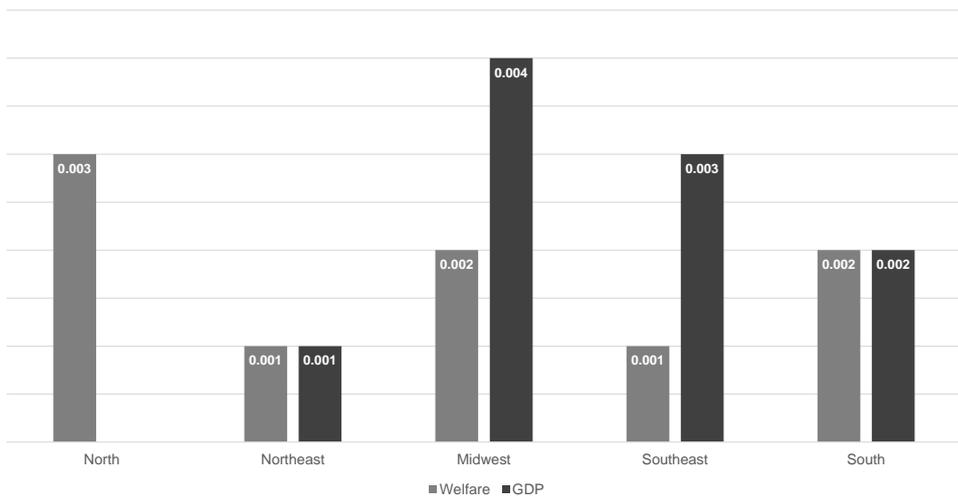
Therefore, the changes in the interregional transportation’s costs, simulating the efficiency gains of the transport sector, which allowed to analyze the impacts in Brazilian economy under the activity level, balance of trade (export minus import), production factors usage, GPD and welfare perspectives.

**4. IMPACTS IN BRAZILIAN ECONOMY**

In general terms, the impact on Brazil's economy with the improvement of agricultural cargo transport service was positive, demonstrated by the positive variation in GDP and welfare. These benefits were measured with the increase of these indicators for all macro-regions.

Projected GDP and welfare provide an initial trend of balance between them, departing as efficiency increases. Thus, the positive variation by changing the efficiency of the cost of transporting agricultural loads, that is, the decrease in freight in the EGC model caused efficiency gains that generate an increase in GDP, an indicative of economic growth.

Despite noting an almost linear and constant variation in GDP, this directly impacts on improving the regional economy. Thus, by varying the level of transport losses and efficiency gains, the observed trend of GDP is increasing. Table 1 shows the post-GDP and welfare shock result.



**Figure 3: Welfare and GDP after the shock**

The GDP of the southeast region, despite presenting behavior similar to that of other regions, the economic impact for Brazil is greater. This indicates a significant improvement in the Brazilian economy because the economy of the southeast is the most representative of the country, starting from a higher comparison base among the other macro-regions. With GDP and welfare as elements of regional analysis, the Brazilian midwest region has positive trends of economic growth with the lowest cost of transporting agricultural cargo.

Through the shock a proportion of GDP and welfare remain constantly. Regarding welfare, the behavior is similar to that observed by GDP, with the exception of the northern region, where no change is observed. In general terms, by varying

the cost of transport negatively the impacts on GDP and well-being are negative, just as when efficiency varies positively, the response becomes positive.

As the only region which has not suffered any influence on GDP, the northern region behaves differently from the others, with no change in GDP but positive change in welfare. This indicates that the transport service is not a significant sector for the region to the point of altering, in itself, the generation of wealth in the region.

The impact on the level of welfare is most evident when increasing transport efficiency. In absolute terms, GDP growth is composed of a share of household consumption which indirectly translates into well-being. Given that the welfare variable grows more than GDP, when considering the other variables, it can be inferred that GDP is high due to increased consumption.

After verifying the macro-regions, it becomes possible a broad view of the impact on the Brazilian economy in changing the cost of transporting agricultural cargo.

As already observed, GDP has a positive response to the change in freight prices. When one observes the Brazilian economy, without the breakdown by macro-region, the variation becomes smoother, since there are other components in which they can impact at the national level.

It is possible to correlate GDP with the gains projected by the shocks in order to estimate a value for the different transport costs, given Equation 3.

$$GDP_{projected} = GDP_{current} \times (1 + shock\ variation) \tag{13}$$

Therefore, the projected GDP at the different simulated levels is exposed in Table 17, whose calculation of the variation is consistent in the respective shock.

**Table 2: Brazilian’s projected GDP post-shocks (base 2018)**

Efficiency level	Post-shock GDP change (%)	GDP (R\$ trillion)	Potential GDP (R\$ trillion)
2.7%	0.002	6.827	6.839

Through this projection, it is already possible to observe that the service of transport of agricultural cargo, by itself, is an influencing factor of the country's economy. This proves what is observed throughout the scenario in each region.

In summary, with this projected scenario from the perspective of efficiency gains in agricultural cargo transportation services indicate a slight improvement for GDP and welfare, resulting in a positive economic impact and some regional development. However, because it demonstrates a minimal impact on the economy, the cargo transportation service cannot be characterized as a major barrier in the economic and regional development of Brazil.

**5. FINAL REMARKS**

The present study analyzed the transport services of agricultural cargo and aimed to investigate and quantify the economic impact of its efficiency for Brazil.

As the projected scenarios the economic with the simulation in efficiency shocks indicates positive variation in GDP and welfare, characterizing economic growth and development for the macro-regions. The trend of GDP and welfare growth is noted in all regions.

In the shock, it was validated that logistics is a limiting factor for the development of the Brazilian economy, but not unique. The low variation in the results, in the third decimal place symbolize a small variation, and points to the existence of more obstacles to the economic development of the country. With that said, the agricultural cargo transportation service does not directly impact the country's economic growth.

It is concluded that the transport service of agricultural cargo has its limitations and prevents the economic development of Brazil but should not be considered as one of the main obstacles to this.

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## **Special Session: SS24 - Education inequality and Economic development: a regional perspective**

**17:30 - 18:45 Thursday, 27th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89993853386>**

**Chair Amaghous Jabrane**

## AN ANALYSIS OF SUPPLY- SIDE INEQUALITIES IN EDUCATION SECTOR IN SRI LANKA

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### ABSTRACT

Education is the most prominent factor that determines personal wellbeing and economic development. As well, education is a basic human right. United Nation's Sustainable Development Goals also have emphasized the importance of provide quality education for all. Sri Lanka provides free education for all school aged children. However, there are huge inequalities in micro level. These inequalities limit the development of human capital which is the essential factor for economic development. Hence, the main objective of this study is to identify the supply side inequalities in school education in Sri Lanka. To analyze this objective secondary data are used. Data are analyzed using descriptive statistical methods. The results indicate huge inequality in distribution of National Schools in district and provincial level. Although there are considerable number of National Schools in some districts, the students' enrollment rate is low because those schools have located only in the main cities. Students from remote area have limited access those schools. Further, results highlighted that students in remote areas have limited chance to follow Mathematics and Science scheme subjects for Advanced Level. This barrier negatively affects the economic development since some human resources move out from their potential path. Availability of adequate teachers also important to ensure quality education. However, distribution of teachers according to their specialized subjects and education level are highly unequal. Especially schools located in remote areas suffer from trained and graduate teachers and teachers for subjects such as English, Mathematics, and Science. Unequal distribution of infrastructure facilities also hindered the right for quality education. All these inequalities negatively affect for passing rate of the benchmark examinations of the students. Policymakers and government should properly involve to reduce inequalities in education sector by providing equal facilities for every and each student.

### KEYWORDS

Inequality, School Education, Sri Lanka, Supply -Side

### 1. INTRODUCTION

Education is essential factor in economic development and social development of any country. Every person has right to get quality education. The importance of equal access to education has been emphasized in international conventions and national policies. United Nation's Sustainable Development Goals (SDGs) also have emphasized the importance of providing quality education for all. The fourth SDG especially focus on equality in education ensuring "inclusive and equitable quality education and promote lifelong learning opportunities for all" (undp.org.com, 2015).

Sri Lanka's national free education policy is designed to provide a common and equitable education for all. As a result, commendable educational achievements such as high literacy rate, the higher enrollment rate for primary and secondary education, and decent Human Development Index (HDI) have been achieved. In 2018, the school enrolment for primary education in Sri Lanka was 99.11 per cent and that was 100 per cent for secondary education (World Bank, 2020). As well, the literacy rate in Sri Lanka is 91.7 per cent reflecting the value of providing free education (Central Bank, 2020). But, there are micro-level disparities in accessing education, quality, and performance of education. This difference can be seen according to type of schools and according to available human and physical resource facilities. Those disparities have associated with a range of negative outcomes, such as lower economic growth and high risk of violence and conflict because of lower labor market returns and low social mobility. Therefore, it is more important to assure equitable and quality education to accelerate economic growth, reduce social and economic vulnerabilities and social violence.

Inequalities in education are caused by supply-side reasons as well as demand-side reasons. Government expenditure and policies can be identified as supply-side reasons. These inequalities limit the development of human capital which is the essential factor for economic development. Therefore, it is very important to identify and address supply-side inequalities in Sri Lankan education system.

## 2. LITERATURE REVIEW

Many researchers have analyzed the inequalities of education in different prospective. Taylor (2001) has found that socio-economic-status of a family in Canada is the one of the strongest indicators of a child's educational outcomes. Low socioeconomic status not only is associated with poor grades but also is a strong predictor of dropping out of school and skipping school. This research has shown that an achievement gap exists between children in low-income families and other families. Emma and Elaine (2017) have concluded that children's social class is one of the most significant predictors if not the single most significant predictor of their educational success using the data from two academic cohorts, the kindergarten classes of 1998 and 2010 in America. Baisla, (2020) has analyzed the causes of education inequality in India. This research found that regional inequality, gender-based inequality, caste, and social group's parental income and occupation are affecting factors for the education inequality in India. He recommends to plan education policies by addressing factors of educational inequalities so as to assure equal education for every student. Agrawal (2014) has analyzed educational inequality in rural and urban India and have pointed out that income of the parents has closely affect to students' achievements. This study found high inequalities in education in majour Indian state by calculating Gini Index separately for the rural and urban sectors. Although inequality declined from 1993 to 2009 period the Gini index is above 50 per cent in 2009. Tilak, (1989) has found educational inequalities affect for economic growth and unequal distribution of income based on primary data that collected from sample of 400 households in West Godavari district, Andhra Pradesh. He has pointed out that investment in education sector by targeting backward castes and women is essential for achieving equality in education. Kalmijn (2005) has analyzed educational inequality and family relationships based on contact and proximity in the family. The results have shown sharp but nonlinear educational effects on proximity and distance, although most of the educational effect on contact is indirect. This research has found that educational differences within family relationships lead to greater distances and less contact. Francisco (2014) has pointed out that inequalities in education is caused to educational achievement and opportunities using 57 countries based on Programme for International Student Assessment survey which was conducted in 2006. He indicated that 35 per cent of disparities in educational achievement are related inequality of opportunities and, this inequality is higher in continental Europe and Latin America than in Asia, Scandinavia, and North America. Stiglitz, (1923) has mentioned that differences in the education have been led to income inequality in any country. Furthermore, Lee (2013) has indicated that family background of the students is the most influential factor in educational inequality. Sarma et al, (2018), have analyzed inequalities in education in Sri Lanka using data collected from Monaragala, Batticaloa, and Mullaitivu districts. The results indicated that poverty and rurality are key contributors of educational inequalities. Differences in the types of schools and their congeniality especially limit poor and rural children's learning and educational outcomes and possibly put away later life opportunities. Although Sri Lanka is on the path to achieving universal primary and secondary enrolment across the island, evidence have pointed out that inequalities between rural and urban, and rich and poor areas are much worst especially when consider the quality of education. Although many researchers have analyzed the inequalities in education and it consequent to economy, research that analyzed the education inequalities in Sri Lanka is limited. Especially research that focus on supply side inequalities. Therefore, this research attempt to fil this gap. The finding of this research will help to policy makers to take decision to reduce inequalities in education sector.

## 3. OBJECTIVES

The objective of this study is to identify the supply-side inequalities in education sector in Sri Lanka.

## 4. METHODOLOGY

This analysis is based on secondary data. Secondary data are collected from various reports of the Central Bank in Sri Lanka, Ministry of Education, Department of Examination, Department of Census and Statistics (DCS), Centre for Poverty Analysis (CEPA), published research articles and websites, etc.

Collected data from secondary sources were analyzed using descriptive statistical methods. Data were analyzed using Microsoft Excel.

## 5. RESULTS AND DISCUSSION

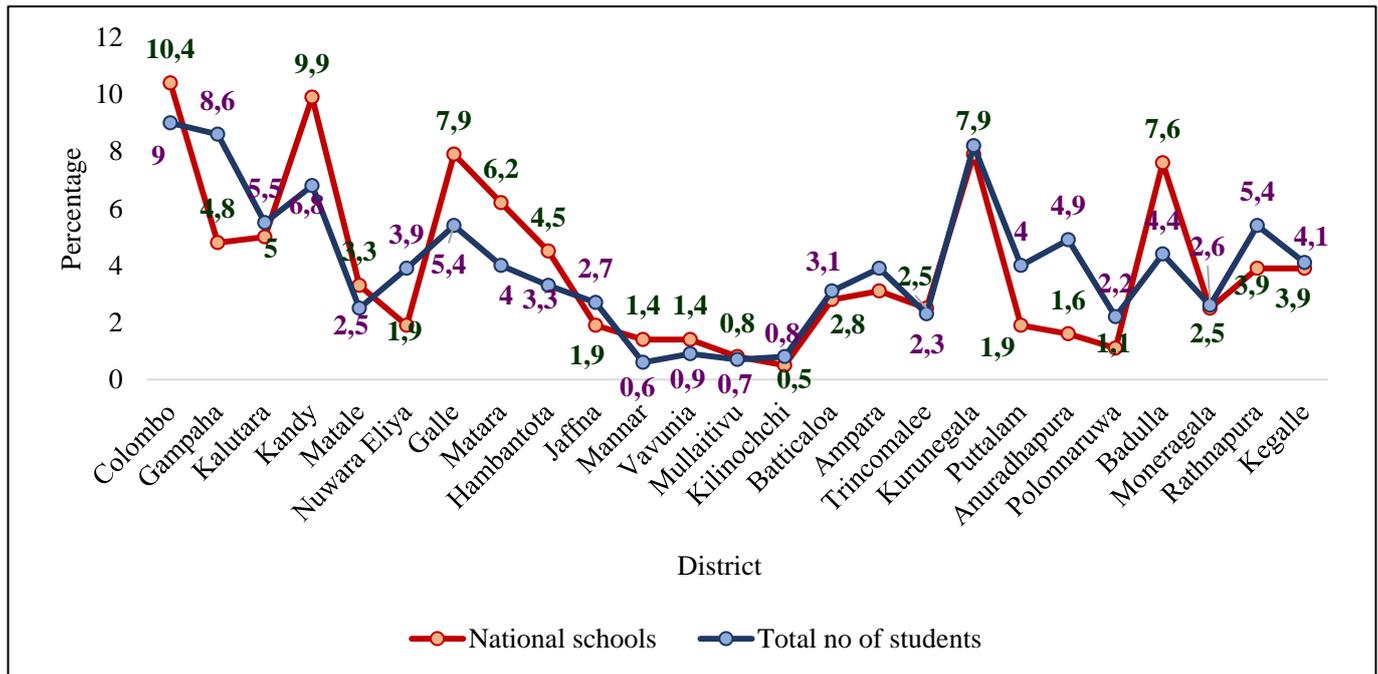
This study mainly focusses on supply -side inequalities of education sector in Sir Lanka. Within the context supply-side inequalities are analyzed according to distribution of type of schools, availability of physical facilities and human resource facilities.

**5.1 Unequal Distribution of Different Type of Schools in Sri Lanka**

In Sri Lanka, the type of schools plays an important role in determining the quality of education. Education facilities such as availability of different subjects, medium of teaching and other facilities vastly vary according to the type of schools. Unequal geographical distribution of type of schools cause to inequality in education and prevent some students getting quality education especially in remote areas.

The school system in Sri Lanka has consisted of government schools, private schools, special schools, and Pirivens. In terms of the level of schools, there are two main categories of government schools in Sri Lanka such that national schools and provincial schools. Out of total number of government schools (10,175) 353 are national schools and 9,822 are provincial schools (Ministry of Education (MOE), 2019). The schools administrated by the central government are designated as national schools and schools administrated by the provincial councils are named as provincial schools. National schools are recognized as providing the best primary and secondary education out of the government schools and their disproportionate distribution can lead to spatial disparities in education (MOE, 2017).

Following graph shows the distribution of national schools and total number of students in each district.



**Figure 01: Distribution of National Schools and Total Student Population in 2017**

Source: MOE, 2018.

According to the graph, Colombo district has the highest percentage of national schools (10.4 per cent) in Sri Lanka. Kilinochchi district has the lowest percentage of national schools (0.5 per cent). About 54 per cent of national schools are centered in Western, Southern, and Central provinces in Sri Lanka while remaining six provinces have 46 per cent of national schools (MOE, 2018). There is a big difference between percentage of national schools and percentage of students’ population in Gampaha and Anuradhapura districts. Especially Anuradhapura district is one of the largest district in Sri Lanka. Although in some districts such as Killinochchi and Mullaitivu, have reasonable percentage of national schools compared to percentage of students. However, students’ enrollment in national schools in these districts is very low (MOE, 2018). As a percentage the students’ enrolments rate of Killinochchi district is 0.2 per cent and Mullaitivu district is 0.3 per cent (MOE, 2018). The wide geographical spread and the highest distribution of rural sector may reasoned for low students’ enrollment in national schools (DCS, 2018) (CEPA, 2018). Most of the national schools are located in urban areas (CEPA, 2018).

It is more clearly understand the unequal distribution of national schools by calculating National Schools Students Ratio (NSSR).

**Table 01: National School Student Ratio in 2017**

District	The national school student ratio	District	The national school student ratio
Colombo	10,279	Kilinochchi	16,225
Gampaha	21,406	Batticaloa	13,056
Kalutara	12,849	Ampara	14,981
Kandy	8,159	Trincomalee	10,913
Matale	8,812	Kurunegala	12,401
Nuwara eliya	23,658	Puttalam	24,246
Galle	8,113	Anuradhapura	<b>34,578</b>
Matara	7,743	Polonnaruwa	23,091
Hambantota	8,818	Badulla	6,910
Jaffna	16,118	Moneragala	11,980
Mannar	<b>5,418</b>	Rathnapura	16,285
Vavunia	7,512	Kegalle	12,307
Mullaitivu	9,564		

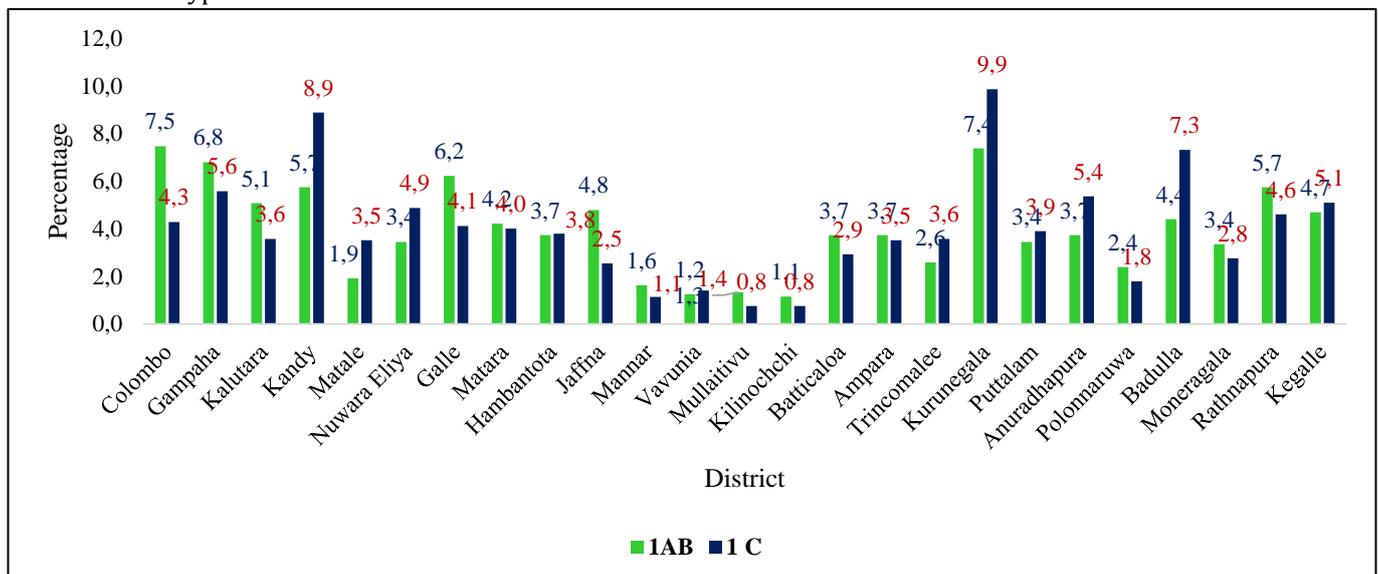
Source: Author calculation based on MOE, 2018.

The NSSR is the number of students in each district divided by the number of national schools. It was calculated by using following equation.

$$\text{National school student ratio} = \frac{\text{Number of total students}}{\text{Number of national schools}}$$

According to this table, NSSR in Anuradhapura district is 1: 34,578 which is the highest ratio. Anuradhapura is one of the largest district in Sri Lanka and compared that there are few number of national schools are located in this district. The lowest ratio shows in Mannar district (1:5,418). NSSR is more than 1: 20,000 in five out of twenty-five districts. However, when compared to available physical facilities and human resources the capacity of school is around 3000 to 4000 students for the school which have highest facilities. Although class room facilities are enough for 35 students most national schools have around 60 students in each class room. Entrance for national school is very competitive. It is very difficult to enter low income people since political influence, other personal relationship and corruption deprived their right to enter national schools. The main solution for this is increase the facilities and quality of education equally in all the schools in Sri Lanka.

In addition to the unequal distribution of national schools among districts, types of schools are also unequally located in Sri Lanka. The government schools are classified by type depending on the terminal grade of the school and according to subjects offered for Advanced Level. There are four main types of schools 1AB, 1C, Type 2 and Type 3. 1AB type schools have Advanced Level Science (Bio Science and/ or Physical Science) stream classes with or without primary sections. The schools having Advanced Level classes at least one stream of Arts and/or Commerce and/or Technology streams and/ or Vocational with or without primary sections are defined as 1C schools ((MOE, 2017). Following graph shows the distribution of type 1AB and 1C schools.



**Figure 02: Distribution of 1AB and 1C Schools in 2017**

Source: Author calculation based on MOE, 2018.

Out of total government schools 10 per cent are 1AB schools (MOE, 2018). This graph shows that distribution of type 1AB and 1C schools according to district. It has been calculated by using following formula.

$$\text{Percentage of 1AB schools} = \frac{\text{Total Number of 1AB schools in district}}{\text{Total number of 1AB schools in the country}} * 100$$

Same formula was applied to calculate 1C schools. As shown in graph 02 the highest percentage of total 1AB type schools are located in Colombo (7.5 per cent) and Kurunegala (7.4 per cent) districts. Kilinochchi district has the lowest percentage (1.1 per cent) of 1 AB schools. The highest numbers of IAB schools are located in the Western, Southern, and Central provinces compared to other six provinces in Sri Lanka (MOE, 2018). Also 91.5 per cent of 1AB schools belong to national schools (MOE, 2018). Out of total number of government schools only 18 per cent of government schools are belong to 1C schools (MOE, 2018). Kurunegala district has the highest percentage of 1C type schools which is 9.9 per cent. Both Mullativu and Kilinochchi districts have the least percentage of 1C type schools. When 1AB and 1C schools are taken together, Colombo, Gampaha, Kandy, Galle, Matara, and Hambantota districts have more than 30 per cent 1AB and 1C schools out of the 25 districts in Sri Lanka. Exception of these six districts, nineteen out of twenty-five districts has less than 30 per cent 1AB and 1C schools (MOE, 2018). According to this, it is clear that less than two-thirds of the existing government schools (only 28 per cent) do not offer Advanced Level.

Unavailability of Advanced Level class in schools prevent some students to continue their education after finishing Ordinary Level examination especially in remote areas and student with financial problems. Those students may not have opportunity to enter government universities which offer free undergraduate courses. In some cases, students have to spend lot of time to go to school that located in far from their area because of unavailability of Advanced Level class in rural area especially which offer Bio-Science or Physical Science subjects for Advanced Level. This situation may worsen with poor transportation facilities in remote areas. This cause to reduce their time that has to spend on education and finally end with low results and cannot continue higher education. Not only that, unavailability of Bio- Science and Physical Science subjects for Advanced Level prevent some students to select other subjects other than their preference and this may violent basic human right. As an example Killinochchi, Mannar, and Mullativu districts, each had approximately 1 per cent of the Type 1AB schools in 2015 and had no students entering university via the science stream on merit in 2016/2017 (Department of Examination (DOE), 2017). This may reason for deprive some potential labour for specific field in future and cause for many more social and economic problem in the country. Finally, unequal distribution of schools causes for economic development in the country.

## 5.2 Unequal Distribution of Teachers

Inequalities in education sector exist in terms of teacher’s distribution and qualification of the teachers. The qualifications of the teachers are measured according to their level of education and training to the types of subjects they qualified to teach. In terms of qualification of the teachers there are five main categories such that graduate, trained, untrained, trainee, and other teachers.

- Graduate teachers – teachers having a 3 or 4 years’ degree by recognized university and postgraduate degree
- Trained teachers – teachers trained in teachers’ training colleges/ National Colleges of Education and teachers having 2 years’ diploma in science/mathematics.
- Untrained – untrained teachers and 2-3 years’ diploma holders (absorbed to Sri Lanka teacher service)
- Trainee – teachers not absorbed to Sri Lanka teacher service
- Other – teachers paid by other government institutes and teachers paid by nongovernment institutes / organizations.

Source: MOE, 2017.

Following table shows the distribution of the teachers according to their qualifications.

**Table 02: Distribution of Teachers in 2017**

Province	Graduate teachers (%)	Trained teachers (%)	Trainee teachers (%)	Untrained teachers (%)	Other teachers (%)
Western	9.8	7.2	0.1	0.0	0.03
Central	5.7	8.3	0.4	0.3	0.01
Southern	5.3	5.8	0.1	0.1	0.01
Nothern	3.1	4.6	0.1	0.0	0.00
Eastern	3.9	5.7	0.3	0.0	0.00
North Western	5.6	6.3	0.3	0.0	0.01
North Central	3.7	4.1	0.1	0.0	0.00
Uva	3.2	4.8	0.2	0.1	0.05
Sabaragamuwa	4.7	5.5	0.2	0.1	0.00
Total	45.0	52.4	1.8	0.7	0.11

Source: Author calculation based on MOE, 2018.

As showing in the table, about 97.4 per cent of the teachers in government schools are either graduates or trained teachers. The highest number of graduate (9.8 per cent) and trained (8.3 per cent) teachers are in Western and Central provinces. The highest number of trainee (0.4 per cent) and untrained (0.3 per cent) teachers are in the Central province. However, the lowest percentages of all graduate and trained teachers are in Northern (3.1 per cent) and North Central province (4.1 per cent), respectively. Northern Province has recorded the lowest percentage (7.8 per cent) of all teachers. Furthermore, teachers have been recruited to schools on the basis of difficulty service by the Ministry of Education and the Provincial/Zonal Educational Departments in Sri Lanka. This rule may cause for some dissimilarities compared to requirement of the school. Because it is mandatory for a teacher to serve in a 'difficult' or 'very difficult' school for a period determined by the government (minimum of three years). As well, some teachers use political and other influences to transfer to a school of their preference.

The gross student-teacher ratio is the number of students per teacher. The Western province has the highest student-teacher ratio (1:21) while Northern Province have the lowest student-teacher ratio (1:13). However, there is no huge disparity in student-teacher ratio in Sri Lanka, that is stayed average level in each district. Also, Type 1AB schools compared to other schools categories have the highest student teacher ratio (1:21) (MOE, 2017).

Unequal distribution of teachers in education sector negatively affect for student's education. When students' teachers' ratio is high it is difficult to manage one teacher to lot of students and pay their attention to students individually. Especially this badly affect primary education of the students who need more attention at their early age. Further, lack of trained teachers in some schools especially in remote area badly affect for quality of the education. Especially, schools located in remote areas suffer from lack of teachers who trained specific subjects such as English, Science, and Mathematics. So, the failing rate of those subjects in Ordinary Level examination is high in schools which do not have enough teachers for English, Science and Mathematics. However, it is mandatory to pass Mathematics to follow Advanced Level according to the education system of Sri Lanka. Because of this reason most of students have to stop their school education without following Advanced Level which is mediatory to enter university. Further, there are no teachers who qualified for teaching English in most schools (Ranasinghe et al. 2016). He states that by 2012 there were 205 students per English teacher. Therefore, students are poor with English which is the international language. This negatively affect for them to find good job and follow higher education since most higher education institutes offer programs in English medium. As well, very few government schools in Sri Lanka offer education in English medium because of lack of teachers to teach in English medium and lack of class rooms facilities in schools. Hence, students have limited opportunity to follow school education in English medium and it is very competitive to enter the English medium class. This may negatively affect to their language skill and job market opportunities.

Some schools in Sri Lanka severely suffer with lack of teachers. Following table illustrates the schools which have only one teacher two teachers.

**Table 03: Student-Teacher Ratio in School with One Teacher and Two Teachers in 2016**

<i>Student per teacher</i>	<i>Number of schools with one Teacher</i>	<i>Number of schools with two Teachers</i>
1 student per teacher	5	3
2 student per teacher	13	7
3 student per teacher	2	6
4 student per teacher	7	11
5 student per teacher	6	10
6 student per teacher	1	8
7 student per teacher	-	12
8 student per teacher	2	8
9 student per teacher	3	1
10 - 20 student per teacher	8	20
21 - 30 student per teacher	-	6
31 - 40 student per teacher	-	3
41 - 50 student per teacher	1	1
51 - 75 student per teacher	5	1
76 -100 student per teacher	-	-
101 or more student per teacher	1	-
<b>All schools</b>	<b>54</b>	<b>97</b>

Source: MOE, 2017.

According to above table, 54 schools have one teacher and 97 schools have only two teachers. Out of the 54 schools which have one-teacher, five had one student and one school had 101 or above students. However, as shown in this table, 47

schools have student per teacher ratio less than 1:20. Teachers are the main resource in the school. Students have to find another school because of lack of teachers. Especially schools in remote area suffer from lack of teachers because of poor infrastructure facilities. Students have to find schools far from their areas which may costly and time consuming for them to access since lack of teachers. In some cases, assigned teachers also rarely come to schools. Number of leave days entitle for the teachers are 15 per cent of total school working days and student achievements being low as the days of leave taken by teachers are high (Institute of Policy Studies of Sri Lanka (IPS), 2017). Because of those reasons some financially destitute people do not continue their children’s education. These inequalities lead some social and economic problems in future. Further, in 2016, there were 262 schools with 15 students or less (MOE, 2017). Accordingly, this has highlighted the poor management of resources in the country.

**5.3 Unequal Distribution of Infrastructures Facilities**

Infrastructure facilities and other facilities that essential for maintain the quality education are also shown the inequality of education facilities in Sri Lanka. Out of total number of schools, 5,643 schools (55 per cent) have computer facilities for students. The highest percentage of computer facilities which is 69 per cent recorded from western province and the lowest percentage of computer facilities record from North Western province which is 47 per cent. More than 50 per cent of computer facilities have secondary schools, 1AB, and 1C schools (MOE, 2017). Lack of computer facilities prevent the students get new knowledge and working with new technologies. Especially in the current situation such that COVID-19 pandemic it is essential to use the computers to access online learning. However, without basic knowledge of computers it is very difficult for students to access it. Therefore, lack of computer facilities may lead inequality in education and limit the labour market participation.

Availability of basic facilities such as water, electricity and toilet facilities also cause for better education. However, there are some schools which lack even basic facilities, such as water, electricity and toilet facilities.

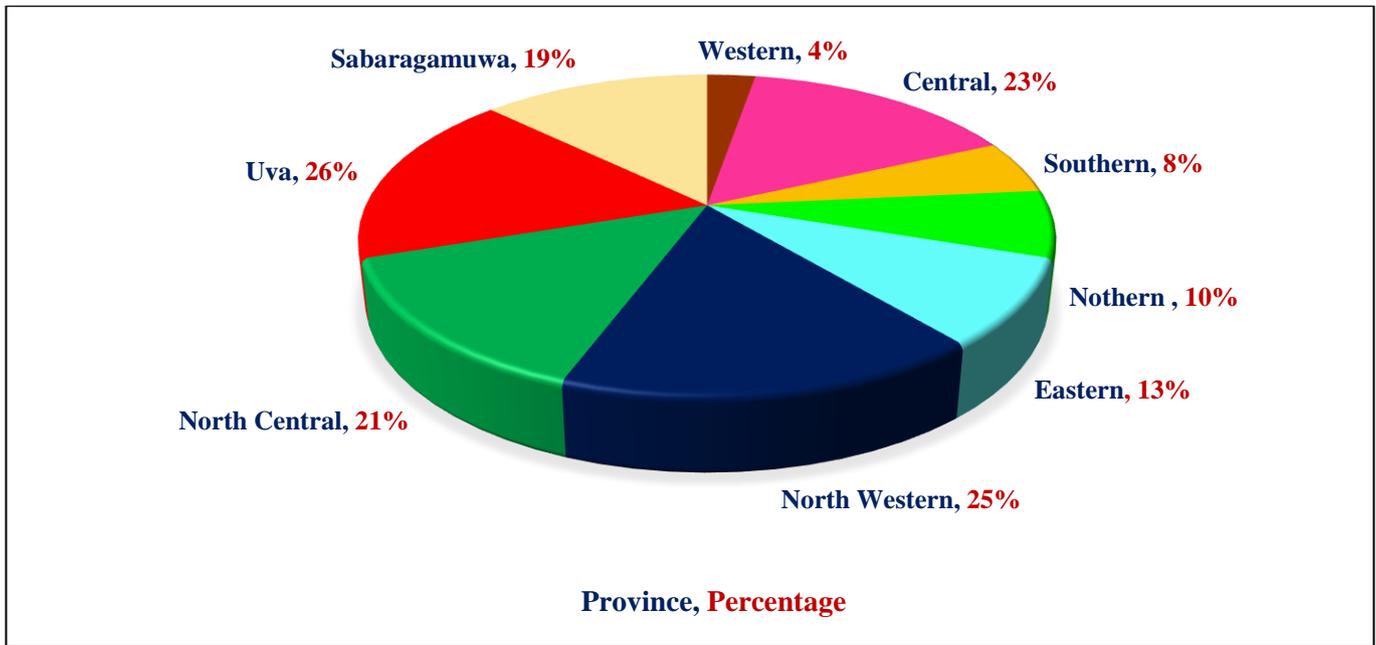
**Table 04: Percentage of Schools by Drinking Water Facilities in 2016**

<i>Province</i>	<i>Wells/Tube Wells in school premises (%)</i>	<i>Piped Water Facility (Municipal &amp; Urban Councils/Water Supply &amp; Drainage Board) (%)</i>	<i>Water from Streams/Springs (%)</i>	<i>Bowser (%)</i>
<i>Western</i>	40	54	2	0
<i>Central</i>	21	35	20	0
<i>Southern</i>	36	52	4	0
<i>Nothern</i>	73	12	0	5
<i>Eastern</i>	29	57	0	1
<i>North Western</i>	57	18	0	0
<i>North Central</i>	46	32	0	1
<i>Uva</i>	25	27	21	1
<i>Sabaragamuwa</i>	36	25	20	0
<b>Total</b>	<b>40</b>	<b>35</b>	<b>8</b>	<b>1</b>

Source: MOE, 2017.

According to table 04, main drinking water sources of the schools are wells/tube wells in school premises, piped water facility (Municipal & Urban Councils/Water Supply & Drainage Board), water from streams/springs, and bowser. Out of total schools 40 per cent of schools fulfil their drinking water requirement from wells/tube wells in school while most of other schools use piped water which is provided by Municipal & Urban Councils/Water Supply & Drainage Board. Most schools in Northern and North Western province used wells/tube wells in school premises and it is because rural areas are more widespread. Only 84 per cent of schools have any kind of drinking water facilities. According to this, 16 per cent of the government schools in Sri Lanka have no water facilities (uninterrupted water facilities).

Following graph shows the schools which do not have dirking water facilities according to province.

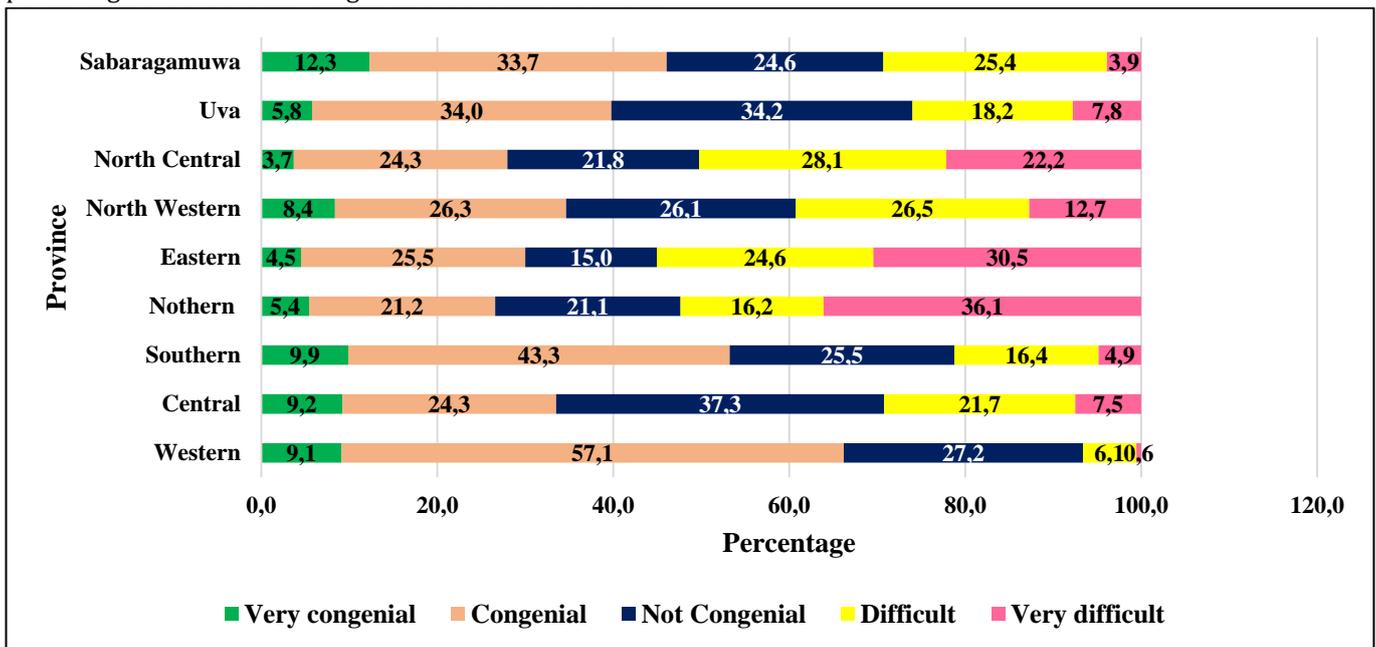


**Figure 03: Percentage of Schools which do not have Water Facilities according to Provinces of Sri Lanka in 2016**

Source: MOE, 2017.

As shown in this graph, there are no water facilities approximately one-fifth of the schools in Central (23 per cent), North Western (25 per cent), North Central (21 per cent), and Uva (26 per cent) provinces. However, most of schools in Western and Southern provinces have water facilities.

Schools in Sri Lanka have been divided into five categories according to available basic infrastructure and other necessary equipment. Those categories are very congenial, congenial, not congenial, difficult, and very difficult. Factors considered to measure congeniality include the availability of basic resources (electricity, water, telephone, library facilities), the durability of existing equipment (such as photocopy machines, televisions, and computers), the number of usable toilets, the size of the school buildings, availability of a principal’s office, teachers’ common rooms, the number of teachers and qualification composition (vocational and graduate), distance from school to the nearest bus stop or train station and the number of trips available towards the school between 7–8 am, and distance from the school to key education ministry offices, the nearest bank, post office, and government hospital (Sarma et al,2018). Following graph illustrate the percentage of school according to available basic facilities.



**Figure 04: School Congeniality by Province in 2016**

Source: Author calculation based on MOE, 2017.

As shown in above graph, according to total number of schools in province the majority of very congenial schools and congenial schools are located in Western and Southern provinces. Most of the not congenial schools can be seen in Central province. The lowest percentage of very congenial schools is in North Central province. As well, the majority of difficult and very difficult schools are centred in Eastern and Northern provinces in Sri Lanka. However, in the former war-torn provinces of Kilinochchi, Mannar, Mullaitivu, and Vavuniya close to 50 per cent of the schools are non-congenial, less accessible, and less conducive as a learning environment due to insufficient facilities (MOE, 2017). This is in sharp contrast to schools in Colombo where approximately 70 percent of the schools are congenial (MOE, 2017). Lack of basic facilities hinders the welfare of the students and negatively affect for education increasing inequality in education sector.

## 6. CONCLUSION

Free education policy in Sri Lanka has made it one of the most literate countries in South Asia. However, there are lot of inequalities in education sector in Sri Lanka because of supply-side reason. Therefore, this study attempt to evaluate the supply side factors that cause for education inequality in Sri Lanka.

The results of the study indicate national schools are distributed across the country unequally. Especially in some districts there are very few national schools compared to students. The student ratio compared to national schools are very high and not affordable to existing facilities of the school.

Further results indicate that there are limited opportunities for students to follow Bio-Science and Physical Science subjects for Advanced Level because of unequal distribution of 1AB schools which offer Bio-Science and Physical Science subjects for Advanced Level across the country and this type of schools are rarely located in remote areas. As well, the IC type schools that offer Advanced Level except Bio-Science and Physical Science subjects are also unequally distributed among the districts and among the sectors. Hence, some students have stopped their education without following Advanced Level which is the university entrance examination in Sri Lanka. Further, there are lack of graduate and trained teachers in some schools limiting students right to have quality education. Especially lack of trained teachers for English, Mathematics, and Sciences affect the equality and quality of the education in remote areas. Further limited schools in Sri Lanka offer English medium learning facilities creating another inequality in education sector.

There are considerable number of school do not have enough drinking water facilities in each province. Out of total number of schools 16 per cent of school do not have enough drinking water facilities. Schools in Northern and Eastern province highly suffer with lack of basic facilities that need to get quality education compared to other provinces.

Unequal opportunities and resources to access education can be translated into low learning outcomes. As well, disadvantaged groups will face later life disadvantages, which affect for lower labor market returns, low social mobility and slow economic growth.

## 7. SUGGESTIONS

According to findings of this study it can be recommended to increase equal physical and human resource facilities in both urban and remote areas so as to every student get equal quality education. Policymaker should take necessary steps for training teachers especially for subjects such as English, Mathematics and Science. As well, it is important to provide opportunities for every student who like to follow their school education in English medium since it cause for positive outcome in future. In this regards it is essential to train teachers for English medium subjects.

It is basic human right to have school education for all students. However, limited number of schools that offer Advanced Level class prevent some students to continue their education. Hence, policymakers should pay attention to expand the schools that provide Advanced Level class so that every student able to get quality education equally.

Basic facilities such as water, electricity, toilet, library, and other necessary facilities for education is essential for quality education. However, most of schools in Sri Lanka do not have such facilities. Therefore, it is necessary pay attention by policy makers to improve those facilities in every school so as to consider all the schools in same level.

## ACKNOWLEDGEMENT

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## DISPARITIES AND DETERMINANTS OF REGIONAL UNEMPLOYMENT RATE: EMPIRICAL EVIDENCE FROM MOROCCO

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### ABSTRACT

Unemployment is one of the most important macroeconomic indicators of an economy. Its analysis, in Morocco, was carried out mainly by referring to national data while neglecting regional aspects. Although the unemployment rate at the regional level is considered as one of the socio-economic indicators of a region, the disparities in unemployment and its determinants are little debated in Morocco.

The objective of this paper is, first, to describe the spatial configuration of the unemployment rate. Then, we study the factors likely to explain the disparities in unemployment between the regions of the country.

There is a growing interest in studying unemployment in the literature. Thus, many studies are carried out in this field. While some analyze unemployment disparities between countries, others focus on unemployment disparities within a country (Marukawa, 2017; Dixon et al., 2001; Rios, 2017).

The theoretical literature puts forward several factors to analyze unemployment at the regional level. Thus, regional disparities in unemployment are due to regional problems and specificities. Furthermore, the variables used to explain unemployment disparities between countries are not valid for describing regional unemployment disparities. Indeed, the social security system and the tax system are mentioned as explanatory factors of the unemployment disparities between countries but have little or no value at the regional level because there are no large ones within the country. 'a country (Elhorst, 2003).

The estimation of the determinants of regional disparities in the unemployment rate will be made using the techniques of exploratory spatial data analysis. The models of spatial econometrics are needed to justify, through their lessons in terms of analyzing spatial disparities, why geographic should be taken into account in the framework of the analysis of regional determinants of the unemployment rate (the participation in the labor market, the rate of the young population (aged between 15 and 24, the level of education, the rate of industrialization). It is important to point out that developing countries lack unemployment data by regions over several years. Morocco is no exception to this situation. In this study, we use the spatial data of the general census of population and habitat (RGPH) of 2014.

More precisely, it is a question of showing that the taking into account of spatial disparities renews the debate on the effectiveness of regional development policies. These inequalities cannot be neglected and they allow an improvement in the understanding of the process of convergence between the provinces.

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## A SPATIAL ANALYSIS OF EDUCATION INEQUALITY DETERMINANTS: THE CASE OF MOROCCO

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### ABSTRACT

Since its independence, the Moroccan economy has been characterized by a fluctuation in growth rates (Agénor and El Aynaoui, 2015), despite the successive reforms adopted (Ben Ali and Cherkaoui, 2007). Dictated by the World Bank, Morocco has adopted a structural adjustment program aimed at maintaining its macroeconomic balance, the main guidelines of which are austerity affecting largely social investments (Ben Ali, 1998). The latter were assigned to so-called regions with high growth potential, neglecting the other regions of "useless Morocco", thus reinforcing territorial inequalities (Achy and Sekkat, 2008), including in the field of education. Indeed, the analysis of the performance of the Moroccan education system reveals asymmetries and territorial imbalances hiding disparities between regions. This problem manifests itself, in particular, by the existence of a large number of "poor" regions whose educational performance is low. It should also be noted that the Moroccan provinces are characterized by the persistence of a dual structure between the Kenitra-Settat axis, developed, and a periphery in difficulty.

From a theoretical point of view, there is a broad consensus that socio-economic determinants contribute substantially to the reinforcement of educational inequalities. Paradoxically, despite this reality and the challenges that individual, socio-economic and institutional factors may pose, very few theoretical and empirical studies have focused on the spatial dimension of observations. It is therefore not surprising to note that research on spatial inequalities in Morocco remains very marginal.

The estimation of the determinants of educational inequalities is carried out using the techniques of the exploratory analysis of spatial data. These are techniques that make it possible to visualize spatial distributions, to identify atypical locations and extreme observations, to detect patterns of spatial association and to suggest spatial regimes or other forms of spatial heterogeneity. Models of spatial econometrics are needed to justify, by their lessons in the analysis of spatial disparities, why the geographical should be taken into account in the context of the analysis of the determinants of educational inequalities. It is important to note that developing countries lack educational data by region over several years. Morocco is not immune to this situation. In this study, we use spatial data from the recent 2014 General Population and Housing Census (RGPH). More specifically, the aim is to show that taking into account spatial disparities renews the debate on the effectiveness of regional development policies. These inequalities can not be neglected and they allow an improvement in the understanding of the process of inequalities between the provinces. We seek to show that educational inequalities are related to patterns of distribution of poverty.

**Friday, 28 May 2021**

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# PARALLEL SESSIONS (16)

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**SS42.1 - Regional Science from Down Under:  
perspectives from Aotearoa New Zealand**



**05:30 - 07:00 Friday, 28th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88511789571>**

**Chair Philip Morrison**

**GEOGRAPHY MATTERS FOR SMALL ADVANCED ECONOMIES: THE  
IMPLICATIONS FOR AN ECONOMIC STRATEGY**

**Paul Dalziel, Caroline Saunders**

AERU, Lincoln University, New Zealand

**ABSTRACT**

New Zealand is a small advanced economy (SAE) in the South Pacific Ocean. Policy advisers often compare New Zealand's economic performance with those of other SAEs: Austria; Belgium; Denmark; Finland; Hong Kong; Ireland; Israel; Netherlands; Norway, Singapore; Sweden; and Switzerland. These comparisons generally recognise that among SAEs, New Zealand is uniquely distant from the world's largest and highest income markets. Nevertheless, it has become commonplace for policy advisers to say "Geography is not destiny: New Zealand can do better" (the heading of a section in a 2020 New Zealand Productivity Commission draft report). This paper draws on standard regional economic development analysis to conclude that geography matters for economic strategies. It frames that analysis with the insights of endogenous growth theory to lay foundations for an economic strategy relevant to the New Zealand region of the South Pacific Ocean in the global economy.

**THE EFFECT OF UPZONING ON HOUSE PRICES AND REDEVELOPMENT PREMIUMS IN AUCKLAND, NEW ZEALAND**

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<sup>1</sup>The University of Auckland, New Zealand. <sup>2</sup>Auckland University of Technology, New Zealand

**ABSTRACT**

We study the short-run effects of a large-scale upzoning on house prices and redevelopment premiums in Auckland, New Zealand. Upzoning significantly increases the redevelopment premium but the overall effect on house prices depends on the economic potential for site redevelopment, with underdeveloped properties appreciating relative to intensively developed properties. Notably, intensively developed properties decrease in value relative to similar dwellings that were not upzoned, showing that the large-scale upzoning had an immediate depreciative effect on pre-existing intensive housing. Our results show that the economic potential for site redevelopment is fundamental to understanding the impact of changes in land use regulations on property values.

## THE CONNECTION OF RENTAL AND HOUSE PRICE AFFORDABILITY MEASURES IN NEW ZEALAND

[Graham Squires](#)<sup>1</sup>, [Hai Trinh](#)<sup>1</sup>, [Don Webber](#)<sup>2</sup>, [Arshad Javed](#)<sup>1</sup>

<sup>1</sup>Massey University, New Zealand. <sup>2</sup>University of Sheffield, United Kingdom

### ABSTRACT

The aim of this paper is to examine the cointegration and long-run relation between affordability measures of house ownership prices and house rental prices in New Zealand. Using the approaches by Westerlund (2007) and Dumitrescu and Hurlin (2012), the study shows that there is an existence of cointegration and unidirectional causality effects between house price affordability (HPA) and rental price affordability (RPA) across 11 regions. Auckland, Wellington and Canterbury are the three regions in which the results detect the most extreme effects among HPA and RPA compared to other places in the country.

We extend our study by examining the lead-lag correlation between those two affordability measures. Our extended empirical work shows interesting results that the lead-lag effects of HPA and RPA on each other and mortgage rate have been discovered in New Zealand using GLS approach and for each of 11 regions via OLS model. Those effects are consistent for both methods but are changed at individual lead-lag variables and among different regions. The study empirically provides useful insight for both academia and practitioners in examining the long-run effects and cointegration between house price and rental price affordability.

Application of the bootstrap robust Westerlund technique confirms the presence of strong cointegration between these two housing affordability indicators. Application of Dumitrescu and Hurlin's (2012) Granger non-causality panel tests reveal that the statistically optimal lag length is equal to one quarter with house price affordability Granger-causing rental price affordability over the period 2000q1 to 2017q4. Application of Dumitrescu and Hurlin's (2012) Granger non-causality test results to individual regions suggest that house price affordability Granger-causes rental price affordability in Wellington, Auckland, Canterbury, Nelson and Hawkes Bay and that rental price affordability Granger-causes house price affordability in Wellington only.

## VULNERABLE PEOPLE, LOCAL LABOUR MARKET RESILIENCE AND GLOBAL SHOCKS: NEW ZEALAND EVIDENCE FROM THE COVID-19 PANDEMIC AND THE GLOBAL FINANCIAL CRISIS

William Cochrane<sup>1</sup>, Jacques Poot<sup>1,2</sup>, Matthew Roskrug<sup>3</sup>

<sup>1</sup>University of Waikato, New Zealand. <sup>2</sup>Vrije Universiteit Amsterdam, Netherlands. <sup>3</sup>Massey University, New Zealand

### ABSTRACT

Despite its remote location in the South Pacific, New Zealand is tightly integrated in the global economy through trade, tourism, capital & migration flows, and strong digital connectivity. Nonetheless, the country weathered the Global Financial Crisis (GFC) relatively well. More recently, exemplary public health policies have muted the economic impact of the Covid-19 pandemic to date. Despite these favourable national outcomes, there are large differences across people and places in the impact of these exogenous shocks, although the shocks themselves occurred nationally with virtually no spatial differentiation. There are interesting similarities and differences between the socio-economic impact of the GFC shock and Covid-19 pandemic shock. In this paper we focus on one key outcome of public policy concern: the uptake of social security benefits in the short-run (first 12 months) after the onset of the shock. We construct a two-wave panel of 66 regions observed in 2008-09 and 2020-21. We link the corresponding social security data with regional characteristics mainly obtained from the preceding censuses. Using data reduction and model selection methodologies we find that pre-shock vulnerability in terms of unemployment is a key predictors of post-shock growth in social security uptake. This conclusion is robust to accounting for interregional spatial spillovers. There is notable similarity between the impact of the two shocks in terms of demographic composition (age and ethnicity), and the extent to which the self-employed and those in the private sector are relatively more exposed to the shocks. Income and wealth differences and the regional sectoral mix matter too but in a different way when comparing the GFC shock with the Covid-19 shock.

## SS42.2 - Regional and urban resilience in a turbulent world: perspectives from Aotearoa New Zealand



09:00 - 10:30 Friday, 28th May, 2021

Room Lagouira

<https://us02web.zoom.us/j/88511789571>

Chair Jacques Poot

**HOW DO PANDEMICS AFFECT ECONOMIC GROWTH? LESSONS FROM  
THE 1968 H3N2 INFLUENZA AND 2003 SARS**

[Ilan Noy](#)

Victoria University of Wellington, New Zealand

**ABSTRACT**

We evaluate the 1968 H3N2 Flu pandemic's economic cost in a cross-section of 52 countries. Using excess mortality rates as a proxy for the country-specific severity of the pandemic, we find that the average mortality rate (0.0062% per pandemic wave) was associated with declines in consumption (-1.9%), investment (-1.2%), output (-2.4%), and productivity (-1.9%). Our main findings highlight the role of both negative demand-side and supply-side shocks in the flu pandemic's aftermath. We also assess the impact of SARS on the 4 most-affected economies (Taiwan, China, Hong Kong, and Singapore).

## THE WELLBEING IMPACT OF EXOGENOUS SHOCKS. NEW ZEALANDERS' REACTION TO COVID-19.

[Philip Morrison](#)<sup>1</sup>, [Stephanié Rossouw](#)<sup>2</sup>, [Talita Greyling](#)<sup>3</sup>

<sup>1</sup>Victoria University of Wellington, New Zealand. <sup>2</sup>AUT, New Zealand. <sup>3</sup>University of Johannesburg, South Africa

### ABSTRACT

While several studies have explored the wellbeing consequences of crises, particularly economic recessions and natural disasters, investigations of countries wellbeing responses to epidemics remain relatively scarce. Several disciplines offer theoretical priors in the case of individuals but there is little in the way of theory or historical evidence that addresses the wellbeing response to epidemics at the level of the nation.

In this paper we explore the sensitivity of a national wellbeing index to the arrival and passage of COVID-19 in a small, physically separate economy in the South Pacific. The index is constructed from daily tweets originating within New Zealand which captured the daily mood of the country several weeks before the first domestic case of Covid-19 was recorded until several weeks after the number of cases had dropped to zero.

We find distinct reactions to the epidemic: a marked drop in national wellbeing generated by a descent in positive emotions which exceeded the fall in negative sentiment. We find the reduction in national wellbeing to be short-lived due in large part to the rapid and effective response by the New Zealand government whose actions saw the national mood return to 'normal' within a month.

Although our time series paper complements cross-sectional micro-level studies of the New Zealand experience, our average measures of wellbeing are unable to reveal the distributional consequences of the epidemic. We add this limitation to a number of challenges facing the growing literature employing tweets to monitor changes in national wellbeing.

## THE DISTRIBUTIONAL IMPLICATIONS OF COVID-19 IN AOTEAROA NEW ZEALAND

**Daniel Exeter, Janine Paynter, Vili Nosa, Matire Harwood, Chris Bullen**

The University of Auckland, New Zealand

### ABSTRACT

Aotearoa New Zealand has experienced the re-emergence of COVID-19 in the community, prompting an initial 3-day shift to Level 3 restrictions for Auckland and Level 2 for the rest of the country from 23:59 on Sunday 14 February 2021. At the time of writing the country returned to these alert levels at 06:00 on Sunday 28 February, for at least 7 days, continuing the goal of eliminating the Auckland's second COVID-19 cluster since the re-emergence of COVID-19 in August 2020.

While the New Zealand Government continues its drive to eliminate COVID-19, the economic and societal impacts of lockdown are becoming apparent. The new-found sense of community experienced during the March 2020 lockdown must continue to ensure vulnerable populations are not further marginalized.

In this paper, we explore the socio-spatial distributions of COVID-19 testing and cases in NZ. We also investigate the geography of those most impacted by the prioritization of the COVID19 vaccination rollout, in addition to healthcare during lockdown and the economic realities of a new life after lockdown.

## REGIONAL PATTERNS OF WELLBEING THROUGH PANDEMIC LOCKDOWNS

[Arthur Grimes](#)

Victoria University of Wellington, New Zealand. Motu Research, New Zealand

### ABSTRACT

Several papers have tracked wellbeing patterns through lockdowns across multiple countries since the onset of COVID-19. Findings have been diverse, reflecting different lockdown experiences and differing country and societal characteristics.

Much less work, however, has examined regional patterns of wellbeing through the pandemic. New Zealand's official statistical agency (Stats NZ) has collected a range of data on wellbeing before and through the pandemic which this paper utilises.

The paper provides a (largely descriptive) analysis of wellbeing developments across 12 regions of New Zealand which vary in their degree of rurality. It focuses on four wellbeing metrics: overall life satisfaction, self-rated health, self-rated financial situation, and loneliness. The analysis relies on both temporal variation in the wellbeing metrics and on variation according to lockdown experience. The first lockdown was shared equally across all regions, but subsequent lockdowns have affected northern regions (particularly the largest city, Auckland) more than elsewhere.

The New Zealand experience of virtual elimination of the virus in the community (through the first nationwide lockdown) is unusual internationally; hence the national-level findings may not be generalisable to many other countries. The unique regional perspective provided here does, however, add a rich extra perspective on how lockdowns may affect different places within a country.

## National Session: SS31 - Regional Economic Development in Asia



Indonesian Regional  
Science Association

**09:30 - 10:45 Friday, 28th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/83755472428>**

**Chair Budy Resosudarmo**

## THE SOLOW GROWTH MODEL AND TRADE: THE LATEST EMPIRICS FOR THE WORLD AND ASEAN ECONOMIES

[Yuri Mansury](#)<sup>1</sup>, [Jingwen Li](#)<sup>2</sup>

<sup>1</sup>Illinois Institute of Technology, USA. <sup>2</sup>Cornell University, USA

### ABSTRACT

We revisit the relationship at the nexus of innovation, savings, and living standards by estimating the productivity impact of accumulation in physical and human capital. Based on the latest Penn World Table (PWT version 9.1), we found that the augmented Solow growth model remains consistent with the international variation in both the level and growth of worker productivity. While the canonical Solow model still provides a reasonable approximation, the fit with the PWT data is weaker than in previous studies that make use of older and less comprehensive datasets. Furthermore, the evidence indicates that member countries of the Association of Southeast Asian Nations (ASEAN) as a group converge at about the same rate as the rest of the world. That is, holding accumulation in physical and human capital constant, ASEAN countries grow at the rate predicted by the augmented Solow growth model. We then examine the implications of regional trading arrangements for convergence in standards of living using data assembled from the United Nations Conference on Trade and Development (UNCTAD) and the World Integrated Trade Solutions (WITS). To control for the presence of spatial effects, we adopt a spatial econometric modeling approach that incorporates both spatial lag and spatial error components. Preliminary results from spatial panel data analyses suggest that ASEAN countries tends to benefit from trading with the less developed neighbors while experiencing slower GDP growth as a result of trading with developed neighbors. Our study thus challenges the conventional wisdom touting trade with developed economies as the path to faster growth through innovation and knowledge spillovers. Furthermore, trade agreements with developed economies could actually lead to a slower growth path than a strategy that focuses on strengthening trade links with emerging, neighboring economies.

## COORDINATED DEVELOPMENT OF INDUSTRIAL STRUCTURE AND EMPLOYMENT STRUCTURE: EVIDENCE FROM QINGHAI PROVINCE, CHINA

Ma Xiao

China University of Geosciences, China

### ABSTRACT

Under the background of the digital age, how to study the coordination of industrial structure and employment structure is an important driving force to solve the problem of regional development, promote regional coordinated development and achieve sustainable development. This study selects the relevant data of industrial structure and employment structure in Qinghai Province from 1990 to 2019 as the research object, and makes a systematic analysis on the coordination of industrial structure and employment structure in Qinghai Province. Based on the Aitchison geometry and logarithmic ratio transformation of component data theory, this paper improves the existing coordination coefficient index to measure the coordination relationship between industrial structure and employment structure, puts forward the improved coordination coefficient index, and verifies the rationality of the coordination coefficient through the empirical analysis of Qinghai Province. In addition, in order to further measure the coordination degree of industrial structure and employment structure in Qinghai Province, this study takes the Moore structure value as the basic data. The method of grey relational analysis is used to calculate the lag time of employment structure. The research shows that: (1) compared with the existing coordination coefficient, the improved coordination coefficient has the advantages of theoretical and practical application. The improved coordination coefficient can measure whether the evolution direction of industrial structure and employment structure is the same or not, and can reasonably explain the change of the coordinated relationship between industrial structure and employment structure. (2) the evolution trend of industrial structure and employment structure in Qinghai Province is basically in line with the law of modern economic development. However, there is still a certain gap between the development of the ideal industrial structure and employment structure. (3) the economic development strategy has a long-lasting impact on the industrial structure and employment structure of Qinghai Province. The low quality of labor force and the low degree of labor marketization are formed in Qinghai under many factors, such as history, population, nationality, geomorphology and so on. In addition, the degree of opening to the outside world is not high, the pace of urbanization is slow, and the investment and consumption mainly depends on the transfer payment of the central government, which is also an important factor restricting the industrial structure and employment structure of Qinghai Province. It is also an important issue that we should think deeply about how to achieve regional coordinated development and sustainable development in the digital era.

## REGIONAL DISPARITIES AND HETEROGENEOUS CONVERGENCE IN INDONESIA: A MULTISCALE GEOGRAPHICALLY WEIGHTED REGRESSION APPROACH

Carlos Mendez

Nagoya University, Japan

### ABSTRACT

Large and persistent income disparities characterize the subnational regions of Indonesia. The study of regional income dynamics and convergence is important for both scholars and policymakers. Many scholars find the evolution of regional disparities in Indonesia particularly appealing due to its complex and rich geographical structure. Indonesia is the world's largest island country composed of more than seventeen thousand islands. It is also the world's fourth-most populous country with most of its population located on Java island. Indonesian policymakers are also greatly concerned with the evolution of spatial disparities. Aiming to foster regional development and inequality reduction, Indonesia has implemented large-scale decentralization reforms since the late 1990s. District-level governments now have larger political discretion and economic resources to design and implement development plans that respond to the local needs and interests of their constituents. After two decades of a decentralized government system, however, there are few studies that examine the evolution of regional disparities and convergence in Indonesia using recent methods from the spatial statistics and econometrics literature.

Motivated by this context, this paper employs a Multiscale Geographically Weighted Regression (MGWR) model to examine the spatial variation of regional income convergence across Indonesia. This new MGWR model provides a multiscale analysis of spatial heterogeneity. Given the large socioeconomic, demographic, and geographic differences across Indonesian islands, models based on spatial heterogeneity are likely to provide a more accurate and realistic assessment of a regional convergence process. Most previous studies have largely ignored the role of spatial heterogeneity. They usually report a common convergence speed for all subnational regions. In contrast, this paper departs from the assumption of a common convergence speed and aims to identify multiple spatial clusters that characterize the heterogeneity of the regional convergence process of Indonesia.

Regional studies about Indonesia are usually constrained by a modifiable areal unit problem (MAUP). Specifically, the number of districts, as well as provinces, have largely increased in the post-decentralization era. To handle this issue, most previous studies have used smaller samples based on the initial number of provinces and districts. In this paper, however, a larger sample is used based on a novel dataset that is constructed for the current number of provinces and districts. This sample covers 514 districts over the 2010-2018 period.

Preliminary results indicate that spatial heterogeneity plays a significant role in the process of regional convergence in Indonesia. Specifically, there are location-specific convergence speeds. The MGWR model also identifies significant spatial non-stationarity in both the speed of regional convergence and the determinants of regional growth. The marginal effects and spatial scale of the growth determinants clearly indicate an east-west divide in the evolution of regional disparities. Taken together, these results indicate a multi-speed convergence process that has a marked spatial distribution. These results also highlight the need to re-evaluate policies of spatial cohesion and territorial development in Indonesia.

## REGIONAL PUBLIC INFRASTRUCTURES AND DEVELOPMENT ON DECENTRALIZED INDONESIA

**Benedictus Raksaka Mahi<sup>1</sup>, Budy P. Resosudarmo<sup>2</sup>**

<sup>1</sup>Faculty of Economics and Business, University of Indonesia, Indonesia. <sup>2</sup>Arndt-Corden Department of Economics, Australian National University, Australia

### ABSTRACT

Empirical evidence on how different types of regional investment in public capital plays a role in influencing economic and social development within the context of a decentralized government system in developing country been relatively limited. Using a case study of Indonesia, this paper aims to analyse the impacts of regional infrastructures development for different types of government regional infrastructure spending, which are: (1) district/city governments' infrastructure spending, (2) provincial governments' infrastructure spending, (3) the national government's deconcentrated budget on infrastructure to district/city governments and (4) the national government's deconcentrated budget on infrastructure to provincial governments on district/city's economic and social development. Such disaggregation is a unique feature of this paper. The main conclusion obtained is that, compared to district/city governments, provincial governments seem to be better at allocating their infrastructure spending and utilizing national government infrastructure spending deconcentrated to them to induce regional economic and social development in their regions.

## **National Session: SS51.4 - Sustainable Regional Development in China**



**09:30 - 10:45 Friday, 28th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/85127009544>**

**Chair Lily Kiminami**

## CAN CARBON EMISSION TRADING MARKET INTEGRATION RESHAPE ECONOMIC GEOGRAPHY OF CHINA?

Ling Xue, Xiaolin Zhang, Tianjiao Zhang

Peking University, China

### ABSTRACT

The emergence of emission trading system is expected to improve low carbon development, but its design and effect on economic agents should be analyzed carefully by policy makers. As carbon trading in China is about to commence, the effect of carbon market integration on China's industrial relocation and economic geography calls for theoretical research. Combining "new" new economic geography (NNEG) and agent-based Modeling (ABM), this paper incorporated production and location decision-making of heterogeneous companies, as well as carbon emission trading, into a dual-region economic geography model on a computational platform based on agent. The paper set different policy scenarios to discuss the dynamic effects of carbon quota constraint, carbon trading and carbon quota allocation on location decision-making, efficiency, regional development equality and trading vitality in the context of carbon market integration. Results showed: 1) without carbon emission trading or carbon quota allocation favoring the western China, carbon emission reduction policy (carbon quota) doesn't necessarily alter firm location choices, but may increase efficiency of firms through competition; 2) without carbon emission trading, carbon quota allocation favoring the western China may influence firm location choices, bridging the gap between the western and the eastern, but the effect gets weaker when tighter carbon constraint; 3) with both carbon emission trading and carbon quota allocation favoring the western China, firms agglomerate in the eastern China, increasing social welfare with marginal costs decreased and firm number increased; 4) the allocation of carbon quota determines vitality of trading activity, and firm heterogeneity should be taken into account. These results contribute to literature in spatial economics, ABM and carbon market integration in China. The related methodological issue such as integrating spatial economic model with agent-based simulation as well as empirical analysis and econometric test is also discussed. The paper innovatively combines ABM and NNEG and may set a paradigm for future work in micro level ex ante research on the nexus between economic geography and carbon emission policies.

## DEPICTING THE BLURRED REGIONAL BOUNDARIES IN CHINA USING INDIVIDUAL MOBILITY DATA

[Hongmou Zhang](#)<sup>1</sup>, [Liu Liu](#)<sup>2</sup>

<sup>1</sup>School of Government, Peking University, China. <sup>2</sup>CitoryTech, China

### ABSTRACT

Delineating the boundary or impact area of an economic, cultural, or life-style region has been a long-lasting problem in regional studies. The fundamental difficulty lies in the exact definition of a region, and what criteria need to be considered. Existing methods either use the strength of macro-level connections to evaluate the affiliation of a city to a region, e.g., the proportion of commuters in between, or use network science methods to “cluster” cities into regions. However, both types of methods only give static and definitive results but ignore the dynamism and graduality between regions—it could be debatable to include the so-called periphery cities to either side of the regional boundary. In this paper, we propose a Singular Value Decomposition (SVD)-based method to depict the impact areas of regions in China using individual-level connections among cities. Using the individual mobility data from a mobile map service, we decompose the mobility patterns of China into a series of eigen-mobility patterns—each corresponds to the impact area of a city, or a mobility-based region. The overlay of multiple eigen-mobility patterns depicts the “blurred” boundary between the respective regions—or their competing hinterlands. With the blurred mobility region boundaries as an example, we hope the method could be used to help understand the complexity of drawing regional boundaries and help policy makers to identify the non-confined but blurred economic and cultural landscape of various contexts in regional governance.

## RESEARCH ON THE ASSESSMENT OF CITIES' ADAPTATION TO CLIMATE CHANGE AND ITS RELATIONSHIP WITH URBANIZATION IN CHINA

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### ABSTRACT

With the aggravation of climate change, extreme climate events occur frequently in urban areas, resulting in great loss of human life and property. Therefore it is urgent to enhance the cities' adaptation to climate change. Focusing on the impact of high temperature, low temperature, drought, and flood, multi-dimensional assessment systems covering natural, economic, social elements for cities' climate change adaptation are established. Based on the assessment systems, the studies of adaptation to climate change are conducted in 248 cities in China with using entropy weight method, coefficient of variation method, exploratory spatial data analysis. And with the help of geographically weighted regression (GWR), the relationships among the four types of urbanization and cities' adaptation to climate events are explored. The results showed: (1) High-administrative-level cities have stronger adaptation, lower vulnerability and higher readiness than ordinary-prefecture-level cities. (2) The differences of adaptation to the four types of climate events among cities within each of the seven regions in China present different spatial patterns. The gaps of adaptation among cities within Southern China and Southwestern China are very prominent. (3) Compared with Southern China, Northern China has a wider advantage in adapting to climate change and climate events, and the gap among different regions in adapting to low temperature is relatively small, while there is a significant adaptation gap in coping with high temperature. The key to improving balanced adaptation to climate change in all regions of China lies in narrowing the gap of adaptation to high temperature. (4) The adaptation to high temperature and flood are characteristic of high-in-north and low-in-south. Cities with high adaptation to low temperature mainly belong to high-administrative-level, forming a high-low agglomeration area centered on cities of this level, and cities with low adaptation to low temperature are mainly distributed in Southwestern China, Central China and Huaihe River Basin. Cities' adaptation to drought shows a significant trend of decreasing from southeast to northwest, with high adaptation cities mainly concentrated in Jiangsu, Zhejiang, Anhui and Pearl River Delta, while adaptation in Northwestern China is generally low and shows the characteristics of low-low agglomeration. (5) Under the four types of climate events, the global spatial correlations of cities' adaptation in China are positive, and the agglomeration characteristics of adaptation are mainly H-H and L-L agglomerations. (6) When analyzing the impacts of four types of urbanization on cities' adaptation to climate events, the fitting effects of GWR models are far better than those of OLS models. Population urbanization affects cities' adaptation to four types of climate events, economic urbanization on low temperature, drought and flood, industrial urbanization on drought, and land urbanization on flood. Population, economic and industrial urbanization have positive impacts on adaptation of most cities. Population urbanization can improve adaptation of all cities to high temperature, while land urbanization hinders adaptation of most cities to flood. Under the influence of social and economic development, the urbanization regression coefficients of different cities have significant spatial differences.

### KEYWORDS

Adaptation; assessment system; climate change; GWR model; urbanization

### 1. INTRODUCTION

Since the Industrial Revolution, the amount of GHGs in the atmosphere has been rising, and the global climate is now changing at an unprecedented rate. According to the IPCC Fifth Assessment Report (IPCC 2013), the global average land and ocean surface temperature increased by 0.85°C from 1880 to 2012, and climate warming has caused glacial retreat, sea level rise, ocean acidification, imbalance of water resources distribution, and serious negative effects on natural ecosystems and biodiversity; meanwhile, with the increasing frequency, impact scope and damage degree of extreme weather events, people's lives and property have suffered heavy losses, and the sustainable development of the socio-economic system is also facing serious challenges. Cities, as the main gathering place for human activities, occupy just 2% of the Earth's land, but account for more than 60% of energy consumption and 75% of carbon emissions (Akbari et al., 2016). As regions with high risk of global climate change disasters, cities have also become the main battlefield of human response to climate change, which need to be paid more attention to.

In terms of coping with climate change, the formulation of countermeasures has changed from prevention and mitigation in the 1970s and mitigation in the 1980s to adaptation, which is widely accepted today (Chen, 2004). Adaptation, which

first originated in the field of ecology, is now widely used in climate research and has become one of the core concepts of global change science. In the field of climate change, different scholars have different conceptualizations or definitions of adaptation according to their own academic background or research objects (Smith et al., 1996; Roger et al., 1998; Doria et al., 2009; O'Brien et al., 2012), but all of them emphasize the adjustment of systems to reduce vulnerability and enhance coping capacity in the face of adverse climate change impacts. Research on adaptation to climate change is diverse, but mainly focuses on two aspects: **(1) Policy formulation and framework design.** Based on the evaluation of the effectiveness and benefit of the adaptation measures of related projects, UNDP has designed a comprehensive monitoring and evaluation framework for climate change adaptation, which is suitable for research at various scales (UNDP 2007); Brink et al. (2016) proposed an analytical framework of urban ecosystem adaptation based on the relationship among climate change adaptation, ecosystem services and sustainability theories; Kuang et al. (2018) proposed a decision-making assessment tool for climate change impacts by discussing the framework of adaptation assessment and management of international rivers under climate change; Aguiar et al. (2018) investigated 147 local adaptation policies in Europe, and found that the main obstacles that needed to be overcome to promote the formulation and implementation of climate adaptation plans are insufficient resources, lack of capacity, unreliable commitments and uncertain risks. **(2) Quantitative analysis of adaptation.** Araya-Munoz et al. (2016) constructed an indicators system from three aspects of awareness, capacity and action to evaluate the adaptation to climate change in the Concepcion metropolitan area in Chile and found that the adaptability of all cities had improved significantly from 1992 to 2002, but the relative differences among cities had not changed significantly; Zhao et al. (2020) combined the SPRR model and the IPCC assessment framework to establish an exposure-sensitivity-resilience indicators system and evaluated the adaptation capacity of 12 urban agglomerations in China by using set-pair analysis, and found that adaptation capacity level of different regions varied greatly, and the level of economic development played a key role; Bachner et al. (2019) proposed a general modeling framework to comprehensively analyze how public adaptation to climate change affects the federal budget, and found that it could have substantial positive macroeconomic effects on GDP, welfare and employment; R et al. (2020) conducted a cost-benefit analysis of the proposed climate change adaptation measures in Bosnia and Herzegovina, and explored their feasibility; Huang-Lachmann et al. (2018) conducted an empirical study on 63 cities through multi factor analysis and logistic regression model, which showed that the climate change adaptation plan had a positive impact on the economic opportunities of cities.

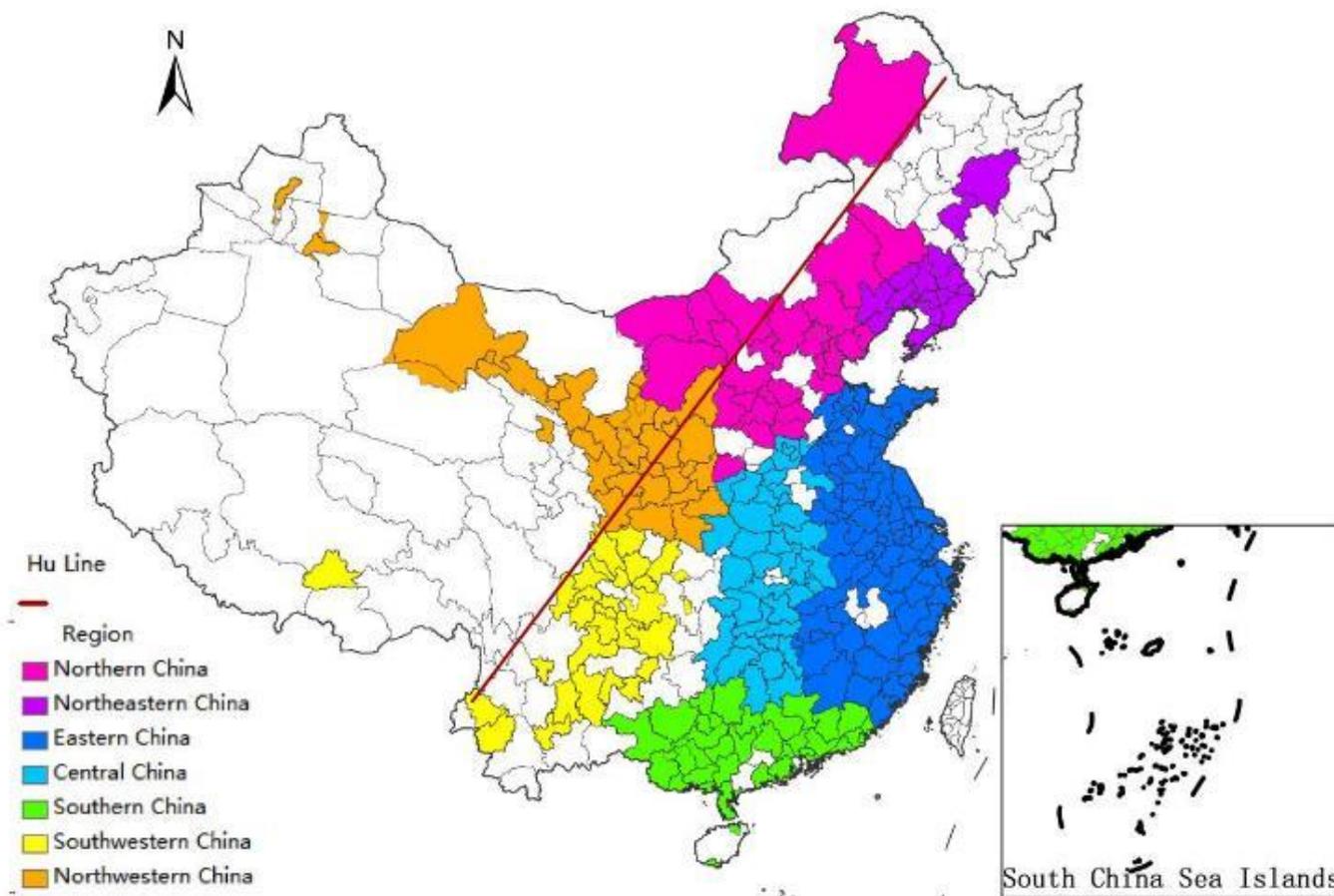
Under the background of human sustainable development, the close relationship between climate change and urbanization has been widely concerned. Many studies (Liddle 2013; Wang et al., 2016; Lu 2017; Nyangena et al., 2019; Zhou et al., 2021) have shown that, in the process of urbanization, the rising energy consumption and land use changes increase GHGs emissions, and then exacerbate climate change. There are also studies focusing on the relationship between urbanization and climate change vulnerability (Romero-Lankao and Dodman, 2011; Mutizwamangiza et al., 2011; Friend and Macclune, 2013; He et al., 2019). For example, the SREX report (Murray and Ebi, 2012) finds with high confidence that urbanization along with settlement patterns and changes in socio-economic conditions have all influenced observed trends in risk and vulnerability to climate extremes. Nowadays, the mainstream perspective in the literature tends to focus on urbanization as a driver of climate change and urban vulnerability, and few studies have explored the relationship between urbanization and climate change adaptation. In fact, urbanization is likely to have both positive and negative consequences for overall adaptive capacity of cities and regions (Agrawala et al., 2007). Applying the urban environment transitional model, researchers found that although wealthy cities in the Global North generate large amounts of GHGs emissions, urbanization and urban economic growth have made them rich enough to develop adaptive systems to counteract the adverse affects of climate change (Mcgranahan and Songsore, 1994; Jacobi et al., 2010). Urbanization can also offer opportunities for disaster risk management, which can be the main driving force to enhance the ability to cope with climate change (Garschagen and Romero-Lankao, 2015). In view of these facts, it is very necessary to further explore the relationship between urbanization and adaptation to climate change.

In general, there are still relatively few studies on the assessment of urban adaptation to climate change. The existing literature on climate system change and its indicators selection is relatively single and simple, with limited coverage. In addition, the mechanism of urbanization affecting climate change adaptation is not fully explored. As one of the most vulnerable countries to climate change and extreme events in the world, China has a large number of cities with different geographical conditions and climate backgrounds, and therefore these cities differ in types and occurrence probabilities of climate events they face. Meanwhile, since the implementation of the economic reform in late 1978, China has experienced rapid economic growth and urbanization (Wang 2014; Li and Lin, 2015), and there are great disparities in the urbanization process among China's cities, which make the mechanism and impact degree of urban adaptation to climate change different. Therefore, it is necessary to evaluate cities' adaptation to various specific climate events, and analyze the driving force of adaptation from the perspective of urbanization. Focusing on the four most common climate events including high temperature, low temperature, drought and flood in China, this paper constructs comprehensive assessment systems covering natural, economic and social factors to carry out the assessment of cities' adaptation to climate change, and discusses the spatial patterns of and impact factors (four urbanization types) on adaptation. The research results have certain guiding significance and reference value for the development of climate change adaptation assessment methods in cities and the formulation of adaptation policies tailored to local conditions.

## 2. DATA AND METHODS

### 2.1 Study area and data sources

In this study, we chose 248 cities in China as the research objects: 4 municipalities, 5 state-plan cities, 27 provincial capital cities and 212 ordinary prefecture-level cities. Cities in Hong Kong, Macau and Taiwan were excluded from this study due to the limitation of data availability. As shown in **Figure 1**, these cities are distributed in seven major regions of China, with the total population and GDP accounting for 83.30% and 92.92% of the whole country respectively. And they have differences in social, economic, cultural and climate conditions with the average population ranging from 0.25 to 30.75 million. Therefore, the exploration results of these cities can basically represent the overall pattern of the whole country.



**Figure 1** Regional distributions of 248 Chinese cities

The population, economic and social data (infrastructures, patents, etc.) involved in this study were mainly obtained from the Sixth Population Census of various cities, China City Statistical Yearbook 2018, China Real Estate Information and Everbright Securities Research Report; the meteorological data were derived from China Meteorological Data Service Centre, which was obtained by spatial interpolation of meteorological station observation data. For some missing parts of the data, statistical methods such as data fitting and forecasting were used or searching through the Internet to supplement them. For details, see **Appendix Table 1**.

### 2.2 The framework

The purpose of this study is to conduct a comprehensive assessment of cities' adaptation to climate change, find out the differences of adaptation in different cities and regions, and explore the impacts of urbanization on adaptation. Based on the previous literature research, combined with the actual situation in China, this paper constructs indicators systems, collects and standardizes the data required for each dimension, determines the weight of each indicator by entropy weight method, calculates the values of cities' adaptation to climate change by weighted comprehensive evaluation method, classifies the cities and analyzes the spatial distribution features of adaptation based on spatial econometric approaches, and finally explores the role of urbanization in cities' adaptation to climate change by GWR model. Based on the research ideas depicted in **Figure 2**, the main research methods of each step are introduced below.

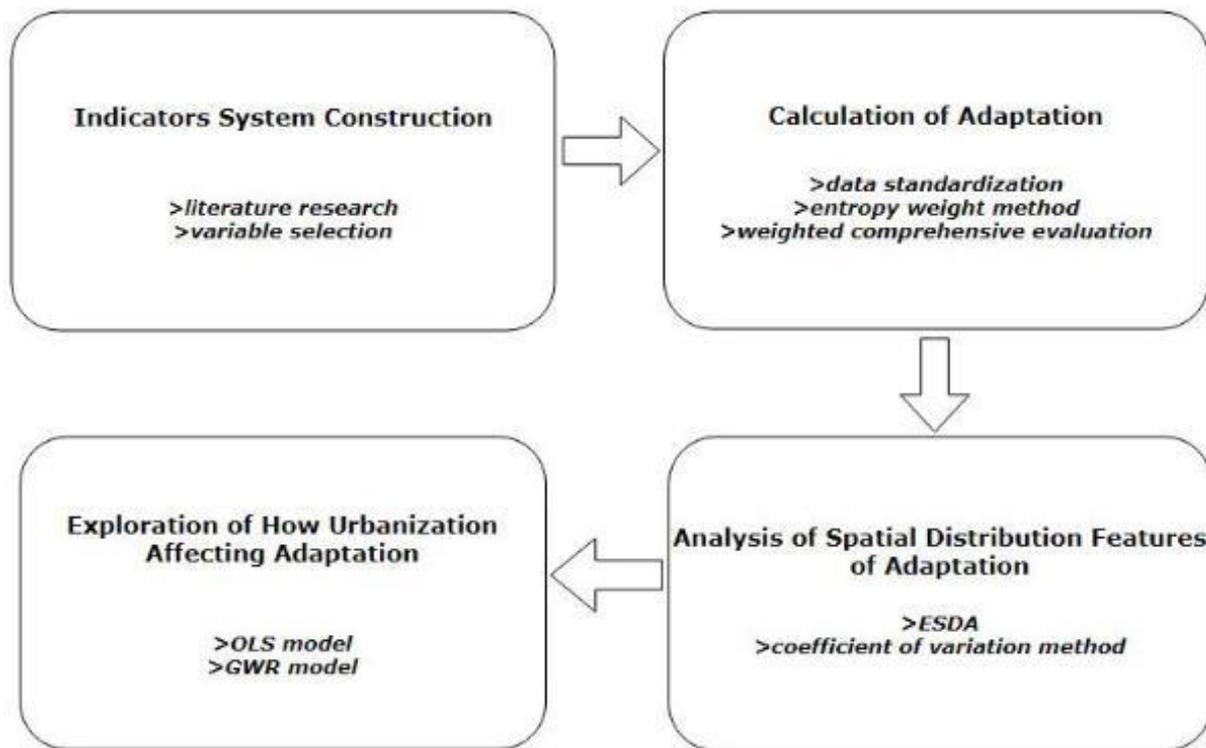


Figure 2 Research ideas and technical routes

### 2.3 The assessment indicators system

Referring to the climate adaptation assessment framework(ND-GAIN 2018; Chen et al., 2015a) established by the Notre Dame Global Adaptation Initiative (ND-GAIN) and considering the actual situation in China and the availability of data, three-level structural assessment indicators systems for cities' adaptation to high temperature, low temperature, drought and flood were constructed in this paper. ND-GAIN climate adaptation assessment indicators system consists of two dimensions: vulnerability assessment and readiness assessment. Compared with IPCC's indicators system(IPCC 2014), ND-GAIN adds readiness assessment, which can make the system more comprehensively reflect cities' adaptation characteristics, and the framework is now widely used in adaptation studies(Nagy et al., 2018; Aydin et al., 2021;Tan and Ho, 2020).

Vulnerability reflects the sensitive reaction and self-recovery ability of the research object to the disturbance of climate events in a specific space-time environment, which is composed by exposure, sensitivity and adaptive capacity; readiness, which is composed of social readiness, governance readiness and economic readiness, reflects the defense characteristics of the research object to the disturbance of climate events in a complex society-economy system and the capacity of to mobilize adaptation investments from private sectors, and to target investments more effectively. The adaptation indicators under different climate events are different to reflect the impact characteristics of each event, as shown in Appendix Figure 1.

### 2.4 Entropy weight method

The key step of assessing cities' adaptation to climate change is to determine the weight of indicators. As an objective assignment method, the entropy weight method is more scientific and reliable than subjective methods, which determines the weight of each indicator according to the difference of data disorder degree. If the indicator information entropy is smaller, it means that the indicator has higher disorder degree and greater range of change, so it has a greater impact on the comprehensive assessment. See (Liu et al., 2021) for the specific calculation formula.

After calculating the weight $w_j$ of each indicator using entropy weight method, the adaptation assessment model is constructed based on weighted comprehensive evaluation method commonly used in multiple indicators assessment, and the degree of adaptation is expressed by the adaptation score. The specific assessment model is:

$$Ai = \sum_j^n w_j Y_{ij} \tag{6}$$

where $Ai$ is the adaptation score of city  $i$ . The calculation methods of vulnerability $VI$ and readiness $RI$ are the same as that of adaptation, but the indicators sets are different.

### 2.5 Coefficient of variation method

Coefficient of variation can objectively reflect the degree of difference within a set of data, and avoid the deviation effect of absolute difference. Compared with range, variance, standard deviation and other statistical indicators, it has the advantage of more accurately reflecting the degree of data dispersion. From the regional perspective, this paper will use the coefficient of variation to explore the unbalanced state of the internal adaptation differences in each region. The calculation formula is:

$$CV_i = \frac{1}{\bar{x}_i} \sqrt{\frac{1}{n-1} \sum_{j=1}^n (x_{ij} - \bar{x}_i)^2} \tag{7}$$

where  $CV_i$  is the coefficient of variation of region  $i$ ;  $n_i$  is the number of research units in region  $i$ ;  $x_{ij}$  is the adaptation value of the  $j$  research unit in region  $i$ ;  $\bar{x}_i$  is the average value of all research units in region  $i$ .

### 2.6 Exploratory spatial data analysis

Exploratory spatial data analysis (ESDA) is the collection of a series of spatial data analysis methods and techniques, with the measurement of spatial association as the core, through description and visualization of the spatial distribution pattern of things or phenomena, to discover spatial agglomeration and anomalies, so as to reveal the mechanism of spatial interactions among research objects. The common methods are Moran I index and Moran scatter plot.

Moran I index ranges from  $-1$  to  $1$ . A value greater than  $0$  indicates spatial positive correlation and the larger the value is, the stronger the spatial aggregation will be. By contrast, a value less than  $0$  is a spatial negative correlation and the smaller the value is, the stronger the spatial difference will be. A value equal to  $0$  is irrelevant, that is, the spatial units are randomly distributed. See (Moran and Ap, 1950) for the specific calculation. Moran scatter plot can further explore the differences in adaptation to climate change among cities from a spatial perspective, which is divided into four quadrants corresponding to four types of local spatial association between a city and its cities: H-H (Quadrant I in the upper right) indicates a city with a high value surrounded by cities with high values; L-H (Quadrant II in the upper left) indicates a city with a low value surrounded by cities with high values; L-L (Quadrant III in the lower left) indicates a city with a low value surrounded by cities with low values; H-L (Quadrant IV in the lower right) indicates a city with a high value surrounded by cities with low values. H-H and L-L (resp. LH and HL) refer to positive (resp. negative) spatial autocorrelation, which indicate spatial clustering of similar (resp. dissimilar) values.

### 2.7 Geographically weighted regression model

In contemporary research, regression analysis is often used to explain the influencing factors. Geographically weighted regression model (GWR) is an extended local regression model based on the classical multiple linear regression model (OLS), which considers the spatial characteristics of observation indicators, and can explore the non-stationarity of spatial relations according to the change of parameter estimation values with geographical location, and explore the spatial differentiation characteristics of the influence of various factors on explanatory variables in the study area. By using this method, the results are more realistic and accurate. The model can be shown as:

$$y_i = \beta_0(u_i, v_i) + \sum_k \beta_k(u_i, v_i) x_{ik} + \varepsilon_i \tag{8}$$

where  $y_i$  are the dependent variables;  $x_{ik}$  are the independent variables;  $(u_i, v_i)$  is the geographic coordinate of sample spatial unit  $i$ ;  $\beta_0(u_i, v_i)$  are the intercept terms;  $\beta_k(u_i, v_i)$  are the regression coefficients;  $k$  is the number of independent variables;  $\varepsilon_i$  are the error terms.

## 3 SPATIAL PATTERN ANALYSIS OF ADAPTATION

### 3.1 Perspective of cities administrative level

Based on the calculation results of adaptation to climate change of 248 cities, it is found that the average adaptation scores of each type of climate events in high-administrative-level (HAL) cities (municipalities, state-plan cities, provincial capital cities) are higher than those of ordinary-prefecture-level (OPL) cities, and the average vulnerability scores are lower and the average readiness scores are higher, as shown in **Table 1**. In fact, high-administrative-level cities are more advantageous in adapting to climate change because of their advanced economic development level, superior social security system and mature governance institution. Besides, when setting up high-administrative-level cities, China fully takes into account the climatic conditions, resource endowments and location conditions of the candidate cities, and the cities with lower risk of being affected by disasters are more likely to be selected. In addition to the ability to attract large amounts of investment and financing in the field of climate, these cities are more likely to be favored by national policies and financial support.

**Table 1** AI, VI and RI scores of HAL cities and OPL cities

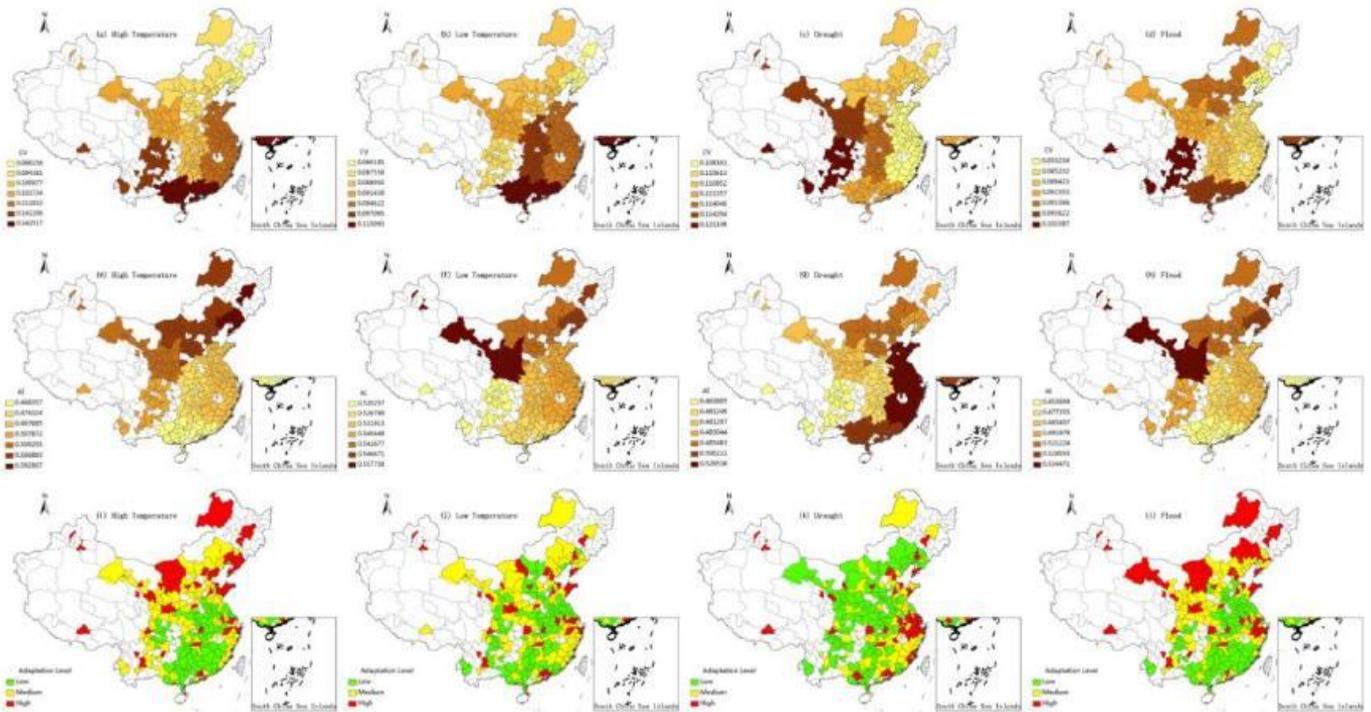
Climate events	AI		VI		RI	
	HAL cities	OPL cities	HAL cities	OPL cities	HAL cities	OPL cities
High Temperature	0.6015	0.5009	0.4008	0.3522	0.2007	0.1488
Low Temperature	0.6141	0.5254	0.4131	0.3766	0.2010	0.1488
Drought	0.5829	0.4825	0.3294	0.2950	0.2535	0.1876
Flood	0.5558	0.4847	0.3753	0.3508	0.1805	0.1339

**Note:** The greater VI indicates the lower vulnerability.

### 3.2 Perspective of regions

According to the coefficient of variation formula, the degree of difference of adaptation to climate change within each of the seven major regions of China was calculated, as shown in **sub-figures (a)-(d) of Figure 3**. As can be seen from the figure, the high temperature (low temperature) adaptation gap between cities shows an overall decreasing spatial pattern from south to north. The coefficients of variation for high and low temperature adaptation in Southern China are the largest, reaching  $0.142517$  and  $0.115093$ , respectively, indicating that there is a large difference in high temperature

(low temperature) adaptation among cities within the region, and the adaptation ability is extremely uneven. Comparatively speaking, the internal differences in Northeastern China are the smallest, showing a good and balanced adaptation ability. The overall spatial pattern of drought adaptation gap among cities decreases from west to east, with the largest coefficient of variation in Southwestern China and the smallest in Eastern China, but the differences in coefficients of variation among regions are not significant, indicating that the adaptation gap among cities within each of the regions shows a similar pattern. And the coefficient of variation of adaptation to flood is still the largest in Southwestern China and the smallest in Northeastern China. Comparing the four sub-figures, Southern China and Southwestern China need to be focused on: cities within the former face uneven adaptation to high temperature, low temperature, and flood, and cities within the latter face uneven adaptation to high temperature, drought, and flood, indicating that the adaptation gaps of cities within each of the two regions are very significant. The high-adaptation cities should provide technology, experience and knowledge of adaptation to low-adaptation cities. Meanwhile, higher-level administrative units should strengthen financial and policy support to cities with low adaptation to enhance their readiness.



**Figure 3 Spatial pattern of adaptation from the regions and cities perspectives**

The coefficient of variation only reflects the gaps among cities within each of the regions. Besides, the adaptation gaps among regions are also worth exploring. The average adaptation scores of cities covered by each region are used to represent the regional score, as shown in **sub-figures (e)-(h) of Figure 3**. It can be found that the scores of adaptation to high temperature, low temperature and flood in Northern China, Northeastern China and Northwestern China are always ranked in the top three of the seven regions, and the scores of adaptation to low temperature and flood in Northwestern China are the highest, and the top two regions of adapting to drought are Eastern China and Southern China; the scores of adaptation to high temperature and flood are the lowest in Southern China, and the scores of adaptation to low temperature and drought are the lowest in Southwestern China. To some extent, it suggests that the north has a broader advantage in adapting to climate change and climate events compared to the southern regions of China. Meanwhile, the scores range of adaptation to climate events in seven major regions are: high temperature 0.1245, low temperature 0.0375, drought 0.0657, and flood 0.0808. The range of adaptation to high temperature is 3.32 times of that of low temperature, which indicates that there is a small gap in adaptation to low temperature among regions, but there is a significant gap in high temperature. The key to promoting balanced adaptation to climate change in all regions of China lies in narrowing the gap of adaptation to high temperature.

### 3.3 Spatial distribution pattern at cities level

Adaptation analysis from the regional perspective only reflects the macro spatial distribution pattern. In order to more accurately explore the characteristics of cities' adaptation and carry out climate policies based on cities' conditions, it is very necessary to conduct analysis and discussion at the cities level, as shown in **sub-figures (i)-(l) of Figure 3**.

**High temperature.** The overall pattern can be described high in the north and low in the south. High-level cities are mainly concentrated in the three northeastern provinces (Heilongjiang, Jilin, and Liaoning), Inner Mongolia, Shandong and Beijing-Tianjin-Hebei region. Medium-level cities are mainly distributed in Eastern China, Southwestern China and the vast areas north of Huaihe River-Qinling Mountain Line. In addition, some cities in southern Shaanxi near Huaihe River-Qinling Mountain Line and some in Hunan and Hubei are also in this level. Low-level cities are mainly located in

Guangdong, Guangxi, Sichuan, Chongqing, Henan and Eastern China region. In addition, it can be observed from the figure that the vast majority of coastal cities are in medium and high level of adaptation.

**Low temperature.** Most of high-level cities are high-administrative-level, which are widely distributed, but scattered in spots. Both medium-level and low-level cities form a relatively obvious agglomeration. The former mainly located in Eastern China, Northwestern China, the three northeastern provinces and Inner Mongolia, which is due to the improvement of adaptation ability to low temperature by heating in winter in these areas. Relatively speaking, cities located in Southwestern China, Huaihe River Basin and Central China are less adaptable.

**Drought.** Cities' adaptation shows an obvious decreasing trend from southeast to northwest, forming a significant agglomeration characteristics. Jiangsu-Zhejiang-Anhui region and Pearl River Delta region present two high-level clusters. In addition, Fuzhou, Quanzhou and Xiamen in Fujian province are also cities of high-level adaptation to drought. And the medium-level cities are mainly concentrated in the southeast coastal areas and Pearl River Basin. The majority of cities located in China's Second Ladder show low adaptation characteristics to drought, especially the Northwestern China has the significant agglomeration characteristics.

**Flood.** The spatial clustering characteristics of adaptation to flood are also very prominent, especially in Pearl River Basin, Huaihe River Basin, Hunan and Jiangxi, where the large hydrographic networks, copious rainfall and low-lying flat terrain make them face greater risks. From south to north, the adaptation gradually increases, and the cities with high adaptation ability are mainly distributed in Inner Mongolia, the three northeast provinces and the northwest area of Gansu province.

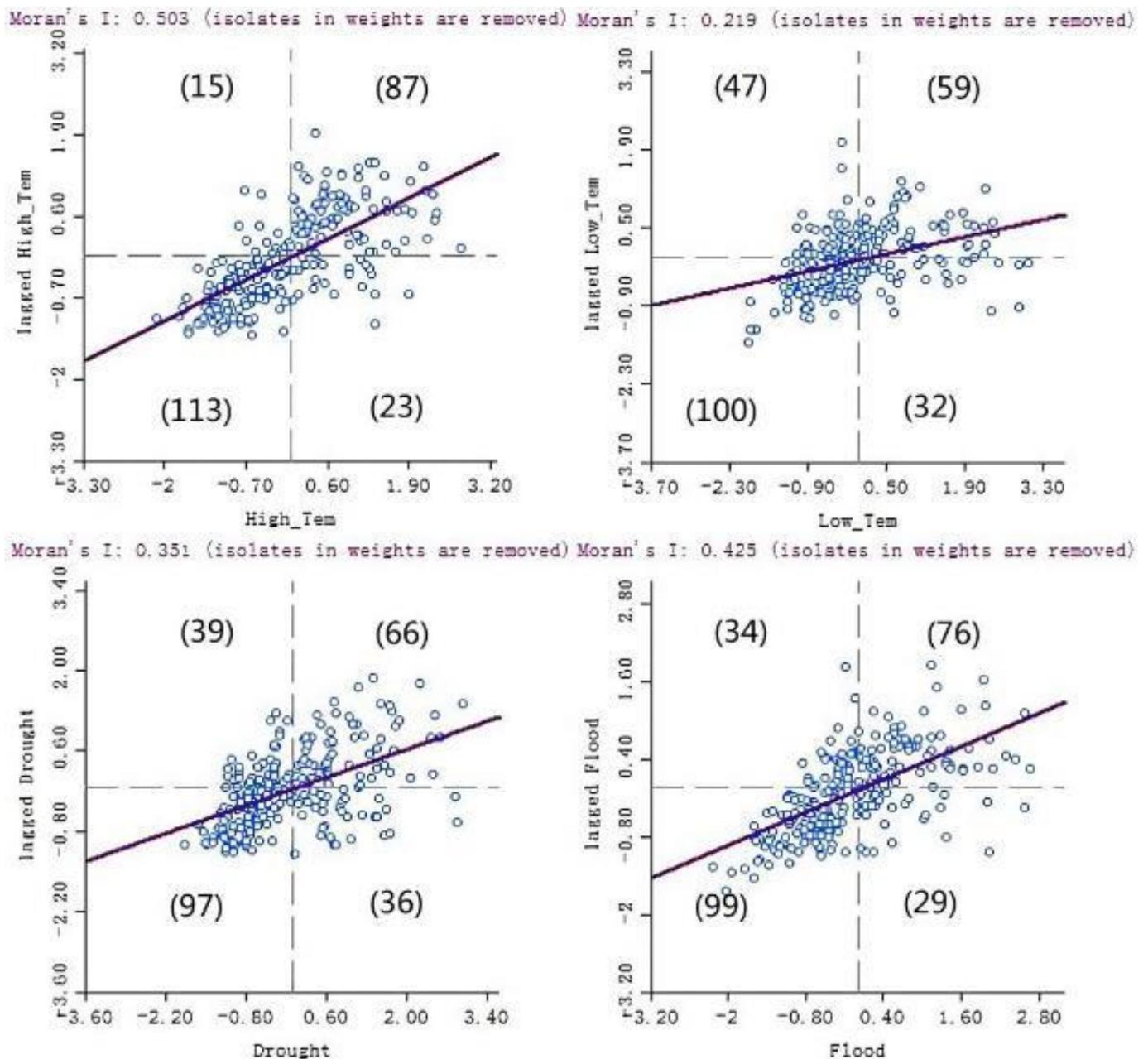
Besides, as shown in **Table 2**, there are 50 cities with low adaptation under the four types of climate events, which indicates that these cities are facing greater climate risks, and it is urgent to carry out research and development, integration and promotion of adaptation technology, so as to effectively improve their adaptation level. These cities account for 20.16% of the study sample, covering a population of 230.901 million, mainly distributed in the southern region of China. Hunan, Hubei, Anhui, Henan, Guangdong, Sichuan and Guangxi contain a large number of the above-mentioned cities, affecting more than 20 million people respectively, which should be paid more attention to. To advance the construction of adaptation ability to a higher level, it is extremely necessary to coordinate the work of adaptation to climate change, strengthen communication and exchanges, deepen cooperation actively among cities.

**Table 2 List of cities with low adaptation under four types of climate events**

Provinces	Cities	Total population(million)
Jiangsu	Yancheng	7.2422
Shandong	Heze	8.7360
Jiangxi	Pingxiang, Ji'an	6.8669
Hunan	Hengyang, Shaoyang, Yongzhou, Loudi	23.9780
Hubei	Ezhou, Xiaogan, Jingzhou, Huanggang, Xianning, Suizhou	22.7202
Anhui	Huainan, Huaibei, Anqing, Chuzhou, Fuyang, Suzhou, Bozhou	33.3530
Henan	Pingdingshan, Puyang, Luohe, Nanyang, Shangqiu, Xinyang, Zhumadian	42.0900
Guangdong	Shaoguan, Shantou, Zhanjiang, Meizhou, Shanwei, Chaozhou, Jieyang	32.0568
Sichuan	Zigong, Luzhou, Suining, Neijiang, Nanchong, Guang'an, Dazhou	29.5659
Guangxi	Fangchenggang, Qinzhou, Guigang, Yulin, Hezhou, Hechi, Laibin, Chongzuo	24.2920

### 3.4 Spatial correlation features

By using GeoDA software, the values of Moran I index of cities' adaptation to four types of climate events were calculated , as shown in **Figure 4**. It can be seen from the figure that the values are all greater than 0, respectively: high temperature 0.503, low temperature 0.219, drought 0.351 and flood 0.425, all of which are positively correlated in space. In order to enhance the robustness of the results, the Moran I values were tested by Monte Carlo simulation, and the P values are all significant at 0.01 level, indicating that the spatial agglomerations of adaptation are significant. That's to say, cities with higher adaptation to climate change have a positive impact on the improvement of adaptation of neighboring cities, and vice versa. Meanwhile, according to Moran I values, it can be found that there are differences in the agglomeration characteristics of cities' adaptation to the four types of climate events. For high temperature, the spatial positive correlation is the most significant and the degree of spatial agglomeration is the highest, followed by flood, and the positive correlation of low temperature is the weakest. The cities' adaptation to climate change in China shows four spatial patterns of H-H, L-H, L-L and H-L, and the distribution quadrants of these cities are also shown in the figure. In general, these cities are mainly distributed in the first and third quadrants under all four types of climate events, indicating that the agglomeration characteristics of adaptation are mainly H-H and L-L agglomerations, which further validates the conclusion that the global spatial correlations are positive. In addition, it can be found that most of the cities in Yangtze River Delta region are located in the first quadrant (H-H). The geographical location of this region is superior, the degree of economic integration is very high, and the development of cities in the region is fully coordinated and integrated. Therefore, the cities in the fourth quadrant (H-L) have strong adaptation to climate change, and the adaptation gap is small. And most of the cities in the fourth quadrant (H-L) are high-administrative-level cities, which indicates that these cities have stronger social, economic and governance capabilities than surrounding cities, and have more significant advantages in coping with climate events.



**Figure 4 Spatial correlation features of adaptation**

**Note:** 10 cities were removed due to the non-existence of adjacent samples, but this does not affect the reliability of the conclusions.

The above analysis shows that it is meaningful to explore the characteristics of adaptation differences and the underlying reasons from the spatial perspective, and it also paves the way for later analysis of the impact factors on cities' adaptation to climate change in China by using spatial econometric methods to construct models.

#### 4. ANALYSIS ON HOW URBANIZATION AFFECTING ADAPTATION

##### 4.1 Variables selection

Based on the interpretation and summary of the connotation of urbanization by existing literatures (Shi et al., 2013; Zhu et al., 2017; Zhu et al., 2019; Chen et al., 2015b) and considering the availability and scientificity of data, this paper selects independent variables from four aspects of population urbanization (PU), economic urbanization (EU), land urbanization (LU) and industrial urbanization (IU) to explore the impact factors on spatial differentiation of cities' adaptation to climate change in China, which are expressed by the four indicators: the proportion of urban residents, per capita disposable income of urban residents, the ratio of urban built up area to total city area, and the proportion of secondary and tertiary industries, respectively.

One of the prerequisites for multiple regression is that there is no multicollinearity among independent variables. In the regression analysis, after standardizing the four indicators, the variance inflation factor (VIF) method was used to diagnose the existence of multicollinearity. The regression results in **Table 3** show that the VIF values of all indicators are less than 3 indicating that there is no multicollinearity or very weak covariance among independent variables (Zuur et al., 2010), which meets the basic requirements of regression analysis.

**Table 3 Multicollinearity test of influencing factors on adaptation**

Impact factors	Selected variables	Collinearity statistics	
		Tolerance	VIF
population urbanization (PU)	the proportion of urban residents	0.345	2.896
economic urbanization (EU)	per capita disposable income of urban residents	0.462	2.164
land urbanization (LU)	the ratio of urban built up area to total city area	0.648	1.544
industrial urbanization (IU)	the proportion of secondary and tertiary industries	0.436	2.292

**4.2 Analysis of regression results**

With adaptation scores of all cities under four types of climate events as dependent variables and four indicators as independent variables, the OLS stepwise regression analysis was conducted. The regression results show that at the 1% significance level, only the proportion of urban residents is included in high temperature OLS model; the proportion of urban residents and per capita disposable income of urban residents are included in low temperature OLS model; the proportion of urban residents, per capita disposable income of urban residents and the proportion of secondary and tertiary industries are included in drought OLS model; the proportion of urban residents, per capita disposable income of urban residents and the ratio of urban built up area to total city area are included in flood OLS model. In the above OLS models, all included independent variables have positive coefficients except for the ratio of urban built up area to total city area, indicating that all the three variables contribute positively to cities' adaptation to climate events.

However, from the previous spatial autocorrelation analysis, it can be seen that the spatial distribution pattern of adaptation is not completely random, but shows significant characteristics of spatial agglomeration and heterogeneity, which shows that cities' adaptation no longer meets the assumption that samples must be independent of each other required by OLS model. In other words, the results and inferences estimated by the classical linear regression model are likely to be less reliable, and it must be modified by introducing spatial factors (spatial differences and dependencies). Therefore, on the basis of OLS model, the component (coordinates) reflecting heterogeneity were included, and the GWR models were used for regression analysis. The results of OLS and GWR models were compared in **Table 4**, and the regression parameters of GWR model were statistically described in **Table 5**

It can be seen from **Table 4** that adjusted goodness-of-fit indexes ( $R_{adj}^2$ ) of GWR models for four types of climate events are 0.744, 0.695, 0.680 and 0.733 respectively, which are greater than the values of corresponding OLS models. Meanwhile, the RSS values of GWR models are far less than those of OLS models, indicating that the fitting effects of GWR models are better than OLS models, with small error and better interpretation effect. Also, the AICcs of GWR models are smaller, and the differences with OLS models are much greater than 3, which further shows that GWR models have better performance (Cuevas et al., 2013).

**Table 4 Comparison of statistics between OLS and GWR models**

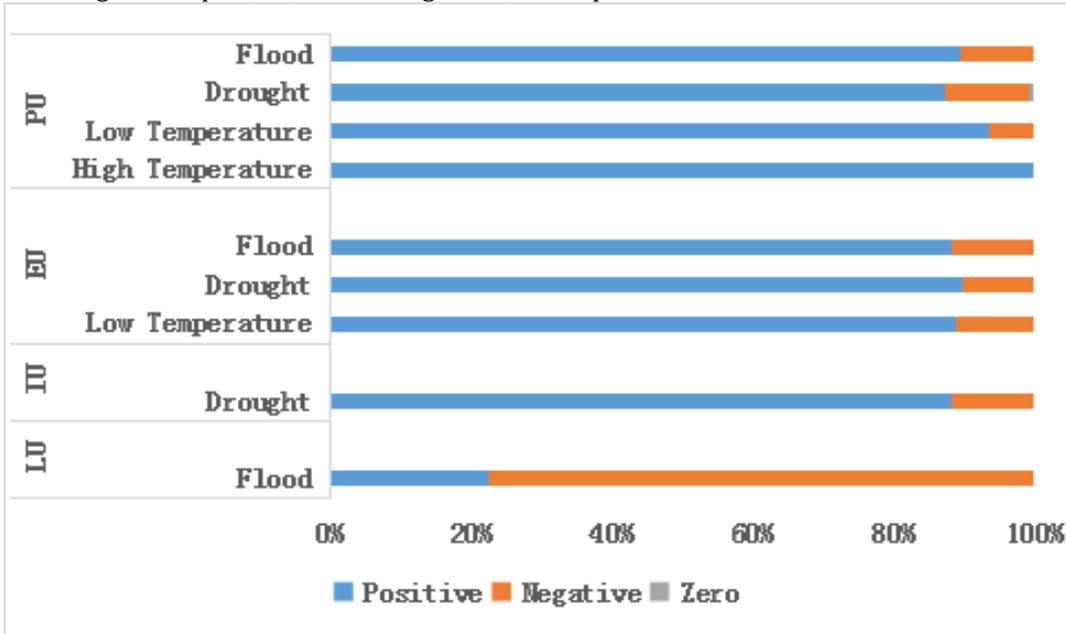
Climate events	Model	AICc	R <sup>2</sup>	R <sub>adj</sub> <sup>2</sup>	RSS
High Temperature	OLS	-724.861585	0.354301	0.349030	0.761955
	GWR	-932.710281	0.784834	0.743669	0.253906
Low Temperature	OLS	-959.812847	0.549487	0.543948	0.293000
	GWR	-1030.611852	0.751280	0.694895	0.161760
Drought	OLS	-910.294683	0.597264	0.590635	0.037822
	GWR	-949.188338	0.730269	0.679576	0.237600
Flood	OLS	-886.657301	0.375056	0.364769	0.390237
	GWR	-1056.719260	0.798689	0.733256	0.125705

**Table 5** shows the quintile statistics results. The mean values reflect the average level of contribution of the impact factors to cities' adaptation to climate change, and it can be seen that all factors, except for the land urbanization factor, contribute positively to adaptation in general, which is consistent with the analysis results of the OLS models. Meanwhile, it can be found that there are significant directional heterogeneities in the maximum and minimum values of the regression coefficients of some impact factors, which also indicates that the regression coefficients are non-stationary according to the geographical locations of cities, that is, there are significant spatial differences in the degree and direction of the role of different impact factors on cities' adaptation to climate change.

**Table 5 The estimation results of GWR models**

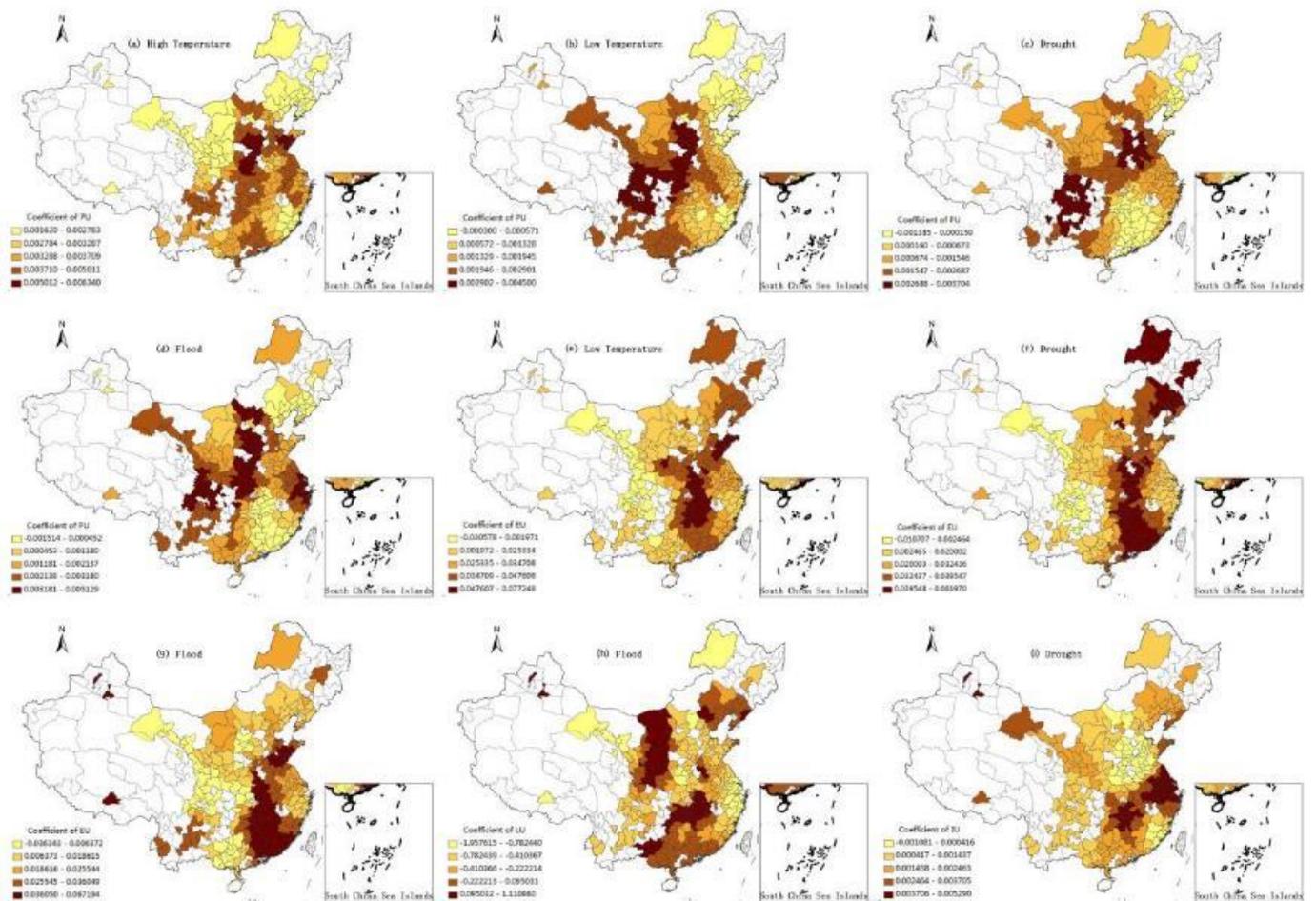
Climate event	Urbanization	Upper quartile	Median	Lower quartile	Max	Min	Mean
High Temperature	PU	0.003969	0.003603	0.00285	0.006340	0.001620	0.003490
Low Temperature	PU	0.002654	0.001833	0.001136	0.004500	-0.000300	0.001883
	EU	0.042054	0.029774	0.016489	0.077246	-0.030578	0.027998
Drought	PU	0.002260	0.001134	0.000362	0.003704	-0.001385	0.001303
	EU	0.039992	0.029926	0.013831	0.061970	-0.010707	0.026198
	IU	0.002715	0.001678	0.000829	0.005290	-0.001081	0.001824
Flood	PU	0.002978	0.001999	0.000715	0.005129	-0.001514	0.001923
	EU	0.033977	0.022143	0.011767	0.067194	-0.036343	0.022239
	LU	-0.067807	-0.565335	-0.291919	1.110860	-1.957615	-0.281499

The positive and negative distributions of the regression coefficients of the four types of urbanization are statistically presented in **Figure 5**. It can be seen that PU, EU and IU have positive impacts on adaptation to climate events in most cities, where PU plays a positive role in enhancing adaptation to high temperature in all cities, while land urbanization has a negative impact, i.e., a hindering effect, on adaptation to flood in most cities.



**Figure 5 Positive and negative statistics of the regression coefficients**

However, simple statistical analysis cannot reflect the specific differences among cities. In order to more intuitively analyze the spatial variations of the impact factors on cities' adaptation to climate change in China, ArcGIS was used to draw the spatial distribution maps (**Figure 6**) of the regression coefficients of each variable in the GWR models.



**Figure 6 Regression coefficients of urbanization**

(1) **Population urbanization.** In the four sub-figures (a)-(d) of Figure 6, the regression coefficients of PU are decreasing from southwest to northeast. The Central Plains region connecting the two directions is always at a high value, while the economically developed Pearl River Delta region is always at a low-medium value. It is not difficult to find that Northeastern China takes the lead in industrialization and has an early and high starting point in urbanization development, and as the vanguard of China's reform and opening up, the Pearl River Delta region has a high level of economic integration and complete infrastructure, both of which are highly attractive to the population. Therefore, their urbanization rates of permanent resident population rank among the top in China. While Southwestern China and Central Plains are both underdeveloped areas, and the urbanization rates still lags behind the national average level, but currently in the stage of rapid development. Population over-urbanization is characterized by massive population inflow or natural population growth that outpaces the development of urban infrastructure, systems, and services, making city governance will become more difficult, thereby increasing vulnerability or decreasing readiness to climate change. The floating population in the Pearl River Delta is mainly educated at the junior high school level, and most of them are engaged in labor-intensive industries and business services industries, rather than scientific and technological industries, which does not help to improve adaptation level from the technical aspect. Meanwhile, a large number of urban villages pose challenges to land use, urban landscape, planning and management, and community security. Nowadays, the overall economy of Northeastern China is in recession, and the mismatch between economic development level and urbanization level makes climate change may bring greater risks and challenges (Sudmeier-Rieux et al., 2015). Due to the existence of Marginal Diminishing Effect, PU has weak and even negative effects on the adaptation of the two regions, while it has positive effects on Southwestern China and Central Plains. Besides, it is worth noting that PU has a limited role in enhancing cities' adaptation to high temperature in Northwestern China, while it has a significant positive contribution to their adaptation to low temperature and flood, which also indicates that the PU sensitivity of cities' adaptation varies significantly depending on climate events.

(2) **Economic urbanization.** We can see from sub-figures (e)-(g) of Figure 6 that the regression coefficients of PU of adaptation to low temperature, drought and flood show highly similar distribution trends: the middle-high value areas are mainly located to the east of Hu Line, while the low value areas are distributed to the west of the line with most cities negative coefficients. West of Hu Line is the less developed area in China, where the economic development is relatively backward. Therefore the disposable income of urban residents there is not high, and the adaptation to low temperature and drought are also at low level, which indicates that the development of EU in this area has limited pulling power and weak impact on the level of adaptation to low temperature and drought. The cities with high values are located in the belt-shaped region consisting of Southern China, Central China, Northern China and Northeastern China, and the development of EU has a significant positive impact on the improvement of their adaptation level. Since the EU is expressed by per capita disposable income of urban residents, it is possible that with more income, residents can buy more facilities and services to protect against climate events, thereby reducing personal and property damage and improving adaptation ability.

(3) **Land urbanization.** As shown in sub-figure (h) of Figure 6, the coefficients of LU vary greatly among cities with the range reaching 3.07, indicating that process of LU varies greatly among these cities. LU plays an extremely critical role in cities' adaptatio to flood, which needs to be paid more attention to. High-value cities are clustered in Northwestern China, Southern China, Central China and Northeastern China; most cities with low coefficient are located in Eastern China, especially in coastal provinces, and the coefficients are even negative. The eastern cities have superior geographical locations, rapid economic development, and early urban planning and infrastructure construction, which has lasted for a long time. However, in recent years, the continuous expansion of urban boundaries has accelerated the concentrated outbreak of urban diseases such as traffic congestion and housing shortage. The resources and environment of these cities are under great pressure, and the disaster resistance abilities and disaster management level are significantly inadequate. In this context, it is not surprising that LU has a negative impact on these cities' adaptation to flood.

(4) **Industrial urbanization.** sub-figure (i) of Figure 6 shows that the high value areas present a belt-shaped distribution, mainly located in Jiangsu, Zhejiang, Shanghai, Anhui and Jiangxi in Eastern China and Hunan and Hubei in Central China, while the low value areas are mainly located in Fujian province and Shanxi-Hebei-Henan region. Besides, some cities in Xinjiang, Gansu and Shandong are also at a high value level. The high coefficient cities have a high level of IU in the country with a diversified industrial pattern or a large proportion of the output value of the dominant industry, and thus IU has a significant positive driving impact on their adaptation to drought. For example, the city of Karamay in Xinjiang is an industrial city with petroleum and petrochemical industries as the main industry. In 2019, the secondary industry accounted for 70%, while agriculture only accounted for 1.5%. In comparison, low value areas are either weak in industrial economy or single in industrial structure. For example, Henan is a typical agricultural province, and the level of secondary and tertiary industries in its cities is relatively backward. From the assessment results, most of these cities are with low values, and IU process cannot play a significant role in promoting adaptation to drought. And Hebei is a large industrial province, not a powerful one, which mainly develops the iron and steel industry with high pollution, high energy consumption and low added-value. So the IU of Hebei does not play a significant positive role in economic development and environmental health. The low-quality IU does not improve the adaptation to drought, but becomes an obstacle factor. To a certain extent, this also indicates that it is very urgent to enhance the industrial output values of cities with low IU coefficient and optimize and adjust their single or unreasonable industrial structure.

(5)

## 5. CONCLUSION AND DISCUSSION

Based on the data of 248 cities in China, this paper constructed the assessment indicators systems of cities' adaptation to climate change under four types of climate events: high temperature, low temperature, flood and drought. And the coefficient of variation method and ESDA were used to analyze the spatial differences characteristics of cities' adaptation, and GWR model was used to explore that how urbanization affects adaptation. The conclusions are as follows:

- (1) In general, high-administrative-level cities have stronger adaptation, lower vulnerability and higher readiness than ordinary-prefecture-level cities, which are determined by their advantages in many aspects.
- (2) The differences of adaptation to high temperature and low temperature among cities generally present spatial patterns of decreasing from south to north, and the difference of adaptation to drought generally presents a spatial pattern of decreasing from west to east. The coefficient of variation of adaptation to flood is the largest in Southwestern China, the smallest in Northeastern China, and the gaps of adaptation among cities within Southern China and Southwestern China are very prominent.
- (3) The scores of adaptation to high temperature, low temperature and flood in Northern China, Northeastern China and Northwestern China consistently rank in the top three, the scores with high temperature and flood in Southern China are the lowest, and the scores of low temperature and drought in Southwestern China are the lowest. Compared with Southern China, Northern China has a wider advantage in adapting to climate change and climate events, and the gap among different regions in adapting to low temperature is relatively small, while there is a significant adaptation gap in coping with high temperature. The key to improving balanced adaptation to climate change in all regions of China lies in narrowing the gap of adaptation to high temperature.
- (4) The adaptation to high temperature is in the opposite distribution between north and south. The cities with high adaptation are mainly concentrated in the three northeastern provinces, Inner Mongolia, Shandong and Beijing-Tianjin-Hebei region, while the cities with low adaptation are mainly distributed in Guangdong, Guangxi, Sichuan, Chongqing, Henan and Eastern China region. Cities with high adaptation to low temperature mainly belong to high-administrative-level, forming a high-low agglomeration area centered on cities of this level, and cities with low adaptation to low temperature are mainly distributed in Southwestern China, Central China and Huaihe River Basin. Cities' adaptation to drought shows a significant trend of decreasing from southeast to northwest, with high adaptation cities mainly concentrated in Jiangsu, Zhejiang, Anhui and Pearl River Delta, while adaptation in Northwestern China is generally low and shows the characteristics of low-low agglomeration. Also, adaptation to flood also shows a distribution trend of higher in the north and lower in the south, with low adaptation cities mainly located in Pearl River Basin and Huaihe River Basin.
- (5) Under the four types of climate events, the global spatial correlations of cities' adaptation in China are positive, and the agglomeration characteristics of adaptation are mainly H-H and L-L agglomerations. Most cities in Yangtze River Delta are H-H agglomeration, and most high-administrative-level cities are H-L agglomeration.
- (6) When analyzing the impacts of four types of urbanization on cities' adaptation to climate events, the fitting effects of GWR models are far better than those of OLS models. Population urbanization affects cities' adaptation to four types of climate events, economic urbanization on low temperature, drought and flood, industrial urbanization on drought, and land urbanization on flood. Population, economic and industrial urbanization have positive impacts on adaptation of most cities. Population urbanization can improve adaptation of all cities to high temperature, while land urbanization hinders adaptation of most cities to flood. Under the influence of social and economic development, the urbanization regression coefficients of different cities have significant spatial differences.

Due to the limitation of time and data acquisition, the above research has the following shortcomings: First, a small part of indicators data are derived from the Internet or estimation, which may make the results not robust enough; second, the cross-sectional data cannot reflect the relative change of cities' adaptation to climate change from the time dimension. More accurate, more comprehensive and in-depth comparative studies need further follow-up.

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**Appendix Table 1 Details of data sources**

Indicators	Abbreviations	Reasons for selection	Source
Population density	PD	The greater the number of people exposed to the disaster-causing factors per unit area, the greater the risk of life and health damage	China City Statistical Yearbook
GDP per square kilometer(economic density)	GPSK	The higher the value of disaster bearing body per unit area is, the greater the economic loss will be	
Percentage of employees working outdoor	PEWO	People who work outdoors are vulnerable to high and low temperatures, leading to health risks	
Proportion of employees in primary industry	PEPI	It reflects the sensitivity of drought susceptible industries to drought at the level of employment structure	
Proportion of primary industry to GDP	PPIG	It reflects the sensitivity of drought susceptible industries to drought at the level of economy	
Number of hospital beds per capita	NHBPC	Medical resources reflect the level of health protection: the more beds per capita, the more favorable post-disaster relief	
Number of doctors per capita	NDPC	Medical resources reflect the level of health protection: the more doctors per capita, the more favorable post-disaster relief	
Greening coverage of built-up areas	GCBA	Green space provides cooling function, which can reduce the impact of extreme heat and biophysical hazards	
Mobile phone ownership rate	MPOR	Reflect the ability of early warning measures, information exchange, etc	
Water resources per capita	WRPC	Reflects the resource endowment to withstand drought, as well as the ability to obtain drinking water after floods	
Number of buses per 10,000 people	NBP	Vehicles provide a more reliable evacuation option in the event of a flood, while also making it easier for cities to recover from weather disasters	
GDP per capita	GPC	The low value may lead to insufficient investment in the construction of climate adaptation infrastructure and affect the implementation of post-disaster recovery	
Percentage of population aged 65 and over	PPA650	The elderly have poor physical resistance ability, weak self-protection and disaster response ability	

Indicators	Abbreviations	Reasons for selection	Source	
Percentage of population aged 0-4	PPA0-4	The child have poor physical resistance ability, weak self-protection and disaster response ability		
Percentage of population with high school education and above	PPHSEA	Education helps raise the city's awareness of how to respond to climate events		
Domestic water consumption per capita	DWCPC	It reflects the sensitivity of water demand after climate change and water shortage	city -level Database of China Real Estate Informatio	
Density of drainage pipes in built-up areas	DDPBA	It reflects the drainage capacity in case of flood disaster		
Patents granted per capita	PGPC	It reflects innovation ability. The higher the value, the better the ability to find countermeasures against the incident		
Loan-to-deposit ratio of financial institutions	LRFI	An indicator of economic development. If the value is too low, it may indicate that the city is unable to carry out the construction or investment of adaptive projects		
High temperature days	HTD	The number of days with daily maximum temperature $\geq 35^{\circ}\text{C}$ and it is directly proportional to the high temperature risk		China Meteorological Data Service Centre
Average value of highest temperature in high temperature days	AVHTHTD	It is proportional to the risk of high temperature		
Low temperature days	LTD	The number of days with daily minimum temperature $\leq 0^{\circ}\text{C}$ and it is directly proportional to the low temperature risk		
Average value of lowest temperature in low temperature days	AVLTLTD	It is proportional to the risk of low temperature		
Average annual precipitation	AAP	The larger the value is, the greater the flood risk is and the smaller the drought risk is		
Average annual temperature	AAT	The larger the value is, the stronger the city is disturbed by drought		
Housing price to income ratio	HPIR	Housing cost burden is a high risk factor for homelessness, and homeless or marginalized populations are most vulnerable to temperature and weather	<a href="https://www.creprice.cn/">https://www.creprice.cn/</a> , China Meteorological Data Service Centre	
Percentage of impervious surface area	PISA	The higher the value, the greater the amount of surface runoff, exacerbating flooding	Calculated by the research group	
Heating situation	HS	Whether a city has heating or not indicates how well it can cope with cold weather events	Article of "map can talk" on WeChat- -Where is China's heating demarcation line?	
Whether a water-saving city	WAWC	It reflects the water management ability, and water-saving cities can rationally allocate, develop and utilize water resources to form a scientific water use system and effectively deal with drought	Baidu Encyclopedia--National water-saving cities	
Government debt balance per capita	GDBPC	The higher the value is, the less investment is likely to be put into the infrastructure construction of adaptation to climate events, and the implementation of post-disaster recovery will be affected at the same time	Everbright Securities Research Report-Special Report on Regional Finance	
Number of corruption and bribery cases per 10000 people	NCBC	It reflects the level of free from corruption, the transparency and management capacity of local governments, and the level of effective use of climate funds	Harvard University -- China Corruption Survey Dataset	

## **Regular Session: RS14.3 - The spatial dimension of sustainable development**

**09:30 - 10:45 Friday, 28th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/83488693367>**

**Chair John Emmanuel Villanueva**

## THE EFFICIENCY OF THE EDUCATION SECTOR BUDGET: EVIDENCE FROM INDONESIA

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### ABSTRACT

The decentralization of education in Indonesia has been going on for two decades. As mandated by the law, starting in 2010, the education budget has been allocated 20 percent of total state expenditure. In the last 10 years, the education budget in Indonesia has more than doubled. However, the high budget allocation for education has not yet matched its performance. This article wants to find out how efficient the use of budgets at the provincial level in Indonesia is. The descriptive analysis method is used to see the description between budget allocation and education performance in each province. To see the efficiency of the use of the budget on the performance of the education sector, a Data Envelopment Analysis (DEA) analysis is used. The data is sourced from the Ministry of Education, compiled from 510 data at the district/city level spread across 34 provinces in Indonesia. As input used the education budget allocation (national and regional levels), school conditions, teacher quality, accreditation, student-teacher ratios in each province. Meanwhile, the education output uses the net enrollment rate and the school graduation rate. From the analysis, it can be concluded which districts/cities are the most efficient in allocating resources. With a reference to the efficiency of resource use, efficiency in the use of the budget can be made.

### KEYWORDS

Performance, Efficiency, Education

### 1. PRELIMINARY

#### 1.1 Background

Education is one of the key pillars to improve the quality of human resources. There are two important things related to education that the Indonesia's constitution stated. First, the Indonesian people's right to obtain education, and the second, the huge allocation of fund to finance the implementation of national education. At least, in the last decade, the government has allocated fund amounting to 20% of the State Budget each year.

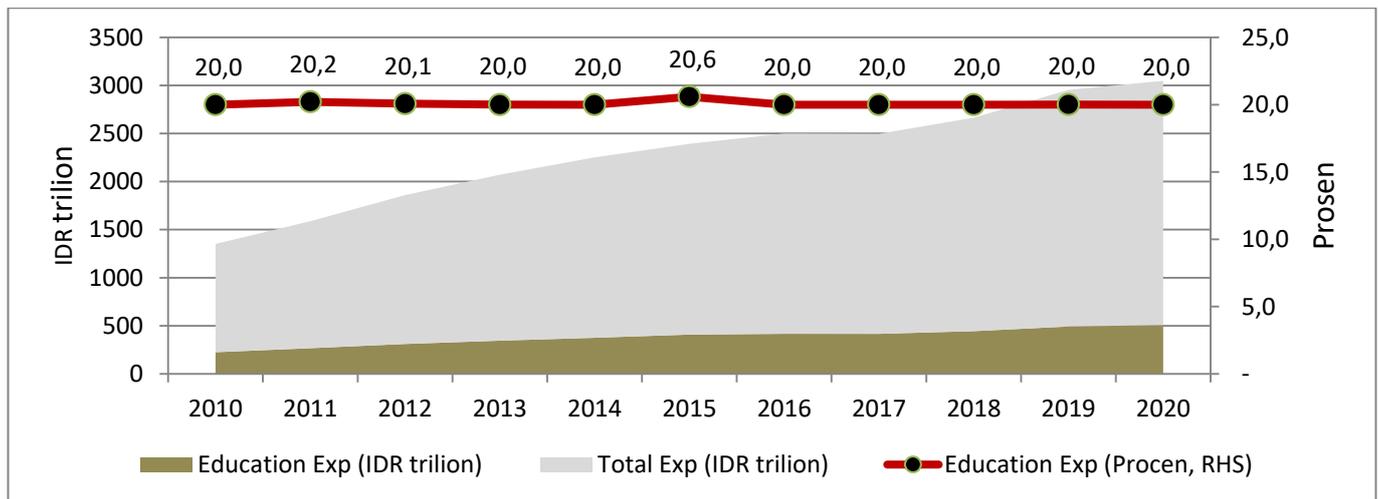
To fulfill education services, the government implemented a 9-year compulsory education program. Based on the 2020-2024 National Medium-Term Development Plan, the program will be completed in the next five years. Currently, mean years of schooling for Indonesian is 8 years. In other words, most of Indonesian had education up to level two junior high school.

The government implemented right policies to encourage the education's sustainability, from elementary to high school. For example, giving educational assistance for children of poor households, providing school operational assistance funds up to the SMA level, and increasing qualified teachers according to the Teacher Law.

As stated in Article 31 paragraph 4 of the 1945 Constitution (fourth amendment), the government is obliged to allocate education spending of at least 20% of the State Budget. The allocation aims to provide educational services to the public, especially basic education, in the implementation of national education.

This mandate has been fulfilled by the government in compiling the State Budget since 2010. The allocation in the 2010-2020 State Budget has never been less than 20%. The allocation is channeled through the central government (National Budget) and local government (Sub National Budget).

In 2010, the overall education budget was Rp225.2 trillion, and then increased to Rp508.1 trillion in 2020, or an increase double over 10 years. The escalation was in line with the increase in the State Budget. Thus, The hike in the State Budget expenditure will automatically enhance the education budget allocation as the mandate of the Constitution.



**Figure 1. Education Budget Allocation**

Source: Ministry of Finance.

Although the education sector allocation has reached 20% of the total State Budget, the education sector’s output is relatively lower than other countries. Based on Program for International Student Assessment (PISA) 2018, Indonesia’s rank is at the bottom of the list. Indonesia is ranked 72 out of 77 countries for reading competency score, ranked 72 out of 78 countries for Mathematics score, and ranked 70 out of 78 countries for the Science score. Those scores tend to be stagnant in the last 10 - 15 years.

With the education budget reaching 20% in the last 10 years, how was the education sector’s performance, particularly at the basic education level? Which province is the most efficient of the education budget use?

**1.2 Research Purpose**

The purpose of this research is to observe how the performance and efficiency of the education budget, especially primary and secondary education in Indonesia.

**1.3 Research Method**

The method used in this research is to measure the efficiency of the use of education sector’s input in producing the education’s output in all provinces of Indonesia. Indonesia consists of 34 provinces, but the analysis is only carried out in 33 provinces, except DKI Jakarta Province. This province as the capital city was excluded of the analysis to avoid the bias result. Because the central government’s education budget is located in the province. The analysis tool used is Data Envelopment Analysis (DEA). DEA analysis uses the CCR model with output oriented.

The main source of data for this study is from the Ministry of Education in 2019. The education sector’s input used is the education sector budget allocation consisting of the education budget from the National Budget and Sub National Budget, classroom conditions, school accreditation, teacher quality, teacher and student ratios and teacher’s competency. While the education’s output used is the Net Enrollment Rate and National Exam’s Score. The focus of the input studied is the input of the education budget.

The student teacher ratio means 1 teacher teaches how many students. The bigger the student teacher ratio, the worse it is. In order for the direction to be positive, in the analysis it is converted into the student teacher ratio (1 divided by the student teacher ratio multiplied by 100) which means how many teachers are needed to teach 100 students.

The variables used in the analysis :

Input variables:

I1 = Education budget per student per year (IDR million / student / year)

I2 = Good School Conditions (percentage)

I3 = School Accreditation (percentage)

I4 = Teacher quality (percentage)

I5 = Student-Teacher Ratio

I6 = Teacher Competence (percentage)

Output variables:

O1 = Net Enrollment Rate (NER)

O2 = National Examination

**2. LITERATURE REVIEW**

Through a long political process, the general government’s system in Indonesia has changed drastically since 2000, from centralized system has become decentralized. One of the strategic affairs delegated to the regions is education sector. With the transfer of authority, it is hoped that the education management in each region can be implemented better than the previous era. This is in line with the Cambridge Institute (2021) expressed that decentralization of education cannot

be separated from the broader political process that shapes the empowerment of local institutions. Evidence suggests that the level of local control is slightly high in states such as states that empower local government agencies. The education decentralization policy will work best if it gets support from various parties in the region. Donald R. Winkler (1989) said that decentralization policies are most successfully implemented if there is a tradition of self-reliance by local communities; if local governments or communities have their own sources of tax revenues and voluntary contributions; if the pressure for decentralization originates with the community rather than ministry planners; if all important affected political groups, especially teachers, are involved and informed about development of decentralization plans; and if administrative capacity at the local level either already exists or is trained.

The education system in Indonesia is the third largest in the Asian region and the fourth largest in the world, with more than 50 million students and 2.6 million teachers in more than 250,000 schools. Two ministries are responsible for managing the education system, namely the Ministry of National Education and the Ministry of Religion (WB, 2014). As a country with a large population, which is spread across 34 provinces, there are high hopes that one day Indonesia will be able to grow as a developed country. This is in line with the education's role as stated by Todaro and Smith (2014) that education has a pivotal role in shaping the ability of a developing country to absorb modern technology and to develop capacity to create sustainable growth and development.

Ciro and Garcia's (2018) study measures the efficiency of public secondary education spending in 37 developing and developed countries using a two-step semi-parametric DEA (Data Envelopment Analysis). This study applies two cross-country frontier models for the 2012-2015 period: one using a physical input (i.e. teacher-student ratios) and one using monetary input (i.e. government and private spending per secondary school student as a percentage of GDP). Some important results of this study are 1) developing countries could increase their enrollment rates and PISA scores by approximately 22% and 21%, respectively, by maintaining the same teacher-student ratios and public-private expenditure levels; 2) Australia, Belgium, Finland and Japan are efficient countries in the cross-country frontier; 3) the physical frontier model significantly benefits developing countries, bringing them closer to the efficiency frontier, but it negatively affects developed countries.

Aristovnik (2013) paper on the measurement of the technical efficiency of the public (primary) education sector within the selected education sector in the 1999-2009 period in the wide range of the EU and OECD countries, including new EU member states. The results showed that within a selected group of EU member countries (Denmark, Hungary and Portugal) was the most efficient in the primary education sector. Other countries achieving the level of efficiency are Greece and Romania, however, their primary expenditures per student (in % of GDP) is very low and have averaged of less than 12% (EU /OECD average is 18.7% in the considered period). On the other hand, the least efficient countries are Belgium, Sweden and Croatia. Some less efficient countries should significantly reduce their input (primary expenditure per student) (e.g. Slovenia from 27% to 22%) and/or increase their output, i.e. school enrollment (e.g. Ireland and Poland), primary completion rate (Belgium) and teacher-student ratio (Ireland) in order to become efficient.

Research on the efficiency of the education sector budget in Indonesia varies considerably. Tisrinasari et al (2020) measured efficiency at the level of vocational high school (SMK) in 2018. The results of calculating provincial efficiency with output oriented Variable Return to Scale DEA show that 14 provinces are declared efficient (and 20 provinces declared inefficient). References and improvements for inefficient provinces, one of which is North Maluku Province which has the smallest score. Input variables include per capita student education allocation (ADM), net enrollment rate (APM), teacher/ student ratio (RGM), and class/student ratio (RKM); while the output variables include the continuing school rate (AM) and the non-dropout rate (100-APS).

Research by Mahmudah et al (2018) evaluated the technical efficiency of high schools (SMA) for the 2015/2016 period in 34 provinces of Indonesia using the Robust DEA approach to reduce biased results on traditional DEA. Input variables include the number of schools, the number of students, the number of teachers, the number of libraries, the number of laboratories, the number of graduates, the number of classes, and the number of classrooms. The output variables include the average national exam score for Indonesian, English, Mathematics, Physics, Chemistry, and Biology.

Another study measuring the efficiency of elementary schools (SD) in Indonesia for the 2014/2015 period by applying the two-stage DEA method was conducted by Fatimah and Mahmudah (2017). The first stage is to calculate the efficiency score using the DEA approach. The second stage uses an econometric approach to analyze the impact of environmental variables on school efficiency. The results show that the VRS model of DEA is better than the CRS model in the first stage to measure the efficiency of SD performance. There are 17 provinces with SD performance is efficient in the VRS model, there are also 12 provinces that are efficient for SD performance in the CRS model. In addition, there are three environmental variables that have a significant effect on the efficiency of primary schools in Indonesia, namely the repetition rate, the average of science of national exam and the qualified teachers' rate.

According to Muniroh (2015) that in general, education development consists of three elements, namely (1) educational content/input, process/transformation, and educational goals/outputs. Education input is students as targets/objects in education, processes/transformations are tools/machines that shape students as planned, and goals/outputs are the final results to be achieved. Education input is a main factor so that the educational process can run well. Education input can be in the form of an education budget, and other resources such as schools, teachers, students, regulations, and others. The readiness of input is necessary so that the process can run well. Therefore, the high and low quality of inputs can affect the educational process and output.

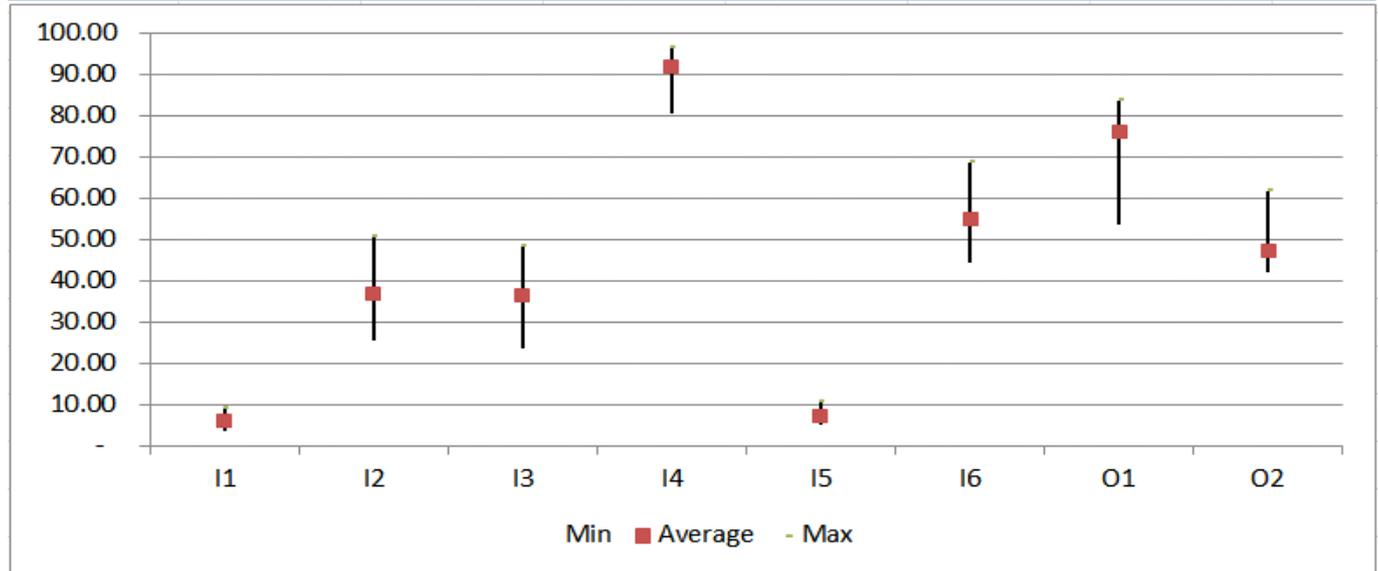
3. RESULTS AND DISCUSSION

3.1 Data description

The data description of the lowest value, average value and maximum value of each input and output variable is presented in the following table:

Table 1 Description of input and output variables

Statistic	I1	I2	I3	I4	I5	I6	O1	O2
Min	3.38	25.54	23.69	80.69	4.98	44.48	53.56	41.86
Average	5.98	36.86	36.45	91.98	7.34	54.99	75.96	47.25
Max	8.93	50.70	48.23	96.50	10.82	68.77	83.69	61.84



Source : Author Analysis.

3.2 Educational Input

Allocation of Educational Expenditure in Regional Budget

Although, at in national level the educational budget has reached 20 percent, seen at the provincial level there are still provinces whose educational budgets are below 20 percent. The Provinces whose educational budget allocation is still below 20 percent are province 21, 64, 65, 82, 91, and 94. The highest educational budget allocation is in the 33 provinces of 31.7 percent of the total Regional Revenue and Expenditure Budget (APBD).

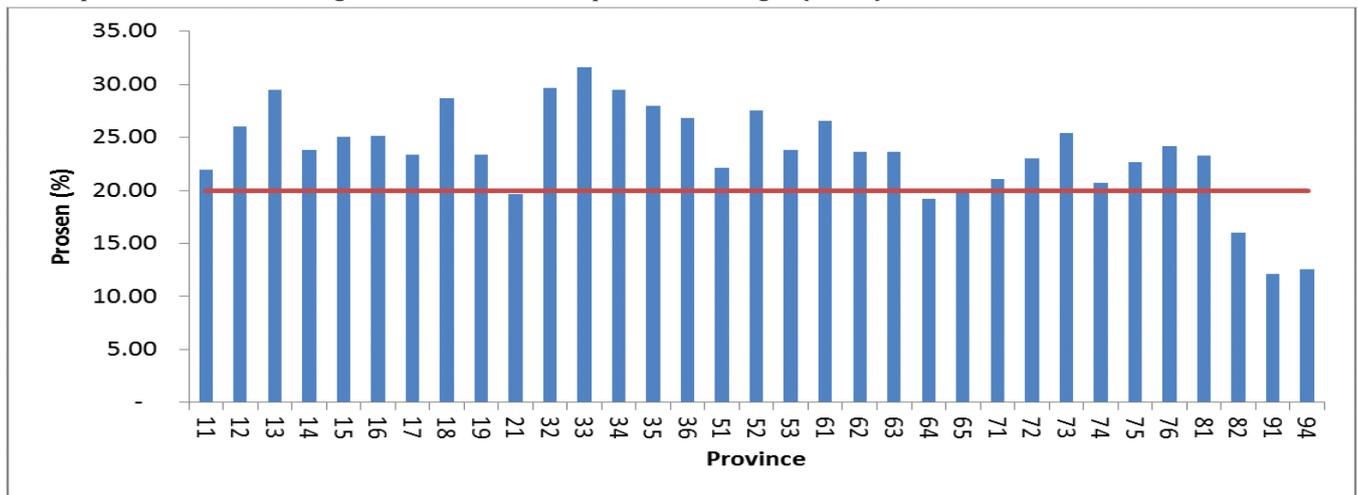


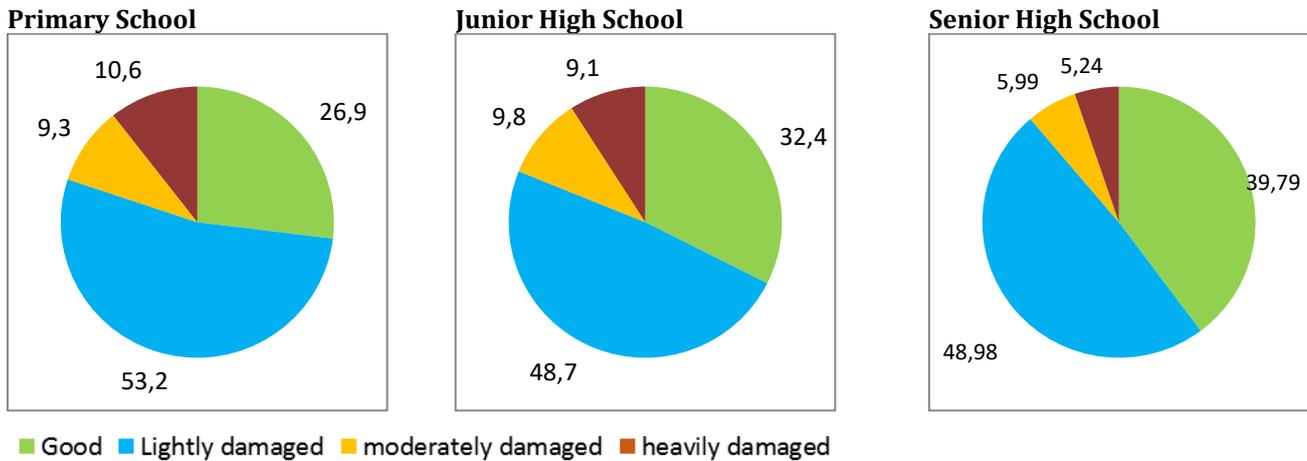
Figure 2. Education Budget Allocation (Prosen)

Source: Ministry of Education Republic of Indonesia, 2020.

Classroom Conditions

One of the other forms of educational input that is also very influential at the stages of the educational process and affects the output of education is the condition of the educational facilities and infrastructure available, especially schools (classrooms). The figure 3 below shows that the majority of classrooms are "lightly damaged", this condition occurs at all levels of education, namely at the SD (53%), SMP (49%) and SMA (39%). Even so, for the "lightly damaged" class conditions it can still be used for teaching and learning activities. Meanwhile, the condition of classrooms with "good"

conditions is at the education level: SD (27%), SMP (33%), SMA (40%). This condition reflects that the Government of Indonesia has a very large homework in improving the quality of education infrastructure so that teaching and learning activities can run better so that they can increase the quality of the desired educational output.

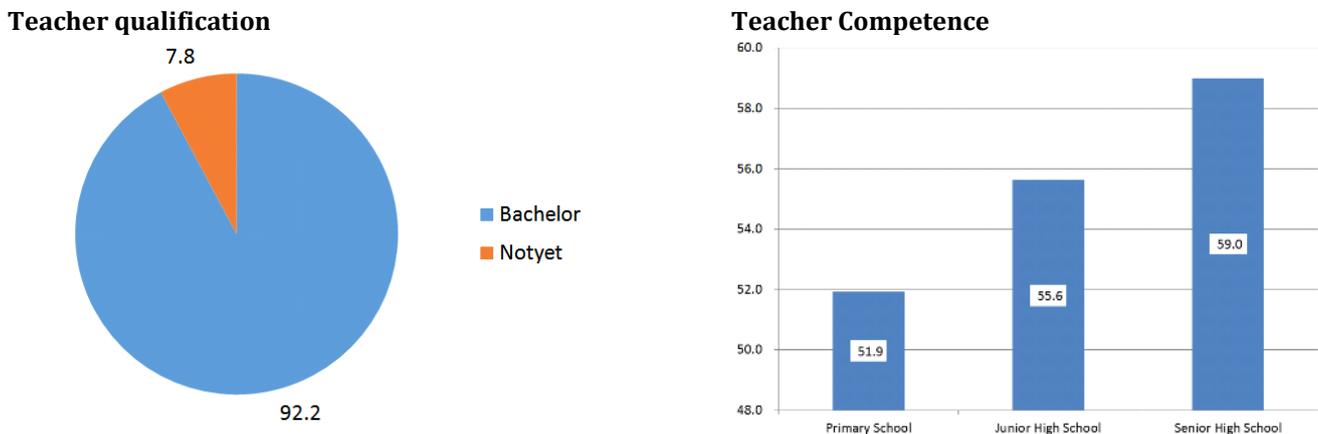


**Figure 3. Classroom Conditions (Prosen)**

Source: Ministry of Education Republic of Indonesia, 2020.

### Teacher Qualification and Competence

Teacher qualifications and competencies are the main elements in the learning process to create good educational output. Teacher qualification is measured by the percentage of teachers who have completed their undergraduate education. Meanwhile, teacher competence is measured by the percentage of teachers who have taken the certification exam. As many as 92.2 percent of teachers in 33 provinces have completed their Bachelor's education. In terms of competence, there were 52 percent of elementary school teachers who had completed the certification exam, 56 percent of junior high school teachers and 60 percent of high school teachers.



**Figure 4. Teacher qualification and Teacher Competence (Percentage)**

Source: Ministry of Education Republic of Indonesia, 2020.

### Student Teacher Ratio

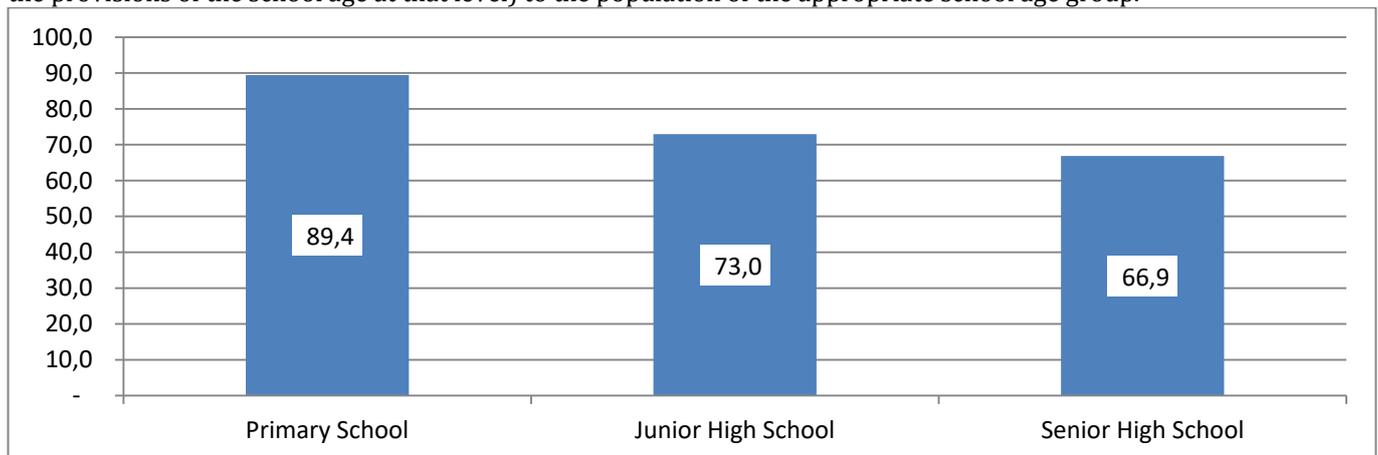
The availability of teaching staff is an important factor in educational services for school students. The balance of the teacher's teaching load in dealing with the number of students must be right. If there is too little it will be inefficient, but if it is too large the number of students to be handled will be ineffective. The teacher-student ratio on average at the SD level is 1: 17, one teacher handles 17 students. At the junior high school level of 1: 14; and at the high school level at 1: 15.

### 3.3 Educational Output

The educational output describes the results of the implementation of educational inputs that have been planned and prepared. The better the educational input, the better the output is expected. The education output also describes the performance of the education process carried out by various parties involved in the process such as the government, teachers, and other parties.

## The Net Participation Rate (APM)

According to BPS (2020), the Net Participation Rate (APM) is the proportion of the population of a certain school age group who is currently attending school at the appropriate level of education (according to the age of the population with the provisions of the school age at that level) to the population of the appropriate school age group.

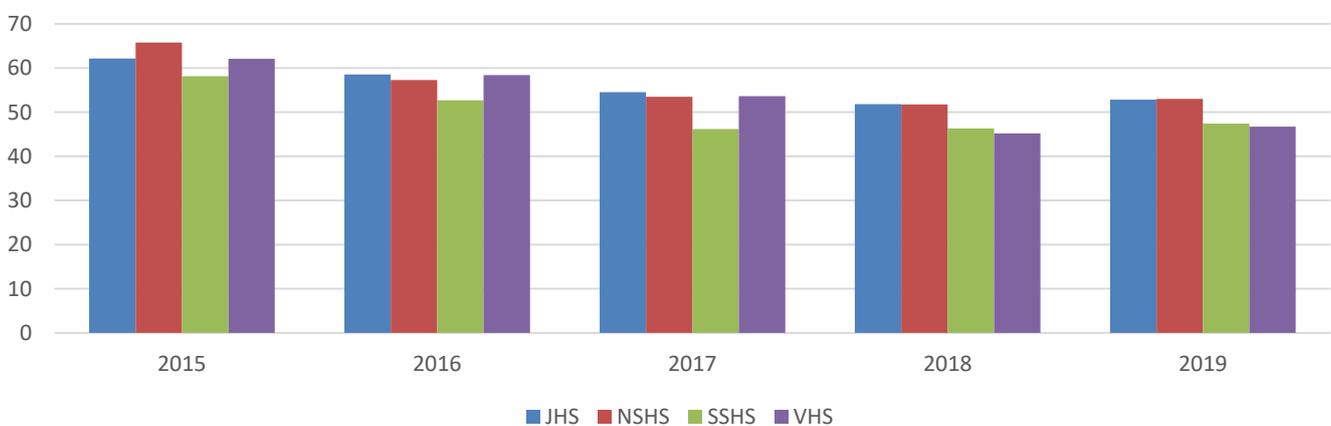


**Figure 5. Net Enrolment Rate: Primary School - Senior High School**

Source: Ministry of Education Republic of Indonesia, 2020.

## National Examination (UN) Results

One indicator of the success of education is by looking at the results of the national exams (UN) that have been taken by students at all levels of education in Indonesia. National exam (UN) results also reflect the quality of teaching and learning activities carried out so far. Below is a description of the Average National Exam Score (UN) held by Public and Private Schools for Junior High School (JHC), Natural Science High School (NSHS), Social Science High School (SSHS), and Vocational High School (VHS) in Indonesia in the 2015-2019 observation year. The types of subjects tested were: Indonesian Language, English, Mathematics, and Natural Sciences (for the JHC level), as for the NSHS level plus Biology, Physics, and Chemistry subjects, and for the SSHS level plus Geography, Sociology subjects. and Economics. The results of the national exam (UN) scores are a combination of the test modes carried out by the Computer-Based National Examination (UNBK) and the Paper and Pencil-Based National Examination (UNKP).



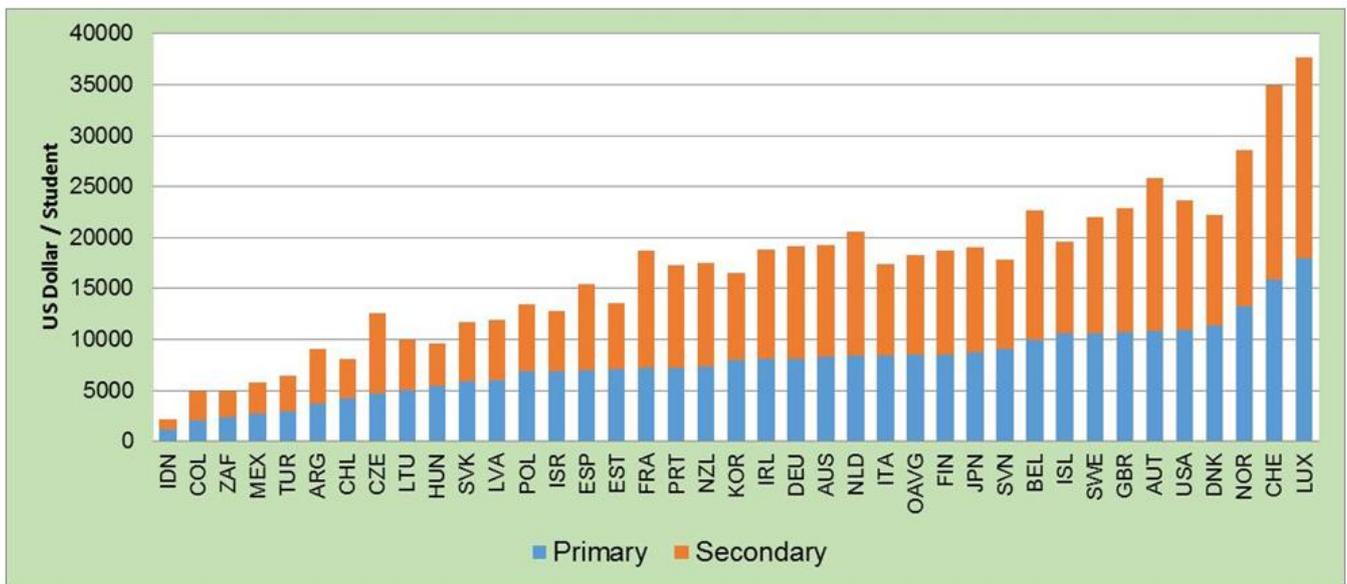
**Figure 6. Average National Examination Score of Public and Private in Indonesia 2015 - 2019**

Source: Ministry of Education of Indonesia, 2020.

The data in Figure 6 shows that all the average scores for the National Examination (UN) above for all levels of education are still below the value of 70, although from year to year it shows an improving trend. This illustrates that there is still a need for improvements to the input and process of education in Indonesia and to find out what internal and external factors have the most influence on the low scores of this national exam.

### 3.4 Indonesian Education in the World

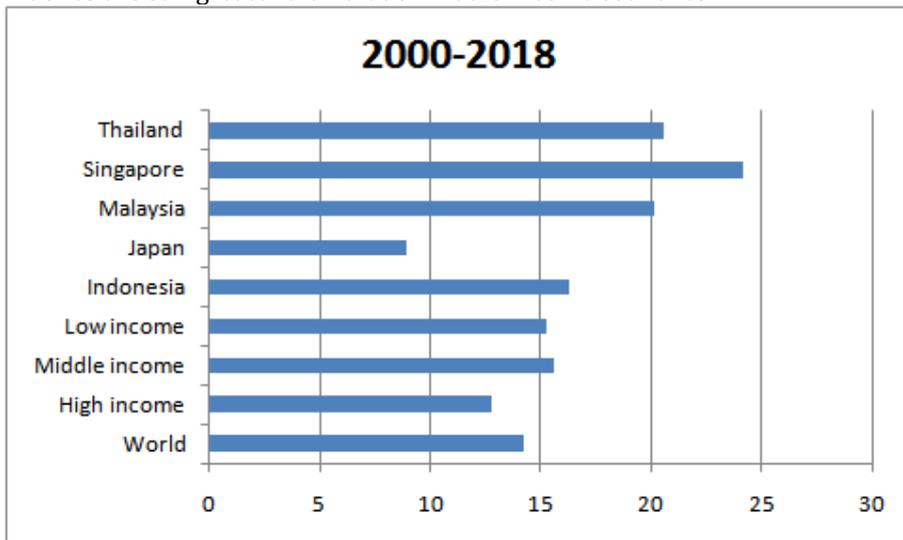
Although the education budget has reached 20 percent of total expenditure, when compared to other developed countries, Indonesia's budget allocation per student is still low. Education budget allocation in Indonesia for primary and secondary levels is only 2.2 thousand USD per student. Meanwhile, the United States reached 23.7 thousand USD, or 10 times that of Indonesia. The problem is, how is the performance and efficiency of education in Indonesia after the 20 percent budget allocation as mandated by law is fulfilled



**Figure 7. Education Spending Primary and Secondary (US dollar/student)**

Source: Education at Glance, OECD.

In terms of budget allocations for the education sector, from 2000 to 2018, the percentage was still below neighboring countries (Singapore, Malaysia, Thailand). However, the percentage of budget allocation for the education sector in Indonesia is still greater than that of Middle Income countries.

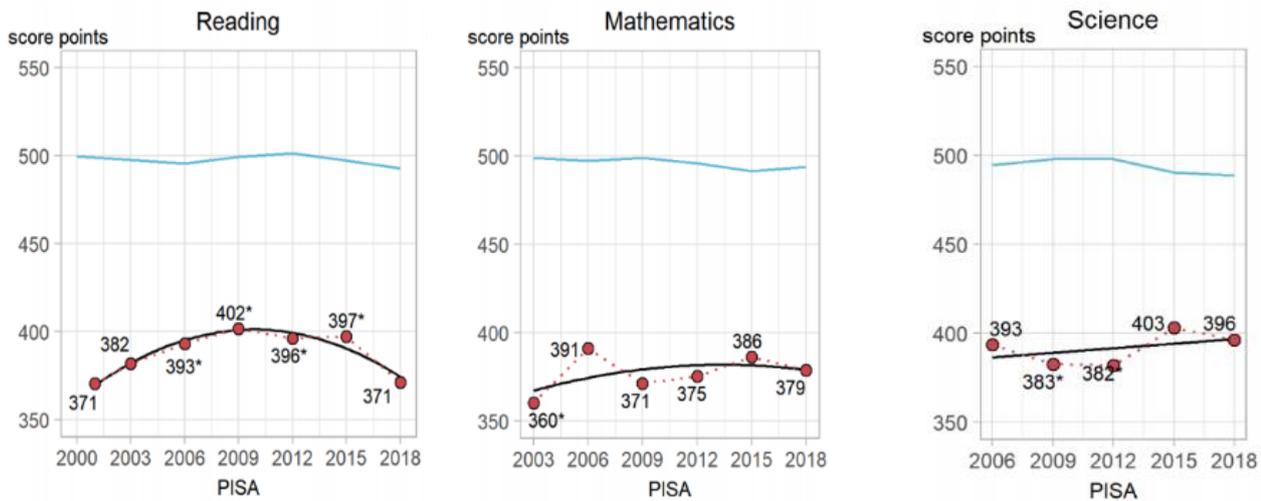


**Figure 8. Budget allocation in Education Sector, (Percentage, %)**

Source: World Development Indicator, 2020.

The OECD has published an international-scale scoring assessment conducted every 3 years through a program for international student assessment (PISA). The result of PISA Indonesia score in 2000 is relatively better than in 2012 after the education budget of 20 percent is fulfilled.

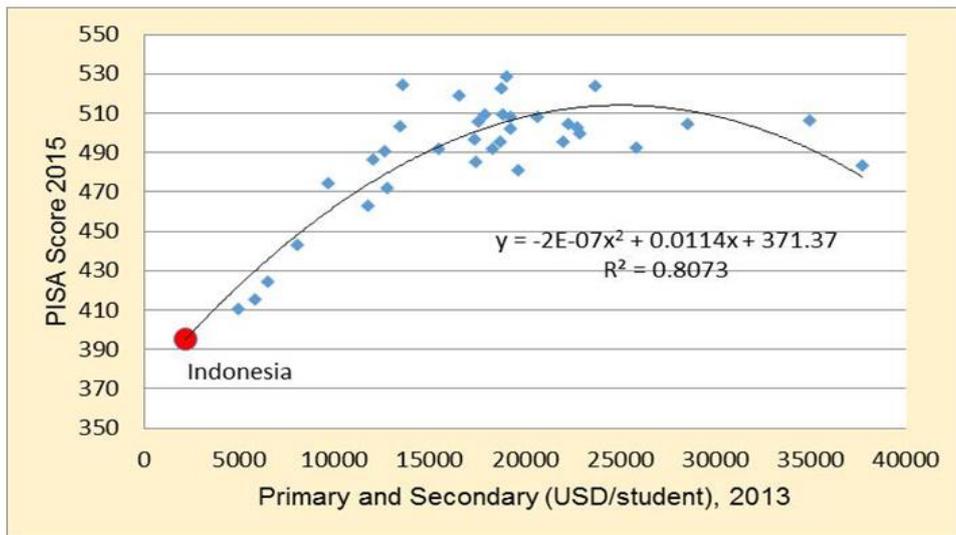
The results of Indonesia's PISA scores from 2000 to 2018 were relatively stagnant. PISA scores in reading, mathematics, and science are far from the average for the country surveyed (blue line). Indonesia's PISA score in 2000 ranks 39 out of 41 countries. In 2018, Indonesia ranks 70 out of 78 countries. This means that since Indonesia has become a participant in PISA, improving Indonesian education has had no impact significant.



**Figure 9. PISA Indonesia Scores 2000 – 2018**

Source: Education at Glance, OECD.

One of the factors causing the low PISA score is the allocation of the amount of the education budget per student. There is a positive correlation between the education budget per student and the PISA score. Indonesia, which has a population of 270 million and 45 million students from SD to SMA, requires a small budget. Although the Indonesian government has allocated a budget for education of 20 percent, with a large number of students the budget allocation per student is small.



**Figure 10. Education budget allocation (primary and secondary) and PISA scores**

Source: Education at Glance, OECD.

### 3.5 Efficiency of the Education Sector

The efficiency of the implementation of the provincial education sector in Indonesia in using inputs to produce education output in this analysis is carried out into 2 parts. The first part is efficiency uses input for Net enrollment rate (NER) output, and the second part is efficiency uses input for National Examination output. In DEA analysis is a data analysis that can use many inputs and many outputs simultaneously. However, in this study, the analysis was carried out separately for each output. The consideration is to do a partial output analysis in order to know the improvement of each output and how much budget could be saved if each region can efficiently produce educational output.

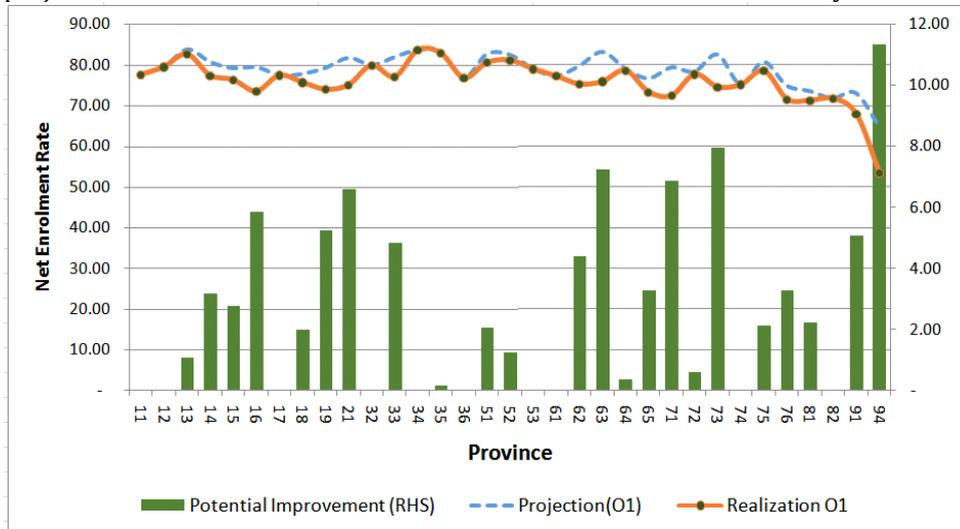
DKI Jakarta Province is not included in the efficiency analysis because it is the center of the Government. The budget for the head office of the Ministry of Education is located in DKI Jakarta Province, if it is included in the analysis it will damage the data (outlier data).

The education budget allocation for 33 provinces in Indonesia is IDR 216 trillion. The budget is used to finance all educational inputs, both for school infrastructure, for teachers, and for improving the quality of education from elementary to high school levels. The total number of students from primary school to senior high school in 33 provinces is 45 million students. If the budget is calculated per student capita, the average value of the education budget is IDR 5.9 million per student per year. Province with the largest budget value is Province 91 with a value of IDR 8.9 million per

student per year. The province with the smallest budget is Province 32 with a value of IDR 3.4 million per student per year.

### Net Enrollment Rate (NER) Output

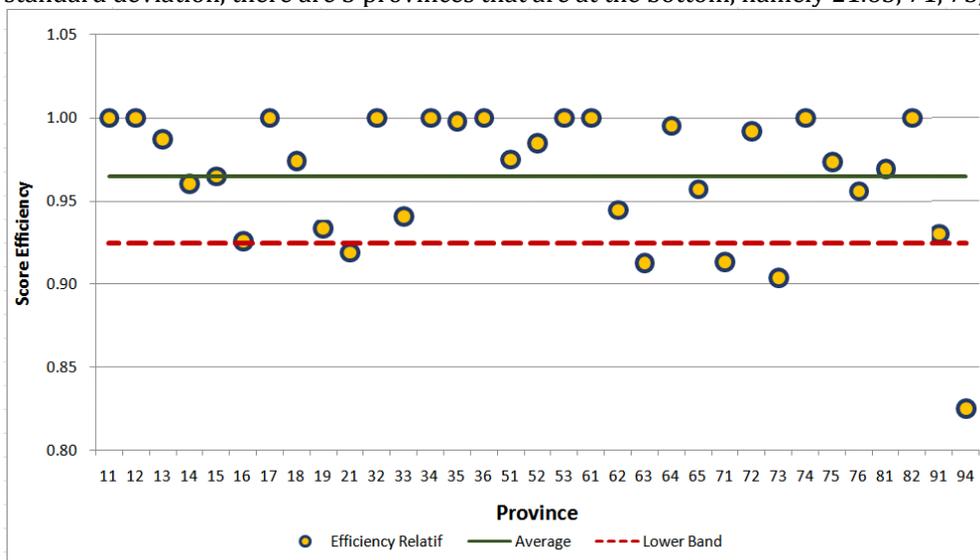
The efficiency analysis of the use of educational inputs to produce educational output in the form of NER using DEA can be seen in the following figure. Provinces with potential NER for improvement are provinces 94. The gap between realization and projection from DEA analysis is the biggest. The realization of NER in Province 94 was 53.56, while the projection result of DEA reached a value of 64.90 or could be increased by 11.35.



**Figure 11. DEA analysis for NER output**

Source : Author Analysis.

Judging from the value of the efficiency score, there are 12 provinces that have been efficient in using inputs to produce the best NER output. The lowest efficiency is in the province 94 which only reaches 0.83. By using a lower band of 1 standard deviation, there are 5 provinces that are at the bottom, namely 21.63, 71, 73, and provinces 94.



**Figure 12. Efficiency Score for NER output**

Source: Author Analysis.

If all provinces can use inputs, especially budget inputs efficiently, budget savings can be obtained. Budget observation simulation can be calculated by finding the difference between the budget input realization and the budget input projection. The value of the difference in the per capita budget in each province is multiplied by the number of students in the province concerned. The total savings from budget inputs in each province, the total value is IDR 35 trillion.

### National Examination Output

In the efficient analysis of the use of educational inputs to produce educational output in the form of the National Examination, the biggest gap between realization and projection occurs in the province of 75. The realization of the

Provincial National Exam 75 is 43.74, while the projection results of the DEA reach a value of 50.67 or can be increased by 6.94.

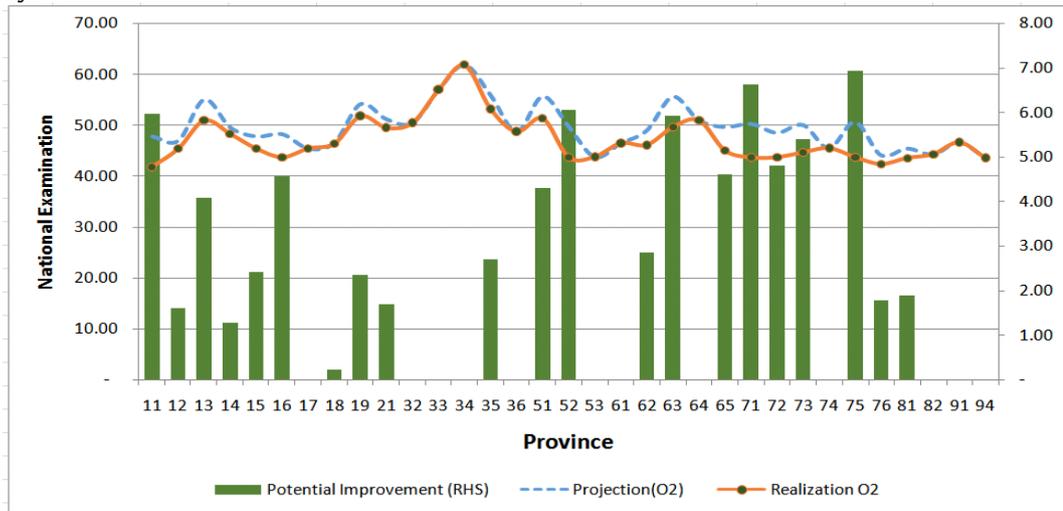


Figure 13. DEA analysis for National Examination output

Source: Author Analysis.

Judging from the value of the efficiency score, the use of input to produce the output of the national exam which produces an efficiency of 1 is in 13 provinces. The province with the lowest efficiency was Province 75 with an efficiency score of 0.83. There are 8 provinces whose efficiency scores are still below the lower band with 1 standard deviation, namely the provinces of 11,16,52,63,71,72,73 and 75. Province 94, which has the lowest NER output efficiency, turns out to be in the National Exam it has an efficiency of up to 1 or is efficient in the use of inputs. The simulation of budget savings for the output of the national exam obtained a total savings from the budget input in each province totaling IDR 1.3 trillion.

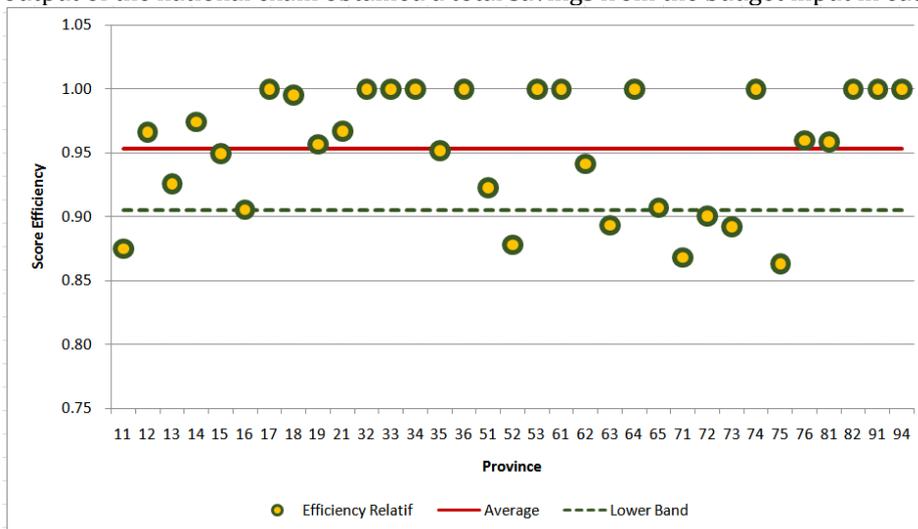


Figure 14. Efficiency Score for National Examination output

Source: Author Analysis.

#### 4. CONCLUSIONS

The efficiency of management of the Indonesian education sector needs to be continuously evaluated how efficient the use of educational inputs is in its output. By knowing which provinces are inefficient, it will be easier to evaluate so that existing inputs can be allocated appropriately and efficiently.

If the input, especially budgetary input, can be used efficiently, savings will be obtained that can be allocated to increase the education output up from the NER output or increase the results of the national examination.

The results showed that there are 12 provinces that have been efficient to produce the best NER output. On the other hand, there are 5 provinces that are at the bottom, which the lowest efficiency is province 94 (Papua). Besides that, there are 13 provinces that have been efficient to produce the national exam. On the contrary, there are 8 provinces that are at the bottom, which the lowest efficiency is province 75 (Gorontalo).

There are provinces that are good at producing output 1, but not good at producing other outputs. Like Province 94, the use of inputs produced the lowest NER output, but was successful in producing the national exam output. With partial output analysis, it can be obtained more detailed information about which output should be improved.

If all provinces in Indonesia are efficient in managing the input of the education budget, to produce the current output, the education budget can be saved. The potential for savings in the education budget in 33 provinces is up to IDR 36.3 trillion. The government needs to evaluate the performance of the use of inputs, especially the education budget input, so that the educational output, both NER and national exams in the future, can be increased.

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## ANNEX

### Provincial code

Code	Province	Code	Province
11	Nangro Aceh Darusalam	52	Nusa Tenggara Barat
12	Sumatera Utara	53	Nusa Tenggara Timur
13	Sumatera Barat	61	Kalimantan Barat
14	Riau	62	Kalimantan Tengah
15	Jambi	63	Kalimantan Selatan
16	Sumatera Selatan	64	Kalimantan Timur
17	Bengkulu	65	Kalimantan Utara
18	Lampung	71	Sulawesi Utara
19	Bangka Belitung	72	Sulawesi Tengah
21	Kepulauan Riau	73	Sulawesi Selatan
31	DKI Jakarta	74	Sulawesi Tenggara
32	Jawa Barat	75	Gorontalo
33	Jawa Tengah	76	Sulawesi Barat
34	DI Yogyakarta	81	Maluku
35	Jawa Timur	82	Maluku Utara
36	Banten	91	Papua Barat
51	Bali	94	Papua

## THE CONSTRUCTION OF A TERRITORIAL (ENVIRONMENTAL) GOVERNANCE INDEX FOR THE BRAZILIAN AMAZON REGION

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### ABSTRACT

Brazilian environmental public policy has advanced in an attempt to control illegal deforestation in the administrative political region called the Legal Amazon over the past twenty years. The environmental governance structure in the region was improved, such as the creation of conservation units, tightening environmental legislation, improvement in the systems for monitoring, inspection and control of deforestation, including the performance in illegal deforestation combat carried out by government agencies such as IBAMA, the federal police and the military. In addition, networks and channels for popular participation in civil society councils and associations were strengthened. In spite of this the enforcement capacity is not sufficient to dealing with the deforestation problem in all its dimension and complexity. Considering this scenario, through Factor Analysis and Principal Component Analysis, this article builds an index of territorial (environmental) governance in the Amazon to assess environmental governance in that region. This index was composed by six governance sub-indices estimated to reflect local dimensions, namely: Governance Capacity; Effectiveness and Control of Deforestation; Living Conditions; Productive Structure; Government Intervention and Social Participation. After that these sub-indices was used to study spatial correlations between them, applying the Exploratory Analysis of Spatial Data (Moran's I and Lisa Map.). The main results of this index confirm relative weaknesses in environmental governance in the Amazon region, especially with regard to the dimensions: government capacity and government intervention, but with significant spatial differences in their municipalities. Otherwise, the results also revealed that the municipalities with greater social participation, cooperation and social cohesion (high-high Social Participation) are confused with those with greater ability to govern (governance capacity) and government intervention, with local influences more relevant among the municipalities of the southeast of Pará, southwestern Tocantins and Mato Grosso, and among the municipalities of the metropolitan area of Manaus, mainly.

### KEYWORDS

Territorial Governance; Factor Analysis; Principal Component Analysis; Exploratory Analysis of Spatial Data; Brazilian Amazon Region.

### 1. INTRODUCTION

The word "governance" incorporate many interpretations and connotations within domains in different areas of knowledge. However, there is a convergent sense toward understanding it as different patterns of cooperation and articulation, including formal and informal networks between social actors, under manifold institutional arrangements, that express authority's exercise to coordinate and regulate transactions (transaction costs) and to promote economic development (World Bank, 1992; Santos, 1997; Stoker, 1998; Kauffman, Kraay & Zoido-Lobaton, 2000; Dallabrida & Becker, 2003; Dellabrida, 2011; Kauffman, Kraay & Mastruzzi, 2011).

Adherent to this definition is the governance idea related to the coordination of economic actors, who, within the same geographic proximity, face the problems addressed to these territories (Pecqueur, 2000). This coordination and articulation are also carried out through networks which public policies are manifested (Calmon & Costa, 2013), and can be thought as social capital level expression obtained within the environment of this governance. This means good governance should be thought as goal and, at same time, as a process (Basu, 2002) that accelerates the achievements of individual and society-wide desirable objectives.

The Brazilian territorial development, in general, related to regional development policies has as historical characteristic the centralization of the initiatives and little articulation with the experiences generated by the local agents themselves. This has been the practice of elaborating regional programs and policies for the Amazon in an attempt to create a connection between the region's economy and the national economy, in general, from the interest of the latter.

Thus, the perspective of territorial governance in the Amazon region in Brazil has been conducted toward the exploration and appropriation of its natural resources: forestry, water resources, including for energy purposes and more recently

for ecosystem services uses, especially of biodiversity, as an integration way of local economies into the national economy.

Indicators can be a valuable informational tool to subsidize the managers, detailing the knowledge of facts and processes, allowing the diagnosis of the municipal situation and the evaluation of the results of the public action.

In the specific case of this article, an attempt is made to construct an index that expresses the various dimensions of governance in the region, reflecting, to a certain extent, the very weaknesses of the exercise of governmental authority and its representative institutions. In addition, environmental governance is conceived as the central element in the operation of its construction.

## 2. METHODOLOGICAL REVISION OF GOVERNANCE INDEX

Social indicators can be grouped based on the objectives they are intended in terms of what they measure and the public policy that underpins them. Thus, there are social indicators that involve, for example, different dimensions of society, such as education, health, quality of life, housing (housing), security, degree of urbanization, environmental sustainability, among others.

On the other hand, one can think of specific indicators in each social dimension, such as indicators of sustainability and environmental quality, urban indicators, health indicators, educational indicators, public safety indicators, indicators of corruption, poverty indicators, among others. However, indicators can be classified by their comprehensiveness in terms of uni or multifaceted aspects or dimensions of reality between those involving elements or macroeconomic aspects of reality and those involving particular elements or aspects.

Broad index examples are: Human Development Index (HDI); FIRJAN Municipal Development Index; Environmental Sustainability Index - ESI; Social Progress Index (SPI), among others.

The starting point for establishing a Territorial Governance Index, which will meet the expectation of good governance, is to establish its relevant dimensions, that is, those that have desirable aspects or characteristics, at least from the normative point of view, so that the existing governance structure at its various scales or levels can work. The experience of other governance indices helps in this direction.

### 2.1 Governance Index

An international benchmark on governance index is derived from the World Bank Governance Indicators (Kauffman, Kraay & Zoido-Lobaton, 2000; Kauffman, Kraay; Mastruzzi, 2011), in which governance is understood from three dimensions: a) as the process by which governments are selected, monitored, accountable and replaced; b) the capacity of governments to manage resources efficiently, as well as formulate, implement and enforce their policies and regulations; c) respect of citizens and the state itself the institutions that govern the social interactions between them.

Six would be the sub-dimensions forming this indicator: i) Voice and Accountability; (ii) Political Stability and Absence of Violence / terrorism; iii) Government Effectiveness; iv) Regulatory Quality; v) Rule of Law and vi) Control of Corruption, with each group of two corresponding to the dimensions previously mentioned, as described below (Kauffman, Kraay & Mastruzzi, 2011).

In Brazil, the most recent governance index, was elaborated by the Federal Council of Administration and called the Municipal Governance Index (MGI-FCA), which involves three dimensions: public spending and finances, quality of management and performance. The first dimension has two (2) indicators, formed by three variables; the second dimension consists of 7 (seven) indicators, related to 45 (forty five variables), while the last dimension is composed of 6 (six) indicators, generated from 17 (seventeen) variables.

Another index that also has the character of evaluating governance is the Institutional Capacity Index - ICI (Nunes et al., 2014), which has, as a theoretical scope, the New Institutional Economy.

Another experience in the construction of an institutional performance indicator was the elaboration of the Municipal Institutional Quality Index - MIQI, by the Brazilian Ministry of Planning, Budget and Management - MPBM.

The MIQI is composed of three dimensions: degree of participation, financial capacity and managerial capacity, each with equal weight distribution (33.3%).

## 3. EMPIRICAL STRATEGY

Based on the procedures suggested by Cohen & Franco (1983) and Januzi (2005), the empirical strategy used in the construction of the Territorial Governance Index was divided into three phases. The first phase consisted of the construction of subindex, one for each chosen dimension. In order to do so, we used the Principal Components Analysis and Factor Analysis, to "reduce" the set of selected variables in each dimension. The second phase was established as the compilation of the composite index, which was determined from the simple arithmetic mean of the indices considered. The third phase was composed by the Exploratory Spatial Data Analysis of the subindex and the computed final composite index.

It is observed that, with respect to the qualitative variables, it was adopted as criterion to create a subscript, from the proportion of attributes that the municipality had in relation to the total of possible attributes. This procedure was used with respect to the attribute of belonging or not of the municipality to a rural territory or to a territory of citizenship. Thus, 1 was assigned to municipalities belonging to a rural territory or territory of citizenship and 0, if the municipality does not belong. Another attribute considered was the municipality being or not reached by dams (being in its area of influence). In this case, 1 was assigned to the municipality belonging to the area of influence of the dams and 0, in case the municipality does not belong to this area.

In the dimension of participation, cooperation and social cohesion, as all variables were dichotomous, we assigned 1 has the attribute and 0, otherwise, then the subindex of the dimension itself was calculated as the proportion of attributes, in relation to the total attributes possible, in this case, nineteen, which, therefore, corresponds to the total number of variables used in this dimension.

$$I_i = \frac{a_i^j}{\sum_{i=1}^{n=19} a_i^j} \quad (1)$$

$I_i$  = Attribute Index or Dimension  $i$ ;

$a_i^j$  = attribute or dimension  $i$  in the municipality  $j$ , wherein  $i$  ranges from 1 to 19.

On the other hand, the mathematical formulation used from which the indices of the continuous variables were elaborated based on the Factor Analysis was:

$$I = \sum_{j=1}^q \left( \frac{\varphi_j}{\sum_j \varphi_j} FP_{ij} \right) \quad (2)$$

where  $\varphi_j$  is the eigenvalue, generated from factorial analysis, so are multiplied the relative participation these eigenvalue in the set of eigenvalues by their characteristic roots  $FP_{ij}$ . In addition, to place the variables in the same interval between 0 and 1, normalization of the values of  $I$  was performed based on the following expression:

$$I_n = \left( \frac{F_{ij} - F_{ij}^{min}}{F_{ij}^{max} - F_{ij}^{min}} \right) \quad (3)$$

where,  $F_{ij}^{min}$  is the minimum value e  $F_{ij}^{max}$  is the maximum value between the index.

After findingg the subindex and index, we adopted the Exploratory Spatial Data Analysis – ESDA, with the objective of testing the influence of spatial autocorrelation on the distribution of indexed attributes in Amazonia Lagal geographic space (Anselin, 1996).

In this case, we opted to use LISA (Local Indicators of Spatial Association), also called Local Moran’s  $I$  (Anselin; Bera, 1998), to permit evaluate the individual contribution of each municipality to the formation of the global indicator. The local spatial autocorrelation indicators are visualized on a geographic map (LISA map) in order to identify the spatial heterogeneity dimension among the municipalities.

### 3.1 Data Source

The construction of the data sources used was based on the recognition of the existence of six competing dimensions for the index formation. Three dimensions that express the quality and strength of governance: 1) Governance Capability; 2) Government intervention; and 3) Participation, Collaboration and Social Cohesion. And three dimensions that, in the specific case of the Amazon, converge to its weakness or the lack of robustness of this governance: 1) Effectiveness of the Control of Deforestation; 2) Living Conditions; and 3) Productive Structure.

Governability is related to variables that describe a greater capacity of municipal governments to manage public activities (services) in their sphere, and this is directly linked to their greater autonomy and financial independence in relation to the state, as well as their participation in the economy of the state and even the region. In this dimension, the following variables were tested: relationship between the municipality's GDP and the state's GDP; relation between the GDP of the municipality and the GDP of the Amazon; Firjan Index; Firjan Index Recipe; Firjan Index Investment; Firjan Liquidity Index, whose original data sources were IPEAdata and FIRJAN.

The Government Intervention dimension considers the three main forms and experiences of federal government intervention in the region: through agrarian reform policy; through large public enterprises such as the large dams - hydroelectric power plants; the creation of environmental conservation units and, more recently, the regional development policy of a territorial nature, which gave rise, among other things, to the creation of the Rural Territories and Territories of Citizenship. In this dimension, the following variables were tested, with the respective data sources: household capacity in the settlement (INCRA); number of families living in settlements (INCRA); total settlement area (INCRA); and the relationship between the area of the municipality destined to a Conservation Unit and the total area of the municipality (MMA). In addition, three dummy variables were considered in this dimension - dichotomous, conferring 1 if the municipality had the attribute and 0, otherwise. Here the variables appeared: belonging to a rural territory (MDA); belonging to a territory of citizenship (MDA) and belonging to the area of influence of dams (MMA).

The dimension of Participation, Collaboration and Social Cohesion was formed by a set of variables that express the degree of maturity of the citizens of the municipality in the creation of participatory forums and social representation. Here, also, the variables were considered as attributes and, therefore, are dichotomic, calculated as 1, if the municipality has this attribute, and 0, otherwise. The variables tested were: existence of Municipal Education Council; existence of Municipal Health Council; existence of Municipal Housing Council; existence of Municipal Sanitation Council; existence of Municipal Council of Human Rights; existence of the Municipal Council for Children and Adolescents; existence of an Environmental Service Contract; existence of Municipal Council of Environment; existence of Municipal Environment Fund; the municipality performs environmental licensing at the site; the municipality has some cooperation instrument with state environmental agency; the municipality has specific legislation to address the environmental issue; the municipality is part of the river basin committee; the municipality participates in an intermunicipal public consortium; the municipality participates in a public consortium with the state; the municipality participates in a consortium with the

federal government; the municipality has some partnership with the private sector; the municipality has support from the private sector or the community; the municipality hosted the Cities Conference. All variables were based on IBGE. On the other hand, the detrimental dimensions are related lack of control of deforestation, to the productive structure, in which only variables were considered that are directly connected at some level of influence on the environment - use of natural resources and, in particular, life conditions, whose low quality of life expressed in several development indicators in the municipality, in the areas of health, education, public services, among others, was considered.

Regarding the Effectiveness dimension of Deforestation Control, the following variables were tested, with the respective sources of observations: cattle herd (IPEAdata); area planted with temporary crops (IPEAdata); area planted permanent crop (IPEAdata); area of the municipality (INPE); accumulated deforestation (INPE); proportion of deforestation (INPE); forest area (INPE); proportion of forest area (INPE); and annual deforestation rate (INPE).

As for the Productive Structure dimension, the following variables were tested: percentage of persons employed in the mineral extractive sector; percentage of people employed in the agricultural sector; degree of formalization of the work of the employed persons. All had their source from the data UNDP.

Finally, the list of variables tested in the conditions of Life dimension comprised: life expectancy at birth; infant mortality up to 1 year of age; infant mortality up to 5 years of age; expected years of study (18 years of age); Adult illiteracy rate up to 15 years; Human Development Index; Human Development Index Education; Human Development Index Longevity; Human Development Index Income; Gini index; proportion of extremely poor; proportion of vulnerable to poverty; income ratio of the richest 10% and the poorest 40%; income ratio of the richest 20% and the poorest 40%; average per capita income; average household income per capita of the extremely poor; average per capita household income of the poor; average per capita income of vulnerable to poverty; Theil Index; total population living in permanent private households; percentage of the population living in households with channeled water; percentage of households with inadequate water supply and sewage. Here, also, the original source of the data was UNDP.

The final empirical model that was estimated to generate the Factor Loads of each dimension took into account the commonalities, that is, the measure of how much of a variable's variance is explained by the factors derived by the factorial analysis.

Before we apply the techniques selected here, it is necessary to test how large the correlations between the variables are in order to justify the application of these two methods. In this direction, two tests are usually employed: the Kaiser-Meyer-Olkin (KMO) sample adequacy measure and the Bartlett sphericity test. In the first case, it is verified (Table 2) that not all the KMO tests presented satisfactory results, so that the dimensions Governance Capacity and Productive Structure, presented the test values 0.3607 and 0.4932, respectively. However, in the second case, the variance independence Likelihood Ratio tests (Bartlett's test) checked for each dimension results lower than the 5% test statistic and, therefore, we reject the null hypothesis of correlation identity matrix (Ranher, 2002) (Table 2).

**Tabela 2: Resultados dos Testes de Adequação do Modelo Selecionado**

<b>Governance Capability</b>		
Kaiser- Meyer-Olkin	0,3607	
	Approx. Chi-Square	2275,85
Bartlett's sphericity test	Sig	0,0000
<b>Effectiveness of the Control of Deforestation</b>		
Kaiser- Meyer-Olkin	0,6553	
	Approx. Chi-Square	8834,68
Bartlett's sphericity test	Sig	0,0000
<b>Living Conditions</b>		
Kaiser- Meyer-Olkin	0,8670	
	Approx. Chi-Square	50000
Bartlett's sphericity test	Sig	0,0000
<b>Productive Structure</b>		
Kaiser- Meyer-Olkin	0,4932	
	Approx. Chi-Square	357,41
Bartlett's sphericity test	Sig	0,0000
<b>Government Intervention</b>		
Kaiser- Meyer-Olkin	0,7191	
	Approx. Chi-Square	5143,57
Bartlett's sphericity test	Sig	0,0000

Source: Prepared by the authors. Stata Program 13.

It was adopted as a criterion to define the number of relevant factors, to consider the results of their eigenvalues above the unit or respective individual proportion explained by them, above 5% (Edwards, 1991; Rachman, 2002; Raykok, 2008). It should be noted that a rotated array indicates the best particular combination of the original variables, which further explains the variances of the data as a whole than any other linear combination of variables. The rotation used was by the Varimax method, since this one tries to minimize the number of variables with high loads in a factor, that is, to maximize the variance of the load.

In Table 3, the results of the Factor Analysis, according to the eigenvalue, are presented the individual and accumulated proportion of each factor for the non-rotated and rotated matrix. It is observed that, for the Governance Capability

dimension, both in relation to the non-rotated matrix and in relation to the rotated matrix, only three factors had an eigenvalue / variance above the unit, representing 82.95% of the cumulative proportion / variance.

**Table 3: Factors – Governance Capability Dimension**

Factors	Non-Rotation Matrix			Rotation Matrix		
	Eigenvalue	Proportion	Acumulated	Variance	Proportion	Acumulated
Fator 1	2,3139	0,3857	0,3857	1,8887	0,3148	0,3148
Fator 2	1,6598	0,2766	0,6623	1,8255	0,3042	0,6190
Fator 3	1,0033	0,1672	0,8295	1,2630	0,2105	0,8295
Fator 4	0,7027	0,1171	0,9466			
Fator 5	0,2466	0,0411	0,9877			
Fator 6	0,0735	0,0123	1,0000			

Source: Prepared by the authors. Stata Program 13.

Regarding the Effectiveness dimension in Deforestation Control (Table 4), Factor Analysis results indicated that only three factors had an eigenvalue / variance above the unit, representing 85.54% of the accumulated proportion / variance.

**Table 4: Factors – Effectiveness of the Control of Deforestation Dimension**

Factors	Non-Rotation Matrix			Rotation Matrix		
	Eigenvalue	Proportion	Acumulated	Variance	Proportion	Acumulated
Fator 1	3,8453	0,4807	0,4807	2,7263	0,3408	0,3408
Fator 2	1,6500	0,2063	0,6869	2,7069	0,3384	0,6791
Fator 3	1,3483	0,1685	0,8554	1,4104	0,1763	0,8554
Fator 4	0,6669	0,0834	0,9388			
Fator 5	0,3734	0,0467	0,9855			
Fator 6	0,0962	0,0120	0,9975			
Fator 7	0,0179	0,0022	0,9998			
Fator 8	0,0020	0,0002	1,0000			

Source: Prepared by the authors. Stata Program 13.

As regards the Living Conditions dimension (Table 5), five factors with eigenvalue / variance above the unit, bringing together in the non-rotated matrix, as well as in the rotated matrix, 89.32% of the cumulative proportion / variance.

**Table 5: Factors – Living Conditions Dimension**

Factors	Non-Rotation Matrix			Rotation Matrix		
	Eigenvalue	Proportion	Acumulated	Variance	Proportion	Acumulated
Fator 1	12,659	0,5504	0,5504	6,7380	0,2930	0,2930
Fator 2	3,9268	0,1707	0,7211	5,3791	0,2339	0,5268
Fator 3	1,6208	0,3195	0,7916	5,0973	0,2216	0,7485
Fator 4	1,3013	0,0566	0,8482	1,9727	0,0858	0,8342
Fator 5	1,0346	0,0450	0,8932	1,3553	0,0589	0,8932
Fator 6	0,7133	0,0310	0,9242			
Fator 7	0,5230	0,0227	0,9469			
Fator 8	0,3244	0,0141	0,9669			
Fator 9	0,3020	0,1312	0,9741			
Fator 10	0,1708	0,0074	0,9816			
Fator 11	0,1422	0,0062	0,9877			
Fator 12	0,1137	0,0049	0,9927			
Fator 13						
Fator 14						
Fator 15						
Fator 16						
Fator 17						
Fator 18						
Fator 19						
Fator 20						
Fator 21						
Fator 22						
Fator 23						

Source: Prepared by the authors. Stata Program 13.

The results for the Productive Structure dimension, (Table 6), showed only two factors with eigenvalue / variance above the unit, bringing together in the non-rotated matrix, as well as in the rotated matrix, 87.31% of the accumulated proportion / variance.

**Tabela 6: Fatores – Produtive Structure Dimension**

Factors	Non-Rotation Matrix			Rotation Matrix		
	Eigenvalue	Proportion	Acumulated	Variance	Proportion	Acumulated
Fator 1	1,6156	0,5385	0,5385	1,6150	0,5383	0,5383
Fator 2	1,0036	0,3345	0,8731	1,0042	0,3347	0,8731

Elaboração dos autores. Programa Stata 13.

Finally, in relation to the Government Intervention dimension (Table 7), only one factor presented an eigenvalue / variance above the unit, bringing together in the non-rotated matrix, as well as in the rotated matrix, 97.03% of the cumulative proportion / variance.

**Tabela 7: Fatores – Government Intervention Dimension**

Factors	Non-Rotation Matrix			Rotation Matrix		
	Eigenvalue	Proportion	Acumulated	Variance	Proportion	Acumulated
Fator 1	2,9109	0,9703	0,9703	2,9109	0,9703	0,9703
Fator 2	0,0829	0,0276	0,9979			
Fator 3	0,0062	0,0021	1,0000			

Source: Prepared by the authors. Stata Program 13.

From the factors selected as relevant in each dimension, the variables were selected, considering the weight in the factorial loads, as well as the respective "uniqueness" (unexplained part of the variance of the variable), from the result of the matrices rotated in each dimension. Thus, from the criteria defined above, the variables selected in each dimension were: 1) Governability: partipibest; partipibamaz; IFGF; IFGF\_R; IFGF\_I; IFGF\_L; 2) Effectiveness in Deforestation Control: Inefebov; Inareaplavtemp; Inarea; Indeflorestmento; Inpdesm; Infloresta; Inpfloresta; Intxdesm; 3) Conditions of Life: Inpespvida; Inmi1; Inmi5; Inanoest; Intxa15; IDHM; IDHM\_E; IDHM\_L; IDHM\_R; gini; Inpind; Inppob; Inpmpob; In1040; In2040; Inrdp; Inrind; Inrmpob; Inrpob; THEIL; Inpop; Inpagua; Inaguaesg; 4) Productive Structure: Inpagro; Inpextr; Inpformal; 5) Government intervention: Incapac; Infam; Inareakm2.

In order to define the subindex, referring to the five dimensions of governance composed only of continuous variables, a matrix of factorial scores was estimated after the orthogonal rotation of the initial factorial structure, considering the weight of each factor along the characteristic roots, constructed from the division of the score of each factor by the sum of all eigenvalues, being the factorial weights are used in combination with the values of the original variable to calculate the score of each variable. Table 8 below shows the correlations of the subindex of territorial governance dimensions.

**Tabela 8: Correlation of the Normalized Territorial Governance Subindex**

	ICGOV	IEF	ICV	IEP	ITGOV	IPS
ICGOV	1,0000					
IEF	0,0475	1,0000				
ICV	-0,4767	0,0290	1,0000			
IEP	-0,5382	0,0333	0,7859	1,0000		
ITGOV	0,0512	0,4522	0,0516	-0,0389	1,0000	
IPS	0,3233	0,0700	-0,3410	-0,4098	0,1877	1,0000

Source: Prepared by the authors. Stata Program 13.

Table 8 shows that there is a negative correlation between ICV (subscript that expresses living conditions) and ICGOV (subscript that expresses governmental capacity), which indicates a contrary direction of the administrative and management capacity of the municipalities in relation to the improvement of the quality of life of its citizens, and, in addition, this low quality of life (ICV) has a strong positive correlation with the characteristics of the productive structure (IEP) dependent on the natural resources base of the region and low capacity to generate employment and income. It is also observed the characteristics of this archaic and underdeveloped productive structure expressed in IEP present negative correlation with IPS and ITGOV. In the first case, it shows that, in municipalities with greater participation, cooperation and social cohesion, including between federal entities and their citizens, this goes against the productive structure more dependent on the exploitation of natural resources. This is also reinforced by the experiences of government implemented, although with very low negative correlation.

At that point, reinforcing governance capacity through experiences and progress (ITGOV), especially of an environmental nature, seems to suggest, due to the negative correlation between the index, that the pressure for natural resources, control of deforestation (IEF).

**4. INTERPRETATION OF RESULTS**

As previously mentioned, we seek to describe and identify spatial regimes with similar characteristics, configuring spatial clusters, as well as the identification of atypical localities with discrepant attributes in relation to the mean, typically called spatial outliers. In the scope of this study, such localities assume the geographical dimension of the municipalities of the Legal Amazon, and attributes are the governance sub-indices estimated from six local dimensions, namely:

Governance Capacity (ICGOV), Effectiveness and Control of Deforestation (IEF), Living Conditions (ICV), Productive Structure (IEP), Government Intervention (ITGOV) and Social Participation (IPS).

The first hypothesis to be explored is the absence of spatial dependence. It means that any governance index of a given municipality can not depend on the socioeconomic conditions established in its closest neighbors. If this occurs, fortuitously, then each index would be the exact representation of the socioeconomic relations carried out internally in each municipality, disregarding any kind of external interference. Since the nature of some relationships does not depend on geographic distance, finding evidence to support such a hypothesis is not a trivial exercise. However, it can be conducted through statistics that provide spatially correlated autocorrelation coefficients at local and global levels.

Table 9 shows a matrix with coefficients of global spatial autocorrelation inferred from the Moran (1948) statistic. Its main diagonal contains univariate coefficients that record the spatial correlation of the same index, but distributed in different municipalities. The elements above the main diagonal, in turn, correspond to the bivariate coefficients and record the influence of any index on any other indexed to the nearest neighbors. It is worth mentioning that the spatial connectivity was established through a binary matrix of contiguity that attributes: 1 to the neighbors of first order; and 0 in all other cases. In order to restrict the coefficient of spatial autocorrelation between 0 and 1, this matrix was normalized in the line.

We test the null hypothesis that the variables underlying the dimensions (represented in the sub-indices) are distributed randomly in space, implying in the absence of spatial dependence. As can be seen (Table 9), there is insufficient statistical evidence supporting this hypothesis, either in the univariate or bivariate context. All univariate Moran I coefficients are positive and statistically significant at 5% probability of error, indicating that improving the quality of any index, in most of the municipalities of the Legal Amazon, should generate external benefits that affect first-order neighbors. In this sense, it is worth mentioning the actions of command and control to combat deforestation in the Legal Amazon, represented by the IEF, whose actions will be more effective if spatially coordinated in the regions where this problem is most incident. Another prominent result refers to the bivariate correlation established between ICV and ICGOV (Table 9). Its estimated negative coefficient indicates that improving living conditions reduces not only the cost relative to the municipality's own governance capacity but also generates positive externalities in the neighborhood. An example of this is with hospital medical services of medium-high complexity, which are generally not available everywhere. Better basic health care in the most isolated municipalities (improving quality of life) should reduce the pressure on hospital services offered by large urban centers in the Legal Amazon.

**Table 9: Moran's I Spatial Correlation Coefficients**

	ICGOV	IEF	ICV	IEP	ITGOV	IPS
ICGOV	<b>0,1921</b> (8,687) [0,001]	<b>0,0643</b> (4,151) [0,001]	<b>-0,1961</b> (-11,636) [0,001]	<b>-0,0991</b> (-6,048) [0,001]	<b>0,0386</b> (2,438) [0,008]	<b>0,0951</b> (5,697) [0,002]
IEF		<b>0,8111</b> (37,046) [0,001]	<b>0,3181</b> (18,925) [0,001]	<b>0,4232</b> (24,436) [0,001]	<b>0,4613</b> (24,894) [0,001]	<b>0,0425</b> (2,625) [0,006]
ICV			<b>0,6951</b> (33,223) [0,001]	<b>0,5823</b> (30,026) [0,001]	<b>0,2052</b> (13,255) [0,001]	<b>-0,1092</b> (-6,576) [0,001]
IEP				<b>0,6162</b> (29,986) [0,001]	<b>0,2383</b> (14,484) [0,001]	<b>-0,0688</b> (-4,254) [0,001]
ITGOV					<b>0,4013</b> (18,121) [0,001]	<b>0,0972</b> (5,886) [0,001]
IPS						<b>0,1415</b> (6,456) [0,001]

Nota: Coeficientes de correlação espacial univariado e bivariado em negrito, valores críticos da distribuição normal entre parênteses, e probabilidade de aceitar a ausência de correlação espacial entre colchetes.

Fonte: Resultado da pesquisa.

Based on the six governance sub-indices of the municipalities of the Legal Amazon, the LISA index were estimated. Of the 792 municipalities surveyed, 570 appear with a non-significant LISA index at 5%, 75 municipalities were classified as High-High, and 105, as Low-Low. It should be noted that the Low- Baixo concentrates mainly in the north of the state of Pará, more specifically in the Island of Marajó, and in areas of the state of Maranhão; the Alto-Alto group, in turn, covers mainly municipalities in the state of Mato Grosso and Rondônia.

The High-High group on IEF is the most comprehensive in territorial terms, involving 226 municipalities that share positive externalities. This result refers to the magnitude of the autocorrelation coefficient of Table 13, as well as to the positive cross-correlations investigated in this study. The Low-Low group, in turn, is concentrated in the extreme east of the Legal Amazon, on the border between Maranhão and Tocantins.

The cost of living is relatively higher, or, in other words, quality of life is lower (High-High ICV group), for those residing in the extreme north of the state of Pará, including Marajó Island, in municipalities in the state of Maranhão and in the

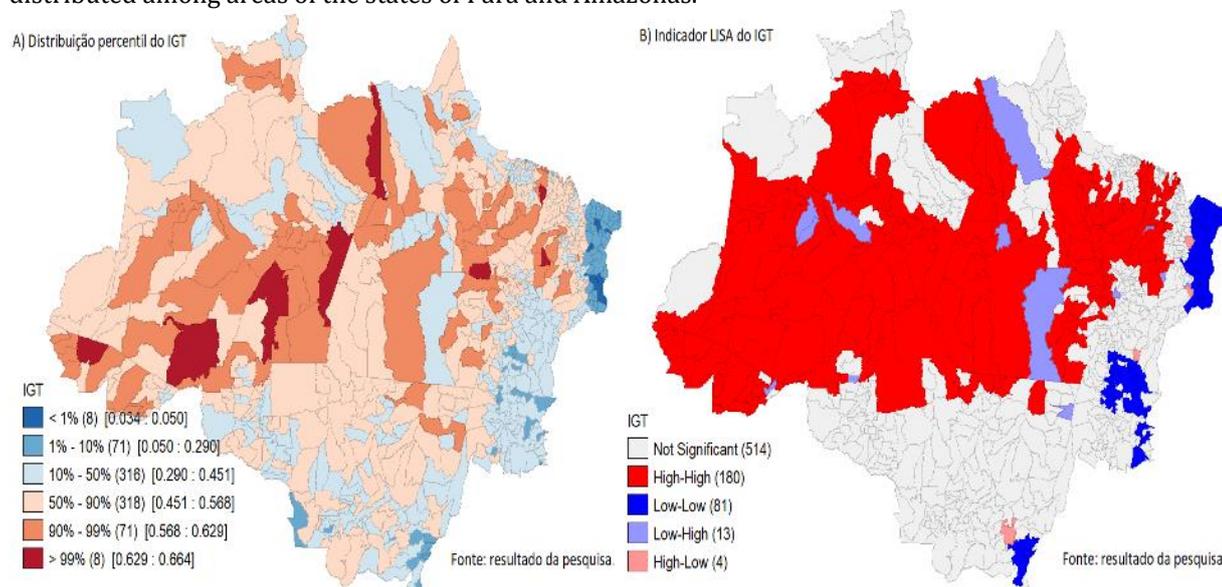
extreme west of the state of Amazonas. Those living in areas of Mato Grosso face less precarious living conditions than the regional average.

Given that the IEP reflects the participation of people engaged in extractive activities of agriculture and mining, then, where the productive structure is more dependent on natural resources, living conditions tend to be more precarious. This positive relationship is evidenced by the cross-spatial correlation coefficient between the ICV and the IEP of Table 9, indicating that municipalities with a high IEP value (High-High group) are confused with the areas mentioned in the previous ICV analysis.

It is not by chance that these areas have received greater intervention from the federal government, as shown by the LISA indices and the cross-spatial correlation coefficient between the IEP and the ITGOV in Table 9. The results (ITGOV High-High group in Figure 6) show that families are settled more frequently in southeastern Pará. The index also points to areas on the border between the states of Amazonas, Mato Grosso, Rondônia and southern Pará.

The results showed that municipalities with greater social participation, cooperation and social cohesion (IPS High-High IPS group, cross-spatial correlation of IPS in Table 9) are confused with those with greater governmental capacity (ICGOV) and governmental intervention (ITGOV). In general, these municipalities offer lower cost of living (ICV) and have a less dependent productive structure of extractive activities based on the exploitation of natural resources. Although evidence shows a significant overall effect, although relatively weak (lower I of Moran IPS in Table 9), more relevant local influences are noted among municipalities in the southeast of Pará, southwestern Tocantins and Mato Grosso, and between the municipalities of metropolitan area of Manaus, mainly.

Based on the previous results, it was possible to calculate a general index that aggregates all six dimensions. The Territorial Governance Index (IGT) is set out in Figure 1. In this, it can be seen that the municipalities with the worst governance indices are located in the state of Maranhão, mainly; and the municipalities with the best results are distributed among areas of the states of Pará and Amazonas.



**Figure 1: Spatial Distribution of the Territorial Governance Index**

Source: Prepared by the authors. R Program.

Finally, it should be noted that the spatial configuration of the global index - IGT is based on positive (good governance) and negative (low governance) forces, the first represented in the subindex governance capacity, government intervention and participation, collaboration and social cohesion. second group integrates the productive structure subindex; effectiveness of deforestation control and living conditions. Thus, it is observed in this general context (IGT) that there is a relatively large number of municipalities that have this indicator low, which indicates a low level of governance in the region, especially to deal with their most emergency problems: deforestation and poor quality of life of the population.

## 5. CONCLUDING REMARKS

Based on the methodology used here, the index prepared was based on the aggregation of different 6 (six) subindex, each representing a significant dimension of governance in the region, despite factors that contribute to "good governance" and factors that contribute to a fragile governance, or that present weaknesses in relation to one of its main objectives, which is to control illegal deforestation in the region.

The results of the sub-indices, elaborated from the Analysis of Principal Components and Factor Analysis, show a very significant correlation and well adherent to the heterogeneous characteristics of the region. Thus, for example, a negative correlation was observed between ICV (subscript that expresses living conditions) and ICGOV (subscript that expresses governmental capacity), which indicates a contrary direction of the administrative and management capacity of the municipalities in relation to the quality of life of its citizens and, in addition, this low quality of life (ICV) has a strong

positive correlation with the characteristics of the productive structure (IEP), very dependent on the natural resource base.

On the other hand, there was a negative correlation between the archaic and underdeveloped productive structure (IEP) and the efficiency of deforestation control (IEF) with the Social Participation Index (IPS), as well as the experiences of governmental intervention in the region (ITGOV), which indicates that municipalities with greater power of cooperation, collaboration and social cohesion, as well as the own experiences of modification of the territory to increase the environmental governance, as, for example, the creation of units of conservation, are forces contrary to the dependency condition of natural resources and their degradation.

Finally, based on the exploratory analysis of spatial data, the spatial distribution of these subscripts and their spatial dependence were verified using Moran's I and Lisa Map. Thus, for example, it was well-established that the Low-Low group of ICV was concentrated in the Marajó Island and in areas of the state of Maranhão, while the High-High group, in turn, covers mainly municipalities of Mato Grosso and Rondônia.

Otherwise, the High-High group related to the IEF is mainly concentrated in the states of Pará and Mato Grosso, the states of greater deforestation in the region. In addition, the Alto-Alto group of ITGOV shows that families are settled more frequently in southeastern Pará. The index also points to areas on the border between the states of Amazonas, Mato Grosso, Rondônia and southern Pará.

In contrast, the results also revealed that the municipalities with greater social participation, cooperation and social cohesion (high-high group IPS) are confused with those with greater ability to govern (ICGOV) and government intervention (ITGOV), with local influences more relevant among the municipalities of the southeast of Pará, southwestern Tocantins and Mato Grosso, and among the municipalities of the metropolitan area of Manaus, mainly.

All these results contribute to the spatial configuration of the global governance index (IGT), which shows that there is a relatively large number of municipalities that have this indicator low, which indicates a low level of governance in the region, especially to deal with its most urgent problems: control of deforestation and low quality of life of the population.

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## POLITICAL DYNASTIES AND HUMAN DEVELOPMENT INVESTMENTS: EVIDENCE OF LINKAGE FROM RIZAL PROVINCE, PHILIPPINES

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### ABSTRACT

To test whether dynastic mayors tend to have lower human development investments for their constituents, this study draws inference from a panel data composed of all 13 municipalities in Rizal, a well-known dynastic province in the Philippines, as a preliminary empirical investigation. These municipalities are dichotomized into dynastic or non-dynastic and observed over 17 years (i.e., 2001-2017). All identified political dynasties are categorized as fat dynasties—elected public officials occupying political seats simultaneously with their relatives over several incumbency periods. Based on the results of Panel-corrected Prais–Winsten Generalized Least Squares (GLS) estimation, this research finds that Rizal municipal governments led by fat dynastic mayors tend to have significantly lower human development investments, compared with non-dynastic counterparts. Specifically, they spend less on human development at the (1) aggregate level (i.e., total municipal expenditure on health, education, and social welfare), at the combined levels of (2) education and health, and (3) at the specific sector of education. These findings are in line with the prediction of the predatory view of political dynasties, particularly the fat type. Results are robust to various alternative model specifications and econometric estimation procedures.

### KEYWORDS

political dynasties, fat dynasties, human development investments, health, education, social welfare, municipal government, municipal expenditure

### 1. INTRODUCTION

A thriving culture of self-perpetuating political families (Rossi, 2017) that manifest elite persistence (Querubin, 2013), hence, the term “political dynasties”, is a hallmark of Philippine politics, particularly at the local level (Teehankee, 2018). Political dynasties in the Philippines are “exceptional in their persistence and scope” (Mendoza, Ong Lopez, & Banaag, 2019, p. 3), so much so that their pervasiveness “is off the chart compared to any other country in the world” (Acemoglu & Robinson, 2013a, para. 3). As it is, nearly 80% of all representatives in the Congress are from political dynasties (Mendoza, Ong Lopez, & Banaag, 2019). At the subnational level, average dynastic share among local government officials stood at 81% for governors and vice-governors, 69% for mayors, and 57% for vice-mayors (Mendoza, 2018).

A political family is considered as political dynasty if it retains political power through maintaining control in at least one elective position over successive electoral cycles (Albert et al., 2015). Alternatively, an elected politician is labeled as “dynastic” if he/she is related by blood (i.e., consanguinity) or by marriage (i.e., affinity) to other politicians currently or previously holding elective public office (Geys & Smith, 2017).

Article II, section 26 of the 1987 Philippine Constitution proscribes political dynasties in the country. However, it requires an enabling legislation to be passed by the Congress to define and implement the said dynastic regulation (Collas-Monsod et al., 2004). Since most representatives in the Congress are members of political dynasties (Mendoza, Ong Lopez, & Banaag, 2019), passing an anti-political dynasty bill remains an uphill battle (Tadem & Tadem, 2016).

Literature on political dynasties is predominantly concerned with why and how they arise and persist (e.g., Dal Bo et al., 2009; Querubin, 2013; 2016). Relatively fewer studies analyze their consequences, particularly with respect to governance, socioeconomic outcomes, and development (Daniele & Geys, 2014; Geys, 2017; Geys & Smith, 2017). Contributing to the latter strand of the literature, this research examines the effect of dynastic presence on human development investments. Specifically, the research investigates the effect of fat political dynasties on human development investments at the municipal level, as reflected in the municipal government expenditure on education, health, and social welfare.

In line with the predatory view of political dynasties, this study posits that fat dynastic municipal governments have significantly lower human development investments compared with non-dynastic counterparts, *ceteris paribus* (i.e., everything else held constant/fixed). To empirically test the theoretical conjecture posed, the study employs a case study approach and draws inference from multivariate panel regression analysis of all 13 municipalities in Rizal province, Philippines observed over a 17-year period (2001-2017). Rizal is a well-known dynastic province in the country.

Based on the results of Panel-corrected Prais–Winsten Generalized Least Squares (GLS) estimation, this research finds that Rizal municipal governments led by fat dynastic mayors tend to have significantly lower human development investments for their constituents, compared with non-dynastic counterparts. These findings are in line with the prediction of the predatory view of political dynasties, particularly the fat type: with wider and deeper entrenchment of

political power due to monopoly of multiple elective positions over consecutive years, fat political dynasties are inherently prone to be predatory—inimical to governance, socioeconomic outcomes, and development.

The rest of the paper is structured as follows: the remaining part of this section provides essential background information; section II presents a review of related literature; section III expounds on the methodology employed; section IV shows the results and offers various plausible explanations; and lastly, section V concludes and outlines several recommendations for further studies.

## Human development investments

Human development is about expanding the richness of people's lives, rather than merely the richness of the economy in which they live. It concentrates on "improving the lives people lead rather than assuming that economic growth will lead, automatically, to greater wellbeing for all" (United Nations Development Programme (UNDP), para. 2, n.d.). As a development paradigm, it endeavors to provide people with greater freedom to live the lives they value (UNDP, n.d.).

Central to the pursuit of human development are human capital accumulation and human capabilities expansion (Sen, 1997). Human capital refers to the stock of skills, knowledge, expertise, and other similar attributes that increase an individual's productivity (Becker, n.d., 1962; Goldin, 2016; Schultz, 1961, 1972). Human capital benefits both the individual and his/her society at large (Abrigo et al., 2017; Schultz, 1961). At the individual level, increased productivity associated with human capital is a source of future earnings or of future satisfaction, or both (Schultz, 1972). At the societal level, a large body of theoretical and empirical literature provides evidence that human capital plays a central role in bolstering economic growth and provides other positive externalities (Abrigo et al., 2017; Goldin, 2016). Nonetheless, the concept of human capital is fundamentally economic in nature (Becker, n.d., 1962; Schultz, 1961, 1972) and relates more to human development as a means to an end. To complement the notion of human capital, Sen (1997, p. 1959) introduces the concept of human capabilities: "the ability of human beings to lead lives they have reason to value and to enhance the substantive choices they have." This, in turn, embraces the end aspect of human development.

Human development will not prosper without necessary government investments aimed at enhancing human capital and enlarging human capabilities (UNDP, 1991). In a decentralized representative democracy like the Philippines, LGUs are at the forefront of such public investment initiative (Manasan, 1997). It is in this context that the study operationally defines human development investments as local government investments, reflected in the level of local public expenditure, on policy areas that directly reinforce both human capital and human capabilities. This definition does not discount the importance of private investments on human development, as people do invest in themselves in the form of private spending (Schultz, 1961). Instead, it highlights the government's pivotal role in helping citizens help themselves, because not all individuals have the initial endowments to be able to invest in their own human capital and capabilities. Disparities in income, age, gender, educational background, health status, and social status are just some of many constraints (Beverly & Sherraden, 1997). In essence, government investments on human development are grounded on both efficiency (in relation to economic growth and positive externalities) and social equity (equal opportunity for all) considerations (Abrigo et al., 2017; Goldin, 2016; Beverly & Sherraden, 1997).

There are three (3) major pillars of human development: the ability to (1) live a long, healthy, and creative life; (2) be knowledgeable; and (3) have access to resources necessary for a decent standard of living (UNDP, n.d.). Progress in these fundamental dimensions of human development is measured through a composite index dubbed as the Human Development Index (HDI) (UNDP, 2016). It is unsurprising then, that discourse on human development investments is heavily focused on public spending on health and education.

Nonetheless, there is mounting recognition that public expenditure on social welfare should also be treated as human development investment, especially in terms of providing social protection and support for rehabilitation to disadvantaged and marginalized groups (Ahn & Kim, 2014; Morel et al., 2012; Gonzalez, 2017). The argument is that government investments in education and health is for all citizens, regardless of their constraints, while investment on social welfare is particularly focused on helping disadvantaged and marginalized groups enhance their human capital and expand their human capabilities to be able to participate in employment and social life (European Commission, n.d.; Beverly & Sherraden, 1997).

Collectively, public expenditure on education, health, and social welfare embodies an inclusive government strategy for human development investments as they represent "an essential part of what governments do to improve the quality of life of their citizens and the foundations of human capital in their societies." (Huber et al., 2008, p. 420). In relation to political dynasties that dominate local governance in the Philippines, the focus is on the level of local public expenditure on the said policy areas at the municipal level.

At this point, it is worthy to note that while it is more desirable to examine the effects of political dynasties directly on outcomes pertinent to human development (e.g., through the HDI), this study focusses instead on local public spending where they have direct influence. As explained by Solon et al. (2009), using local government outlays instead of development outcomes is justified because expenditures are more directly controlled by local leaders—thereby reflecting their real priorities. Consequently, given its implications on human development, local government expenditure on health, education, and social welfare represents a reasonable measure of good performance of incumbent local officials who may be dynastic or non-dynastic (Solon et al, 2009; Manasan, 1997).

## Good governance and decentralization

In a bid to bring governance closer to the people, the Philippine national government devolved substantial taxing, spending, and borrowing powers to local government units (LGUs) through a wide-ranging decentralization process

embodied in the 1991 Local Government Code (henceforth, 1991 LGC) (Llanto, 2012; Manasan, 2005). The central government institutionalized the transfer of the Internal Revenue Allotment (IRA), a formula-based block grant, to help LGUs finance the additional responsibilities (Labonne et al., 2015; National Tax Research Center (NTRC), 2008).

With the 1991 LGC in place, responsibility for basic services delivery were transferred to LGUs (i.e., provinces, cities, municipalities, and barangays): social welfare services, primary health care, hospital care, and an array of agricultural and environmental services.<sup>190</sup> A special case is basic education, as the primary responsibility for its provision still lies with the national government. LGUs' role is limited to the construction and maintenance of basic education infrastructure (e.g., school buildings) and funding of sports activities. At the municipal level, main devolved functions for basic services that relate to human development are as follows: (1) education – construction and maintenance of public elementary schools; (2) health – primary health care; and (3) social welfare – programs and projects concerning the welfare of vulnerable population (i.e., children, youth, elderly, and disabled persons) (WB, 2016; Labonne et al., 2015; Bautista, 2013; Manasan, 2005).

From an economic standpoint, the Philippines' decentralization drive redounds to increased efficiency and effectiveness in public service delivery, given that local chief executives (LCEs) are in a better position to know and respond (given their relative proximity) to the preferences of their constituents compared with national-level officials (Oates, 1972). But from the view of good governance paradigm, decentralization is more than economic welfare gains (Capuno et al., 2012a; Llanto, 2012): it symbolizes the "logical application of the core characteristics of good governance at the sub-national and local levels" (UNDP, n.d., as cited in Brillantes Jr. & Cuachon, 2002, p. 3).

Governance can be considered "good" at the subnational level when local governments effectively and efficiently allocate and manage public resources to respond to collective problems of their constituents, in general, and in relation to human development, to help them attain individual satisfaction and prosperity by providing them with key public services in the fields of health, education, and social welfare (UN Department of Economic and Social Affairs (UN DESA), 2007).

### **Political dynasties: Predatory vs. stationary bandit view**

Although decentralization (ideally) improves local public service delivery and enhances constituents' overall welfare (Solon et al., 2009), it may also reinforce the dominance and propagation of local hegemonies (UN DESA, 2007). In the Philippines, this is evident in the proliferation and perpetuation of political dynasties among LGUs in the Philippines after the 1991 LGC was enforced (Querubin, 2013, 2016).

In general, political dynasties may be considered as extractive political institutions (Acemoglu & Robinson, 2013b) that effectively concentrate and maintain political power within their families as relatives take turn occupying elective positions successively or simultaneously (Simbulan, 2012). Moreover, they "inherit an electoral advantage from their political forebears" (Daniele & Benny, 2014, p. 2)—in the form of "brand name recall", wealth, and control of political and economic resources (George & Ponattu, 2017). Aside from these political and financial capital (Ali, 2016), political dynasties benefit from externalities or spillover effects of the so-called incumbency advantage, which claims that incumbent officials running for re-election have electoral advantage and therefore, more likely to win (Querubin, 2013). In the Philippines, Querubin (2016) finds that candidates related to an outgoing incumbent enjoy an electoral advantage over non-dynastic candidates, but such advantage doubles for candidates who run in an election while their relative still sits in office.

Because of these attributes, members of political dynasties have a higher likelihood of winning elections compared with non-dynastic candidates, all things being equal. Hence, political dynasties may: (1) weaken political competition (high-quality non-dynastic candidates are easily defeated in elections); and (2) and worsen governance and negate accountability (moral hazard problems: self-assured of continuous re-election due to deep political entrenchment, incumbent dynastic officials may (a) not have incentives to engage in productive vote courting activities and hence, underperform in office; (b) implement self-serving policies; and (c) perpetuate corruption). These, in turn, may (3) lead to poorer socioeconomic outcomes and development (Bragança et al., 2015; George & Ponattu, 2017; Geys, 2017; Pano, 2016; Tusalem & Pe-Aguirre, 2013).

Essentially, these socially undesirable characteristics of political dynasties embody the more popular perception on them—the so-called "predatory view" of political dynasties (Solon et al., 2009). Consistent with this perspective, political dynasties are usually portrayed as necessarily inimical within the political science and sociology literature (Mendoza et al., 2016).

However, there is an alternative strand in the economics literature that may possibly see political dynasties in a positive light. That is, if political dynasties govern like "stationary bandits", they may conceivably have positive effects (George & Ponattu, 2017; Mendoza, Jaminola III, & Yap, 2019; Solon et al., 2009). This lesser-known perspective on political dynasties takes off from the idea of economist Mancur Olson (1993). According to Olson (1993, p. 569), a stationary bandit is an autocratic/monarchic-type of leader who has "encompassing interest in the territory he controls and accordingly provides domestic order and other public goods.. at the same time that he extracts the largest possible net surplus for himself." Further, he/she "anticipates and values dynastic succession that further lengthens the planning horizon and is good for his subject." (Olson, 1993, p. 571). Hence, although their interests are purely extractive, political dynasties may have the incentive to govern well and thereby induce positive effects on socioeconomic outcomes and development because of longer political horizon and bequest motives (Besley & Reynal-Querol, 2017; George, 2019; George & Ponattu, 2017; Mendoza, Jaminola III, & Yap, 2019; Zheng et al., 2016).

<sup>190</sup> For a full list of devolved functions per LGU, please see Section 17 of the 1991 LGC.

Sequential tenure in office among relatives may reinforce familiarity and continuity that bodes well with performance and bolsters inter-temporal incentives to pursue long-term government projects and programs (Bragança et al., 2015; Tusalem & Pe-Aguirre, 2013). Meanwhile, legacy/reputation concerns ascribed to bequest motives may mitigate or even trump moral hazard problems associated with political dynasties (Besley & Reynal-Querol, 2017). Concern for their relatives' success in upcoming elections may mitigate the opportunistic behavior of incumbent dynastic officials and may likewise provide incentive to govern well and demonstrate good performance in office (Crowley & Reece, 2013; George & Ponattu, 2017; Zheng et al., 2016).

This study dwells on the extractive political institutions (Acemoglu & Robinson, 2013b) nature of political dynasties and therefore, adopts the predatory view of political dynasties (Solon et al., 2009) as the guiding theory behind the hypothesis being tested empirically.

### **Political dynasties: Fat vs. thin**

While political dynasties are typically considered as a monolithic group (Lacroix, et al., 2019), there is a growing body of literature that examines whether political dynasties have divergent effects when disaggregated into various categories (e.g., Ali, 2016; George, 2019). The logic is that perceived effect of political dynasties as a homogenous group is a net effect of its various types—some of which are more inclined to have positive (negative) effects than the others (George, 2019). In the Philippines, Mendoza and colleagues (i.e., Mendoza et al., 2016; Mendoza, Jaminola III, & Yap, 2019; Mendoza, Ong Lopez, & Banaag, 2019) propose a functional typology of political dynasties: (1) thin dynasty – if relatives occupy an elective position sequentially (i.e., family members continuously take turns serving in the same post); or (2) fat dynasty – if family members occupy multiple political seats simultaneously (i.e., at least two family members occupy different elective positions at the same time over consecutive years).

Mendoza and colleagues argue that fat and thin dynasties may possibly have divergent effects owing to fundamental differences in constraints and incentives. On the one hand, fat dynasties have higher proclivity to have deleterious effects, whereas thin dynasties may possibly have desirable effects, *ceteris paribus*. Since fat dynasties are the predominant type in the Philippines (Mendoza, Jaminola III, & Yap, 2019), the perceived net effect of political dynasties in the country in general (as homogeneous group) is logically assumed as malign.

Due to wider and deeper entrenchment of political power (monopoly of multiple elective positions over consecutive years) (Mendoza, Jaminola III, & Yap, 2019), as well as greater incumbency advantage externalities (extends to relatives in several positions) (Querubin, 2016; 2013), fat dynasties may not have the incentive to signal their competence by performing well in office and worse, may be more motivated to pursue self-serving activities to the detriment of their jurisdictions (Ali, 2016; Daniele & Vertier, 2018; George, 2019; George & Ponattu, 2017; Geys, 2017; Tusalem & Pe-Aguirre, 2013).

On the other hand, thin dynasties are constrained with less concentration of power (domination of only one political seat over successive years) (Mendoza, Jaminola III, & Yap, 2019) and limited spillover effect of incumbency advantage (applies to one position only) (Querubin, 2016; 2013). Hence, relative to fat dynasties, thin dynasties will more likely turn to bequest motives to ensure re-election (Mendoza, Jaminola III, & Yap, 2019)—they have the incentive to uphold their family's legacy or reputation by exhibiting good performance in office, which in turn, benefits constituents' welfare (Crowley & Reece, 2013; George & Ponattu, 2017; Olson, 1993; Solon et al., 2009; Zheng et al., 2016).

Since fat dynasties have higher tendency to have inimical effects compared with thin dynasties, studies of Mendoza and colleagues are concentrated on the former, rather than the latter type. This research follows suit by focusing on fat dynasties among municipalities in Rizal province.

### **The municipal mayor**

As the LCE in charge of local governance at the municipal level in the Philippines (1991 LGC), the mayor serves as the principal decisionmaker in setting priority agenda and implementing policies in line with the said agenda within the municipality (Dulay & Go, 2021). Section 444 of the 1991 LGC lists the duties and functions of the municipal mayor: (1) exercise supervision and control over all municipal government policies, programs, projects, services, and activities (PPPSA); (2) enforce all laws and ordinances and implement all approved PPPSAs within the municipality; (3) initiate and maximize generation of revenues and other resources for the implementation of the municipal development plan and other PPPSAs; and (4) ensure the delivery of basic services for the constituents.

Pursuant to the execution of the municipal development plan and provision of basic services, the mayor is primarily responsible for proposing and disbursing the municipal government's annual fiscal budget (Local Government Academy (LGA), 2019). With this power, a mayor can prioritize spending on specific PPPSAs. For instance, a mayor may focus more on expenditure items within the social services sector that includes human development investments in health, education, and social welfare of constituents. Or he/she may seek to spend heavily on general public services which is perceived as a bountiful source of rents in office owing to its less transparent nature (Capuno, 2012b; Diokno-Sicat, 2016). The mayor may likewise utilize discretionary funds to return favors to current supporters and/or win new supporters/allies, subject only to the central government's oversight (Capuno, 2010).

An incumbent mayor in the Philippines is typically supported by the majority of the municipal council, gets to freely appoint allies in key appointive positions (Capuno, 2010), can take advantage of the wide latitude of discretion in fiscal decision making (revenue generation and expenditures) to be re-elected (Solon et al., 2009), and may effectively boost election bids of his/her relatives to the position he/she will vacate and other elective posts via incumbency advantage (Querubin, 2016; 2013; De Dios, 2007).

Indeed, the municipal mayor wields sizable political and administrative powers and thereby, possesses considerable leeway in the use of discretion (Labonne et al., 2015), particularly with respect to prioritization of municipal government expenditures. Therefore, examining the effect of political dynasties on human development investments with the mayoralty seat as reference position is a worthwhile research endeavor.

**Case study: Municipalities of Rizal province**

Many studies in the Philippines analyze political dynasties at the provincial level (e.g., Collas-Monsod et al., 2004; Virola et al., 2016). However, there is a growing number of researches here and abroad that examine the effects of political dynasties at a lower local government level—at the municipal level where governance is closer to the people (e.g., Capuno et al., 2012a, 2012b and Dulay & Go, 2021 for the Philippines; Asako et al., 2015 for Japan; Bragança et al., 2015 for Brazil; Daniele & Vertier, 2016, 2018 for Italy). This research aims to contribute to this stream in the literature by using the case of municipalities in Rizal province as a preliminary empirical investigation.

Composed of 13 municipalities and one (1) component city (i.e., Antipolo City), Rizal province stands as an interesting case for an initial empirical study on political dynasties on two (2) accounts: firstly, the province itself is considered dynastic, with the Ynares family at the helm of gubernatorial position from 1992-present (Rizal provincial government, 2019); secondly and more importantly, its municipalities<sup>191</sup> provide a good mix of dynastic and non-dynastic incumbent politicians, as will be shown in the results section of the study.

**2. REVIEW OF RELATED LITERATURE**

Viewing political dynasties as a homogeneous group, relevant Philippine literature is dominated by empirical studies pointing to a negative effect of political dynasties on governance, socioeconomic outcomes, and development. Pertinent international literature reflects the same trend. While political dynasties are typically considered as a monolithic group (Lacroix et al., 2019), there is a growing body of literature that examines whether political dynasties behave differently when categorized into various types. At this disaggregated level of analysis, results are mixed—both negative and positive associations are prominent. All studies cited utilized econometric analyses.

**Philippine context: Political dynasties as homogeneous group**

In the Philippines, Tusalem and Pe-Aguirre (2013) rely on ordinary least squares (OLS) regression and enunciate the pernicious effect of political dynasties on democratic governance in terms of public goods provision. Their results suggest that provinces dominated by political dynasties are less likely to experience good local governance with respect to: (a) health spending; (b) infrastructure development; (c) employment; (d) criminality; and (e) overall quality of government. Meanwhile, Collas-Monsod et al. (2004) observe that political dynasties seemingly constrain the efficient delivery and quality of public services. Their regression analyses suggest that presence of political dynasties among provinces is linked to lower primary education completion rates, lower per-capita income, and higher poverty.

Similarly, Mendoza et al. (2012) find, based on partial correlations, that provinces with higher concentration of political dynasties are associated with lower human development and higher levels of poverty. Using a more nuanced approach via beta-binomial maximum likelihood estimation (MLE-BB), Mendoza et al. (2016) show that presence of political dynasties is correlated with greater poverty, specifically in non-Luzon provinces.

In congruence with Mendoza et al. (2012, 2016), Tusalem (2019) provides evidence that dynastic prevalence among Philippine provinces is linked to higher poverty incidence, as well as lower average family income. Tusalem (2019) employs a panel-corrected standard error (PCSE) estimation.

**Philippine context: Political dynasties as various types**

While Mendoza and colleagues propose a dichotomous fat-thin classification of political dynasties, their analyses focus more on consequences of fat dynasties since they represent greater political concentration compared with thin dynasties (Mendoza, Ong Lopez, & Banaag, 2019). In their previous studies, Mendoza and colleagues show that “where there are fatter dynasties, there tend to be deeper poverty and underdevelopment.” (Mendoza & Banaag, 2017, p. 1). More recently, Mendoza, Ong Lopez, and Banaag (2019) present a special case of fat dynasties pertaining to provinces where incumbent governor, mayor, and congressman are relatives. Following Mendoza et al.’s (2016) econometric strategy (i.e., MLE-BB), their results reveal a positive association with poverty, with a more pronounced correlation in non-Luzon areas.

Dulay and Go (2021) also investigate the effects of fat dynasties but prefer to call them horizontal dynasties. Banking on a close elections Regression Discontinuity Design (RDD) among municipalities, they find that horizontally dynastic mayors (1) tend to have higher total government spending, (2) a mayor-vice-mayor dynastic linkage is specifically correlated with increased spending in the health and economic services components of total municipal expenditure; (3) but such increased expenditures do not lead to economic growth or lower poverty.

Using Fixed Effects (FE) specification, Capuno et al. (2012b) find evidence suggesting that dynastic mayors on their last term (i.e., last-termer or term-limited) tend to reduce health insurance coverage to the poor but do not appear to have higher or lower expenditure on other local public services, compared with other mayors. On the other hand, Diokno-Sicat (2016) adopts a Random Effects (RE) estimation and finds that last-termer dynastic governors spend more on health, education, labor and employment, and housing and community development, but less on economic services. Meanwhile,

<sup>191</sup> Antipolo City is excluded from the sample for comparability among observations.

results of Solon et al. (2009) based on RE logit estimates reveal that dynastic governors aiming for re-election tend to increase spending on economic development services when faced with competition from other political dynasties.

## **International literature: Political dynasties as homogeneous group**

Drawing inference from the flooding incidence across Pakistan in 2010, Ali (2016) employs period FE regression approach and finds that dynastic politicians significantly spend less on development-oriented programs and the expenditure is further dampened in the aftermath of floods. The definition of development expenditure in the study includes spending on education and health, among others.

Similarly, Asako et al. (2015) use instrumental variable (IV) estimation and reveal that Japanese municipalities with dynastic representatives to the Lower House exhibit lower economic performance despite having abundant resources. Meanwhile, Setyaningrum and Saragih (2019) unearth evidence from Indonesia that political dynasties are negatively correlated with local government performance.

Using OLS and quantile regressions, Acemoglu et al. (2007) find that municipalities in Cundinamarca region, Colombia with higher prevalence of dynastic mayors are less developed today. They treat presence of political dynasties as indicator of political concentration, which in turn, is viewed as measure of political inequality.

In India, George and Ponattu (2017) provide evidence that dynastic rule worsens both public goods provision (in terms of health, transport, financial services, and social welfare programs) and local economic development (proxy: night-time luminosity). On the other side, Bragança et al. (2015) show that dynastic municipal governments in Brazil spend more resources on the following expenditure items: (1) education and culture; (2) health and sanitation; (3) housing and urban development; and (4) public transportation. Despite the larger expenditures, they find no significant changes in the quality of public services and improvements in economic growth among dynastic municipalities, compared with non-dynastic counterparts. Both George and Ponattu (2017) and Bragança et al. (2015) rely on close elections RDD strategy.

## **International literature: Political dynasties as various types**

Extending her analysis on political dynasties in Pakistan, Ali (2016) disaggregates dynasties in terms of their sources of power: land owning, business ownership, and connection to a *biradari* (clan). She finds that dynastic representatives whose source of power is landholding (linkage with *biradari*) are more (less) likely to engage in local development spending.

Among Italian city governments, Daniele and Vertier (2016) observe the following based on their results drawn from various specifications (i.e., close elections RDD, FE estimation, and propensity-score matching): (1) among mayors eligible for reelection (on a second term for a two-term limit), dynastic mayors spend relatively much more at the last year of their first term compared with non-dynastic mayors; and (2) among last-termer mayors, dynastic mayors seemingly reduce expenditures at the end of their term, compared with non-dynastic counterparts. In a more recent study using close elections RDD and FE estimation only, Daniele and Vertier (2018) show that dynastic city mayors who are not yet term-limited are more likely to increase capital expenditure in the year before an election.

On the other hand, George (2019, p. 28) continues to use RDD strategy and offers a binary classification of political dynasties: founder and descendant. He finds that founders (descendants) of political dynasties in India have positive (negative) effects on public goods provision: “greater exposure to founders improves the availability of public goods” along categories such as education, healthcare, and connectivity, whereas descendants worsen public goods provision in terms of education, healthcare, and sanitation.

Meanwhile, Lacroix et al. (2019) categorize political dynasties in France as democratic and non-democratic. Taking on the case of the enabling act giving full powers to Marshal Pétain, a dictator, on July 10, 1940, they find that democratic dynastic parliamentarians were more likely to oppose the act (by 7.6-9.0 percentage points margin) than non-democratic dynastic and non-dynastic parliamentarians. Lacroix et al. (2019) bank on a binary logit regression model.

## **Synthesis**

As it appears, the effect of political dynasties on governance, socioeconomic outcomes, and development is not straightforward: findings differ depending on (a) whether political dynasties are viewed as homogeneous group or as various types, (2) what the response variables are, and (3) the specific econometric strategy employed. Nevertheless, the predatory view on political dynasties ostensibly dominates the relevant literature.

Of particular interest to the research at hand, which focuses on the effect of dynastic presence on human development investments, are the following studies: Tusalem and Pe-Aguirre (2013) and Dulay and Go (2021) on health spending, Bragança et al. (2015), Diokno-Sicat (2016), and Ali (2016) on health and education spending, George and Ponattu (2017) and George (2019) on public goods provision in terms of education, health, and social welfare programs, and Capuno et al. (2012b) on health insurance coverage for the poor. The researcher draws from the insights of these studies in discussing the results of the present research.

## **3. METHODOLOGY**

### **Research design**

This work adopts a quantitative, case study approach as a research design and employs multivariate panel regression analysis of publicly available government data as a research method to empirically test the hypothesis posed.

### **Variables and hypotheses**

## **Main variable of interest: Political dynasties**

Akin to how several relevant studies identified family ties among elected public officials, proxy measure for political dynasties in the study is determined through the “family name identification process” (Bragança et al., 2015; Daniele & Vertier, 2016; Mendoza et al., 2016; Querubin, 2013, 2016). However, the primacy of the mayoralty position as a reference point in identifying political dynasties is accentuated, given its power and discretion on municipal government expenditure consistent with the provisions of the LGC of 1991 (Labonne et al., 2015).

Following such modified approach, the family name of an elected municipal mayor (reference position) in Rizal province in 2001 is matched with the family name of elected (1) mayor (in subsequent elections), vice-mayor, and councilors in the same municipality; (2) mayors, vice-mayors, and councilors in other Rizal municipalities and city (Antipolo); (3) governor, vice-governor, and board members of Rizal; and (4) representatives of Rizal’s two (2) legislative districts<sup>192</sup> between election years 2001 and 2016. The levels of matching process are presented in order—from within the municipality up to the legislative districts. If the family names are the same, they are initially considered relatives (whether by consanguinity or affinity). This method is closely related to the strategy of Dulay and Go (2021) and is more expansive compared with other related municipal level researches that restrict family ties matching to within the same municipality only (i.e., Bragança et al., 2015; Daniele & Vertier, 2016, 2018). Meanwhile, familial relations are further verified through desk research and informal interviews. Data is culled from local election results for six (6) electoral years between 2001-2017 (i.e., 2001, 2004, 2007, 2010, 2013, and 2016) collected and maintained by the Commission on Elections (Comelec).

This research considers a municipality/municipal government as “dynastic” if it is led by a “dynastic mayor” (homogeneous view) who may be fat dynastic or thin dynastic (disaggregated view), based on the dichotomized classification proposed by Mendoza and colleagues. A municipality/municipal government is classified as “thin dynastic” if members of the same family hold the mayoralty position continuously from 2001-2017 but do not have kinship ties with other locally elected officials in Rizal in any of the incumbency periods. On the other hand, a municipality/municipal government is categorized as “fat dynastic” if an incumbent mayor and at least one (1) relative who also holds elective office are serving their terms simultaneously for at least two (2) incumbency periods between 2001 and 2017.<sup>193</sup> This is a stricter characterization of fat dynasties compared with Mendoza, Ong Lopez, and Banaag (2019) who propose a temporal conditionality of at least one (1) election cycle only. The argument rests on the succession and considerable time facets of the “dynastic” nature of political dynasties. The Merriam-Webster dictionary defines dynasty as “a succession of rulers of the same line of descent” and/or “a powerful group or family that *maintains its position for a considerable time.*” Typical examples are the dynasties that ruled China for hundreds of years. Clearly, relatives who concurrently serve their incumbencies for just one term should not be considered as fat dynasties, or political dynasties at all, unless they demonstrate the “staying power” characteristic of dynasties by being re-elected for at least another term.

Based on the identification procedure cited above, six (6) Rizal municipalities/municipal governments are identified as dynastic and all are categorized as fat dynasties: Baras (Robles family), Binangonan (Ynares), Cardona (San Juan), Jala-Jala (Pillas), San Mateo (Diaz), and Tanay (Tanjuatco). The remaining seven (7) municipal governments are considered non-dynastic: Angono, Cainta, Morong, Pililla, Rodriguez, Taytay, and Teresa. Further details are provided in the results section.

Fat dynastic municipalities/municipal governments are coded=1 in the database, while non-dynasts are coded=0. Such dummy variable treatment of political dynasties is consistent with how relevant studies operationally define dynasties in their regression analyses (e.g., Bragança et al., 2015; Daniele & Vertier, 2016, 2018; Diokno-Sicat, 2016; Dulay & Go, 2021; Lacroix et al., 2019; Mendoza, Ong Lopez, & Banaag, 2019; Tusalem & Pe-Aguirre, 2013). Further, the author concurs with Mendoza, Ong Lopez, and Banaag (2019) who assert that utilizing a dummy variable as indicator of dynastic presence is a much more nuanced approach compared with earlier indicators that simply relied on the share of political dynasties among all locally elected officials. The political dynasty dummy clearly links the familial ties among key incumbent officials. In this case, between the mayor and (a) vice-mayor and councilors in the same Rizal municipality, (b) the same set of local officials in other municipalities and city within the province, (c) the most powerful LCE in the province (i.e., the governor) and other key provincial government officials (i.e., vice-governor and board members); and (d) Congresspeople who represent Rizal municipalities in the Lower House.

## **Outcome variables: Municipal expenditure on human development**

This research examines the effect of dynastic presence on five (5) distinct categories of human development-oriented municipal government expenditures. These categories are clustered into three (3) domains: at the aggregate, combined, and specific sector levels. Firstly, analysis starts at the aggregate level wherein total local public spending on health, education, and social welfare will be collectively called as human development spending/expenditure. This is consistent with the study’s assertion that the three (3) sectors represent an inclusive government strategy for human development investments. Secondly, combined spending on education and health will be analyzed since expenditures on the two (2)

<sup>192</sup> Rizal’s first district covers Angono, Binangonan, Cainta, and Taytay; the second district encompasses Baras, Cardona, Jala-Jala, Morong, Pililla, Rodriguez, San Mateo, Tanay, and Teresa.

<sup>193</sup> Incumbency periods considered based on the three (3) year term limit provided for LGU officials (LGC of 1991): 2001-2004; 2004-2007; 2007-2010; 2010-2013; 2013-2016; 2016-2019.

sectors are considered primary investments for human development. Lastly, analysis on the specific sector spending among the three (3) expenditure items ensues.

Indicators representing the various categories of LGU expenditure are extracted from the pertinent database compiled and maintained by the Department of Finance-Bureau of Local Government Finance (DOF-BLGF): the Statement of Receipts and Expenditures (SRE) Report which monitors financial performance (income and expenditure) of LGUs (BLGF, n.d.) (Table 1). Missing data, though few and far in between, are addressed through interpolation and extrapolation methods for a balanced panel dataset. Consistent with related researches (e.g., Daniele & Vertier, 2016, 2018; Kelekar & Llanto, 2013, 2015; Manasan, 1997, 1998), this study measures the outcome variables in per capita terms to control for each municipality’s population size.

**Table 1. Outcome variables: Indicators and their technical definitions**

Outcome variable	Indicator*	Technical definition
Human development expenditure	Total municipal spending on health, education, and social welfare	Sum of municipal government expenditures on education, health, and social welfare
Total education and health expenditure	Not applicable (NA)**	Sum of municipal government expenditures on education and health
Total education expenditure	(Expenditure on) Education, culture & sports/manpower development	Covers sector expenditures for services in support of schools and education facilities; planning and manpower development; sports; and cultural preservation and enrichment*
Total health expenditure	(Expenditure on) Health, nutrition & population control	Covers sector expenditures for health program including medical, dental and health services; planning and administration of nutrition programs; population and family planning programs; and administration of these programs*
Total social welfare expenditure	(Expenditure on) Social services and social welfare	Covers sector expenditures for the upliftment of disadvantaged families and children; the rehabilitation of the physically and socially handicapped; assistance to distressed and displaced individuals and families; care of the aged and other welfare services and payment of retirement pension and other social security benefits. Also included are expenditures for the provision of services and facilities for recreational, religious and other social activities not elsewhere classified*

Notes: \*Adopted as is (i.e., verbatim) from the metadata document of SRE (BLGF, n.d.); \*\*Computed by the author from SRE database.

**Control variables**

Among various determinants of human development expenditures, four (4) factors are selected as control variables (all measured at municipal-level): (1) total local source revenue; (2) total IRA; (3) proportion of young population; and (4) proportion of elderly population. The first two variables belong to the supply side (ability to provide social services to constituency which is tied to income that dictates how much a municipality can spend), while the other two variables represent the demand side (demanded social service component varies depending the age group) of the fundamental equation for human development-oriented basic services provision at the local level (Cantarero & Lago-Peñas, 2012).

In light of the budget constraints theory (Samuelson & Nordhaus, 2010), the ability of an LGU to spend for human development services is largely a function of its total income (Kelekar & Llanto, 2013, 2015) which in turn, is comprised mainly of IRA and local source revenue in the case of the Philippines (Manasan, 1997, 1998). Following Manasan (1997, 1998), IRA and local source revenue are used as distinct explanatory variables in the study’s regression models to capture their individual effects.

Meanwhile, the respective proportions of young and elderly populations are among the standard set of demographic variables utilized in most empirical studies on LGU expenditure (Koppl-Turyna et al., 2015). The rationale for inclusion rests on economic means—or lack of it. Compared with the working age population (ages 15-64) who are likely to be employed and therefore able to spend for their own education, health, and social security needs (private expenditure), young and elderly populations who are not yet working/have already stopped working need and/or demand more publicly funded social services (Kang & Magoncia, 2016).

Both age groups are associated with higher local government expenditures on health and social welfare (Lusky & Weinblatt, 1998, as cited in Žokalj, 2016; Nguyen et al., 2009). However, they have divergent effect on education expenditure owing to substitution effect. Young constituents are direct consumers of publicly provided basic education, while elderly constituents are not, but are high-level consumers of the two other types of basic services, namely, health and social welfare. Hence, the higher the share of young (elderly) age population, the higher (lower) the education expenditure at the local level, *ceteris paribus* (Fernandez & Rogerson, 1997; Guziejewska & Majdzińska, 2018).

This research adopts relevant revenue data from BLGF’s SRE Report and municipal-level population data from the Philippine Statistics Authority (PSA) Census of Population and Housing for years 2000, 2007, 2010, and 2015 as indicators for the four (4) control variables (Table 2). Since the database deals with observations from 2001-2017, population data are interpolated for 2001-2006, 2008-2009, 2011-2014, and extrapolated for 2016-2017.

**Table 2. Control variables: Indicators and their technical definitions**

Control variable	Indicator	Technical definition
Total local source revenue	Total Local Sources	Sum of the municipality’s total tax revenue and non-tax revenue*
total IRA	IRA	Share of the municipality from national internal revenue taxes collected*
Proportion of young population	NA**	% share of population ages 0-14 to total municipal population***
Proportion of elderly population	NA**	% share of population ages 65-above to total municipal population***

Notes: \*Adopted as is from the metadata document of SRE (BLGF, n.d.); \*\*Computed by the author from the PSA population data; \*\*\*To fit with the PSA (n.d.) definition of working age population (ages 15-64), the author adopts these age limits, which are also used by Guziejewska & Majdzińska (2018) and Kang & Magoncia (2016).

**Dataset: Composition**

This research relies on a panel dataset comprised of 13 municipal governments in Rizal province observed over a 17-year period (2001-2017). While limited relative to a national scope, the number of observations analyzed in this study is still statistically viable (e.g., N>30). Owing to the cross-sectional and time-series character of panel data (Wooldridge, 2020), a total of 221 observations are generated for the study (i.e., 13 municipalities X 17 years). The dataset contains information on municipal income, expenditure, population, as well as on whether the municipal governments are governed by dynastic mayors or not.

**Econometric Model**

The dataset compiled is analyzed based on the linear regression model shown below:

$$Y_{it} = \beta_0 + \beta_1 \text{dynasty}_i + \beta_2 \text{control\_var1}_{it} + \dots + \beta_5 \text{control\_var4}_{it} + \mu_{it}$$

**Where:**

- Y<sub>it</sub>** Outcome variable representing each of the five (5) categories of human development expenditure; **i** = municipality and **t** = year
- β<sub>0</sub>** Common intercept (constant)
- dynasty** Main variable of interest representing dynastic presence; dummy variable coded=1 (coded=0) if municipality is deemed fat dynastic (non-dynastic)
- β<sub>1</sub>** Coefficient of the main explanatory variable; represents partial effect of dynastic presence on human development investments
- control\_var1-control\_var4** Vector of control variables applicable to all dependent variables
- β<sub>2</sub> - β<sub>6</sub>** Coefficients of control variables
- μ<sub>it</sub>** error term

With a total of five (5) outcome variables (various categories of human development expenditure), the research estimates a total of five (5) related, but nonetheless, distinct panel regression models where all control variables are kept the same across all specifications.

**Data analysis**

Akin with Tusalem (2019), this research employs PCSE estimation to analyze the regression model shown above, using the statistical software Stata 16. Particularly, it banks on a Prais–Winsten generalized least-squares (GLS) estimator with PCSEs (henceforth, Panel-corrected Prais–Winsten GLS estimator). Such estimation strategy is chosen over the usual panel data estimators, namely, Ordinary Least Squares (OLS), Random Effects (RE), and Fixed Effects (FE) estimators (Torres-Reyna, 2007; Wooldridge, 2020), based on two key considerations: (1) the peculiarity of the study’s panel data structure; and (2) the need to account for possible spatial dependence among the analyzed municipalities in Rizal province.

Standard model specification tests were conducted to check for specification error, omitted variable bias, and multicollinearity in the study’s regression models. Results of these tests reveal absence of all three. Ergo, the study’s econometric models are properly and sufficiently specified (WSU, 2015). However, supplemental regression diagnostics confirm the presence of “HPAC” disturbances (Blackwell, 2005) in the study’s models: panel heteroskedasticity, panel autocorrelation, and contemporaneous correlation (cross-sectional dependence).<sup>194</sup> Disregarding these nuances in the analysis will lead to biased statistical inference (Hoechle, 2007).

Meanwhile, the panels/cross-sections observed over time in this study are municipalities which are geographical units, hence, spatial dependence is highly likely (Suárez et al., 2018). Spatial dependence pertains to “the propensity for nearby locations to influence each other and to possess similar attributes” (Goodchild, 1992, p. 33). In econometrics parlance, spatial dependence is a form of cross-sectional dependence or contemporaneous correlation among observations (Hoechle, 2007). When such aspect is overlooked, results of any panel data analysis is prone to produce “biased, inefficient, and/or inconsistent coefficient estimates” (Tosun & Skidmore, 2004, p. 172).

Utilizing OLS estimation when HPAC disturbances are present is problematic (Beck & Katz, 1995). In the face of such disturbances, OLS regression estimates will likely be “biased, inefficient and/or inconsistent” due to violations of

<sup>194</sup> Stata commands and results of these diagnostic tests are available upon request.

“standard OLS assumptions about the error process” (Podestà, 2002, p. 9). On the other hand, FE & RE models are inefficient alternatives because they can only address autocorrelation and heteroskedasticity, but not contemporaneous correlation (Hoechle, 2007; Stata Corp., 2019). Further, all three (3) panel data estimators cannot address spatial dependence.

Developed by Beck and Katz (1995), the PCSE method is a robust estimator utilized in social science research when panel regression models have HPAC disturbances (Hoechle, 2007; Sarafidis & Wansbeek, 2012). It has also been used in several studies to specifically account for spatial dependence, for instance, Tosun and Skidmore (2004) for counties in West Virginia, USA, and Diaz-Foncea and Marcuello (2014) for Spanish regions. Within the political dynasty literature, Tusalem (2019) used PCSE estimation to analyze the effect of dynastic prevalence, among other institutional, political, and geographical covariates, on several socioeconomic outcomes in the Philippines. Meanwhile, Martin-Mayoral and Sastre (2017) adopted the PCSE strategy in examining the determinants of aggregate social expenditure, including those for education and health, in Latin America.

If no autocorrelation function is specified, the PCSE strategy only accounts for heteroskedasticity and contemporaneous correlation by relying on OLS regression with PCSEs (Stata Corp., 2019). To address all three (3) disturbances that comprise the HPAC, the author follows the advice of Beck and Katz (1995) and sets a first-order autocorrelation AR(1) common to all panels (i.e., common AR(1) parameter). This approach is embodied in the use of PCSE method’s enhanced version, the so-called Prais-Winsten transformation (Plumper et al., 2005), which is dubbed in the study as Panel-corrected Prais-Winsten GLS estimator (Stata Corp, 2019).

**4. RESULTS**

**Political dynasties among municipalities in Rizal Province**

**Table 3. Fat dynasties in Rizal province**

Municipality	2001	2004	2007	2010	2013	2016
Baras	-	M <sub>0</sub>	M <sub>0</sub>	M <sub>0</sub> -C <sub>0</sub>	M <sub>0</sub> -VM <sub>0</sub> -C <sub>0</sub>	M <sub>0</sub> -VM <sub>0</sub> -C <sub>0</sub>
Binangonan	M <sub>0</sub> -G	M <sub>0</sub> -C <sub>0</sub> -G	M <sub>0</sub> -G	M <sub>0</sub> -G	M <sub>0</sub> -G-M <sub>1</sub>	M <sub>0</sub> -VM <sub>0</sub> -G-M <sub>1</sub>
Cardona	M <sub>0</sub>	M <sub>0</sub>	M <sub>0</sub> -VM <sub>0</sub> -C <sub>0</sub> -VG-PBM	M <sub>0</sub> -C <sub>0</sub> -VG-PBM	M <sub>0</sub> -C <sub>0</sub> -VG-PBM	M <sub>0</sub> -VG
Jala-Jala	-	M <sub>0</sub>	M <sub>0</sub> -C <sub>0</sub>	M <sub>0</sub> -C <sub>0</sub>	VM <sub>0</sub> -C <sub>0</sub>	M <sub>0</sub> -C <sub>0</sub>
San Mateo	M <sub>0</sub>	M <sub>0</sub> -VM <sub>0</sub>	M <sub>0</sub>	M <sub>0</sub>	M <sub>0</sub> -VM <sub>0</sub> -C <sub>0</sub>	M <sub>0</sub> -VM <sub>0</sub> -C <sub>0</sub>
Tanay	M <sub>0</sub>	M <sub>0</sub>	M <sub>0</sub> -PBM	M <sub>0</sub> -PBM	M <sub>0</sub> -PBM	M <sub>0</sub>

Note: M<sub>0</sub>, VM<sub>0</sub>, C<sub>0</sub>=Mayor, Vice-Mayor, and Councilor in a reference municipality; M<sub>1...n</sub>, VM<sub>1...n</sub>, C<sub>1...n</sub>=Mayor, Vice-Mayor, and Councilor in other municipalities/city; G=Governor; VG=Vice-Governor; PBM=Provincial Board Member; Source: Author’s summary based on 2001-2016 local election results (Comelec data).

Upon inspection using the popular “family name identification” approach in the literature and following Mendoza and colleagues’ fat-thin dynasty dichotomy, this research identifies six (6) dynastic mayors, and therefore, six (6) dynastic municipal governments in Rizal: Baras (Robles family), Binangonan (Ynares), Cardona (San Juan), Jala-Jala (Pillas), San Mateo (Diaz), and Tanay (Tanjuatco). All these identified dynastic municipalities are categorized as fat dynasties because they satisfy the following conditions: the incumbent mayor serves his/her term concomitantly with at least one (1) relative also holding elective office in Rizal province for at least two (2) incumbency periods between 2001 and 2017 (i.e., six out of 17 years). The other half, or the seven (7) other municipal governments, are considered non-dynastic because they do not fit the criteria set for categorization into either fat or thin dynasties (i.e., Angono, Cainta, Morong, Pililla, Rodriguez, Taytay, and Teresa).

Table 3 presents the fat dynasties in Rizal province and illustrates how they dominate local elective positions in the province. For example, in Binangonan where the Ynareses hail, the notation “M<sub>0</sub>-VM<sub>0</sub>-G-M<sub>1</sub>” for the 2016 column means that members of the Ynares political dynasty won all four (4) local positions in the 2016 elections, and therefore, will serve their incumbencies simultaneously. The winners are as follows: Cesar Ynares as Binangonan mayor; brother Cecilio “Boyot” Ynares as Binangonan vice-mayor; sister-in-law Rebecca “Nini” Ynares (wife of brother Casimiro “Ito” Ynares Jr.) as Rizal governor; and nephew Casimiro “Jun” Ynares III (son of brother Ito Ynares Jr.) as Antipolo City mayor. Ito Ynares is a former Binangonan mayor from 1972-1986/1988-1992 and Rizal governor from 1992-2001/2004-2007 (Binangonan Municipal Government, 2017b).

A closer look at Table 3 points to several interesting observations. Firstly, between 2001-2017, the mayoralty position among fat dynastic municipalities in Rizal is entirely monopolized by a single political family—except for Baras and Jala-Jala. Secondly, fat dynasties’ extent of political control among elective positions in Rizal ranges from a minimum of three (3) terms or nine (9) years to a maximum of six (6) terms or 18 years.

Elections are far from being competitive among fat dynastic municipalities in the province of Rizal. In fact, fat dynasties in these municipalities not only win by large vote margins, some of them are already winners<sup>195</sup> even before votes are cast—because they don’t have a single competitor. For instance, Cesar Ynares ran unopposed as mayor of Binangonan in the last term of his first three (3) consecutive terms between 1998 and 2007 (i.e., in the 2004 elections) (Binangonan Municipal Government, 2017a). Incidentally, it was in the 2004 elections when the brothers’ tandem of Cesar and Boyet Ynares started in Binangonan when the latter ran and won as a councilor. This is over and above the Ynares family’s

<sup>195</sup> Unopposed local election candidates only need to have one (1) vote to be declared as official winners (Tomacruz, 2019).

unrelenting clout on the Rizal gubernatorial position which started in 1992 and Antipolo City mayoralty seat since 2013. Meanwhile, in the 2016 elections, Bernardo San Juan, Jr. and Ely Pillas won as mayors in Cardona and Jala-Jala, respectively, without any competition (ABS-CBN Investigative and Research Group, 2016).

The political entrenchment of fat dynasties in Rizal province continues beyond the covered period of this research (i.e., from 2001-2017). In the most recent 2019 elections, Cesar Ynares did a repeat of his 2004 electoral dominance and won again unopposed as Binangonan mayor (Rappler, 2019). As he was mayor (again) starting 2016, Cesar Ynares is poised to have a second three (3) consecutive incumbency come 2022 elections (i.e., from 2016-2025). The same trend applies to his brother, Boyet Ynares, who, after being term-limited as mayor from 2007-2016, ran and won as vice-mayor in the 2016 elections and was re-elected in 2019 by an enormous winning margin of 46,002 votes. Boyet Ynares got 61,329 votes while his independent opponent, Manuel Reyes, got a paltry 15,137 votes (Rappler, 2019). Meanwhile, erstwhile San Mateo Mayor Jose Rafael Diaz (i.e., from 2007-2016) won unopposed as Vice-Mayor, while his wife, Cristina Diaz was re-elected mayor via landslide victory over Wilfredo Selga, an independent candidate. The winning margin between Cristina Diaz and Selga was a whopping 47,878 votes, with the former garnering a total of 60,571 votes while the latter got a measly 12,693 votes (Rappler, 2019).

**Fat political dynasties and human development investments in Rizal province**

**Table 4. Effect of dynastic presence on human development investments**

Main Variable	Explanatory	Dependent Variables				
		Human Development Spending	Education & Health Spending	Education Spending	Health Spending	Social Welfare Spending
Political Dynasty		<b>-35.77*</b> <b>(18.34)</b>	<b>-42.08***</b> <b>(12.31)</b>	<b>-34.53***</b> <b>(8.37)</b>	-5.05 (6.92)	7.42 (10.55)
<b>Covariates:</b>						
Local source revenue		3.59e-07*** (1.07e-07)	3.60e-07*** (8.66e-08)	1.56e-07*** (5.37e-08)	2.30e-07*** (6.87e-08)	8.10e-09 (4.72e-08)
IRA		2.09e-07* (1.08e-07)	1.31e-08 (7.76e-08)	-5.87e-09 (4.92e-08)	-5.66e-09 (4.81e-08)	1.88e-07*** (7.05e-08)
% of ages 0-14 to population		4.69** (1.99)	4.79*** (1.74)	5.14*** (1.14)	-0.40 (1.49)	-0.16 (0.78)
% of ages 65-up to population		66.83*** (10.05)	50.29*** (7.77)	5.28 (5.80)	44.31*** (5.15)	16.49** (6.48)
<i>R-squared</i>		0.29	0.37	0.28	0.37	0.09
<i>Probability &gt; Chi-squared</i>		0.00***	0.00***	0.00***	0.00***	0.00***
<i>Number of observations</i>		221	221	221	221	221

Note: \*\*\*, \*\*, \*=statistically significant at 1%, 5%, and 10% levels, respectively; Panel-Corrected Standard Errors (PCSEs) in parentheses; Dependent variables are in Php per capita terms.

Based on the Panel-corrected Prais–Winsten GLS regression estimates shown in Table 2, it appears that fat dynastic municipal governments in Rizal province considerably invest less on their constituents’ human development compared with their non-dynastic counterparts—controlling for other relevant variables.

At the aggregate level, Rizal municipalities governed by fat dynastic mayors from 2001-2017 tend to have significantly lower human development expenditures as they spend, on the average, around Php 35.77 less per capita. With a probability value (henceforth, p-value) of 0.051, this result is statistically significant at the 90% confidence level and provides moderately strong empirical evidence in support of the study’s hypothesis on the effect of dynastic presence on human development investments.<sup>196</sup>

Meanwhile, the disparity in human development investments between dynastic and non-dynastic Rizal municipalities is more pronounced when social welfare spending is excluded, and analysis is focused on the combined expenditures for health and education only. Holding other factors fixed, education and health spending among fat dynastic municipal governments in Rizal is around Php 42.08 lower per capita, compared with non-dynastic municipalities. The relevant coefficient of the dynasty variable here has a p-value of 0.001—statistically significant at the most stringent 99% confidence interval. This offers a rather robust evidence in favor of the study’s hypothesis.

Lastly, Rizal municipalities governed by fat dynastic mayors tend to significantly under-invest in education specifically. Relative to non-dynastic municipalities, dynastic municipal governments in Rizal spend, on the average, about Php 34.53 less per person. This result is likewise statistically significant at the most stringent 1% level (p-value: 0.000), providing a very strong evidence in support of the research hypothesis. As for health and social welfare expenditures, respectively, the study finds no statistically significant effect of dynastic presence among Rizal municipalities.

These findings are hardly surprising given the plethora of related studies that point to the same negative effect of political dynasties on governance, socioeconomic outcomes, and development. In terms of human development-oriented public

196 Interpretation of p-value as evidence against the null hypothesis (i.e., there is no relationship/effect) and in favor of the alternative hypothesis (i.e., there is relationship/effect) is in line with the guidelines recommended by Hartmann et al. (2018): p ≤ 0.01 as very strong evidence; 0.01 < p ≤ 0.05 as strong evidence; 0.05 < p ≤ 0.10 as moderate evidence; and p > 0.10 as weak or no evidence.

expenditures, specifically, results here are in line with the following: Ali (2016) on health and education spending among constituencies in Pakistan; Tusalem and Pe-Aguirre (2013) on health spending among Philippine provinces; Capuno et al. (2012b) on health insurance coverage for the poor among Philippine municipalities and cities; and George and Ponattu (2017) and George (2019) on public goods provision in terms of education, health, and social welfare programs among Indian villages.

But why do dynastic mayors in Rizal perform poorly in terms of local public spending on human development? Does it not adversely affect their chances of staying in power via re-election? As argued in this study, a plausible explanation is the predatory view of political dynasties: ostensibly, they do not have the incentive to invest in human capital enhancement and human capabilities expansion of their constituents as a means to endear themselves to voters and ensure their stay in political power. Reliance on their monopoly of political power coupled with inherited political and financial capital, as well as incumbency advantage externalities is apparently enough to secure votes for them and their relatives during elections.

To recapitulate, members of political dynasties have higher likelihood of winning elections compared with non-dynastic candidates, all things equal (Querubin, 2016). This is ascribed to their key attributes: (1) effective concentration and preservation of political power as relatives take turn occupying elective positions (Simbulan, 2012); (2) bequeathal of massive political and financial capital (Ali, 2016) in the form of “brand name recall”, wealth, and control of political and economic resources (George & Ponattu, 2017); and (3) benefiting from externalities or spillover effects of incumbency advantage. Such substantial electoral advantage may induce dynastic politicians to feel self-assured of continuous re-election, resulting to several moral hazard problems, including underperformance in office (Zheng et al., 2016). Among other mechanisms, this may manifest in terms of the incumbent dynastic mayor’s substantially low human development investments, as shown in the case of municipalities in Rizal province.

Further, this study concurs with Mendoza and colleagues that the deleterious effects of political dynasties are more prominent among fat ones, compared with the thin type. To recall, fat dynasties enjoy wider and deeper entrenchment of political power (monopoly of multiple elective positions over consecutive years) (Mendoza, Jaminola III, & Yap, 2019) and benefit considerably more on incumbency advantage externalities (extends to relatives in several positions) (Querubin, 2013; 2016). These advantages almost ensure continuous re-election for them and their relatives. Following such logic, fat dynastic mayors in Rizal seemingly lack the incentive to signal their competence by performing well in office. Particularly, they appear less motivated to project a caring image to boost their re-election (and/or election of relatives) by spending more on human development-oriented sectors. Inherited and accumulated electoral advantages of fat dynastic mayors in Rizal may so insulate them from the threat of competition from non-dynasts “that they (seemingly) mute performance incentives.” (George & Ponattu, 2017, p. 2)

Beyond its popularity in the relevant literature, the choice of predatory view of political dynasties as a guide in elucidating the results of the research is grounded on the political and electoral realities in Rizal province where fat dynasties are deeply entrenched and are not faced with significant electoral/political competition—as discussed in the previous section. This also helps explain why the study’s findings run counter with Bragança et al. (2015) and Dulay and Go (2021). In Brazil, Bragança et al. (2015) find that dynastic municipalities spend more on health and education, while in the Philippines, Dulay and Go (2021) show that horizontally dynastic municipalities have higher health expenditure. Both studies rely on Regression Discontinuity Design (RDD) anchored on close elections, and therefore applies mainly on localities with high political competition. As Braganca et al. (2015, p. 13) put it, the estimated effects of their political dynasty variable “represent local estimates of dynastic politicians on economic outcomes for municipalities that are highly competitive” and that “*these effects might be quite different in localities where dynasties win by a large vote margin [emphasis added].*” This argument is in sync with Asako et al. (2015) who assert that political dynasties tend to have higher public expenditures only among jurisdictions with competitive elections. As shown in the previous section, elections are far from being competitive among fat dynastic municipalities in the province of Rizal. In fact, fat dynasties in these municipalities not only win by large vote margins, some of them run—and win—totally unopposed. In this section, the study provides empirical evidence that fat dynastic mayors in Rizal significantly invest less on human development of their constituents. The reminder of Braganca et al. (2015, p. 14) is seemingly instructive in this case: “political dynasties facing less electoral competition can be less accountable and therefore perform worse than dynasties facing a lot of competition.”

#### ***Control variables and models’ overall significance***

Consistent with findings in the literature, all control variables have their expected signs (denoting direction of association) and all are statistically significant predictors of municipal per capita human development investments at various combinations, which justify their inclusion in the study’s regression models.

The R<sup>2</sup> or coefficient of determination, which represents the “percentage of variation in the dependent variable explained by variation in the independent variables” (Filho, Silva, & Rocha, 2011, p. 60), among the regression specifications above (i.e., between 9-37%) fall within the range of R<sup>2</sup> values reported by scholars who publish articles on determinants of local government expenditure on health, education, and social welfare (e.g., Araújo et al., 2017; Kelekar & Llanto, 2013, 2015; Manasan, 1998). Moreover, the study’s R<sup>2</sup> range of 9-37% is a decent result, given that R<sup>2</sup> values of regression models in the social sciences field are typically low (Wooldridge 2020), with a value of at least 9% considered to be respectable (Itaoka, 2012).

On the other hand, all five (5) regression models are statistically significant at the 99 percent confidence level, based on the Prob>chi2 values—denoting a strong “joint significance” of all explanatory variables in each specified model (Solon et al., 2009; Torres-Reyna, 2007).

**Robustness Check: Alternative estimation strategies**

**Table 5. Alternative estimation strategies: Effect of dynastic presence on human development investments**

Estimation Strategy	Dependent Variables					
	Human Spending	Development	Education & Health Spending	Education Spending	Health Spending	Social Welfare Spending
<b>Adopted:</b>						
Prais-Winsten w/ PCSEs	-35.77* (18.34)		-42.08*** (12.31)	-34.53*** (8.37)	-5.05 (6.92)	7.42 (10.55)
<b>Alternatives:</b>						
FGLS	-35.77* (19.74)		-42.08*** (13.61)	-34.53*** (8.13)	-5.05 (7.78)	7.42 (11.26)
FE with Driscoll-Kraay SE	-29.56*** (8.24)		-30.78*** (7.49)	-27.45*** (5.84)	-3.32 (4.34)	1.21 (4.42)

Note: Coefficients shown are those of the political dynasty variable; \*\*\*, \*\*, \*=statistically significant at 1%, 5%, and 10% levels, respectively; Standard Errors in parentheses; Dependent variables are in Php per capita terms.

Results of the study are robust to two (2) alternative estimation strategies that also address HPAC disturbances: (1) feasible generalized least squares (FGLS) estimator and (2) Fixed Effects (FE) estimator with Driscoll-Kraay Standard Errors (SE). As illustrated in Table 5, coefficients of the dynasty variable stay statistically significant even when estimated using FGLS and Driscoll-Kraay approaches. In fact, the coefficients generated by FGLS are identical to those from the adopted Panel-corrected Prais–Winsten GLS strategy, with slight differences in standard errors. Nevertheless, the latter strategy was adopted because it is superior to the former when focus is on hypothesis testing (Moundigbaye et al., 2017; Reed & Ye, 2011), which is the case for this research. Besides, compared with FGLS, the PCSE approach possesses “finite sample advantage” and generates more accurate standard errors for small panels<sup>197</sup> like the study’s dataset (Beck & Katz, 1995; Hoechle, 2007; Moundigbaye et al., 2017; Stata Corp., 2019; Reed & Ye, 2011). Meanwhile, the Driscoll-Kraay strategy is not used since it is more suitable for panel datasets where cross-sections are larger than the number of time periods (i.e., N>T) (Knight, 2014; Hoechle, 2007). The study’s dataset follows the N<T structure (i.e., 13 municipalities<17 years).

**Robustness Check: Alternative specifications**

**Table 6. Alternative specifications: Effect of dynastic presence on human development investments**

Regression Specifications	Dependent Variables					
	Human Spending	Development	Education & Health Spending	Education Spending	Health Spending	Social Welfare Spending
<b>Adopted:</b>						
Linear model	-35.77* (18.34)		-42.08*** (12.31)	-34.53*** (8.37)	-5.05 (6.92)	7.42 (10.55)
<b>Alternatives:</b>						
With unit and period dummies	-84.93 (62.77)		-153.55*** (42.78)	-104.37*** (27.12)	-43.89 (37.05)	8.39 (30.57)
Log-linear model	-0.189** (0.085)		-0.232*** (0.066)	-0.450*** (0.119)	-0.069 (0.067)	0.086 (0.236)
Log-linear with unit and period dummies	-0.813*** (0.158)		-0.408** (0.173)	-1.059*** (0.366)	-0.627*** (0.217)	-0.056 (0.303)

Note: Coefficients shown are those of the political dynasty variable; \*\*\*, \*\*, \*=statistically significant at 1%, 5%, and 10% levels, respectively; Panel-Corrected Standard Errors (PCSEs) in parentheses; Dependent variables are in Php per capita terms.

Sticking with the PCSE approach, findings are likewise generally robust to three (3) alternative model specifications as depicted in Table 6: (1) adding unit and period dummies to the adopted linear model (i.e., linear model with unit and period dummies); (2) transforming the dependent variable into its natural logarithmic form (i.e., log-linear model); and (3) adding unit and period dummies to the log-transformed specification (i.e., log-linear model with unit and period dummies). Several related studies (e.g., Ali, 2016; Diokno-Sicat, 2016; Dulay & Go, 2021) have employed these alternative specifications to estimate the effect of political dynasties on human development investments. For this research, however, these specifications are found to be saddled with omitted variable bias, specification error, and multicollinearity. This is the primary reason why the study adopts a linear model without unit and period dummies, which is free from the said biases/errors.

Another motivation behind the choice of the adopted specification is the word of caution given by Plumper et al. (2005). When panel data is estimated using the PCSE approach, Plumper et al. (2005) advises against the inclusion of unit and

<sup>197</sup> Composed of 10-20 cross-sections and 10-40 periods (Stata Corp., 2019).

period dummies because unit (period) dummies disproportionately absorb most of the theoretically interesting cross-sectional (time-series) variance in the data. The use of unit dummies is specifically problematic when a level effect of a time invariant variable (e.g., the study's political dynasty dummy) is being tested, since adding unit dummies suppresses the level effects. Meanwhile, including period dummies not only absorb large portions of the trend in the outcome variable, but also tends to bias estimates (Plumper et al., 2005). True enough, the study's alternative regression specifications with unit and period dummies generate unacceptably high coefficients—as can be observed from Table 6.

## 5. CONCLUSIONS

Local government investments on human development, reflected in their level of expenditure on health, education, and social welfare, are necessary public investments geared towards enhancing human capital and enlarging human capabilities of their constituents. Therefore, human development spending represents a reasonable measure of good performance of incumbent local officials who may be dynastic or non-dynastic (Solon et al, 2009; Manasan, 1997).

To empirically test whether dynastic mayors tend to have lower human development investments for their constituents, this study draws inference from municipalities in Rizal, a well-known dynastic province in the Philippines, as a preliminary empirical investigation. A panel dataset is constructed which consist of all 13 Rizal municipalities, dichotomized into dynastic or non-dynastic, and observed over 17 years (i.e., 2001-2017). All identified dynastic municipalities in the province are categorized as fat dynasties—wherein an incumbent mayor serves his/her term concomitantly with at least one (1) relative also holding elective office in Rizal province for at least two (2) incumbency periods between 2001 and 2017.

Based on the results of Panel-corrected Prais–Winsten GLS estimation, this research finds that Rizal municipal governments led by fat dynastic mayors tend to have lower human development investments for their constituents, compared with non-dynastic counterparts. Specifically, they spend less on human development at the (1) aggregate level (i.e., total municipal expenditure on health, education, and social welfare), at the combined levels of (2) education and health, and (3) at the specific sector of education. These findings are in line with the prediction of the predatory view of political dynasties, particularly the fat type: with wider and deeper entrenchment of political power due to monopoly of multiple elective positions over consecutive years, fat political dynasties are inherently prone to be predatory—inimical to governance, socioeconomic outcomes, and development.

While the study's findings are statistically significant, economically meaningful, and robust to various alternative model specifications and econometric estimation procedures, there are caveats that need to be pointed out. For one, results of this research only apply to Rizal province and therefore, provides only a snapshot of how fat political dynasties affect local governance in the Philippines. A subsequent research analyzing all municipalities in the country is needed to portray a nationally representative empirical evidence. Meanwhile, like Tusalem and Pe-Aguirre (2013), the author recognizes that the study's findings may possibly be affected by endogeneity, since the regression modeling employed “cannot control for unobserved characteristics of politicians, parties, or efforts of mobilization” (Bragança et al., 2015, p. 14). A future research intends to build on the econometric model developed in this study to address possible endogeneity concern.

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# Special Session PCNS - The COVID-19 Crisis Viewed from the South

09:30 - 10:45 Friday, 28th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/82899500055>

Chair Eduardo A. Haddad



## PREVENTING AND MANAGING DEBT CRISES: THE ROLE OF DEBT TRANSPARENCY

**Rym Ayadi**

Founder and President, Euro-Mediterranean Economists Association (EMEA)

## HEALTH CAPACITIES AS A NEW POWER INSTRUMENT

**Salma Daoudi**

Research Assistant in International Relations, Policy Center for the New South

## ECONOMIC POLICIES IN DEEP MUTATIONS: PERSPECTIVES FROM AFRICA

**Wilson Erumebor**

Senior Economist, Nigerian Economic Summit Group

## FOOD SECURITY AND POLICY IN THE CONTEXT OF COVID-19: POLICY INSIGHTS FROM SELECTED COUNTRIES

**Isabelle Tsakok**

Senior Fellow, Policy Center for the New South

## **Regular Session: RS09.5 - Regional and urban policy**

**09:30 - 10:45 Friday, 28th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/81254577425>**

**Chair Dan Zheng**

## ECONOMIC DEVELOPMENT PROCESSES OF CENTRAL AND EASTERN EUROPEAN CITIES

Szilard Racz

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### ABSTRACT

The research seeks to explore FDI-driven transformation and development processes in Central and Eastern European (CEE) cities in the post-transition period. The geographical focus of the analysis is limited to post-socialist states, while the scale of the analysis targets the metropolitan and regional level. Research questions: 1) What common specifics characterize the economic development of CEE cities? 2) Can the existence of specifics indicating unique development paths (i.e. Visegrad Group, Western Balkan states; gateway cities, automotive cities) be verified? 3) What are the consequences of capital city centrality and the role of second tier cities? The first part of the study presents the background of the macroregion. In the course of the past three decades, Central and Eastern Europe has witnessed a particularly dynamic transformation process. Central Europe has emerged as a winner of global industrial relocation processes, industrial decline was followed by reindustrialisation, while economic restructuring produced a multi-layered spatial structure. According to Gál and Schmidt (2017), the main specifics of the transition model include a double shift in ownership structure (from state to private, from domestic to foreign) and a double shift in the system model (from state socialism to market capitalism, from industrial capitalism to financialized capitalism). The region's externally driven and financed global economic integration was not the result of bottom-up development, which led to the proliferation of literature challenging core ideas of mainstream theories or presenting their variable geo-economic framework conditions referred to as externally-driven capitalism or the dependent market economy model (Nölke and Vliegthart, 2009). The second part of the study focusing on the examination of individual urban development paths. While FDI was the dominant foreign capital type in the first phase of the transition (privatization), foreign bank capital took over the predominant role of FDI at the turn of the millennium. The unfolding of this process was spatially uneven since capital cities, port cities and western regions adjacent to EU Member States were seen to provide profitable investment opportunities by investors in the first round. Initially, investments targeted only a small number of cities and regions, hence, economic growth was also concentrated in these areas, providing them a source of relative advantage. The global economic crisis has impacted this trend, without, however reversing long-term tendencies. The penetration of advanced services follows the urban hierarchy and in the bulk of the states this sector is concentrated in the capital city. The dominance of capital cities and city regions is a well-established fact. In smaller countries, or in the case of central location, the role of capital cities cannot be overstated. In addition, there is a substantial difference in size between capital cities and second-tier cities in every respect.

## INNOVATIVE ACTIVITY OVER SPACE AND TIME - SPATIOTEMPORAL MODELING OF INNOVATION PROMOTING FACTORS

[Imke Rhoden](#)

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### ABSTRACT

As innovation and innovative activity are regionally bound and prone to spill over not only locally, their development over time is also not negligible. To show determinants for innovative activity over the course of time and stress the importance of considering time series together with spatial indicators is the matter of this paper. A time-dependent geospatial model is able to factor in linear as well as nonlinear innovation-influencing factors, and consider time and space simultaneously. The dataset used is based on data by the German Patent and Trademark Office and is mined according to location and time of the published patents. All analyses are executed in the timeframe 2009-2016 on the map of German administrative districts (NUTS-3 level). The prevailing analytics follow Bayesian statistical reasoning. Results of the model show that time as well as space are relevant dimensions for investigating innovation in Germany. Theoretically motivated covariates like knowledge intensity, R D funding as well as productivity and openness impact innovation favorably. Population density seems to be negligible, and firm size impacts innovation negatively. Incorporating the spatial dimension leads to increased reliability and interpretability of the model. Including the time dimension is necessary, as the effects suffer from overestimation otherwise. The results allow better formulations of future models for innovation activity and allow improvements in targeting regional innovation policy. For the latter the model shows effects specifically for each region and for each type of determinant, so that precise leverage points can be concluded.

## DO AGGLOMERATION ECONOMIES INFLUENCE ENVIRONMENTAL REGULATORY COMPETITION? THE CASE OF CHINA

Dan Zheng

University of Chinese Academy of Sciences, China

### ABSTRACT

Using panel data of 30 Chinese provinces during the period from 2005 to 2015, this paper empirically examines to what extent agglomeration economies influence environmental regulatory competition. It is found that a province's environmental regulation, which is measured by the enforcement of command and control policy and market-based economic policy, is positively related to the regulation of its competitor provinces. Therefore, Chinese provinces do engage in environmental regulatory competition. It is also found that provinces with different levels of agglomeration economies respond asymmetrically to the change of their competitors' regulations. The more agglomerated a province is, the less responsive is the province's environmental regulation to its competitors' environmental regulation. In particular, the asymmetric response is only significant when provinces adopt a market-based economic policy to engage in regulatory competition.

## **Regular Session: RS10.9 - Regional development**

**09:30 - 10:45 Friday, 28th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/86828580970>**

**Chair Juan Piedra-Peña**

## ON THE DYNAMICS OF PATIENT MIGRATION FLOWS: IS EFFICIENCY PERFORMANCE EXPLAINING INFLOWS FOR NEIGHBORING HOSPITALS? AN APPLICATION TO THE ECUADORIAN HEALTHCARE SYSTEM

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### ABSTRACT

This study aims to analyze whether higher efficiency performance of Ecuadorian hospitals attracts larger inflows of interregional patients to a given hospital and the existence of spatial dependence in terms of larger inflows of patients for neighboring hospitals in the region. We develop a novel two-stage approach. In the first stage, we use conditional order-m estimations to obtain robust efficiency values for each hospital. In the second stage, we use a spatial Durbin interaction model to estimate the effect of hospital efficiency on patient migration flows and disentangle the spillover effects in the migration dyad. The results show a positive effect of specialized hospitals' efficiency in attracting patients from other regions. In addition, patient inflows present spillover effects not just on neighboring hospitals in the same region but also from hospitals in regions neighboring the origin. Policy implications mostly drive the attention to the importance to elaborate well planned healthcare strategies taking care of territorial externalities. Negative shocks affecting specialized hospitals could imply an adverse effect on the flow of patients to the whole region, affecting the regional public healthcare performance and potential welfare gains. Conversely, more resources could be directed to less-developed regions to incentivize competition.

### KEYWORDS

Hospital efficiency, patient migration, spatial dependence, spillover effects.

### 1. INTRODUCTION

In healthcare system analysis, patient choice of hospitals and the resulting patient mobility has been a topic that has occupied a vast body of the literature over the past two decades (Balía et al. 2014). Models that allow patient choice of hospitals have a wide spread of useful applications both for governments and the hospitals' own governance (Lowe and Sen 1996). In this context, Balía et al (2014) state that the importance to assess patient mobility can be twofold. First, the geography of patient mobility yields indications on the actual level of services provided. This can be particularly useful given that the preferences of the individuals are not perfectly observable. For example, patient outflows might reveal the possible inefficiency or low quality of public healthcare supply in a given region.<sup>198</sup> Second, the flow imbalances across regions may challenge the stability of their healthcare budgets. This kind of information can be useful for central planners and regional authorities interested in correcting inefficiencies in the system as well as improving the healthcare system performance. Understanding the mobility patterns of healthcare consumers may represent an important tool for the central government and regional planners to identify clusters of hospitals and take advantage of spillover effects to better allocate the resources and enhance the efficiency of the system.

Essentially, patients move because they want to get the best hospital treatment that the system can provide, or at least better services than those offered in their local region. They can be expected to move when possible inefficiencies translate into longer waiting lists but also when the perceived quality of the local healthcare services is low (Aiura 2013; Balía et al. 2014). These movements might be permanent over time if the local regions in a country present a certain level of asymmetry in their systems (Balía et al. 2018).

In this sense, there is a strand running through the literature stating that eliminating barriers of access to healthcare, and thus giving patients the ability to choose between hospitals, creates a financial incentive for providers to compete among them, which leads to improvements in quality of care (Gaynor et al. 2012; Gravelle et al. 2014; Bloom et al. 2015). This theory might hold in a country where the healthcare system is rather homogeneous across regions. However, when regional disparities are significant and persistent over time, high-income regions tend to offer a better quality of care. This motivates patients to move from low- to high-income regions seeking better treatment. In turn, the dynamic of such

<sup>198</sup> Throughout this paper, hospital efficiency reflects the ability of a hospital to properly make use of its resources or inputs (e.g., physicians, medical equipment, capacity, etc.) to provide medical attention derived from given outputs (e.g., patients treated, treatments carried out, etc.). In this sense, a fully efficient hospital can maximize its outputs with a given amount of inputs. This is commonly known in the healthcare efficiency measurement literature as *technical efficiency* (Peacock and Hollingsworth 2008).

flows, closely relating with the spatial pattern, could be giving rise to network effects often detected in the data and translating into a structure correlation, known in the literature as spatial dependence (Anselin 2010).

An interesting context of analysis is brought to this setting by Ecuador, whose marked regional disparities offer us a framework of study that can allow us to understand the interregional and intraregional dynamics of patient mobility that can be driven by the performance gaps of their heterogeneous hospitals.

Like other Latin American countries, Ecuador has suffered a continuous process of deterioration of its public healthcare system, which has been exacerbated by the neoliberal reforms of the 1990s and the 2000s, resulting in a widening of the existing territorial disparities in the country. These disparities derived in a concentration of healthcare resources in a few public hospitals (the high-performers), which at the same time were located in developed regions (Piedra-Peña 2020). With the approval of the new constitution in 2008, new healthcare reforms were enhanced to promote free access of medical care and an increase of social security coverage. This gave patients the possibility of choosing the hospital where they wanted to receive treatment.<sup>199</sup> At the same time, this increased the demand for medical attention, promoting a behavior of mobilization to seek treatment in developed regions (Piedra-Peña 2020).

As the barriers of access vanished, patients were expected to seek better treatment in areas where they perceived would get the best possible treatment, leading to patient mobility. Mobility then caused an increase in patient demand, and this can result in two different outcomes. On the one hand, higher demand fuels competition among hospitals in the region, resulting in an increase in quality of care or more efficient use of resources in order to cope with the demand. On the other hand, when demand for hospital treatment increases, hospitals become crowded and additional resources are needed to reduce congestion, entailing eventually inefficiencies like longer waiting times and finally in an underprovision of public services such as healthcare (Aiura 2013). Moreover, if developed regions are the receivers of a bigger share of patients, one can expect that other adjacent hospitals may receive patients driven by the demand at their neighbors.<sup>200</sup>

So far, the literature on patient mobility has focused on identifying and measuring the effects of the determinants on patient flows either between regions or between healthcare institutions, but there has not been an empirical study that assesses the dynamics of interregional patient mobility in the hospitals within a given region. Understanding these dynamics can help regional planners and hospital managers to understand the patterns of demand as not just interregional but also intraregional patient flows. High-performing hospitals can be prepared for potential boosts in demand generated by new reforms that widen the insured population or allow for the gratuity of medical services. They can account for these demand increases and plan to improve their capacity, medical staff, or technological endowment. Low-performing hospitals can also benefit from this, and enhance their medical resources as well, to increase their performance and avoid possible outflows of patients.

Piedra-Peña (2020) emphasizes the important influence that patient mobility can have on the performance of any given public hospital in Ecuador and that of surrounding hospitals as well, given the spillover effects in hospital efficiency.<sup>201</sup> Here we seek to understand the patterns of these patient flows and determine the extent to which these performance gaps are driving people to move from different regions to be treated in a (high-performing) hospital, and what the repercussions are for their surrounding hospitals.

Thus, this study aims to analyze whether higher hospitals' efficiency performance encourages larger inflows of interregional patients to a given hospital and whether these are accompanied by larger inflows of patients for neighboring hospitals in the region. So far, the literature on healthcare economics has focused on the measurement of the effects of hospital competition, patterns of access to hospital services, and the determinants of patient migration flows by just accounting for the spatial distance between hospitals or regions, using gravity models (e.g., Congdon 2001; Varkevisser et al. 2012; Moscelli et al. 2016). A large part of the literature has concluded that the healthcare efficient performance of hospitals and regions is a strong driver of patient mobility. But there has not been an attempt—to our understanding—to consider the possible spillover effects that give rise to higher patient migration flows to neighboring hospitals. In this respect, our contribution to the literature is to provide a robust measure of hospital efficiency, consistent with economic theory, that allows us to identify its effect to attract patients. In addition, if spillover effects in the patient migration network are significant, this measure can serve as a reliable tool for decision-making to identify key hospitals that attract demand and foster competition.

To that end, we follow an innovative two-stage approach. In the first stage, we make use of the conditional order- $m$  efficiency measurement proposed by Cazals et al (2002), Daraio and Simar (2005), and Daraio and Simar (2007) to obtain robust efficiency measures for Ecuadorian public hospitals in 2014. This method is based upon the economic concept of Pareto efficient allocation and takes into consideration the effect of other environmental variables (related to the region) in the hospital performance. In the second stage, we address patient mobility flows with spatial interaction models proposed by LeSage and Pace (2008) and LeSage and Pace (2009), which take into account traditional origin-destination (OD) models, but incorporate spatial lags of the dependent variable in order to account for spatial dependence, represented by flows from neighboring regions in these models and accommodating for endogenous interactions (i.e.,

<sup>199</sup> The new constitution approved in 2008 (which stated that health is a right guaranteed by the state who will ensure full exercise of the right and access to social insurance) provided reforms aiming at providing higher access to medical treatment, like the gratuity of medical services provided by the Public Ministry of Health (MSP) or laws that deprived the liberty to employers that do not affiliate workers (Orellana et al. 2017; Piedra-Peña and Prior 2020).

<sup>200</sup> For example, if a given hospital has a long waiting list, patients could try to receive attention in alternative hospitals in the region.

<sup>201</sup> Piedra-Peña (2020) provides evidence of the existence of positive spatial dependence in public hospital efficiency deriving from the existence of global and local spillover effects. In other words, the increase in the efficiency of neighboring hospitals is having a positive impact on the efficiency of an observed hospital as well.

global spillovers). In addition, we consider exogenous interaction arising from contextual effects, accommodating for spatial dependence of the explanatory variables, and representing characteristics of the neighboring regions and hospitals (i.e., local spillovers) (LeSage and Fischer 2016). In the applied literature, these models have been used in cases where origins and destinations coincide (LeSage and Thomas-Agnan 2015). However, this is not our case: the list of origins (cantons) differs from the list of destinations (hospitals).<sup>202</sup> This calls for a modification in the econometric estimation which has been recently addressed by Laurent et al (2019) that, to our understanding, has not yet been applied, and constitutes an additional contribution of our study.

This paper is structured in the following way. Section 2 reviews the literature on hospital patient migration. Section 3 explains the methodology of the order- $m$  efficiency measurement and the spatial interaction model. Section 4 describes our dataset and Sections 5 present the estimation results. Finally, the main conclusions are presented in Section 6.

## 2. LITERATURE REVIEW

The aim of our study is to single out the effect that hospital efficiency has on interregional patient mobility. Moreover, we want to disentangle the potential spillover effects found in these mobilization flows between and within regions so, we can identify demand patterns of healthcare treatment that can be used as a tool for decision-making. In so doing, we combine two different strands of the literature: healthcare efficiency measurement and patient mobilization literature. There is a vast body of literature on healthcare efficiency measurement that focuses on obtaining a single value that measures the efficiency performance of an observed unit through parametric and non-parametric methods that combine multiple inputs and outputs. The idea of efficiency is linked to the concept of Pareto efficient allocation, where those efficient units are either minimizing inputs or maximizing outputs in the production of health (i.e. in providing medical attention). The main advantage of these approaches is that we can rely in a single estimated efficiency score, more consistent with economic theory, as it allocates technical or Pareto inefficiencies instead of measuring efficiency based on single averages (Cantor and Poh 2018). A rich review of this literature can be found in O'Neill et al (2008), Hollingsworth (2008) and Cantor and Poh (2018).

Furthermore, we rely on the hypothesis that the performance of a given set of hospitals is going to be determined –to a certain extent– by regional characteristics, and specially by the level of development or income level in the region (Brekke et al. 2016) due to the evident territorial disparities in Ecuador (Piedra-Peña 2020). To avoid the separability assumption and provide meaningful results, we implement a non-parametric method known as the conditional order- $m$  efficiency estimation (Cazals et al. 2002; Daraio and Simar 2005). Recent applications of this technique include Halkos and Tzeremes (2011), who perform a conditional order- $m$  efficiency analysis on Greek prefectures, and find a negative relationship between per-capita GVA and efficiency; whilst population density has a positive effect in hospital performance. Other micro-level approaches such as Mastromarco et al (2019) analyze the cost efficiency of Czech Republic hospitals during the period 2006-2010. They implement an order- $m$  efficiency estimation controlling for non-profit status, teaching status, presence a specialized center (in the hospital) and occupancy rate, finding that non-profit hospitals, university hospitals and hospitals with specialized centers are generally less efficient. Another advantage of conditional order- $m$  estimation is that we do not need to assume a production function in the estimation process. This is particularly important in our study, as the multidimensional nature of public hospitals and regional heterogeneity in the country posits a difficulty at the time of defending the assumption of a single production function for all hospitals in the sample.

However, despite the clear advantages of these methods to provide a robust estimation of efficiency, there has not been an attempt to combine them along with econometric models to study patient mobility patterns. The empirical literature directly focused on patient mobility has been developed in the past decade. Instead of focusing on specific determinants of patient flows, it centers on modeling hospital choices and flows across different jurisdictions (Balia et al. 2014). Some micro-level studies single out potential determinants of mobility. Victoor et al (2012) offer a survey in which they put in evidence that some common determinants of patient mobility can refer to patient characteristics (e.g. education, income, and age) and provider characteristics.

In our setting, we need to take into account macroeconomics (regional) variables since they impact patient decision of seeking care across regional borders. In this respect (macro-level) applied economic studies have mainly been based on gravity models, commonly used to model flows that take many forms, like population migration, commodity flows and traffic flows (Thomas-Agnan and LeSage 2014). These models embed movements of individuals between origin and destination regions. Levaggi and Zanola (2004) look for the determinants of net patient flows from regions of Italy to the rest of the country. They estimate gravity models for a sample of Italian regions from 1995-1997 and conclude that regions characterized by lower outflows are the ones that provide better or faster services. Cantarero (2006) develops the same analysis to patient flows across regions in Spain between 1996 and 1999 and identify that patients from the economically lagged regions move more than those regions that provide better health services.

However, the use of traditional gravity models to explain spatial interaction can be limited. These models rely on a function of the distance of the OD to clear spatial correlation and cross-section independence. As LeSage and Pace (2008, 2009) state, the notion that use of distance functions to effectively capture the spatial dependence of observations can be erroneous. Also, the idea that flows are independent since OD flows are fundamentally spatial in nature. In our framework

<sup>202</sup> In Ecuador, cantons are the second-level administrative divisions. The Republic of Ecuador is divided into 24 provinces, which in turn are divided into 221 cantons. The cantons in turn are subdivided into parishes.

of analysis, we expect to find a behavior pattern where high-income regions are the main receivers of patients, following a spatial pattern, that, if not controlled for in the econometric estimation, could lead to biased conclusions.

So far, no studies have tried to account for the spatial dependence in patient mobility. Moreover, even when a big part of the literature implicitly concludes that healthcare performance is a strong driver of patient flows, there has not been an attempt to disentangle its sole effect. The closest paper to our approximation is Balia et al (2018) who account for local spillover effects by incorporating the spatial lags of the exogenous variables in the gravity model. They use a spatial panel data framework of Italian hospital discharges between 2001 and 2010 to assess the effect of the main determinants of interregional patient flows, differentiating between the impacts of regional health policies and other exogenous factors. Their results show that neighboring regions' supply factors, specialization and performance largely affect mobility by generating local externalities that explain OD patient flows; bringing some insights of the inherent spatial-dependent nature of hospital performance, and, its effects on patient mobility.

Our empirical estimation, hence, goes beyond the incorporation of local spillover effects as in Balia et al (2018), and includes potential global spillover effects likely found in OD flows, as stated by LeSage and Pace (2008, 2009). In so doing, we use the extended gravity models developed by LeSage and Pace (2008, 2009) to allow for spatial dependence in the sample, represented by the flows from cantons (regions) to public hospitals in these models. Additionally, we consider exogenous interactions of the explanatory variables (LeSage and Fischer 2016) to accommodate for the contextual effect of the neighboring regions and hospitals in the OD dyad, as in Balia et al (2018).

### 3. METHODOLOGY

The method used in this study is developed in two stages. First, we need to obtain the efficiency measures for each hospital, conditional to the environmental variables they face and can constrain their performance. In the second stage, we develop a spatial interaction model (based on the conventional gravity specification) to estimate the impact that the efficiency value has on migration flows, accommodating for potential spillover effects.

#### 3.1 Order-m efficiency estimation

The first stage of our strategy uses a nonparametric order- $m$  efficiency estimation approach, introduced by Cazals et al. (2002), Daraio and Simar (2005) and Daraio and Simar (2007) that relies upon the production theory (Debreu 1951; Koopmans 1951). Introducing the notation used in this paper, we assume a set of  $y \in \mathbb{R}_+^p$  outputs produced by a set of  $x \in \mathbb{R}_+^q$  inputs, the production technology is the set of all feasible input-output combinations:

$$\Psi = \{(x, y) \in \mathbb{R}_+^{p+q} \mid x \text{ can produce } y\} \tag{1}$$

The multidimensional nature of public hospitals, with different functions that are difficult to quantify, plus the impossibility to obtain input and output prices information makes  $\Psi$  impossible to observe. To account for this, we need to estimate  $\Psi$  from a random sample of production units denoted by  $X = \{(x, y) \in \mathbb{R}_+^{p+q} \mid i = 1, \dots, n\}$ . Following this framework, an observed production unit  $(x_i, y_i)$  defines an individual production possibility set  $\Psi(x_i, y_i)$ , which under the free disposability of inputs and outputs can be expressed as:

$$\Psi(x_i, y_i) = \{(x, y) \in \mathbb{R}_+^{p+q} \mid (y \geq y_i) x \leq x_i\} \tag{2}$$

Nevertheless, there could be other environmental factors  $Z \in \mathbb{R}^r$  exogenous to the production process that could be affecting the production and the distribution of efficiency scores. In this matter, Cazals et al. (2002), Daraio and Simar (2005) and Daraio and Simar (2007) use a probabilistic formulation of the production process to develop a conditional efficiency approach to account for the environmental variables in the efficiency estimation, conditioning the production process to a given value of  $Z = z$ . This conditional function is given by:

$$S_Y(y|x, z) = Prob(Y \geq y \mid X \leq x, Z = z) \tag{3}$$

Representing the probability of a unit operating at level  $(x, y)$  being dominated by other units facing the same environmental conditions  $z$ . This way, the conditional output efficiency can be defined as the Farrell (1957) efficiency measure:

$$\theta(x, y|z) = sup\{\theta \mid S_Y(\theta y|x, z) > 0\} \tag{4}$$

Those points where  $\theta(x, y|z) = 1$  are the technically efficient ones and correspond to the efficiency frontier, while those with  $\theta(x, y|z) > 1$  are technically inefficient. To obtain the nonparametric estimators of the conditional frontier  $\theta(x, y|z)$ , mitigating the impact of outliers, we use the order- $m$  frontier (Cazals et al. 2002). The order- $m$  frontier considers as a benchmark the expectations of the best practice among  $m$  peers randomly drawn from the population of units from which  $X \leq x$ .<sup>203</sup> The procedure is repeated  $B$  times resulting in multiple efficiency measures  $(\hat{\theta}_m^1, \dots, \hat{\theta}_m^B)$ , where the final order- $m$  efficiency value is the sample mean  $(\hat{\theta}_m)$ . This way, the efficiency of a decision making unit (DMU)<sup>204</sup> can be compared with  $m$  potential DMUs that have a production larger or equal to  $y$ . The conditional order- $m$  output efficiency estimator can be obtained by the computation of the one-dimensional numerical integral defined as in Daraio and Simar (2007b):

$$\hat{\theta}_m(x_0, y_0|z_0) = \int_0^\infty [1 - (1 - S_{Y|X,Z}(u y_0|X \leq x_0, Z = Z_0))^m] du \tag{5}$$

The efficient frontier corresponds to the DMUs where  $\hat{\theta}_m(x, y|z) = 1$ . Notice that the efficiency values can take a score lower than one. In this case, the hospitals are labeled as super-efficient, meaning that they exhibit higher levels of outputs than the order- $m$  frontier.

<sup>203</sup> We fix the value of  $m = 90$ , following the approach of Daraio and Simar (2005) for which the decrease in *super-efficient* observations ( $(\theta(x, y|z) < 1)$ ) stabilizes.

<sup>204</sup> We can call DMU to any unit of analysis, say, individuals, departments, firms, municipalities, or in the case of this study, hospitals.

To estimate the conditional order-m model, we need to incorporate smoothing techniques such that in the reference samples of size  $m$  units with comparable  $z$ -values have a higher probability of being chosen. Hence, we rely on the estimation of nonparametric kernel functions to select the reference observations, and a bandwidth parameter  $h$  in the estimated probability function  $S_Y(y|x, z)$ , given by:

$$\hat{S}_{Y,n}(y|x, z) = \frac{\sum_{i=1}^n I(x_i \leq x, y_i \geq y) K_{\hat{h}}(z, z_i)}{\sum_{i=1}^n I(x_i \leq x) K_{\hat{h}}(z, z_i)} \quad (6)$$

where  $K_{\hat{h}}(\cdot)$  represents the kernel function,  $I(\cdot)$  is an indicator function,  $n$  represent the number of observations and  $h$  is the appropriate bandwidth. Considering that our environmental variables  $Z$  are continuous, we estimate the appropriate bandwidth  $h$  following Daraio and Simar (2005) and use the k-Nearest Neighbor (k-NN) method.

### 3.2 Spatial Durbin interaction model

In the second stage of our strategy we make use of spatial interaction models, which rely on gravity models to explain OD migrations flows. However, a potential drawback for gravity models is that they rely just on a function of OD distance to account for spatial correlation and ensure cross-section independence (Balía et al. 2018). These assumptions have been challenged by many authors. Porojan (2001) and Lee and Pace (2005) find evidence of spatial dependence in the residuals of international trade and retail sales flows, respectively; while LeSage and Pace (2008, 2009) point out that the assumption of independence among observations might be difficult to defend, as OD flows are fundamentally spatial in nature. The explicit consideration of flow data correlation due to the spatial configuration of the units involved has been drawing much attention in the literature as the so-called network autocorrelation (Patuelli and Arbia 2016).

To embed spatial dependence in a spatial interaction setting, LeSage and Pace (2008) consider spatial spillovers at three dimensions: *origin-based*, *destination-based*, and *origin-destination based*. As described by LeSage and Pace (2009), origin-based spatial dependence reflects the notion that forces leading to flows from any origin to a particular destination may create similar flows from neighboring origins. Destination-based spatial dependence is related to idea that forces leading to flows from the origin to a destination may generate similar flows to nearby destinations. Thus, origin-destination-based spatial dependence reflect those forces that create flows from neighbors to the origin to neighbors to the destination. Using this definition of spatial dependence means that we need to model spatial dependence for flows of patients as a spatial autoregressive specification, accommodating endogenous interactions. This definition will allow us to define spatial spillover effects to hospitals neighboring the destination hospital in the flow of patients.

Additionally, we can accommodate the model for exogenous interactions in a Spatial Durbin Model (SDM) representing a situation where local spillovers arise from changes in the characteristics of neighboring hospitals and environmental features of neighboring regions (cantons). The exogenous interactions can be modeled by including the spatially lagged covariates in the econometric specification (along with the spatial lag of the endogenous variable). If statistically significant, the omission of these interactions can lead to problems of omitted variable bias (LeSage and Fischer 2016). We control for this issue: we begin by defining the model with no spatial interactions (based on the conventional gravity model) and adjust it for exogenous interaction specifications as in LeSage and Fischer (2016), and, then, we move to its SDM extension as illustrated in LeSage and Pace (2008) and Laurent et al (2019).<sup>205</sup> We define our final model as follows:

$$y = \rho_d W_d y + \rho_o W_o y + \rho_w W_w y + c\alpha_i + \alpha l_N + e_d \beta_d + X_o \beta_o + X_i \beta_i + W_d e_d \phi_d + W_o X_o \phi_o + W_i X_i \phi_i + \gamma g + W_o g \gamma_o + W_d g \gamma_d + \varepsilon \quad (7)$$

Where  $y$  is the  $N = n_o n_d$  vector of patient migration (logged) flows, that has been obtained by stacking the columns of the matrix  $Y$  of patients' migration flows, whose columns reflect origins (cantons), and rows destinations (hospitals). With  $n_o$  being the number of geographical observations at the origin and  $n_d$  the number of geographical observations at the destination. The vector of distances  $g$  is composed by the euclidean logged distances between origins and destinations. We define a contiguity matrix  $W_d$  where hospitals are neighbors if they are located in the same canton. Hence,  $W_o$  defines as neighbor those cantons that share a border line. The spatial lag  $\rho_d W_d y$  reflects flows from neighbors to each destination observation in the vector of origin-destination flow to form a linear combination of flows from neighboring destinations. While  $\rho_d$  captures the strength of destination-based dependence. Similarly,  $\rho_o W_o y$  reflects a linear combination of flows from regions neighboring the origin; and  $\rho_o$  reflects the strength of origin-based dependence. Hence,  $\rho_w W_w y$  forms a linear combination of flows from neighbors to the origin and flows from neighbors to the destination, and the parameter  $\rho_w$  represents the strength of this dependence.

The vector  $e_d$  contains the robust logged efficiency scores obtained with (5) specific to every hospital. The matrix  $X_o$  accounts for economic and demographic regional characteristics that proxy the regional income-level and health conditions, and impact patient choice to seek treatment in other (developed) regions. We use cantonal variables such as the logged Gross Value Added per-capita (GVAp<sub>c</sub>), logged population density, logged cantonal mortality, logged unsatisfied basic needs index (NBI),<sup>206</sup> and logged insured population rate.<sup>207</sup>  $\beta_o, \beta_d$  are the associated  $k \times 1$  parameter vectors. The scalar parameter  $\gamma$  is the effect of the (logged) distance  $g$ , and  $\alpha$  is the constant with  $l_N$  vector of ones.

<sup>205</sup> We move in this direction to identify the sources of spatial autocorrelation and avoid model misspecification and omitted variable bias. Following this sequence, we can determine the significant effect of the exogenous interactions by means of an SLX, and, then, those of the endogenous interactions with the SDM model. In such a way, we can select the appropriate framework of analysis that provides the best fit to our data.

<sup>206</sup> The NBI is a multidimensional poverty index, commonly used in Latin American countries.

<sup>207</sup> In order to avoid taking the log of zero, we have added the unity to the dependent and independent variables as in LeSage and Thomas-Agnan (2015).

The spatial lags of the exogenous variables  $W_oX_o$  and  $W_dX_d$  help explain variations in flows across dyads coming from changes in the characteristics of the regions neighboring the origin and hospitals neighboring the destination respectively.  $\phi_o, \phi_d$  are the parameters associated to  $W_oX_o$  and  $W_dX_d$ . We control for the spatial lags of distance  $g$ , so  $W_dg$  and  $W_o g$  explain the variations in flows arising from changes in the distance of neighboring hospitals in the same canton, and from neighboring cantons respectively. This aligns with the idea that patients will select the hospital to be treated depending not just on their proximity (to a given hospital), but to the that of their neighbors, as well. Finally,  $\gamma_d$  and  $\gamma_o$  are the parameters corresponding to  $W_dg$  and  $W_o g$ ; and  $\varepsilon$  is the vector of disturbances.

A problem that might arise in the application of the model (especially for the regions that present large inflow of patients) is the presence of large flows of patients in the matrix of OD flows, relative to smaller (or zero). This would produce the non-normality in flows and jeopardize the estimations (LeSage and Pace 2008, 2009; Thomas-Agnan and LeSage 2014). In our setting, this would be representing an intraregional flow of patients (e.g. residents of developed regions getting treatment in their local area). To deal with this problem, LeSage and Fischer (2010) propose to modify the independent variables, by replacing with zero the values of the independent variables for the intraregional flows. The intraregional variations will be captured in a new set of explanatory variables  $X_i, W_iX_i$ , with non-zero observation for the intraregional observations as well as adding a new intercept term,  $\alpha_i$ .

Note that we cannot interpret  $\beta_d$  (nor any other estimated parameter associated with origin-destination characteristics) as the partial derivative on flows arising from changes in the destination-efficiency. As pointed out by LeSage and Pace (2009), in the spatial econometric specification of the interaction model, changes in the  $k$ th characteristic of an observation  $i$  will produce changes in flows into the  $i$ th observation from other observations, as well as flows out of the observation  $i$  to other observations. Unlike conventional regression models where it leads to changes only in observation  $i$  of the dependent variable,  $y_i$ .

LeSage and Thomas-Agnan (2015) propose scalar summary measures of the impacts arising from changes in characteristics of the observations that involves averaging the *cumulative flow impact* associated with changes in all observations, resulting in the so called *origin effects*, *destination effects*, and *network effects*. Origin and destination effects express the mean impact on flows arising from changes in the origin and destination characteristics, respectively. In turn, network effects characterize the mean impact of a change in the characteristics of the origin  $i$  on all the flows coming from other origins, different from  $i$  to a destination  $j$ .

#### 4. DATA

To estimate (7) we collect data for the year of 2014. Hospital information comes from the Annual Survey of Hospital Beds and Discharges and the Survey of Health Activities and Resources provided by the National Institute of Statistics and Census (INEC, by the acronyms in Spanish). We excluded the psychiatric, dermatologic and geriatric hospitals, and took out from the sample those that presented irregularities in the data.<sup>208</sup> As described above, the migration flow matrix considers the rows to be the hospital destination, while the columns are the cantons (regions) of origin. We retrieved a sample of 176 destination hospitals and 106 cantons of origin. By vectorizing the flow matrix, we obtain a vector of 18.656 observations.

The cantonal economic and demographic variables were retrieved from the Ecuadorian Central Bank (BCE, by the acronyms in Spanish) and INEC's public statistics, respectively. While the poverty and population insurance data was collected from the 2010 national census.

For the selection of input and output variables to estimate model (5) in the first stage of our strategy, we followed previous literature on efficiency measurement. A complete review of the literature is offered in Hollingsworth (2008), O'Neill et al (2008) and Cantor and Poh (2018).

Regarding the input variables, we use the number of beds, the medical equipment, and infrastructure, widely used as a proxy for hospital size and capital. To proxy labor costs, clinical staff is usually included. To that end, we introduce the number of physicians and healthcare professionals beyond the number of physicians of the hospital.

As for the outputs we use the hospital's patient discharged to measure the final production of health.<sup>209</sup> Additionally, we use the total number of morbidity and emergency consults, and the total number emergencies treated. Finally we proxy for the hospital quality using the survival rate after 48 hours of admission.

Finally, we consider three environmental variables that can potentially affect the hospital performance: the cantonal GVApc, cantonal population density and the hospital occupancy rate.

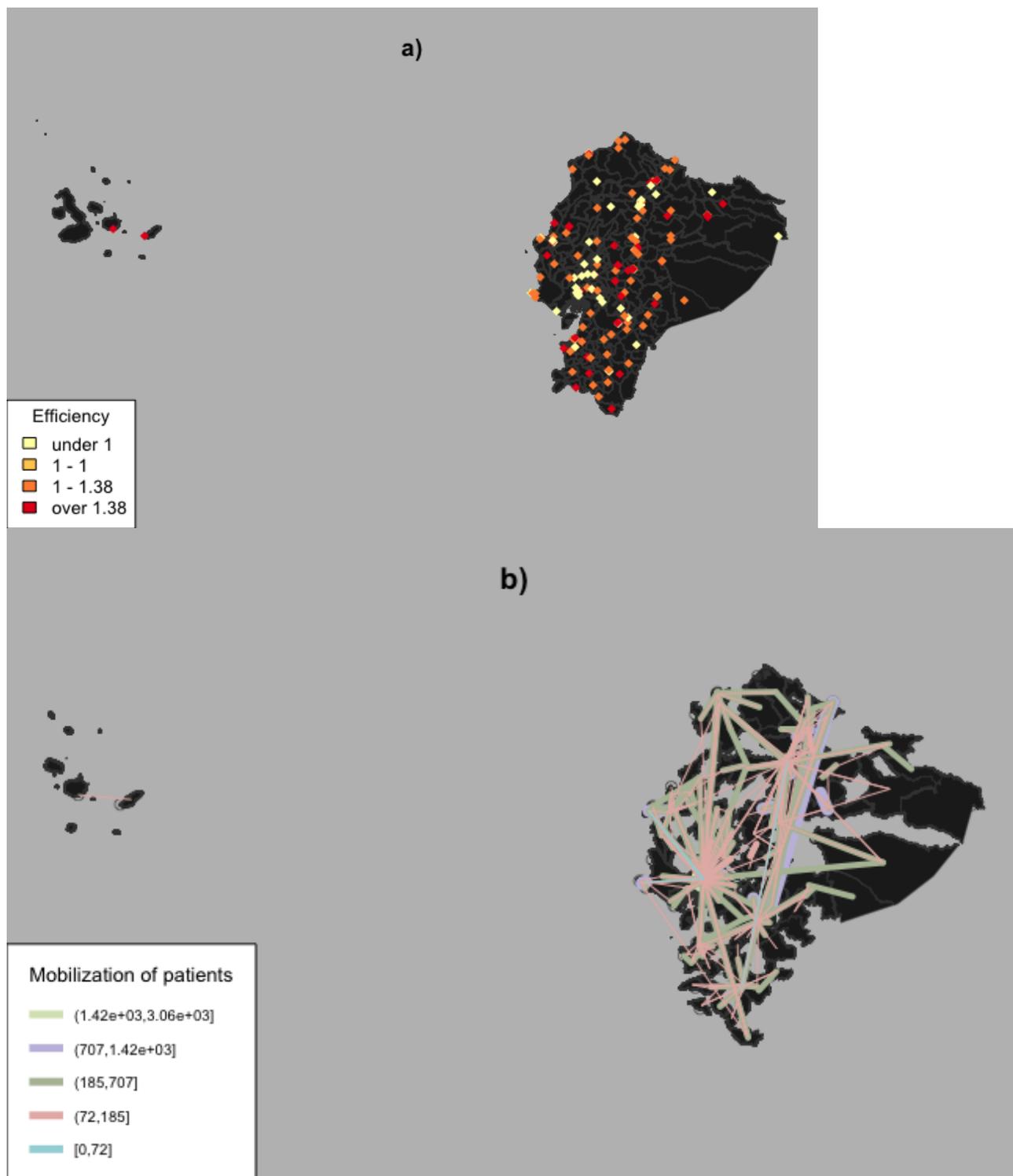
For the second stage of our strategy, we use two sets of variables, at hospital and regional level. First, at the hospital level, we use the efficiency scores obtained in the first stage as a variable of hospital performance. The variable proxies the pulling effect for a hospital to attract patients ( $e_d$  in equation (7)). A negative sign of the efficiency variable destination effect means a good performance, attracting patients from other cantons.<sup>210</sup>

We proxy the cantonal level variables ( $X_o$  in (7)) that will impact on patients' decision to look for medical treatment with five variables: logged GVApc, logged population density, logged cantonal mortality, logged unsatisfied basic needs index (NBI).

<sup>208</sup> We excluded psychiatric, dermatologic and geriatric hospitals as they focus on specific illness and patients that require different treatments that could bias the efficiency values. For example, psychiatric hospitals might require inpatients to stay for long periods of time, wherein our analysis would reflect it as a criteria for less efficiency.

<sup>209</sup> We control for the heterogeneity of the disease-case attended using Herr (2008)'s case-mix index.

<sup>210</sup> Recall that hospitals with efficiency values higher than one are technically inefficient hospitals. Hence, a negative relationship with patient flows would mean that the best-performers are attracting more patients.



**Figure 1: Hospital Efficiency and patient migration flows**

Figure 1 shows the distributions of hospitals by efficiency performance ( $e_d$  in (7)) at the top panel (a), and the migration flow dynamic of the sample ( $y$  in (7)) at the bottom panel (b). Panel a) of the Figure shows the most efficient hospitals (that is, the hospitals with an efficiency value lower than 1, to be mainly concentrated in two of the most developed regions of Ecuador, where most of the healthcare resources are located).<sup>211</sup>

The panel b) of Figure 1 shows the patient flows from origin to destination, organized by intervals. We observe that there is a clear dynamic of patients traveling to the regions where the best performing hospitals concentrate. We can appreciate that most of the patient inflow is coming from neighboring cantons, which is a first signal of potential spatial autocorrelation in the migration flow. Hence, we use spatial interaction models that allow to disentangle the spillover effects of this migration dyad.

<sup>211</sup> These hospitals concentrate mainly in Quito and Guayaquil which are the two bigger and most developed cantons in Ecuador Mendieta Muñoz and Pontarollo (2016).

5. ESTIMATION RESULTS

The Bayesian MCMC estimates based on 1000 draws are presented in Table 1. The estimates show not just a high level of destination-based spatial dependence, but origin-based and origin-destination-based spatial dependence as well. The coefficients  $\rho_d$  and  $\rho_o$  are 0.31 and 0.53, respectively. The estimated parameter  $\rho_w = -\rho_d\rho_o$  is -0.11 and statistically different from zero.

These results provide evidence of the existence of spillover effects arriving from patient migration flows. Destination-based spatial dependence posits that flows coming from a given canton of origin to a destination hospital creates similar flows to neighboring hospitals (located in the same destination canton). In addition, origin-based spatial dependence shows that flows from any origin canton to a destination hospital creates similar flows from neighboring origins. Finally, origin-destination spatial dependence evidence that larger outflows from cantons neighboring the origin generate larger inflows to hospitals neighboring the destination. These findings point out the existence of spillovers steaming not just among cantons, but within cantons.

Table 1: Scalar summary effects

	Mean	t-value
<b>Destination Effects</b>		
log conditional efficiency	-0.3015	-4.9594
<b>Origin Effects</b>		
log GVApC	0.2185	6.7937
log density	0.0473	5.1626
log cantonal mortality	0.1155	2.4933
log nbi	0.0558	0.2817
log insured	0.4012	1.4762
<b>Network effects</b>		
log conditional efficiency	-0.1529	-2.5719
log GVApC	0.1725	1.8814
log density	-0.1026	-3.9597
log cantonal mortality	-0.4405	-3.9308
log nbi	2.0840	4.4193
log insured	-0.5705	-0.9851
$\rho_d$	0.3068	29.2126
$\rho_o$	0.5346	31.4697
$\rho_w$	-0.1085	-4.0614

Note: Dependent variable is the vector of (logged) migration flows. Bayesian MCMC estimates based on 1000 draws. N=18656.  
Source: The author

Table 1 also reports the scalar summary effects for the model (7). In terms of hospital efficiency, the estimates show a significant expected negative effect. The increase in efficiency of an observed hospital leads to higher inflow of patients. Specifically, a 1 percent increase in efficiency on an average hospital would lead to a 0.3 percent increase in patient inflows.<sup>212</sup>As mentioned, these results are supporting the hypothesis that patients are selecting those hospitals that present a higher performance as more qualified. Higher efficiency performance seems to be working as a pull factor that attracts patients from neighboring regions. This effect can also be arising from patient referrals from other (low-performer) hospitals, which do not account with the necessary resources to treat complex pathologies. The information available in our dataset does not allow us to disentangle the size of these effects. We leave this question to be explored in future research.

Interestingly, hospital efficiency is also displaying a significative and negative network effect. This means that 1 percent increase in the efficiency of a given hospital is increasing the patient movements going to neighboring hospitals –different from their initially preferred hospital of destination– in 0.15 percent. These finding goes in line with Piedra-Peña (2020), suggesting a competitive effect where higher efficiency in neighboring hospitals increase patient inflows.

Before drawing any conclusions, we carried out a series of robustness checks to test both for the validity of the estimations in the first stage as well as the second stage of our analysis. One important dimension to check the robustness is by considering the spectrum of treated diseases. There is the possibility that the pulling effect could be mainly driven by the presence of specialized hospitals versus other basic hospitals that provide another scope of treatments. Thus, we split the sample in two different subgroups by distinguishing between basic and specialized hospitals (this latter include chronic and acute hospitals).<sup>213</sup>

212 Note that values bigger than 1 are inefficient.

213 In our database, acute hospitals embed infectious hospitals, obstetric-gynecological hospitals, pediatric hospitals, general hospitals that treat acute diseases and other hospitals of specialization. Whilst chronic hospitals embed oncology and pneumology hospitals

**Table 2: Scalar summary effects by hospital type**

	Basic ( N=7743 )		Specialized ( N=2610 )	
	Mean	t stat	Mean	t stat
log conditional efficiency (Destination Eff.)	-0.0077	-0.1669	-0.8085	-3.9508
log conditional efficiency (Network Eff.)	0.3621	6.2390	-0.7748	-5.2670
$\rho_d$	0.1530	19.2537	0.3453	15.6936
$\rho_o$	0.2692	31.9435	0.4202	12.1845
$\rho_w$	-0.0318	-3.8361	-0.1222	-5.5952

Note: Dependent variable is the vector of (logged) migration flows. Bayesian MCMC estimates based on 1000 draws. N=18656.  
Source: The author

Table 2 presents the scalar summary effects for efficiency and the parameters  $\rho_d, \rho_o$  and  $\rho_w$  for each hospital type. It is not surprising to note that the destination effect for basic hospitals disappears, suggesting that the pulling effect of hospital efficiency performance is mainly being captured by specialized hospitals, because the magnitude of the estimation is larger. As basic hospitals spread across the country, what seems to be driving people to travel to high-income regions is the performance of specialized medical institutions, which are more concentrated in those cantons. However, high performance of an average basic hospital is not enough to attract interregional patients as they are prone to receive medical attention in their local hospital to treat a common disease. Instead, in the case of specific or severe illnesses, patients will select a particular hospital on the basis of the quality of the treatment they perceive they will attain over there, which is being captured by our efficiency variable. Nevertheless, spillover effects are still statistically robust and comparable in both the cases, which means that both arrangements are valid to guarantee patient mobility across the territory. One explanation endorsing these results (particularly for basic hospitals) is that even though the increase in efficiency of a given hospital is not enough to attract intraregional patients, those hospitals are taking advantage of patient inflows, initially attracted by other hospitals (most likely neighbor specialized hospitals).<sup>214</sup>

**6. CONCLUSIONS**

This study aims to analyze whether the higher efficiency performance of Ecuadorian public hospitals is resulting in a higher inflow of interregional patients to a destination hospital, and whether this is also leading to a higher inflow of patients to neighboring hospitals within the same region. To determine the effect of efficiency on the patient migration network, we follow an innovative two-stage strategy where the first step is to estimate robust conditional order-*m* efficiency values, based on the economic concept of Pareto efficient allocation and the second step makes use of a spatial Durbin interaction model to estimate the effect of hospital efficiency in patient migration flows, and separates the spillover effects in the form of larger inflows of patients for neighboring hospitals. We contribute to the empirical applied literature by estimating a model that considers different origins and destinations in the OD dyad, that—to the best of our knowledge—has not yet been applied.

We are referring to a structure in which regional disparities are modeled by means of healthcare asymmetries over time, producing a healthcare performance gap across regions and motivating a patient mobilization pattern since the majority of the influx of patients was concentrated in developed regions. Our results support the hypothesis that hospital efficiency performance is a strong pulling factor for this inflow, and the direction of this effect is robust according to different specifications and estimation methods. However, when we split the sample separating basic and specialized hospitals, this effect disappears for the former, but gets even stronger for the latter. In addition, we identify spillover effects in the mobilization flows, not just in the form of patients arriving at neighboring destination hospitals from an origin canton, but from patients arriving at a given hospital from cantons close to that origin, and arriving at adjacent hospitals as well. This evidence has two implications. First, the efficiency effect suggests that patients are perceiving—to some extent—hospital performance as a proxy for hospital quality that is encouraging cross-border migration to receive a better medical treatment than what they can get in their local area. However, this decision is based on the availability of specialized hospitals in the destination region, which are mostly concentrated in highly developed areas. The possibility also exists that other hospitals are referring patients for complex diseases, as they do not possess the resources to treat them. Second, spillover effects present in the data are suggesting that other hospitals neighboring the specialized ones are also capturing some of those inflows of patients. According to Brekke et al (2014), if there were competition among hospitals (which we find with the statistical significance of the network effects), this could entail a beneficial effect on the welfare of the population, as more competition encourages higher quality of care. However, hospitals from less-developed regions might not be benefiting from that welfare increase, as there is no incentive to provide better medical attention and hence just those that travel beyond regional borders may enjoy it.

Our results deliver useful suggestions for policy makers. On the one hand, new reforms need to be well-planned not just in terms of territorial discrepancies but also in terms of hospital specialization. For example, decreasing the limitations to specialized care could incur an increase of healthcare demand, that, if not controlled, could lead to negative consequences like congestion effects. Negative shocks to specialized hospitals induce a negative impact on their performance as well as the demand for the hospitals that surround them and as consequence, affects the efficiency of the

<sup>214</sup> For example, patients traveling to get specialized medical attention could incur in additional costs that are not covered by their insurance, but similar treatments could be offered in alternative public hospitals. Other scenario could imply that patients would seek medical attention in adjacent hospitals if the waiting time for specialized ones is long enough.

hospitals of the whole region and the welfare of the population. Public authorities could identify those key players in the healthcare network to target strengthening reforms that could encourage better performance within the public healthcare system of the region due to spillover effects.

Public healthcare policy can devote a larger share of their resources to targeting investment in those less-developed regions. The significant origin-based spatial dependence suggests the existence of clusters of less-developed cantons that are recording an outflow of patients. If there were not enough demand for local hospitals to compete, there would be no incentive to increase the quality of care over there. Therefore, public investment could be focused on the creation of specialized hospitals –or specialized wards in existing hospitals– in these regions to attract more demand. Once the inflow of patients is established, new spillover effects could arise, benefiting adjacent hospitals and bringing improvements both for the regional healthcare performance and welfare so as to benefit the low-income patients of that place, who cannot afford to receive treatment in other cantons.

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**STRUCTURAL TRANSFORMATION, LAND USE AND AGGLOMERATION:  
SECTORAL IMPACT GM SOY INTRODUCTION IN BRAZIL****Jaime Carrion Fialkow**

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**ABSTRACT**

Our papers studies the relation between agricultural productivity and manufacturing employment, focusing on impact heterogeneity and its determinants. We build a three-sector model of an open economy with factor-biased shocks on agriculture and agglomeration economies to manufacturing and analyse how these interact, focusing on a labor-augmenting shock in agricultural production; moreover, we look at the role of land supply flexibility in shaping the impact of such a shock. In our model, a shock on agricultural labor productivity might decrease agricultural employment if land and labor are strong enough complements, which may increase manufacturing employment; agglomeration economies lead to or a smaller positive effect of the shock on manufacturing employment, as its direct effect on lowering agricultural employment dampen the impact of the shock on the sector. Furthermore, when we allow for flexible land supply, the labor-saving effect of the shock on agriculture may be counteracted by undeveloped land being put to use and attracting labor as it becomes profitable after the shock increases agricultural rents.

We empirically test the model using the introduction of genetically modified (GM) soy in Brazil after 2003 as a labor productivity shock; FAO-GAEZ data shows the potential benefit of changing soy production from low to high-inputs by municipality, which determines how the speed in which a municipality introduces the genetically modified seeds - faster where the potential change is larger. Using 1996 and 2006 Agricultural Census and 1991, 2000 and 2010 Demographic Census data, we look at the impact of the shock on sectoral employment. To test the agglomeration impact we interact agglomeration variables with the shock. Consistent with our model, the shock leads to lower agricultural employment and larger manufacturing employment - and regions with an initially larger manufacturing base present a smaller effect, while a more general measure of agglomeration, population, positively correlates with the shock effect: larger cities benefit more from the shock in terms of manufacturing employment growth, but more industrialized cities don't. To look at the role of land supply, we split the sample by Brazilian macrorregions, focusing on the two main soy-producing regions, South (where soy substitutes labor-intensive agriculture and land availability is roughly fixed) and Center-West (where soy expands on previously undeveloped or underdeveloped land), finding that reaction of agricultural employment to the shock differs markedly. In the South the behavior is consistent with the baseline model: GM soy introduction leads to a fall in agricultural employment and growth in manufacturing employment; in the Center-West, however, there is no fall in agricultural labor, pointing to the importance of land use in determining the shock's impact. Moreover, in the more economically developed South the shock boosts manufacturing employment as a whole, while in the less developed Center-West only soy-related manufacturing employment is significantly boosted.

## **Special Session: SS36 - Glocalization and Regional Development**

**09:30 - 10:45 Friday, 28th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89457821343>**

**Chair Hideki Fukui**

## GLOCALIZATION OF NATURAL FARMING AND REGIONAL DEVELOPMENT

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### ABSTRACT

The purpose of this paper is to examine the relationship between glocalization and regional development by focusing on how natural farming has been transformed and spreading in India. Natural farming is a farming method that follows the principles of no tillage, no fertilizer, no pesticides, and no weeding, and this method was advocated by the late Japanese farmer and philosopher, Masanobu Fukuoka, who lived in Ehime, in southwestern Japan, in the 1950s. It is also known as “do-nothing farming.” This method is a form of alternative agriculture that does not use any machines, chemicals or biotechnology.

The first half of this paper analyses the mechanism of glocalization of natural farming that started in Ehime, Japan and spread to various parts of India, focusing on the following three dimensions. The first approach focuses on the power of promotion in the “disembedding” phase of the glocalization process. The second approach focuses on the background of the “re-embedding” phase of the glocalization process. The third approach highlights the “complex” dynamism of the glocalization process, where various unintended distortions occur and mutual feedback is activated.

The latter half of this paper examines how natural farming have been contributing to regional development in India. I describe the situations of a farmer who has fully practised Fukuoka’s natural farming and another farmer who has partially practised Fukuoka’s natural farming based on field surveys.

### KEYWORDS

Glocalization, natural farming, regional development

### 1. INTRODUCTION

The purpose of this paper is to examine the relationship between glocalization and regional development by focusing on how natural farming has been transformed and spreading in India. Natural farming is a farming method that follows the principles of no tillage, no fertilizer, no pesticides, and no weeding, and this method was advocated by the late Japanese farmer and philosopher, Masanobu Fukuoka, who lived in Ehime, in southwestern Japan, in the 1950s. It is also known as “do-nothing farming.” This method is a form of alternative agriculture that does not use any machines, chemicals or biotechnology. Natural farming has been accepted by many in various parts of the world as a means of radical dissent against conventional agriculture and modern civilization in general.

The first half of this paper analyses the mechanism of glocalization of natural farming that started in Ehime, Japan and spread to various parts of India, focusing on the following three dimensions. The first approach focuses on the power of promotion in the “disembedding” phase of the glocalization process. The second approach focuses on the background of the “re-embedding” phase of the glocalization process. The third approach highlights the “complex” dynamism of the glocalization process, where various unintended distortions occur and mutual feedback is activated.

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### 2. GLOCALIZATION OF NATURAL FARMING

In past studies on glocalization, it has been elucidated that globalization does not necessarily result in uniformity or homogenization of the world, but globalization always involves localization (or indigenization). The perspective of glocalization seeks to reveal the ways in which particular localities are directly connected to other localities in the world. Thus, the glocalization of natural farming can be described as follows. Natural farming, which had been embedded in a locality, is disembedded from that locality and then re-embedded in other localities in different parts of the world.

This section analyses the mechanism of glocalization of natural farming that started in Ehime, Japan and spread to various parts of India, focusing on the following three dimensions. The first approach focuses on the power of promotion in the “disembedding” phase of the glocalization process. The second approach focuses on the background of the “re-embedding” phase of the glocalization process. The third approach highlights the “complex” dynamism of the glocalization process, where various unintended distortions occur and mutual feedback is activated.

### 2.1 The promotion of natural farming

Masanobu Fukuoka was born in 1913 in a village in Ehime on Shikoku, the fourth largest island in southwestern Japan. Fukuoka was a scientist who worked in the plant inspection section of Yokohama custom house, and in 1937, he suddenly fell ill and was hospitalized. After a while, his condition improved but was not entirely relieved and he was roaming around in Yokohama city. One day in the early morning, when he was still half-sleeping at a park, he told us, that he had a sudden encounter with God, and he understood that everything in this world was nothing (Ishizaka 2017: 23-24). After that enlightenment experience, he quit his job at Yokohama, returned to his native farm in Ehime, and began his experiment with alternative methods of farming. In approximately 1950, he concluded that natural farming would be the best method for sustainable agriculture.

Masanobu Fukuoka's name became globally known after 1978, when the English translation of his book, *One-Straw Revolution*, was published in the United States. Since then, Fukuoka's books have been translated into more than 30 languages (Ishizaka 2018: 19). If Fukuoka had not written his books and if his books had not been translated, natural farming would not be as widely known in the world today.

It is also important to note that Masanobu Fukuoka visited more than 17 countries around the world, and he was actively engaged in promoting his methods and philosophy (Ishizaka 2018: 19; Ishizaka 2021).

### 2.2 The diffusion of natural farming in India

In India, the most important supporters of natural farming have been Gandhian activists and their networks. Gandhian activists are people who aim to realize M.K. Gandhi's dream and are engaged in various activities such as social work, educational work, and social movements. Other supporters have included a Japanese Buddhist sect, Nipponzan Myohoji, and a Quaker community in the Hoshangabad district of Madhya Pradesh. Fukuoka visited India four times, delivering lectures and giving instructions to farmers in various parts of India. These visits were made possible mainly because of the supporters' efforts. For Fukuoka's travels in India, these supporters provided invitations and interpretation and cared for his well-being including the provision of food, accommodation, and sometimes his travel fees.

I would like to highlight two reasons for the emergence of natural farming practices in various parts of India. In the 1980s and 1990s, criticism of the Green Revolution focusing on negative aspects such as environmental degradation and widening disparities and opposition to the development of large dams gained momentum. In the 2000s, the movement against the introduction of genetically modified crops also began. Furthermore, water shortage problems such as falling groundwater levels and the depletion of water sources and farmer suicide due to difficulties repaying loans became major concerns. Natural farming has attracted attention partly as a solution to these problems.

The second reason is the weak organisational capacity of agricultural cooperatives in India. In Japan, for example, not using pesticides or chemical fertilizers is against the wishes of many agricultural cooperatives. It is difficult to practise natural farming without clashing with farmers' cooperatives and surrounding farmers. In India, by contrast, individual farmers seem to be able to more freely and independently choose what kind of farming methods they want to adopt. However, the nature of farming and rural life in India varies greatly from region to region and needs to be more carefully analysed.

In India, top-level politicians and bureaucrats, such as Prime Minister Rajiv Gandhi and Prime Minister Narasimha Rao, met with Fukuoka during his visits to India. Recently, the promotion of "natural farming" has been advocated in several states, with each chief minister taking the lead. It is a significant feature of India that not only the grassroots level but also the government has been paying attention to natural farming.

### 2.3 The complex dynamism of the glocalization of natural farming

Although Fukuoka was invited to visit various parts of the world, there were often gaps in understanding between Fukuoka and his hosts. After observing the arid zone in the United States from the air during his first visit to the country in 1979, Fukuoka's lifelong mission became the prevention of desertification. For that purpose, he enthusiastically visited Africa, India, and China. However, according to a person who accompanied him on his travels, many people who wanted to meet Fukuoka in those areas were interested in his philosophy and methods of farming and not necessarily his methods for preventing desertification.

It is also interesting that the *One-Straw Revolution* was not necessarily regarded as a book on agriculture, the environment, or philosophy. In a bookstore in Thailand, the book is displayed on a shelf in the social sciences section along with books by Max Weber and Benedict Anderson (confirmed by the author during a visit to Bangkok in July, 2017). In China, it is in the Japanese literature section along with novels by Haruki Murakami (confirmed by the author during a visit to Shanghai in September, 2017).

However, natural farming is not something that has one definitive or "real" method. Natural farming, even according to its founder, is always in a constant state of change and will continue to change forever. We tend to think that the "original" or "real thing" exists as determined by the originator and that it is gradually "distorted" as it spreads around the world. However, it may be useful to avoid such a view and analyse the issue of natural farming by not assuming the existence of the "original thing".

Fukuoka's methods and philosophy were transforming throughout his entire life until he passed away in 2008, more than 30 years after the publication of his classic, *One-Straw Revolution*. Thus, there should not be only one, original, authentic, or final method of natural farming.

## 3. NATURAL FARMING AND REGIONAL DEVELOPMENT IN INDIA

### 3.1 The Titus farm at Rasulia

Raju Titus (1946-2018) was fortunate that, in 1988, Fukuoka visited the Titus Farm at Rasulia, Hoshangabad district in the Madhya Pradesh in India and gave him some practical advice. Titus had started natural farming two years before Fukuoka's visit. He had almost given up farming because of the bad yield when he encountered Masanobu Fukuoka's *One Straw Revolution*. Soon after reading the book, he sold his cattle and started natural farming in 1985. It was very fortunate for him that the condition of his farm improved, and in 1988, Fukuoka visited it. The meeting with Fukuoka was a decisive moment for Titus, and after that, he continued experiments with natural farming.

When I visited the Titus farm in August 2017, the main activities were (1) wheat cultivation, (2) goat rearing, and (3) use of the *subabul* trees. The goats were raised for milk and meat processing. *Subabul* trees were not only used to supply nitrogen to crops such as wheat, but also as fodder for goats and fuelwood. Pulses and vegetables were also produced.

Titus continued to experiment with the use of 'clay dumplings', which Fukuoka was keen to develop. He also faithfully followed the 'no-till' principle of Fukuoka's natural farming. As a result, large numbers of earthworms were found in the soil of the Titus farm. Another important point in the cultivation was the crimping of the *gajar ghans*, which initially looks like a weed.

There is a Quaker community, the Friends Rural Centre, which is situated approximately 1.5 km from the Titus Farm. This has been a major Quaker stronghold since the British period, and there are many Quakers living in and around Rasulia. Raju Titus was also Quaker and the name 'Titus' comes from the Bible. At the Friends Rural Centre, Marjorie Sykes (1905-1995), a British woman who was a 'disciple' of M.K. Gandhi, led a movement to reconsider the agricultural situation in the late 1970s and 1980s. The problem was that the Green Revolution, which was spreading in India at the time, was causing soil degradation and poverty in rural areas. At the end of 1983, one of the members of the community, Partap Aggarwal, discovered the English translation of Masanobu Fukuoka's *One Straw Revolution* and immediately ordered a copy of the book from the United States and held a reading session among the community members. This led to the publication of the Indian edition of *One-Straw Revolution*.

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## GERMAN PRISONERS OF WAR IN JAPAN AND THE REGIONAL DEVELOPMENT DURING THE FIRST WORLD WAR

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### ABSTRACT

The purpose of this paper is to investigate the effect that the approximately 4500 German POWs detained in Japan during WWI had on local Japanese cities. By looking at these POWs as producers as well as consumers in local cities, that is, as “military immigrants”, this paper tries to confirm the development that POWs generated within local cities.

On the producer side, it is confirmed that technology transfer through POWs as highly skilled workers was expected, and that such POWs actually gave technical guidance in the workspace in local cities and worked by making the best use of their skills. However, due to the short period during which POW labor was supplied, such guidance occurred only as episodes of individual technology transfer. Regarding low-skilled and unskilled labor, to avoid international trouble caused by the overuse of POWs, except for a few cases, POW labor was limited to activities in POW camps and was not employed on a large scale in agriculture as in the case of contemporary Europe. As a result, in terms of producers, except for the episodes of technology transfer, it cannot be said that German POWs had a great influence on the development of local cities.

On the consumer side, on the other hand, the arrival of POWs had brought economic benefits to local cities. First of all, the amount of money that the POWs themselves could spend was large. The amount of goods purchased at the shuho-store in the camp (post exchange) and through the direct transactions outside the camp had quite large economic impacts, considering the revenue of the local cities. Second, the amount paid for the management of POWs was also large, which was a burden for the government and the army, but such costs brought economic benefits as a kind of public works project for local cities, especially in the industries related to POW management, and a large amount of money flowed into the local market.

German POWs accounted for 0.02% of the Japanese population at that time, which was extremely small. In terms of labor supply, that of the German POWs was insignificant, except for their technical capabilities. Nevertheless, it could be said that German POWs played a role disproportionately greater than their population size in that they provided an opportunity for consumption in local cities.

### KEYWORDS

Glocal Movement of Persons, Prisoners of War, Regional Development

### 1. INTRODUCTION

The purpose of this paper is to investigate the effect that German POWs detained in Japan during World War I had on local Japanese cities, especially from the perspective of glocal human movement and regional development.

The war in Europe that broke out as a regional conflict between Austria and Serbia in July 1914 immediately turned into a war on a global scale, and in August of that year, Japan entered into the war against Germany, obtaining its colonies in the Pacific and in China. After the fall of the German territories in the Pacific Ocean in October and of Qingdao in November, approximately 4500 German soldiers were captured and sent to POW camps built in regional Japanese cities. The path these German prisoners had taken to Qingdao followed several routes. Professional soldiers and civil servants had resided in Qingdao since before the war, while those who were engaged in economic activities in Vladivostok were forced to go there due to the war between Russia and Germany. There were others who resided in other Chinese and Japanese cities and were sent to Qingdao for conscription or as volunteers just before the war between Germany and Japan began. These Germans had migrated to East Asia and Far Eastern Russia through Germany's worldwide colonial expansion, had gathered in Qingdao due to the outbreak of WWI, and were sent to local Japanese cities.

Such global movements of humanity are accompanied by the movement of knowledge and goods. In fact, the German POWs brought various techniques to regional Japanese cities, such as methods for manufacturing sausage and rubber. Moreover, the advent of German POWs produced the so-called ‘horyo-keiki (boom due to POWs).’ However, while the economic and social effects of these POWs have been pointed out, the relationship between these phenomena and regional development has not been examined. What effect did the German POWs have on regional societies, especially in terms of those societies' development? This paper examines the local development generated by the appearance of German POWs in local cities. By looking at these POWs as producers as well as consumers in the local cities, that is, as “military immigrants” (cf. Stibbe (2008), Rass(2016)), this paper tries to confirm the development that POWs brought to these cities.

## 2. A GENERAL DESCRIPTION OF POW CAMPS IN JAPAN

Japan declared war against Germany and Austria and fighting began in the German South Pacific Islands and German colonial city of Qingdao (located on the Shandong Peninsula, southeast of Beijing) in October and November 1914. Qingdao fell, and approximately 4500 German soldiers were taken captive.

At the beginning of the war, POW camps were established in 13 places in Japan, mainly in the western part: Kurume, Kumamoto, Fukuoka, Oita, Matsuyama, Marugame, Tokushima, Himeji, Osaka, Nagoya, Shizuoka, Tokyo, and Narashino. The reasons these cities were selected include easy transfer from Qingdao, the existence of a military base, and their warm and mild climates. The Japanese government converted facilities such as temples, city halls, and even schools into camps. Camps were established mainly in the center of the cities, as they were managed by the Japanese army. Because of their nearness to civilian residential areas, the policing and public safety problem occurred, such as deserting and inappropriate intercourse with the local people, including sexual intercourse. There were also hygiene and space problems. The POWs had to endure mosquitos (temples usually had gardens with ponds), poorly ventilated and poorly lit rooms, and unhygienic toilets, as some of the facilities were not originally built to host a large number of people. As the war continued, to solve these problems, the 13 camps were gradually dissolved and unified into 6 relatively large camps: Kuruma, Ninoshima, Aonogahara, Bando, and Narashino. By this measure, the number of internees increased from 400 in one facility such as a temple at the beginning of war to more than 1000 in barracks after 1917. In 1920, all the POWs were released and most of them returned to Germany, Austria or one of the newly created independent countries. The POWs who found jobs were allowed to stay in Japan, and approximately 140 ex-POWs settled in Japan after WWI.

## 3. GERMAN POWS AS A SOURCE OF LABOR

In WWI, the European powers used POWs as a source of labor due to the lack of a male labor force given the total mobilization system. Since men were mobilized as soldiers, women had to replace or supplement their labor, but there was still a labor shortage in labor-intensive industries such as agriculture and dangerous work. Foreign labor was used to make up for this lack, and POWs were used.

The use of POWs as a source of labor was already permitted under the Hague Convention of 1907 (except for forced, harsh, or military-related work). There were also Russian POWs engaged in easy work in accordance with the Hague Convention of 1899. Based on the contemporary situation in Europe and historical experience, the use of POWs was being considered in Japan during WWI.

In "The Final Report of the POW Information Bureau" published after WWI ended (Final Report (1920)), the reason for using POWs as a source of labor was explained as follows: 1. to relieve boredom, 2. to cut the costs of POW management, 3. to promote industry. There was high interest in knowledge and technology, and the prior occupations of the POWs were accounted for to make use of their special skills. In other words, the use of German soldiers as a source of labor was considered, but the POWs in Europe were used more as low-skilled labor or manual labor unrelated to their occupations from before they were enrolled in military service. For example, Germany employed 1.62 million POWs (approximately 65% of their total number of POWs) in August 1916, half of whom were engaged in agriculture (Otsuru(2013:65)). On the other hand, in Japan, the focus was on employing high-tech workers.

### 3.1. German POWs as highly skilled immigrants

The occupations of the POWs before the war were as follows (Final Report (1920)): professional officers (70%), government officials (0.4%), free-lance professionals (0.1%), and commerce and industry workers (2.4%). Among those working in commerce and industry, 95 % had worked in commerce. More than half of them had participated in trade. Others were in the business of selling general merchandise, machines and leather goods. Those who came from industry had worked in the manufacture of electric goods and machines and in construction. This meant that most of POWs were not members of the labor force with special skills and knowledge; they were instead rather commerce and business workers.

This occupational survey was conducted after containment, apart from this, the Japanese army conducted a "POW special skills survey" (Final Report (1920)). This shows that the army was positive about hiring POWs with specific skills. Initially, the army inquired of the public and private sectors the employment of POWs with special skills, but the movement toward it was very slow for the following reasons: the conditions for use were unclear; it took time to make legal preparations (drawing up POW labor rules); the army and these inquired sectors could not come to a mutually acceptable compromise in terms of labor conditions such as the strictness employment conditions (the need to monitor) and the distance between the camp and their place of work. However, at the end of the war, especially from the cease-fire to the conclusion of the peace treaty, the employment of highly skilled POWs progressed, and employment and technical guidance were provided.

Some of these cases have been pointed out as having an impact on later corporate activities such as those of the Shikishima Bread Company (cf. Menjo (2008), Mori (2005)), and some cultural foods (sausages, baumkuchen, etc.). As already mentioned, there were few highly skilled German POWs who remained in Japan after WWI, and it is difficult to measure the impact of such highly skilled individuals on local industries.

### 3.2. German POWs as a low-skilled labor force

In contrast to the European case, the employment of a low-skilled or manual labor was rarely practiced. Behind this is the Japanese attitude of that time, which was characterized by fear of becoming an international problem due to the overuse of POWs. There was also concern that the use of POWs would “threaten” the Japanese labor market. This was due to the temporary depression in Japan beginning in 1914, which was caused by the turmoil in the international economy after the outbreak of WWI. On the other hand, as the war prolonged, “employment” within the camp was considered and implemented to make the prisoners themselves compensate the army for the costs associated with their management.

Regarding the use of low-skilled labor outside the camp, there was the ground-leveling work for an athletic field, and in the Fukuoka camp, 80 people were used for the construction of a historic monument (the Mongol invasion monument). For those inside the camp, there were activities such as cleaning and meal duty.

### 3.3. German POWs as producers

Looking at the labor situation of the German POWs as a whole, their employment was rather sluggish. In the five years from detention to release, the total number of people engaged in labor was approximately 460,000, which means that only 230 people worked per day (approximately 5% of all POWs). The total wages paid were 73,000 yen, which appears to be a large amount when converted to the current face value, but considering the size of the budgets of the local cities, it cannot be said that this was a large amount. For example, in Nagoya, a core city, as well as Kurume, a local city, the ratio was small (e.g., Aichi Prefecture Statistical Report (1917), Fukuoka Prefecture Statistical Report (1917)). In addition to the small number of German POWs themselves, the number of German soldiers employed was also small, and although the wages of German soldiers with special skills were high, their impact on the overall economy cannot be confirmed.

Note, too, that Japan experienced a so-called war economy when Europe became a battlefield during WWI, and the economy began to improve circa 1915. As a result, special demand was generated in the military and shipbuilding industries. Additionally, light industries centered on the textile industry and heavy industries such as the chemical industry expanded toward the end of WWI. Therefore, as a result of the process of the country’s industrialization as a whole, the advanced skills of German POWs were more likely to have been wanted, rather than causing that industrialization. The impact of German POW labor on the local communities was very limited, except for what can be seen in the episode regarding technology transmission.

## 4. THE GERMAN POWS AS CONSUMERS

In Europe, since the number of POWs that would be produced by the war was uncertain at its beginning, established facilities, including military barracks, fortresses and warehouses, were converted into camps. As they were located near civilian residential areas, some citizens were opposed to the reception of POWs, fearing the deterioration of public safety and the spread of disease. By contrast, some Japanese provincial cities competed for the right to host POW camps after the war against Germany broke out. The Japanese still remembered the “POW boom” produced by POWs in the Russo-Japanese war. During the Russo-Japanese war, Japan accommodated approximately 70,000 POWs at 29 sites in nationwide. The administration of POWs and the money used by them enriched the provincial economies. As a result, during WWI, some cities tried to obtain economic benefits by accommodating POWs (Kainan-Shinbun (1914)).

### 4.1. POWs and cash

The cash that POWs could use included relief remittances from inside and outside Japan, in addition to their own savings and the allowance stipulated by international conventions (equivalent to the amount paid to an officer of the same rank in the Japanese army). The total amount of remittances was 1,410,000 yen and was equivalent to more than 2,800,000,000 yen (26,000,000 dollars) in today’s values. There was high interest in POWs’ cash at the beginning of the war. The local newspapers reported that Siemens Co. had sent 6,000 yen to the Matsuyama POW camp (Kainan-Shinbun (1914)). The Matsuyama POWs decided to limit the amount of cash the POWs could keep and to put the rest in the bank since there were differences in the amount of money each POW had and there were troubles with some POWs losing money or having it stolen. According to a newspaper report in December 1915, the total savings of all POWs amounted to approximately 10,000 yen (Kainan-Shinbun (1915)). Taking into account that the annual expenditure of Matsuyama city was 130,000 yen, the money that the POWs had was quite a large amount in total.

### 4.2 Post exchange and direct transactions in the city

POWs could buy daily goods, tobacco, and foods (fruits, sweets, beverages, canned goods) at the shuho-store in the camp (post exchange), which was outsourced to the private sector. The amount of money paid in the post exchange was substantial, providing economic benefits to the provincial cities. For example, in the Matsuyama POW Camp, it was reported that the sales figures for the post exchange for the 3 months from December 1914 to February 1915 was 15,000 yen (Kainan-Sinbun (1915)). One yen in those days was equivalent to 1000 to 3000 yen today. Supposing 1 yen to be 2000 yen in today’s values, this amounted to approximately 300,000,000 yen (approximately \$233,000; \$1=110 yen). It was also worth as much as half a quarter of the annual budget of Matsuyama city. According to “The Final Report,” the amount of money the German POWs spent across POW camps in Japan throughout their period of detainment amounted to 3,257,000 yen. It is necessary to bear in mind the fact that inflation soared due to the war boom from 1914-1920 and

the Siberia expedition in 1918. However, even if this amount is converted from 1914 currency values, it still amounts to 6,514,000,000 yen (\$60,000,000) and actually is believed to have been worth more.

POWs also purchased goods in the city and ordered goods from other parts of Japan. It is well known that while Governor Meyer-Waldeck was accommodated in the Fukuoka Camp, he indiscriminately bought champagne in Fukuoka to celebrate the birthday of the Kaiser and ordered goods from the areas where many foreigners resided such as Kobe, Yokohama, Tokyo, Osaka. Compared to the situation during the Russo-Japanese War, the POWs could not walk in the city freely; therefore, the amount of money spent in the city was less. It was also said that German POWs were “thrifty” compared to Russian POWs and that the economic benefits might have been smaller than expected. However, the amount of money spent by the POWs, particularly by officers, was significant given the difference in the value of the two countries’ currencies. German lieutenants received a salary 10 times more than that of their Japanese counterparts.

### 4.3. The cost of managing POWs and its effect on local cities

During WWI, people suffered from shortages of food and goods in Europe, and the condition of POWs was severe. In Japan, the war lasted only a short time, and the situation was quite different. The Japanese government was also very keen to follow international rules and retain its reputation as a civilized nation by trying to treat POWs well. As a result, the cost of managing the POWs soared because they spent more money on food supplies than the international convention stipulated. The international convention on POW treatment stipulated providing POWs with food equivalent to that provided to native soldiers. According to “The Final Report,” the Japanese government spent 5,970,000 yen from the time the POW camps were set up to their closure, which is equivalent to more than 12 billion yen in today’s values. This amounted to 1% of annual expenditure in those days, as Japan’s average expenditure from 1914 to 1917 was 0.6 billion yen. This cost was a heavy burden on the Japanese government and military and cancelled out the economic benefits the POWs provided through post exchanges and in the cities.

However, for the local cities, the management of POWs could be described as a public work and, by engaging in this management, money flowed into the city. Local newspapers depicted temples that provided facilities, merchants dealing with the army, shopkeepers of fresh foods, butchers, and bakeries all benefiting from the camps. The custom of eating bread and beef has gradually spread since Japan’s modernization (Meiji Restoration in 1868), and the appearance of German POWs stimulated the demand for those foods, particularly in local cities. The amount of beef sold in Ehime Prefecture, whose capital is Matsuyama, was 1460 kg in 1914, 4800 kg in 1915, 7760kg in 1916, and 5000 kg in 1917 (Ehime Prefecture Statistical Report (1917)). We can observe a positive correlation between the increase in the demand for beef and the time of the opening of a camp to its closure. The demand for pork had also begun to rise in 1914. Japanese meat-eating habits expanded during WWI alongside with the war boom. However, at least from the end of 1914 to 1917, local provinces like Nagano Prefecture, which flourished with the rapidly advancing textile industry caused by the war boom but which did not accommodate POWs, did not observe an increase in the demand for meat (Nagano Prefecture Statistical Report (1917; 1918)). This explains why the accommodation of POWs affected the expansion of the meat industry in local cities. Due to the lack of statistical data and the rise in prices due to inflation, it is difficult to discern how far the demand for other commodities was stimulated by the appearance of the POWs; however, it is estimated that the economic benefits the POWs had generated in local cities were significant considering the central government’s and military’s large expenditure on the POWs.

## 5. CONCLUSION

During WWI, German soldiers were detained as POWs in local cities in Japan. Through this case related to POWs, this paper tried to confirm the effects of these military immigrants.

First, on the producer side, it was confirmed that technology transfer through POWs as highly skilled workers was expected and that such POWs actually gave technical guidance in the workspace in local cities and worked by making the best use of their skills. However, due to the short period of during which POW labor was supplied, such guidance occurred only as episode of individual technology transfer. Regarding low-skilled and unskilled labor, to avoid international trouble caused by the overuse of POWs, except for a few cases, POW labor was limited to activities in POW camps and was not employed on a large scale in agriculture as in the case of contemporary Europe. As a result, in terms of producers, except for the episodes of technology transfer, it cannot be said that German POWs had a great influence on the development of local cities.

On the consumer side, on the other hand, the arrival of POWs brought economic benefits to local cities. First, the amount of money that the POWs themselves could spend was large. The amount of goods purchased at the post exchange in the camp and through direct transactions outside the camp had quite large economic impacts, considering the revenue of the local cities. Second, the amount paid for the management of POWs was also large, which was a burden for the government and the army, but such costs brought economic benefits as a kind of public works project for local cities, especially in the industries related to POW management. Compared to the cost of managing POWs during the Russo-Japanese War, which reached 20% of national expenditure, the cost during WWI was 1%, which gives the impression that standards were lower. However, given that the number of POWs during the Russo-Japanese War was approximately 20 times that during WWI, a large amount of money can be considered to have flowed into the market.

German POWs accounted for 0.02% of the Japanese population at that time, which was extremely small. In terms of labor supply, that of the German POWs was also insignificant, except for their technical capabilities. Nevertheless, it could be

said that German POWs played a role disproportionately greater than their population size in that they provided an opportunity for consumption in local cities.

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## RELATIONSHIP BETWEEN ECONOMIC GLOCALIZATION AND THE DEPOSIT-LOAN RATIO OF REGIONAL BANKS IN JAPAN

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### ABSTRACT

The deposit-loan ratio of banks in Japan, especially regional banks, has been declining. From the perspective of endogenous money supply theory, the deposit-loan ratio is basically unchanged because banks' lending assets and deposit liabilities increase or decrease by the same amount. But that is actually happening. I argued that the reason for the decline the ratio is banking sector have huge JGBs to finance government' deficits. Economic glocalization force the comparison of profit rates of industries on a global scale. As workers are not easy to move, local economies that have lost the global battle for profit rates need government expenditure. The deposit-loan ratio of banks in Scandinavian countries has been maintained or increased. Economic glocalization requires the movement of workers from low to high area of profit rates, and the productivity gains that make this possible. In Japan, there are few workers going abroad and that productivity does not improve. BoJ and private banks hold most balance of JGBs. In the case of Japan, economic glocalization requires a "big government" and "nationalization" of central bank.

### KEYWORDS

Deposit-loan ratio, government expenditure, nationalization of central bank

### 1. INTRODUCTION

#### 1.1 Deposit-loan ratio of banks in Japan

In Japan, the deposit-loan ratio of banks has been declining for 30 years and has recently approached 60%. The ratio is said to be one of the indicators of bank's function. Previous studies on this issue have said that the reason for this is that the demand for borrowing for investment is not strong in the Japanese economy.

#### 1.2 Why does the deposit-loan ratio decline?

From the perspective of endogenous money supply theory, the deposit-loan ratio is basically unchanged because banks' lending assets and deposit liabilities increase or decrease by the same amount. I pointed out the following two factors for the decline in the deposit-loan ratio in Japan. These are the off-balancing of bad loans and the holding of JGBs by BoJ and private banks. Thus, the decline in deposit-loan ratio is neither due to a decline in the functioning of the banks nor to difficulties in finding lenders.

### 2. THE EVER-INCREASING BALANCE OF JGBs

#### 2.1 Japan's money stock growth is largely due to fiscal factors

The reason for the increase in JGBs is the need to increase government spending in order to maintain GDP. In Japan, due to the non-constrained nominal interest rates, monetary policy is not effective and fiscal policy must be relied on. Over the last two decades, fiscal factors have increased Japan's money stock by 200 trillion (JPY), resulting in a marked decline in banks' deposit-loan ratio. As workers are not easy to move, local economies that have lost the global battle for profit rates need government expenditure.

#### 2.2 Glocalization of the economy and government expenditure

The reason to Japan's GDP is sustained by government expenditure is that Japan has not been able to respond to the glocalization of own economy. Equilibrium is achieved by the mobility of firms and workers when the profit rate of an industry is subject to international competition. However, Japanese workers have a bias to stay within the country and are not willing to move to regions with higher profit rates. As the economy becomes more glocalized, the profit rate falls relatively and the reliance on government expenditures is reinforced.

## GLOCALIZATION OF LOCAL GOVERNMENT REFORM AND REGIONAL DEVELOPMENT

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### ABSTRACT

This paper examines the case where the policy idea of governmental reform is applied in the context of Japanese local government reform. By following the process in which an imported policy idea spreads and is embedded in local governments under the pressure of stagnant economies and demographic changes, this paper tries to capture the phenomenon of glocalization from the perspective of public administration.

Since the 1980s, many developed countries have been working on a series of administrative reforms widely known as “new public management”. Local governments, in particular, face the challenge of austerity and retrenchment while managing and steering a variety of public services for their citizens. Under such circumstances, various policy ideas for local government reform are introduced and shared by the global community of academia and administrative practice. Public-private partnerships have long been a major scheme for local government reform, and one of the latest ideas is the social impact bond (SIB). The idea of SIB was born in the United Kingdom in the 2000s, and is understood as a performance-based financial support mechanism utilizing private funds. SIB is now widely adopted by governments outside Anglo-Saxon countries.

In Japan, several municipalities have introduced SIBs in collaboration with major foundations and banks. On the other hand, Higashiomi City, Shiga Prefecture, has introduced the SIB scheme to make the subsidy system of the local government more transparent, involving local people, and achieving results that lead to regional development. This unique version of the SIB is largely due to the history of citizen’s activities in the fields of environment and social welfare in Higashiomi since the 1970s. The purpose of the new SIB, launched in 2017, is to offer the startup grant for community businesses which tackle local issues such as job training for the young adult who withdraw from society. Based on the qualitative case study on the community-based SIB in Higashiomi, this paper examines the process by which the new idea of governmental reform was embedded in the individual backgrounds and issues of a certain municipality and discusses the relationship between glocalization of local government reform and regional development.

### KEYWORDS

Citizen activities, diffusion, local government, policy idea, social impact bond

### 1. INTRODUCTION

This paper examines the case where the policy idea of governmental reform is applied in the context of Japanese local government reform. By following the process in which an imported policy idea spreads and is embedded in local governments under the pressure of stagnant economies and demographic changes, this paper tries to capture the phenomenon of glocalization from the perspective of public administration.

Since the 1980s, many developed countries have been working on a series of administrative reforms widely known as “new public management”. Local governments, in particular, face the challenge of austerity and retrenchment while managing and steering a variety of public services for their citizens. Under such circumstances, various policy ideas for local government reform are introduced and shared by the global community of academia and administrative practice. Public-private partnerships have long been a major scheme for local government reform, and one of the latest ideas is the social impact bond (SIB).

SIB has been adopted by local governments in Japan as a new policy instrument for administrative reform. Decentralization and cuts to central government grants have impaired Japanese local governments with shrinking financial resources who then must attempt to mobilize other community resources (Ohta 2020). Some officers themselves become coordinators to connect various resources outside government. Through collaborative projects such as developing community funds, various local resources (individuals, ideas, knowledge, and money) are linked to be actively circulated in the community. By investigating a case of developing community fund and social impact bond (SIB) project in a suburban area, Higashiomi, this paper analyzes the factors that underlie effective collaboration between Japanese local governments with limited administrative resources and citizen activities with various service deliveries, and the process that affects the development of governance capacity in the community.

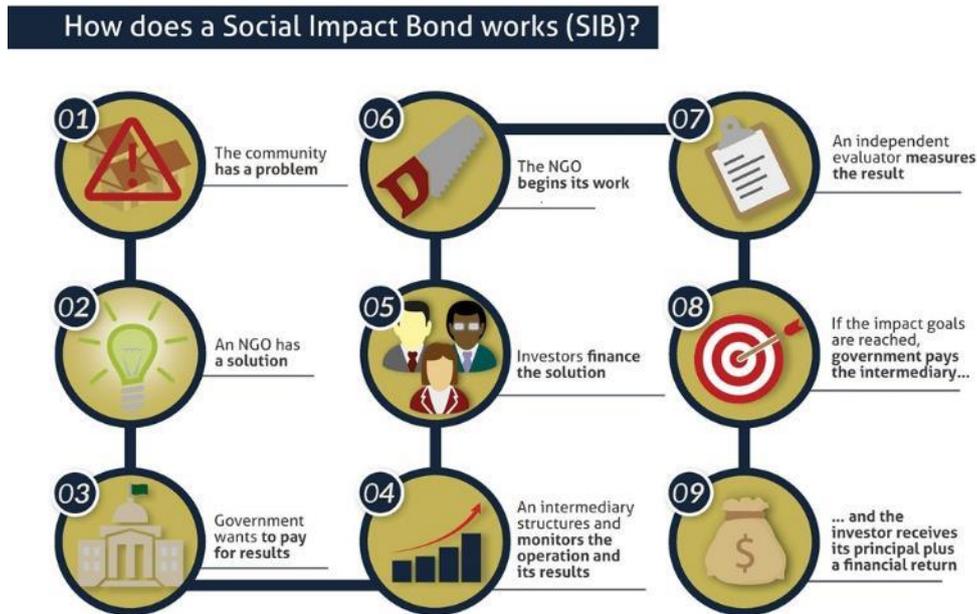
In the latter part of this paper, a case study of how the local government in Higashiomi and citizen activities produced policy innovation through a close collaborative relationship is described in depth. It shows that local governance capacity is improved through cooperation between the local government which has limited resources under the decentralization and the decline of grants from central government, and citizen activities, with their numerous ideas and means of service

supply. The output of the collaboration, an innovative method of a local government subsidy programme (community-based SIB) for community business, was investigated.

## 2. DIFFUSION OF POLICY IDEA IN SUBURBAN REGION

### 2.1 Policy idea: social impact bond (SIB) in Japan

The idea of SIB was born in the United Kingdom in the 2000s, and is understood as a performance-based financial support mechanism utilizing private funds (Figure 1). SIB is now widely adopted by governments outside Anglo-Saxon countries.



Source: SITAWI Finance for Good website (<https://www.sitawi.net/social-impact-bonds-2/>)

**Figure 1: Typical SIB structure**

Japan's SIB initiatives began in Kobe City and the Setagaya Ward of Tokyo in collaboration with the Tokyo Foundation, a Japanese major private foundation. These were started as institutional investor-type SIBs involving major banks such as Mizuho Bank and Sumitomo Mitsui Banking Corporation. Furthermore, through the leadership of the Ministry of Economy, Trade and Industry and the Ministry of Land, Infrastructure, Transport and Tourism, as of 2019, around 50 municipalities countrywide are reportedly working on administrative SIBs (Home Office Pay for Success website). In particular, there are still a limited number of bottom-up and community-invested SIBs based on local initiatives, including the community fund in Higashiomi (Figure 2).

## Types of Social Impact Bond

- Overseas SIBs (mainly in Anglo-Saxon countries, but also in other countries)
  - Social impact investment and social ventures + Performance-based administrative reform
  - Types of Investor: sovereign funds in the UK; large private foundations and individual investors in the US
  - Also applied in the context of development assistance
- Japan's SIBs (mainly by national government and major financial institutions)
  - Part of administrative reform for cost reduction
  - Pilot project in local government, mostly led by the Ministry of Economy, Trade and Industry, the Ministry of Land, Infrastructure, Transport and Tourism, Mega Banks, or Nippon Foundation
- Community-based SIBs (Higashiomi city and Saijo city in Japan)
  - Part of performance-based subsidy reform
  - Characterized by local initiative and citizen participation
  - Investors are mostly from local community
  - Emphasis on involving residents as stakeholders and supporters, rather than reducing administrative costs

**Figure 2: Types of SIB**

## 2.2 Research methods

The empirical research described in this paper is based on a qualitative single case study of Higashiomi, Shiga prefecture, Japan. The author has been following the process of collaboration there for over five years. Higashiomi is a typical Japanese suburban community with a medium-sized city population, typical land-use composition in Japan (65% is forest, 14% farmland, and the rest is composed of industrial, commercial, and residential areas), and a mostly conservative political climate. On the other hand, as mentioned in the next section, historically, Higashiomi has been successful in environmental citizen activities and has a relatively rich social capital. In addition, since 2000, the local government has promoted various collaborative actions in response to local citizen activities, resulting in changes in local governance capacity. Therefore, from this case, we can understand the development of the government-citizen relationship in a suburban area which has typical issues of industrial structure and demographics found in Japan (such as ageing, the decline of local industries, and a local government financial crisis) in recent years.

The case study described here is based on a combination of the following methods. First, the author conducted fieldwork research to clarify the trajectories of local practices. Higashiomi has historically been involved in citizen activities, details of which are recorded in public relations documents and materials of various groups. These materials have not been published and were obtained directly from the relevant organizations in the field. In addition, the information on historical background is supplemented by interviews with relevant parties where appropriate. Second, as a documentary survey, the author used administrative documents, official commission's papers and websites for the background of administrative activities, and newspaper articles for changes in the local political environment.

Third, the author conducted in-depth interviews in Higashiomi. The main purpose of the interviews was to explore the background, experience, and intentions of individuals and key persons; the details of human relationships and their impacts on individuals; how institutions and policies were perceived and influenced by people; and the propagation and acceptance of ideas. All interviews were conducted on 18 and 19 July 2013; 10 February, 2014; and 2 September, 2018, with more than ten key persons including local government officials, senior and frontline staff representatives of NPOs, and community entrepreneurs.

## 3. COMMUNITY-BASED SOCIAL IMPACT BOND IN HIGASHIOMI

This section examines the case of developing a community-based SIB and related projects in a suburban area in Japan (Higashiomi). Higashiomi has experienced problems that are typical in Japan's local communities such as ageing, the decline of local industries, and a local government financial crisis. Based on the environmental movement since the 1970s in the area, experimental initiatives have been developed since the 2000s in various fields such as renewable energy, social services, and employment training. Furthermore, to secure resources for these efforts, a new governance mechanism was developed to change the relationships between these initiatives and the local government.

### 3.1 Background

The municipality of Higashiomi has a population of 120,000 people and is located roughly in the centre of Japan. With Japan's largest lake nearby, an abundant water reservoir and forest, and its proximity to the industrial areas of Nagoya and Kyoto-Osaka-Kobe, many residents work for local factories and offices on weekdays and practise small-scale farming over the weekends. The local economic and social structure has changed since the middle of the 1990s after the collapse of the bubble economy. Some local factories went bankrupt and others moved overseas, and national government revenue deficits brought healthcare budget cuts to local governments and elderly care.

#### Development of citizen activities

An environmental movement emerged in the Higashiomi region in the 1970s when activists protested the pollution of Lake Biwako, the largest lake in Japan. In the 1980s, citizens organized a closed loop for collecting used cooking oil as an ingredient to be used in soap, fuels, and fertilizer, and since the 1990s, have been growing rapeseed to meet the growing local demand for fuels and fertilizer (The Canola Project Network website). Local activists have been actively lobbying the Ministry of Agriculture, Forestry and Fishery and Environmental Agency regarding sustainability issues. Their policy recommendations to central government sometimes led to acquiring subsidies for their activities. Issues pertaining to the environment, climate change, and the need for local revitalization amidst a budget deficit have become common language fuelling various community-based initiatives in Higashiomi. The agenda of the movement expanded from the environment to include welfare, low-carbon energy and food, and this human network has also expanded exponentially (Ohta, 2019).

#### Policy environment since the 2000s

Institutional changes that occurred in the 1990s and 2000s at the national level also affected local citizen activities. After the decentralization in 2000 and municipal merger policy of the national government, seven municipalities merged in 2006 to form the current city of Higashiomi. Although the new city increased in both population and fiscal size, like many other municipalities throughout Japan, it was left in a serious financial condition with the added problem of an ageing population.

In 2008, the national government's science foundation selected Higashiomi Municipality to develop a municipal Low-Carbon Vision for 2030. Higashiomi City and the Shiga Prefecture Environmental Research Institute worked together to formulate a vision and roadmap to halve CO<sub>2</sub> emissions by 2030 through innovation in the local economy. Along with

socioeconomic analysis and simulation, they organized a series of discussion meetings named the Environmental Roundtable for Low-Carbon Vision. To organize the roundtable, Michiko Yamaguchi, a Higashiomi municipality official, and her team included not only key persons in the environmental policy area but also those in other fields including agriculture, forestry, commerce, industry, welfare, medical care, and urban planning. From 2010 to 2011, the Roundtable for Low-Carbon Vision met 20 times and provided opportunities for local frontrunners to engage with new viewpoints about a low-carbon municipality and sustainability (Mizuguchi et al., 2016, p. 82).

Although the Great East Japan Earthquake and Fukushima Daiichi Nuclear Power Plant accident in 2011 had strong impact on the society, no major energy policy change was evident at the national level under the LDP administration, and the citizen activities of Higashiomi entered a new phase under more severe financial conditions than before.

## 3.2 Development of collaboration for community-based SIB

### Key actors and their relationships/interactions

During the decades of citizen activities and the administrative efforts of Higashiomi and Shiga prefecture area, many actors played an active role, establishing a network between them. Though difficult to describe the entire network, this section introduces two key persons, especially those involved directly in the Round Table for Low-Carbon Vision, namely the department and its staff in charge at Higashiomi city government, and the 'outsiders' who provided new ideas for the Vision.

The most important figure in the process was likely Michiko Yamaguchi, a middle-rank municipality official with a background in forest engineering and work experience in the prefecture government after majoring in forestry at university. She played a role in connecting a series of citizen initiatives with the administration. Originally an official of Shiga prefecture, when dispatched to Higashiomi city, she was attracted by the abundant citizen activities and innovative efforts rooted in the area and relocated to the Higashiomi city government. Yamaguchi examined issues on the administrative side, and supported citizen activities linking the revitalization of forestry and job support for younger persons.

Yamaguchi's role entailed belonging to many NPOs and organizations outside the government office and incorporating the personal connections she developed into the administrative business. She has experience working at different levels of government in both prefecture and city; has a degree in forest engineering and has worked for local environmental NPOs; she is a hybrid player who crosses different sectors and fields herself. Taking advantage of these attributes and network, she explored more effective policy innovation to grant and support cross-sectoral citizen activities.

The efforts in Higashiomi were also greatly affected by those from outside the region who were involved. One such outsider was Professor Masataka Fukao at Ryukoku University. Fukao was involved in many community development activities as a consultant and social entrepreneur and served as a committee member for formulating the city's Community Development Plan. He also chaired the committee (examining financial resources) five times in 2015 to revise the city's Environment Basic Plan and review the new community fund. While on the committee, he introduced the idea of SIB which Yamaguchi, as a government officer searching for a new way of subsidizing cross-sectoral citizen activities, approved. These committees in the Higashiomi government functioned as arenas where key actors with different affiliations met and shared ideas and goals. His own company, Plus Social Investment Co., Ltd. was entrusted with the SIB project, which forms one pillar of the new community fund (Higashiomi Sampō-yoshi Fund) described later. He serves as deputy director of the fund.

Hukao was initially involved in Higashiomi city government as an outsider consultant. It is not uncommon for a municipality to outsource such expertise for local planning, but it is Fukao's multi-faceted commitment that has made him a boundary spanner (Van Meerkerk and Edelenbos 2018) in collaboration. Perhaps it was also because the people in Higashiomi were earnestly seeking new ideas, especially someone who brought ideas to the table for the purpose of restoring the regional economic cycle. In particular, it would be significant for Yamaguchi to act as a bridge between him and the local community.

### Focus on the regional economy

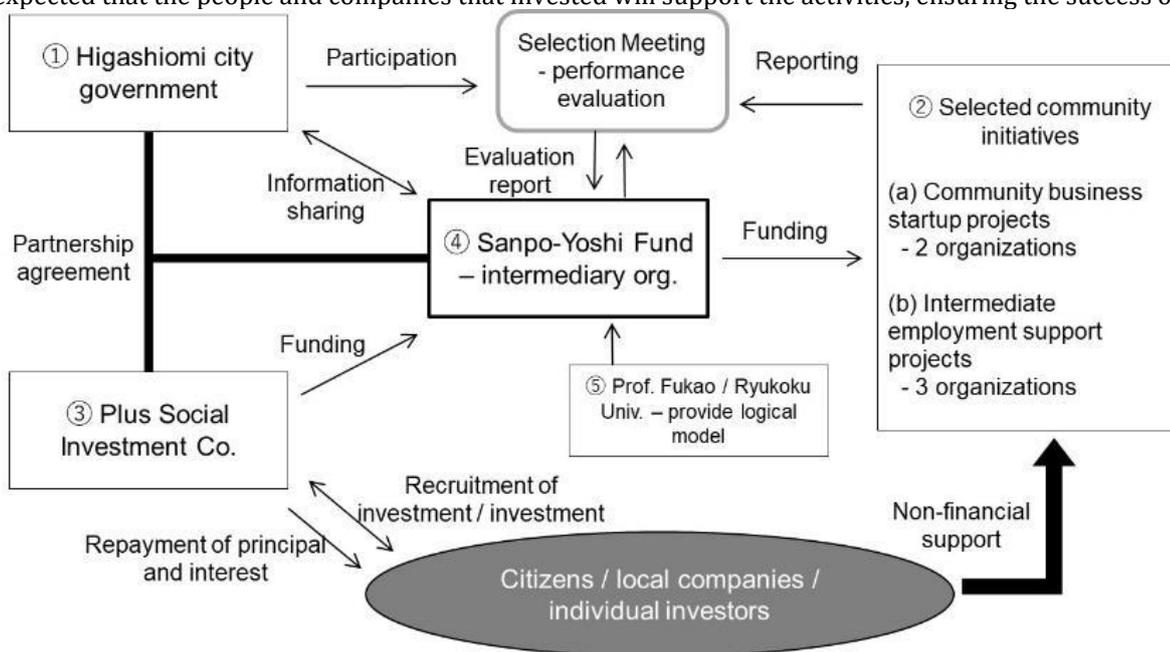
As mentioned, since the initiative in Higashiomi was developed around efforts to address environmental issues, administrative and policy development have become centred on the environmental field. The main arena of the development in the city government was the Forest and Water Policy Division, established in 2015, where Yamaguchi worked as a member. That same year, the revision process of the Environment Basic Plan (nine-year plan) began with the Forest and Water Policy Division in charge.

The revision process focused on the economic cycle in the region. Since around 2010, the city government has, from a financial perspective, studied the necessity of establishing a community fund to support citizen activities. The regional economic cycle was analyzed as preparation for the establishment of the fund. In the committee reviewing the new community fund, which convened five times in 2015, the relationship between this economic flow and the natural capital of the area supporting the flow was discussed. In the revised Environmental Basic Plan, the establishment of a community fund was announced, and the role of the fund clarified as enhancing the sustainability of the region by focusing on the environment, the economy, and local social issues as a whole, not individually.

**Development of community fund and community-based SIB**

As a result of examining issues in the regional economic cycle and as a means of creating a new flow of money, the community fund (Higashiomi Sampō-yoshi Fund) was established in 2017. Members of the preparatory body included people from various sectors such as the Higashiomi city government, local economic sector, civic sectors, consultants, and administrative scriveners. The secretariat was jointly carried out by the staff (Yamaguchi and others) of the Forest and Water Policy Division of the Higashiomi government and a local community-building NPO. In addition, they obtained donations for its establishment, collecting three million yen (which became the basic property of the fund), from 772 people over a period of six months. In June 2017, the fund was established as a general incorporated foundation (and approved as a public interest incorporated foundation in 2018).

The purpose of the community fund is to utilize the region’s potential resources such as donations, dormant deposits, and bequests through the fund in the form of investment, subsidies, and loans to solve local problems and revitalize and support community businesses (Sanpo-Yoshi Fund website). One current core project of the fund is the community-based SIB (Figure 3). This can be considered a policy innovation realized at the meeting of Yamaguchi, who was searching for a subsidy reform of the city, and Fukao, who was involved in Higashiomi as a social entrepreneur and conceptualized the idea of an SIB. This social investment project is jointly carried out by the fund, Higashiomi city government, and the private company, Plus Social Investment. By raising the funds necessary for citizen’s activities from the private sector, it is expected that the people and companies that invested will support the activities, ensuring the success of the project.



**Figure 3: Logical map of Higashiomi SIB**

Plus Social Investment collects funds (20,000 yen per year for 2017, with a target redemption rate of 2% per year) from investors, mostly from the local community, who support the applicant’s project. When the performance targets set for each applicant are achieved at the end of the project, the funds are given to the applicant, and the investors are redeemed by adding interest to the funds invested. The goals that applicants are expected to achieve within the fiscal year are determined in agreement with the fund, city government, and experts. To evaluate the project results, experts, the city government, and directors of the fund cooperate.

In 2016, as a trial stage, the agriculture-based community development association received support. In 2017, the formal launch year, five projects were selected from two fields, namely Community Business Startup Support and Intermediate Employment Support, and 500,000 yen per project was invested. In 2018, two cases were selected in the same two fields.

**SIB as a government subsidy reform**

The SIB programme of the community fund is also positioned as an attempt to introduce performance-linked subsidies from the Higashiomi city government. In 2014, the city government launched a community business startup support project as a regular subsidy programme. The new SIB programme is the evolved version of this subsidy programme. By introducing the SIB, the roles of related actors in the ordinary subsidy programme have transformed as follows.

First, in the past system, the Higashiomi city government used to investigate how funds were spent because the government itself paid subsidies to recipient organizations. Under the new SIB programme, subsidies are granted to applicants on the condition that the expected outcome is reached. Therefore, rather than just checking how the fund is used, the government supports the recipient so that they can produce results while collaborating with intermediary organizations such as the community fund.

Second, the citizens of Higashiomi were once mostly involved as service recipients from businesses. Under the SIB programme, they themselves can invest in the business they want to support while there is no principal guarantee and

the principal is broken if the outcome is not achieved. Thus, the citizens as investors are made aware of themselves as stakeholders and become active supporters of the business.

Third, intermediary organizations such as the community fund and Plus Social Investment used to be in a position to support government subsidy programmes within the scope entrusted by the government. Under the SIB, these organizations provide the necessary support to raise funds in collaboration with both government and recipients to produce expected results.

The key characteristic of the Higashiomi SIB is the mechanism used to ensure citizens' wide involvement. In ordinary subsidized projects, most citizens are merely beneficiaries of the services of the subsidized businesses. However, in the SIB, citizens are not only beneficiaries but also investors, so the relationship with subsidized providers is double-tracked. In addition, citizens can address local issues through investment action and support projects from an investor's standpoint. By setting indicators to measure the outcomes of the business and visualizing it, the provider has clear goals and citizens can share the outcome.

#### 4. CONCLUSION

In Japan, several municipalities have introduced SIBs in collaboration with major foundations and banks. On the other hand, Higashiomi has introduced the SIB scheme to make the subsidy system of the local government more transparent, involving local people, and achieving results that lead to regional development. This unique version of the SIB is largely due to the history of citizen's activities in the fields of environment and social welfare in Higashiomi since the 1970s. The purpose of the new SIB is to offer the startup grant for community businesses which tackle local issues. Based on the qualitative case study on the community-based SIB in Higashiomi, this paper examines the process by which the new idea of governmental reform was spread and embedded in the individual backgrounds and issues of a certain municipality.

The potential downsides and challenges seen in this case are as follows.

In Higashiomi's SIB programme, Plus Social Investment is one of the core actors in the network, so it is necessary to coordinate commercialism and the public interest that the programme should have. Specifically, the issue is how to respond when the company decides to withdraw from a management perspective. In addition, as an issue related to wider public interest, there are inadequate mechanisms for local democratic representatives to properly monitor the programme.

On the other hand, in terms of relations with local politics, how to keep distance from the political activities of the mayor (the head of the administrative department of the local government), is also an important point. The SIB programme is currently strongly supported by the mayor, but the continuation of the project may be affected if the mayor is replaced in an election. This has the potential for recipient citizen initiatives to be subordinated to government not only in terms of money but also in a more complex political structure.

In addition, the fact that the influence of a particular person in the administration is exceptionally large can make governance capacity vulnerable. There is no issue with an individual's influence being great in the launch and development of the programme, however, if it is too reliant on particular persons for its continuation, organizational ability may not be developed and become unsustainable. If the individual is exhausted, the whole may not function. Charisma may be necessary in the early days and development stages, but in the stability stage, it is necessary to change to a sustainable organization management that does not rely excessively on individuals.

Currently, Higashiomi's SIB programme only replaces a small portion of municipal subsidies and has no effect on the majority. Above all, it is important that this innovative programme expands steadily on the grounds of Higashiomi's long-standing citizen's activities.

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# PARALLEL SESSIONS (17)

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## National Session: SS59 - Labour mobility and regional development



**11:00 - 12:15 Friday, 28th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/83755472428>**

**Chair Annekatriin Niebuhr**

## POST-STUDY MIGRATION BEHAVIOUR – DIFFERENCES BETWEEN NATIVE, FOREIGN AND INTERNATIONAL UNIVERSITY GRADUATES IN GERMANY

[Annekatriin Niebuhr](#)<sup>1,2</sup>, [Anne Otto](#)<sup>1</sup>, [Anja Rossen](#)<sup>1</sup>, [Christian Teichert](#)<sup>1</sup>

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### ABSTRACT

We investigate differences in mobility behaviour between graduates who completed secondary school in Germany (German, foreign) or abroad (international) and analyse factors that might give rise to disparities in mobility after graduation. Our analysis focuses on the importance of job-relevant networks and work experience for mobility decisions that are linked to labour market entry because these factors are likely correlated with spatial job-search and the migration decision. The results of an event history analysis show that the long-term share of 'stayers' in the study region is relatively low among international graduates. Regression results indicate that differences in the probability to leave the region of study are associated with individual, study-related and regional factors. In particular, pre-study mobility and work experience turn out to be important predictors. The probability to stay in the university region does not significantly differ between German and international graduates, once we account for these factors. In contrast, foreign graduates who attended school in Germany show a higher propensity to leave the region of study for labour market entry than other graduate groups conditional on covariates.

## DO RETURN INITIATIVES PROMOTE INTERREGIONAL RETURN MIGRATION? - EVIDENCE FROM GERMANY

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### ABSTRACT

This paper investigates whether the establishment of so called 'return initiatives' within the last 20 years increased the likelihood of interregional return migration of workers within Germany. Demographic change leads to a significant decline in (regional) labor supply in Germany like in many other western countries. In particular rather rural regions are hit by this development, partly caused by a net migration loss among young people. Furthermore, these regions typically do not benefit from immigration from abroad like agglomerated regions because destinations of international immigration are often densely populated areas.

Since the beginning of the new millennium in more and more regions of Germany return initiatives have been established. They aim at promoting interregional return migration, i.e. the return of workers who previously left the local labor market in which the respective return initiative is situated. The early initiatives focused on the return of workers from East Germany, who moved to other eastern regions or the western part of Germany after re-unification. However, since 2010 return initiatives also exist in peripheral parts of West Germany and their number is increasing. Among others, they provide information on local vacancies and firms in order to increase the probability that the job search in the 'home region' of a worker, who would like to return given she finds a suitable job, is successful and she indeed returns.

To analyze the effects of return initiatives on return migration, we merge our unique panel data on return initiatives with information provided by the Integrated Employment Biographies (IEB) of the Institute for Employment Research (IAB). The IEB contains, inter alia, administrative data on all workers subject to social security in Germany such as daily information on individual employment relationships (e.g. wages, workplaces) as well as annual information on places of residence. Specifically, we use a 25% percent random sample of all (medium skilled) workers, who completed vocational training in Germany in the period 2000-2013 and who moved to another local labor market until 2014 (14% of all former apprentices). Applying event history estimation, we observe that about 40 percent of these workers return in subsequent years to the labor market of residence during vocational training.

To investigate whether there is a significant and robust relationship between the establishment of a return initiative and return migration rates, we combine discrete time survival data analysis and diff-in-diff estimation. More precisely, we study whether the likelihood to return to a certain region is significantly higher after a return initiative has been established than before conditional on time varying characteristics of the individual, regional labor market conditions as well as region and time fixed effects. Our results indicate that return migration rates are, conditional on covariates, about 10 percent higher after a return initiative has been established than before. However, further analyses suggest that region specific time trends might play an important role in this context, meaning that (some) return initiatives might have been established in regions, for which return migration rates were increasing anyway.

## BEING A LONG DISTANCE OUT-COMMUTER OR HOME EMPLOYEE IN A RATHER PERIPHERAL REGION?

[Stephan Brunow](#)<sup>1</sup>, [Ramona Jost](#)<sup>2</sup>

<sup>1</sup>University of Applied Labour Studies, Germany. <sup>2</sup>Institute for Employment Research IAB, Germany

### ABSTRACT

After reunification a net outmigration from East German regions occurred until the late 1990th. Many relatively younger people were looking for jobs in the west. About 30 years later outmigration flows exist but net migration is almost zero. However, still about 76.000 individuals out-commute for work-related purposes from the Federal State Mecklenburg-Vorpommern (MV). To the same time, employers in MV claim labour shortages. In this paper, we distinguish out-commuters and employees in MV to get a deeper insight into this interesting phenomenon. We especially address the question whether out-commuters are a selective group of individuals working in occupations that are not requested in MV. Additionally, we focus on the wage differential to work out potential strategies to get out-commuters back to work within MV. Lastly, we consider the number of workers that might be willing to work in MV and stop out-commuting. First evidence suggests that this would not appear. Labour demand in MV and respective wage levels are too low and the economic structure is too weak to sufficiently gain back out-commuters from a MV-perspective. Especially females suffer from the job-market weakness in MV.

## National Session: SS62 - Moroccan Regional Science



**11:00 - 12:15 Friday, 28th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/85127009544>**

**Chair Abdellatif Khattabi**

**ANALYSIS OF ECONOMIC AND ENVIRONMENTAL IMPACTS OF SHUTTING DOWN THE MOROCCAN REFINERY SAMIR: AN INTERREGIONAL INPUT-OUTPUT APPROACH**

**Eduardo Haddad<sup>1</sup>, Inácio Araújo<sup>2</sup>, Rachida El Mansoum<sup>3</sup>, Chaimaa Chawki<sup>3</sup>, Marouane Masnaoui<sup>3</sup>**

<sup>1</sup>University of São Paulo, Brazil. <sup>2</sup>Department of Economics, University of São Paulo, Brazil. <sup>3</sup>FGSES, Mohammed VI Polytechnic University, Morocco

**ABSTRACT**

The closing of Samir's Mohammedia refinery in August 2015 due to financial constraints has dramatically affected fuel oil market in Morocco. In this paper we assess the economic and environmental impacts of the disruption of activities of Morocco's only refinery. We are able to isolate the oil refinery sector associated with Samir in a fully specified interregional input-output database, considering 20 sectors in 12 Moroccan regions. We base our empirical strategy on the "hypothetical extraction" method, which serves as the methodological anchor to isolate the systemic measures of value added and CO2 emissions related to the refinery activities in a typical year of operation. The overall impact of the shutdown is close to 5% of the country's output, with stronger regional impacts faced by Grand Casablanca-Settat, followed by its neighboring regions.

## FROM GLOBAL TO LOCAL: EXPLORING INTERREGIONAL LINKAGES OF MOROCCAN EXPORTS IN DOMESTIC VALUE CHAINS

[Elhoussaine Wahyana](#)<sup>1,2</sup>, [Mahmoudou Alioum](#)<sup>1</sup>, [Daniel Sitota](#)<sup>1</sup>, [Inácio Fernandes Araújo](#)<sup>3</sup>,  
[Eduardo Amaral Haddad](#)<sup>3</sup>

<sup>1</sup>FGSES- Mohammed 6 Polytechnic University, Morocco. <sup>2</sup>Mohammed 5 University, Morocco. <sup>3</sup>University of Sao Paulo, Brazil

### ABSTRACT

There is substantial value-added of services incorporated in goods exports, from intermediate services and services bundled with goods. In the quest for increasing and sustaining its competitiveness in Global Value Chains (GVC), Morocco still requires policies, capabilities, and infrastructure to promote intermediate services. On one hand, locational aspects of specific services, such as transportation services, are associated with relatively less concentrated spatial patterns, as production and consumption are more strongly locationally interdependent. On the other hand, knowledge-intensive business services (KIBS) tend to be highly concentrated in Casablanca. However, this does not exclude some movements towards dispersion observed in some business services, as long as working skills limitations are surpassed, which may give room for coordinated regional and trade policies to enhance participation in value addition in Local Value Chains (LVC) of peripheral, natural resource-rich, exporting regions. In this paper, we estimate the contents of services value-added incorporated in goods exports in Morocco, exploring the local dimension of the results. We use inter-regional input-output analysis to trace and map domestic value-added embedded in Moroccan exports. We also look at other dimensions of local value chains of exports in the country.

## MULTIDIMENSIONAL POVERTY IN MOROCCO: AN EXPLORATORY SPATIAL APPROACH

Eduardo Amaral Haddad<sup>1</sup>, Inácio Fernandes<sup>1</sup>, [Zineb Sijelmassi Idrissi](#)<sup>2</sup>, Chanelle Ihezagire<sup>2</sup>,  
Youness El Bouazzaoui<sup>2</sup>

<sup>1</sup>University of São Paulo, Brazil. <sup>2</sup>FGSES, Mohammed VI Polytechnic University of Benguerir, Morocco

### ABSTRACT

In spite of the overall decrease in poverty in Morocco in the recent past, the pace of change did not affect regions equally. Poorer provinces faced slower reductions, increasing the relative gap in poverty indicators. In this paper, we explore the results of a multidimensional poverty indicator produced by the High Commission for Planning (HCP), the Moroccan official statistical agency, for the period 2004-2014. The Multidimensional Poverty Index (IPM) allows investigating the spatial aspects of different dimensions of poverty in the country. We find a clear spatial process underlying the distribution of the IPM. Moreover, the analysis undertaken at the province level suggests a persistent poverty hot spot in the northeast part of the country associated with poor infrastructure. Other poverty areas are more heavily associated with low quality of public services, particularly education and health. We provide a typology of geographically targeted sectoral policies, showing that there is no single recipe for all regions, since structural features matter.

**LINKAGES AND INTERDEPENDENCE OF THE AGRICULTURE SECTOR  
IN MOROCCO: A REGIONAL PERSPECTIVE.**

**Fatima Ezzahra Mengoub<sup>1</sup>, Imane Oumellouche<sup>2</sup>, Wissal Morchid<sup>2</sup>, Nassima Nairi<sup>2</sup>, Eduardo Amaral Haddad<sup>3</sup>**

<sup>1</sup>Policy Center for the News South, Morocco. <sup>2</sup>Mohammed VI Polytechnic University, Morocco. <sup>3</sup>University of São Paulo, Brazil

**ABSTRACT**

In Morocco, the agriculture sector plays a major role in economic and social development. Agriculture contributes 12% of GDP and employs about 34% of the labor force of which 40% are women. In addition to its importance in terms of value added creation, the sector plays a key role in poverty reduction, giving that the marginalized and poorest areas tend to be rural areas where the main economic activity is agriculture. It also contributes to food security by diversifying and stabilizing agricultural production, which has a direct impact on prices, especially those of basic staple food. Given the significant weight of the agricultural sector and the importance of the rural world in the Moroccan economy, this paper develops an in-depth analysis of the sector by region in order to show its systemic relevance in each region and to identify its potential to contribute to the green, inclusive recovery of the Moroccan Economy in the post-pandemic crisis. To do so, we base our analysis on structural properties of the interregional input-output table for Morocco, combining with detailed labor market and environmental databases.

## **Regular Session: RS10.8 - Regional development**

**11:00 - 12:15 Friday, 28th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/83488693367>**

**Chair Piotr Wójcik**

## TOWARDS COHESION AT THE INTERFACE BETWEEN THE EU STATES? CROSS-BORDER ECONOMIC ASYMMETRY AND CONVERGENCE IN THE EUROPEAN UNION

Andrzej Jakubowski<sup>1</sup>, Piotr Wójcik<sup>2</sup>

<sup>1</sup>UMCS, Poland. <sup>2</sup>University of Warsaw, Poland

### ABSTRACT

State borders are barriers that disrupt the course of socio-economic processes and interactions. They adversely affect the development of border areas, traditionally perceived as peripheral, lagging behind and economic outliers. Hopes for overcoming this situation are associated with the process of European integration. Within its framework, barriers resulting from the existence of traditional state borders are being gradually removed. The internal borders of the EU are becoming more and more "invisible".

Previous research does not provide a satisfactory answer to the question about the impact of border opening and economic integration on reducing the level of disparities in cross-border areas. On the one hand, the research results lead to the conclusion that EU enlargement should foster the cohesion of cross-border areas. Other analyzes indicate an increase in disparities in the level of economic development of cross-border areas in the EU. Therefore, this issue requires clarification, especially as it is of great importance in the context of the effects of the EU cohesion policy. There are numerous studies on regional convergence and socio-economic cohesion of European regions, but they do not take into account the criterion of cross-border location.

This paper aims to fill this gap. Its main purpose is to examine the impact of reducing barriers resulting from the existence of traditional state borders on the relative level of development of border areas, i.e. on cross-border convergence (or divergence). Contrary to the existing literature on the subject, the article does not focus on border areas, but cross-border areas, pairs of regions including bordering areas located on both sides of the inter-state border. The article is the first empirical analysis conducted in such a spatial and temporal scope, which allows to deepen the knowledge on the impact of European integration and border opening on the economic cohesion of border areas.

The study takes into account the cross-border areas (NUTS3) adjacent to internal borders between EU countries in the period 1980-2015. The scope of the surveyed units is extended in accordance with the subsequent stages of the EU integration process. The basis for the convergence analysis is the indicator of relative asymmetry of economic development comparing the level of regional GDP per capita (in PPS) in two neighboring border regions from different countries. It reflects the disproportion in the level of economic development of the border region of one country in relation to the neighboring region from another country.

The obtained results confirm that the process of European integration leads to a gradual equalization of the level of economic development of cross-border areas on a European scale (cross-border  $\sigma$ -convergence). It was also observed that increased border permeability allows less developed border areas to benefit from additional development factors. As a result, they achieve faster growth than the more developed border regions on the other side of the border. The level of asymmetry in economic development in cross-border areas is reduced (absolute cross-border  $\beta$ -convergence). The results of the analysis also suggest that cross-border convergence is generally slower than convergence at the inter-state level.

## CONTEMPORARY SOCIO-ECONOMIC DIFFERENCES IN POLAND: (1) SPATIAL POLARIZATION OF DEVELOPMENT

**Pawel Churski, Tomasz Herodowicz, Barbara Konecka-Szydłowska, Robert Perdał**

Department of Regional and Local Studies. Faculty of Human Geography and Planning. Adam Mickiewicz University, Poznan, Poland

### ABSTRACT

The results of political elections in Europe and the world in the second decade of the 21st century show a clear trend of strengthening populist movements. One of the fundamental root causes is the persistent and even growing differentiation of the socio-economic development level, which results in permanent peripheralisation and marginalisation of some areas. This results in polarization and radicalization of electoral behavior as a consequence to the unsatisfactory effectiveness of earlier implemented development activities and the economic exclusion of a part of the society living below the social minimum. The results of our study indicate the persistence of development disparities in Poland, despite the relatively positive trends in economic growth at the national level. We draw attention mainly to the strong significance of historical conditions (relict borders). Against this background, we identify the scope and direction of geographical changes in Poles' electoral behaviour. We aim to determine the relationship between the level of socio-economic development and the support of political parties in spatial terms. The final conclusions emphasize the persistence of "territorial underpinnings" and socio-economic conditions of electoral populism in Poland, which to a large extent results from historical factors. Not only has the distribution of populism not been changed as a result of transformation and integration changes in Poland, but it has in fact been reinforced.

The research procedure consists of three stages presented on separated posters: (1) spatial polarization of development, (2) political scene and electoral behaviour, (3) relations between development level and political preferences.

First stage analysis of this cycle in this aims at determination of the scale and causes of subregional development differences in Poland. The analysis deals 2,478 Polish communes (LAU 2) and describes the period of 2004-2016 allowing for interactions determined for Poland during over last two centuries.

The research procedure involved the following steps: standardization of variables (23 indicators corresponding to five development factors), cluster analysis using the k-means method for 13 observations, verification of the typology using modified classification trees, creation of the typology for each observation in the pattern of communes with different level of development (five class), and finally the creation of a synthetic typology of the communes in the adopted pattern of development classes. The study used published data of the Central Statistical Office in Warsaw. The obtained results confirmed the occurrence of clear and persistent developmental differences in the space of Poland. They are largely determined by the polycentricity of the settlement network, the distribution of economically strong raw materials and industrial areas, as well as they show a large relationship with historical determinants permanently rooted in Polish space.

This study is carried out as part of the FORSED research project ([www.forsed.amu.edu.pl](http://www.forsed.amu.edu.pl)) funded by the National Science Centre (No. 2015/19/B/HS5/00012): New challenges of regional policy in shaping socio-economic development factors of less developed regions.

## CONTEMPORARY SOCIO-ECONOMIC DIFFERENCES IN POLAND: (2) POLITICAL SCENE AND ELECTORAL BEHAVIOUR

**Tomasz Herodowicz, Paweł Churski, Barbara Konecka-Szydłowska, Robert Perdał**

Adam Mickiewicz University in Poznań, Poland

### ABSTRACT

The results of political elections in Europe and the world in the second decade of the 21st century show a clear trend of strengthening populist movements. One of the fundamental root causes is the persistent and even growing differentiation of the socio-economic development level, which results in permanent peripheralisation and marginalisation of some areas. This results in polarization and radicalization of electoral behavior as a consequence to the unsatisfactory effectiveness of earlier implemented development activities and the economic exclusion of a part of the society living below the social minimum. The results of our study indicate the persistence of development disparities in Poland, despite the relatively positive trends in economic growth at the national level. We draw attention mainly to the strong significance of historical conditions (relict borders). Against this background, we identify the scope and direction of geographical changes in Poles' electoral behaviour. We aim to determine the relationship between the level of socio-economic development and the support of political parties in spatial terms. The final conclusions emphasize the persistence of "territorial underpinnings" and socio-economic conditions of electoral populism in Poland, which to a large extent results from historical factors. Not only has the distribution of populism not been changed as a result of transformation and integration changes in Poland, but it has in fact been reinforced. The research procedure consists of three stages presented on separated presentations: (1) spatial polarization of development, (2) political scene and electoral behaviour, (3) relations between development level and political preferences.

This presentation is about stage 2, the purpose of which was to characterize the Polish political scene and the electoral behavior of Poles. The temporal scope of the analysis covers mainly the years 2005 and 2015. The analysis is conducted at the level of LAU-2 units (gmina), enabling detailed identification of intra-regional disparities. During analysis there were used desk research and indicators of electoral support level noticed in the parliamentary elections in 2005, 2007, 2011, and 2015. The formation of the Polish political scene during the transformation period was dynamic and characterized by the emergence of new antagonisms. In a generalized perspective the Polish political scene can be divided along two axes: conservatism vs. liberalism and individualism vs. communitarianism. Political parties can be further aggregated into two main political camps: "Solidary Poland" – more conservative and 'Liberal Poland' – more progressive. The results of the parliamentary elections justify the statement that the Polish political scene is subject to polarization, which in fact brings the party system closer to the bipolar system. The highest concentration of support for the "Solidary Poland" camp was observed in the south-eastern part of the country. On the other hand, the relatively highest support for the "Liberal Poland" camp was in north-western Poland.

This study is carried out as part of the FORSED research project ([www.forsed.amu.edu.pl](http://www.forsed.amu.edu.pl)) funded by the National Science Centre (No. 2015/19/B/HS5/00012): New challenges of regional policy in shaping socio-economic development factors of less developed regions.

## CONTEMPORARY SOCIO-ECONOMIC DIFFERENCES IN POLAND: (3) RELATIONS BETWEEN DEVELOPMENT LEVEL AND POLITICAL PREFERENCES

**Robert Perdał, Paweł Churski, Tomasz Herodowicz, Barbara Konecka-Szydłowska**

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### ABSTRACT

The results of political elections in Europe and the world in the second decade of the 21st century show a clear trend of strengthening populist movements. One of the fundamental root causes is the persistent and even growing differentiation of the socio-economic development level, which results in permanent peripheralisation and marginalisation of some areas. This results in polarization and radicalization of electoral behavior as a consequence to the unsatisfactory effectiveness of earlier implemented development activities and the economic exclusion of a part of the society living below the social minimum. The results of our study indicate the persistence of development disparities in Poland, despite the relatively positive trends in economic growth at the national level. We draw attention mainly to the strong significance of historical conditions (relict borders). Against this background, we identify the scope and direction of geographical changes in Poles' electoral behaviour. We aim to determine the relationship between the level of socio-economic development and the support of political parties in spatial terms. The final conclusions emphasize the persistence of "territorial underpinnings" and socio-economic conditions of electoral populism in Poland, which to a large extent results from historical factors. Not only has the distribution of populism not been changed as a result of transformation and integration changes in Poland, but it has in fact been reinforced. The research procedure consists of three stages presented on separated posters: (1) spatial polarization of development, (2) political scene and electoral behaviour, (3) relations between development level and political preferences. Geographically Weighted Regression (Fotheringham, Brunsdon, Charlton, 2002) was used to study the relationship between the level of socio-economic development and political preferences in Poland in 2005-2015. The value of the synthetic indicator was used as the explained variable describing the level of socio-economic development (see Part 1). In turn, the explanatory variable was the percentage of votes for political parties representing "Solidarity Poland" (mainly currently ruling Law and Justice) (see Part 2). Regression modelling has showed that the relatively largest support for the "Solidarity Poland" bloc is found in communes with low and very low levels of socio-economic development. It should be stressed that the examined relations are not limited to such a simple relationship and require more detailed interpretation, inter alia, as regards the level of socio-economic development, socio-cultural characteristics of the inhabitants and the urban-rural layout. In general, it can be assumed that the greatest support for "Solidarna Polska" occurs mainly in small municipalities, with dominant agriculture, located in the lands of the former Russian and Austrian Partition with a dominant population professing traditional Catholic values and with low mobility.

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## **Regular Session: RS03.4 - Knowledge and innovation**

**11:00 - 12:15 Friday, 28th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/82899500055>**

**Chair Márcia Diniz**

## DIGITAL TRANSFORMATION OF UNIVERSITIES AND INDUSTRY 4.0: A COMMON STRATEGY FOR REGIONAL DEVELOPMENT

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### ABSTRACT

Never before have we experienced so many changes at such speed. We have been saying for years that the education sector cannot produce structural changes as fast as the labor market may need, but in recent months we have seen profound changes in all economic sectors.

In documents such as "The Future of Jobs Employment, Skills and Workforce Strategy for the Fourth Industrial Revolution", 20 Educational Keys for 2020 and Future Work Skills 2020, different interpretations of what would be the most demanded competencies by the labor market were already observed, taking into account all the technological, social and socio-economic changes.

On the other hand, there is extensive literature on competencies and their incorporation into the curriculum at the university level as a teaching innovation practice. Among them are generic or transversal competencies that are being developed internationally by different universities, competencies that are supposed to be in demand in the future, citing among them as the most promising: social intelligence, strategic design, new media literacy, interculturality and focusing on the future of education or the professional profiles that will be in demand in the coming years, given their importance as a contribution to success in the knowledge society.

But the question arises as to whether there is a clear strategy in the digitalization of universities at the European level that minimizes the gaps for the agents involved; the skills demanded by the labor market and those that the university develops in the classroom.

Therefore, it is necessary to stop and think about what strategies are being carried out in the universities so that students are aware and informed of what their future position will demand and if these strategies are effective, to find out if students understand the concept of competencies, if they conceive that they develop some of these competencies in the classroom and not others, to know how to integrate them in the development of their CV and to know how to locate those activities or courses that complement the competencies that have not been developed during their academic life.

If we are talking about the professional community, we should know if they have enough information about the competencies implicit in a candidate's CV and if they have sufficient criteria to verbalize the competencies that are needed today in their sector.

About the University, we should question whether it has a curriculum in line with these competencies and whether it has interlocutors with the labor market that makes it offer updated studies.

These questions make us think of a situation in which the digital era we are living in may require greater clarity in the common strategy between the educational sector and the labor market for regional development. To this end, we propose a descriptive study of the shortcomings associated with each of the agents by analyzing the information of certain recently published job offers, the websites of several universities, and their assessment by a sample of students from the University of the Basque Country (Spain).

### KEYWORDS

Digital transformation, university, industry 4.0, competence, regional development

## EVOLUTION OF REGIONAL INEQUALITIES IN EDUCATION, SCIENCE AND INNOVATION INDICATORS IN BRAZIL: A PROPOSAL FOR TEMPORAL SYSTEMATIZATION

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### ABSTRACT

For historical reasons due to its colonization process, but also institutional ones, including economic policy strategy, Brazil concentrated its industrial production base in the Southeast, followed by the South. A consequence of this process was a concentration of the higher education system and of the country's research, science and technology institutions in the Southeast and South regions of the country, with repercussions, also, in the geographic distribution of innovations and patents in the country, being possible to state that there are marked differences between the State and Regional Innovation Systems in the context of the National Innovation System. Thus, from the calculation of dispersion measures and spatial concentration indicators, this article presents elements that attempt to create a temporal systematization in the evolution of regional inequalities in the indicators of Higher Education, Science, Technology and Innovation in the country, which characterize the differences between the State / Regional Innovation Systems in the country. Considering these indicators, it can be said that the country has four very different moments. The first moment goes back to the beginning of the formation process of Higher Education, C, T & I institutions in the country, lasting until the beginning of the 1990s, where the concentration of these indicators in the Southeast and South regions is clear. It begins, still, in the beginning of the decade of 1990 and goes until the year 2000, with a sharp drop in the spatial inequality of these indicators between the Brazilian regions. A third moment, located between the first half of the 2000s and the years 2013 and 2014. With the maintenance of deconcentration, now more slowly. And the last phase, starting in 2014, which seems to point to a new reconcentration, still, how small.

### KEYWORDS

Higher Education; Innovation Systems; Science, Technology and Innovation (S, T & I)

### 1. INTRODUCTION

Since its origin, the conformation of the Brazilian National Innovation System (NIS) presents unequal characteristics in its quantitative and qualitative elements when analyzed from a regional (RIS) and local (LIS) perspective, each one at a different level of aggregation of spatiality and relationship with the whole. Thus, the physical infrastructure of RIS/LIS, their linkages and performance indicators are not homogeneous in Brazil; although in recent decades there has been a movement towards geographic spreading-out that has been more favorable to the poorer regions of the country: North, Northeast and Center-West.

The Innovation System in Brazil, as in Latin America, has been formed by several factors that places it to other regions or countries in the world in an incomplete or weak position. This can be attributed to several factors: old institutions that have prevailed since the 1980s, periods of great macroeconomic instabilities, high levels of poverty and great income inequalities, as pointed out by Albuquerque et al. (2015). However, it is necessary to take into account how these factors are distributed and intensified at the regional level.

In this context, to follow the asymmetric evolution of Regional, Local and Sectorial Innovation Systems involves understanding the different trajectories that each one has followed. These trajectories have emerged and reproduced under heterogeneous economic structures between Brazilian regions. Each region imposes different demands and needs for the creation of a scientific and technological base, having as inputs: the training and qualification of labor, the production of knowledge, the development of products and services aimed at research and innovation.

Nevertheless, the degree of unequal development among LIS is linked to the dynamics of change in the productive sector and to the fact that public policies in science, technology and innovation (S, T & I) in Brazil and the research funding channels are at the federal and state level.

Archaic structures, little technologically evolved, with low complementarity and sectorial interdependence, are simultaneously product and producer of Innovation Systems that contribute little to the alteration of this process. These

systems function at the margin of modernization and advances at the technological frontier, and of the production of knowledge and innovation; from a fragile degree of articulation in terms of S, T & I.

Freeman (1995) showed in a historical perspective the existence of a systemic relationship between the degree of development of the "professional scientific-technological" apparatus and the productive sector. Additionally, the author indicates that the influence of institutions that support this relationship are a decisive factor in the success of radical innovations, especially those associated with the rate of diffusion and productivity gains.

The level of each productive structure is associated with: 1- the human capital (experiences, skills, competencies, formal and informal learning processes), 2- the organizational systems (accumulated knowledge from routines, procedures, techniques), 3- the technical-physical system (the material base of machinery, equipment, IT systems) and, 4- products and services. All this moves the infrastructure and the productive process, configuring the technological base of a given sector or industry and of the entire economy, at different levels of spatial configuration (Cook, 2001; Figueiredo, 2006; Schwartz and Trippi, 2011).

According to Suzigan and Albuquerque (2011a, 2011b), and Lemos and Cário (2013), Brazil has gone through at least four "waves of institutions" created in the areas of Science and Technology from the time of the Empire to the present day. This division does not portray how these institutions have spread throughout the Brazilian territory in terms of regional concentration over time.

The objective of this article is to map the evolution of the process of concentration of S, T & I institutions in Brazil over the last 30 years. Thus, this article is divided into 4 more sections besides this introduction and references. The second section addresses the evolution of S, T & I institutions from a regionalized perspective. The third centralizes the discussion on the evolution of S, T & I indicators. The fourth presents the methodology of the regional concentration indexes used. The fifth section turns to the interpretation of these indexes and the last section presents the conclusions.

## 2. THE REGIONAL EVOLUTION OF INSTITUTIONS AND S, T & I INDICATORS

The first wave of S, T & I institutions in Brazil dates back to the migration of the Royal Family to Brazil in 1808 and the developments of the installation of the Portuguese Crown in Brazil (Suzigan & Albuquerque, 2011a, 2011b). Thus, the first professional training courses were created to meet the growing demand for more qualified jobs and services, such as in the health and legal areas. During this period, the following were created: the Anatomical, Surgical and Medical School at the Military Hospital of Rio de Janeiro; the Royal Library and the Royal Military Academy; the Botanical Garden; the Fine Arts Academy; the Royal Museum, the Brazilian Historical and Geographical Institute (Fávero, 2006; Figueirôa, 2011).

Between the beginning of the Republic and the 1930s, other research entities are created, the most centralized in the Rio de Janeiro - São Paulo axis: the Natural History Museum of São Paulo (1893), the Institute of Experimental Pathology of Manguinhos (1908), the Butatã Institute (1901). Also, the Biological Institute (1927), the Ezequiel Dias Institute (1936), the Evandro Chagas Institute (1940) and the Technological Research Institute (1934).

Still in the imperial period, institutions were created to train teachers in Brazil (Marchelli, 2017): School of First Languages at the Portuguese Court (1823), Normal School of Niterói (1835), Normal School of São Paulo (1846) and nine more Normal Schools in the state of Minas Gerais (1872, 1879, 1881 and 1884). The core of these institutions centered in four states: Rio de Janeiro, Minas Gerais, Bahia and São Paulo.

The first colleges of Medicine, Law and Polytechnics date from 1830. The first university was the "University of Rio de Janeiro" created in 1920 by Presidential Decree No. 14,343. The first university regulation "Statute of Brazilian Universities" was approved in 1931 in the Vargas Government under the Ministry of Education and Health. In 1934, the state of São Paulo created the first public state university, the University of São Paulo, bringing together independent faculties, with the Faculty of Philosophy, Sciences and Letters as its central axis.

Between 1945 and 1964, 22 Federal Universities were created, one for each state of the federation. In the 1950s, the National Research Council (CNPQ) and the Coordination for the Improvement of Higher Education Personnel (CAPES) were created. They are responsible for policies on the training of higher education teachers, the implementation and evaluation of graduate courses. In addition, they stimulate the dissemination of research through incentives such as the distribution of research and graduate scholarships (*Stricto Sensu*), allocation of funds for capital, funding and realization of academic events, among others.

CNPq invested in structuring research by creating specialized organizations such as the Institute for Pure and Applied Mathematics (IMPA) and the Amazon Research Institute (INPA), which incorporated the Emílio Goeldi Museum of Para. In addition, between 1950 and 1970, the Aeronautical Technological Institute (1950), the Military Institute of Engineering (1959), the National Institute for Space Research (1960), the Nuclear Engineering Institute (1962) and the Brazilian Agricultural Research Corporation (1973) were created.

Until the 1960s, the institutional and organizational structure of the areas of Science, Technology and Innovation in the country, with a few exceptions, was strongly dependent on federal agencies. This begins to change from the 1960s when some states in the Southeast and South regions of the country created from their state secretariats of education, specific secretariats to operate scientific and technological development that soon incorporate research and innovation agendas. The time line of the creation of S, T & I institutions among the regions of the country presents very marked differences between the Southeast and South regions and, to the North region. The Research Support Foundations (FAP) of the states of São Paulo (1962), Rio de Janeiro (1980); Minas Gerais (1985); Rio Grande do Sul (1964); Paraná (1998) and Santa Catarina (1995), were created before the turn of the century and with marked temporal differences between the pioneering ones and the others.

By the end of the 1990s, most FAPs in the Northeast and Midwest regions had also been created. Meanwhile, the FAPs of the North region were created from the year 2000, being that those of Rondônia and Tocantins were created in 2011 and Acre in 2012 (Tables 1 and 2).

As for the innovation environment, the first experiences were the incubators of technological companies, some of them linked to private initiative. The first two emerged in 1986, in Santa Catarina and Paraíba. In the 1990s and 2000s there was a centralized distribution in the states of the Southeast, South and Northeast (Tables 1 and 2).

Between the 1980s and 1990s the first Technology Parks were created, with a centrality in the Southeast and South regions: Technological Park São Carlos (1984), Gênese Institute (1997) and Innovation Agency of the Federal Fluminense University (1999). Also, the Technology Management Agency (1990), Tecnópolis (1994) and Center for Enterprises in Informatics of the Institute of Informatics of the Federal University of Rio Grande do Sul (1996) are included. On the other hand, the Northeast region was responsible for two others: Technological Park of Paraíba (1984) and Technological Development Park of the Federal University of Ceará (1991). In the first decade of the 2000s there was a diversification of Technological Parks and Innovation Agencies throughout the country with a centrality in the Southeast and South regions. In fact, the first Technology Parks in the North region were only created in 2010.

The National Institutes of Science and Technology (INCT) emerged from the improvement of the Millennium Institutes (2005), as an initiative of the Ministry of Science and Technology, to promote the formation of research networks. The National Institutes of Science and Technology Program of the Ministry of Science and Technology (MCT) was officially instituted in 2008, and re-edited in 2014. And today it brings together 30 institutions regionally distributed with 15 concentrated in the Southeast Region, 6 in the South, 5 in the Northeast, 3 in the Midwest and only 1 in the North.

In the first two decades of the 2000s, the states of the Southeast and South regions, created their own Innovation System, organized and networked, such as the Innovation System of Rio Grande do Sul, which brings together 27 technology centers, 12 accredited technology parks and 14 parks associated with the gaúcha network of parks and incubators - REGINP. REGINP currently has 25 associated incubators, two startup accelerators (WOW and Ventur) and more than 190 startups. Similar examples appear in the state of São Paulo, which created the São Paulo Network of Technological Innovation Centers, with 8 already in operation and 13 accredited Technological Parks and 8 more under negotiation. Rio de Janeiro, which created the Network of Innovative Enterprise Promoting Agents that gathers around 200 technology-based incubators and 33 design and Creative Economy incubators.

**Table 1. Matrix of the evolution of Regional Innovation Systems, period 1980 – 1999**

Administrative region	State	1980	1981	1982	1983	1984	1985	1986	1987	1988	1989	1990	1991	1992	1993	1994	1995	1996	1997	1998	1999	
North	RO																					
	AC																					
	AM																					
	RR																					
	PA																					
	AP																					
	TO																					
Northeastern	MA																					
	PI																					
	BA																					
	CE																					
	PB																					
	PE																					
	AL																					
	RN																					
Southeastern	ES																					
	MG																					
	RJ																					
South	SP																					
	PR																					
	RS																					
Central-West	SC																					
	MT																					
	MS																					
	GO																					
	DF																					

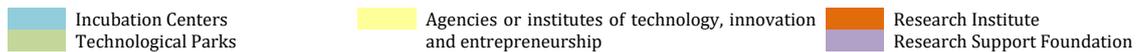
■ Incubation Centers     
 ■ Agencies or institutes of technology, innovation and entrepreneurship     
 ■ Research Institute

■ Technological Parks     
 ■ Research Support Foundation

Source: Prepared by Authors. Due to the limited space of the article, the annex containing the names of the institutions was removed.

**Table 2. Matrix of the evolution of Regional Innovation Systems, period 2000 – 2019**

Administrative region	State	2000	2001	2002	2003	2004	2005	2006	2007	2008	2009	2010	2011	2012	2013	2014	2015	2016	2017	2018	2019
North	RO																				
	AC																				
	AM																				
	RR																				
	PA																				
	AP																				
	TO																				
Northeastern	MA																				
	PI																				
	BA																				
	CE																				
	PB																				
	PE																				
	AL																				
	RN																				
	SE																				
Southeastern	ES																				
	MG																				
	RJ																				
	SP																				
South	PR																				
	RS																				
	SC																				
	MT																				
Central-West	MS																				
	GO																				
	DF																				



Source: Prepared by Authors. Due to the limited space of the article, the annex containing the names of the institutions was removed

**3. REGIONAL CONTEXT AND EMPIRICAL METHODOLOGY**

There is an uneven distribution of innumerable S, T & I indicators in Brazil, considering the major Brazilian regions, both in relation to indicators that can be said of performance for example: number of students with qualifications in stricto sensu postgraduate courses; number of graduate students in undergraduate courses; patent filings; production of scientific articles, among others, as well as process indicators such as: number of higher education institutions; number of stricto sensu graduate programs and vacancies; number of research groups; number of research group relationships with companies; number of postgraduate scholarships, number of doctors, masters and productivity researchers, among others.

Whichever indicator is selected, there is a very asymmetrical relationship in its distribution, with the Southeast and South regions, concentrating a relative participation that reached more than 80%, at least until the 1990s (Table 3).

**Table 3. Relative Participation in Selected C, T & I Indicators according to Brazilian Regions**

Master and Doctorate Scholarships (CAPES System)													
	1995		2000		2005		2010		2015		2018		
	Master	Doctorate	Master	Doctorate	Master	Doctorate	Master	Doctorate	Master	Doctorate	Master	Doctorate	
North Region	0.737	0.236	1.585	0.625	3.075	3.485	5.330	4.758	5.013	3.536	5.183	3.939	
Northeast Region	6.718	1.312	14.037	7.579	13.811	13.824	21.132	18.905	21.706	17.326	19.872	15.769	
Southeast Region	36.628	44.292	59.594	74.469	55.528	61.630	43.097	50.777	38.253	46.930	43.883	50.548	
South Region	55.465	51.298	20.182	15.135	22.353	16.549	22.763	19.498	26.017	25.635	22.933	23.512	
Midwest Region	0.452	2.861	4.602	2.193	5.232	4.513	7.678	6.062	9.011	6.573	8.128	6.232	

Number of Places Offered in Universities													
	1995		2000		2005		2010		2013		2016		
	Total	Public	Total	Public	Total	Public	Total	Public	Total	Public	Total	Public	
North Region	3.553	7.564	4.383	12.007	3.899	10.637	3.307	9.029	4.591	9.568	5.602	9.991	
Northeast Region	15.123	29.997	12.539	30.263	10.396	29.823	13.778	30.424	12.985	30.064	11.846	29.260	
Southeast Region	54.400	29.850	54.365	30.295	60.230	27.848	58.931	29.948	60.198	28.250	60.798	30.104	
South Region	21.390	22.679	21.015	14.093	17.662	20.978	16.071	18.317	14.527	21.390	14.336	19.546	
Midwest Region	5.536	7.522	7.697	11.544	7.812	10.715	7.913	12.283	7.483	10.727	7.418	11.098	

Number of Research Groups											
	1993	1995	1997	2000	2002	2004	2006	2008	2010	2014	2016
North Region	1.749	1.953	1.772	3.010	3.892	3.955	4.438	4.694	5.207	5.838	6.328
Northeast Region	9.859	9.820	11.434	14.626	15.002	14.176	15.549	16.945	18.326	20.368	20.491
Southeast Region	68.492	69.193	65.582	57.253	51.821	52.496	50.381	48.778	46.786	43.894	42.532
South Region	15.743	14.854	17.169	19.702	23.948	23.523	23.568	23.200	22.541	22.409	22.946
Midwest Region	4.157	4.181	4.043	5.408	5.337	5.850	6.064	6.382	7.139	7.492	7.702

Source: Available in: <http://portal.inep.gov.br/web/guest/sinopses-estatisticas-da-educacao-superior>; <http://lattes.cnpq.br/web/dgp/por-uf>; <https://geocapes.capes.gov.br/geocapes/>.  
Elaboration by authors.

The Table 3 shows some of these indicators in relative terms between Brazilian regions: master and doctoral scholarships from the CAPES system; number of places offered at universities and number of research groups, where this disproportionate relationship between regions is quite evident, although with a decreasing trajectory since the 1990s. To verify the evolution of the degree of concentration of the institutions related to the Local and Regional Innovation Systems, classic measures of concentration will be used. To calculate the indices, the participation of the most representative institutions of the Local/Regional Innovation Systems was considered, in terms of: number of higher education institutions (HEI), number of undergraduate courses, number of graduate stricto sensu programs, and number of research groups. Follows the description of the concentration indices used in this study:

The Concentration Ratio (CR) is used to determine the relative share of the largest units in the whole (Table 4). It was observed that five states for each institution considered concentrated more than 50% of the absolute values, so it was preferred the choice of the measured CR5 among the years of each series. In this way, during the period, were few changes among the five most representative states: São Paulo, Minas Gerais, Rio de Janeiro, Paraná and Rio Grande do Sul; all of them located in the Southeastern and Southern regions.

Nevertheless, in order to have an idea of the degree of asymmetry between the extremes of the distribution in each series, we calculated the CR5 (-). That is the sum of the participations of the less representative states, which also varied little in the period. These states are: Roraima, Acre, Amapá, Rondônia, Tocantins (or Sergipe) and, they are located in the North and/or Northeast region. The result of the CR (-) was divided by the CR (+) to get an idea of how well the less representative states were positioned relative to the less representative states.

The Herfindahl- Hirschman’s index refers to the sum of squares of the share of the observation units considered (Table 4). Where,  $S_i^2$  represents the square of the share of the j-th spatial unit relative to the total (of space - among k possible locations) of the variable of interest, and thus takes on the character of a measure of spatial concentration. Implicitly in the calculation of the HHI, the participating of states are considered to have equal weight.

As Braga and Mascolo (1982) note, by replacing  $p_i$  with participation  $s_i$  one can interpret the entropy index as an inverse measure of concentration. The lower the index, the higher the degree of concentration. For its minimum value: if the states' shares are identical ( $s_i = 1/n$ ), then the concentration is minimum for a given n, and  $E = \ln(n)$ , its maximum value. In the present study, the Gini index was used as a way to express the degree of density of the technological higher education courses offered in Brazilian’s HEI (Table 4). Using the number of enrollments as the control variable, the Gini coefficient was calculated as defined by Krugman (1991).

**Table 4. Concentration Indexes**

Concentration Indexes	Formula	Limits	Obs
Concentration Ratio (CR)	$CR = \sum_{i=1}^k p_i$ For k = 5	$0 \leq CR \leq 1$	$p_i$ = the share of the state, order i in the total units considered.
Concentration Ratio in Extremes	$\frac{CR(+)}{CR(-)} = \frac{\sum_{i=1}^k p_i}{\sum_{i=1}^k p_i}$		
Herfindahl- Hirschman’s index	$HHI = \sum_{i=1}^n S_i^2$	$\frac{1}{n} \leq HHI \leq 1$	
Entropy measure (E)	$E = -\frac{1}{\ln(n)} \sum_{i=1}^n s_i \ln(s_i)$	$0 < E < \ln(n)$	$\ln(n)$ , its maximum value
Gini Index (G)	$G_i = \frac{1}{\sum x_j^2} x \sum (s_j - x_j)^2$ For $i=1, \dots, N$ ; $j=1, \dots, M$ .	$0 \leq G \leq 1$	

Elaboration by authors.

**4. CALCULATION AND INTERPRETATION OF EMPIRICAL RESULTS**

In order to remove the effect of the very different population size between the Brazilian regions, especially, considering the greater demographic participation of the Southeast and South regions, in relation to the other regions of the country, all concentration indexes were calculated per capita.

Table 5 shows the concentration indexes for institutions and on-site courses of higher education between the years 1995 and 2019. Comparing the behavior of the two series, three movements are observed. Between the years 1995 to 2000/2002 there is a slight concentration increase process with some oscillations. The contribution of the states with the highest participation - CR5 (+) continues to grow in the case of higher education institutions until the year 2000, while for face-to-face courses this process extends to the year 2002. A second movement that can be highlighted, it is a more pronounced drop in concentration indicators from 2002 to 2008. A Third movement is identified between the period 2009 to 2019, where a relatively continuous drop of less intense intensity of concentration was observed, although, for higher education institutions there is some fluctuation between 2008 and 2011.

**Table 5. Concentration Indexes for Institutions and On-Campus Higher Education Courses**

Anos	Higher Education Institutions				On-campus Courses Higher Education			
	CR5 (+)	CR5(-)/CR5(+)	I-J	Theil	CR5	CR5(-)/CR5(+)	I-J	Theil
1995	0.3609	0.1491	0.0512	0.9404	0.2734	0.3064	0.0438	0.9725
1998	0.3679	0.1520	0.0503	0.9456	0.3124	0.2815	0.0440	0.9719
1999	0.4033	0.1423	0.0539	0.9355	0.3102	0.2725	0.0438	0.9722
2000	0.4222	0.1310	0.0564	0.9288	0.3130	0.2413	0.0443	0.9692
2001	0.3987	0.1395	0.0532	0.9400	0.3118	0.2413	0.0445	0.9682
2002	0.3765	0.1467	0.0519	0.9440	0.3135	0.2521	0.0445	0.9698
2003	0.3429	0.1861	0.0486	0.9543	0.3034	0.2638	0.0436	0.9729
2004	0.3666	0.1869	0.0499	0.9507	0.3084	0.2598	0.0444	0.9714
2005	0.3509	0.2030	0.0482	0.9560	0.2925	0.2895	0.0425	0.9767
2006	0.3480	0.2036	0.0476	0.9578	0.2823	0.3106	0.0421	0.9784
2008	0.3185	0.2431	0.0470	0.9600	0.2814	0.3347	0.0417	0.9804
2009	0.3157	0.2482	0.0455	0.9654	0.2740	0.3403	0.0413	0.9818
2010	0.3187	0.2358	0.0447	0.9683	0.2711	0.3568	0.0410	0.9831
2011	0.3213	0.2348	0.0449	0.9670	0.2662	0.3732	0.0407	0.9842
2012	0.3161	0.2498	0.0449	0.9673	0.2589	0.4109	0.0402	0.9867
2013	0.3044	0.2664	0.0443	0.9697	0.2643	0.4196	0.0401	0.9872
2014	0.3037	0.2757	0.0437	0.9716	0.2582	0.4355	0.0398	0.9884
2015	0.2941	0.2998	0.0432	0.9739	0.2566	0.4406	0.0397	0.9888
2016	0.2911	0.3225	0.0426	0.9764	0.2514	0.4625	0.0394	0.9900
2017	0.2884	0.3515	0.0421	0.9786	0.2507	0.4713	0.0393	0.9904
2018	0.2825	0.3714	0.0418	0.9805	0.2442	0.4929	0.0391	0.9914
2019	0.2763	0.3886	0.0412	0.9831	0.2457	0.5110	0.0390	0.9921

Source: Available in: <http://portal.inep.gov.br/web/guest/sinopses-estatisticas-da-educacao-superior>. Prepared by the authors.

As there is a great heterogeneity between higher education institutions, as well as undergraduate courses inserted in them as to their capacity and performance of Education, Science and Technology indicators, Table 6 calculates the Gini coefficient, considering the density of technological courses offered by HEIs from the enrollment of undergraduate students in technological courses. It is observed that due to the lack of coverage in the Higher Education Census, organized by Inep, some coefficients of states in the Northern Region, mainly, could not be estimated in the years 1995 and 2000. In general, it appears that this increase it is greater in the South and Southeast regions, although with a higher growth rate of this density in the North and Midwest regions.

**Table 6. Evolution of the density of technological courses in HEIs by States**

Region/State	1995	2000	2005	2010	2015	2019
Rôndonia		0.1902	0.7481	0.7386	0.7533	0.5341
Acre			0.3011	0.3771	0.4162	0.2704
Amazonas	0.3772	0.3732	0.7466	0.7455	0.7363	0.7883
Roraima			0.1584	0.4751	0.6289	0.6472
Pará	0.6031	0.7396	0.5959	0.5656	0.5128	0.8266
Amapá			0.5514	0.3774	0.6003	0.5499
Tocantins			0.6636	0.6216	0.7344	0.7553
Norte	0.4848	0.6886	0.7048	0.7323	0.7394	0.7719
Maranhão	0.6999	0.285	0.7586	0.6258	0.7778	0.7356
Piauí	0.6495		0.7146	0.6082	0.7597	0.7275
Ceará	0.4099	0.5699	0.5563	0.6874	0.7372	0.7582
R. Grande do Norte	0.6922	0.605	0.6587	0.5058	0.6258	0.5784
Paraíba	0.3856	0.4621	0.5521	0.6171	0.7158	0.751
Pernambuco	0.3755	0.0846	0.5542	0.6663	0.7352	0.7422
Alagoas			0.3968	0.5164	0.4556	0.53
Sergipe	0.1717	0.3615	0.8072	0.7176	0.7874	0.6964
Bahia	0.2933	0.4817	0.6576	0.7294	0.6929	0.7443
Nordeste	0.727	0.5679	0.6796	0.6924	0.7427	0.7546
Minas Gerais	0.5959	0.65	0.807	0.6799	0.7485	0.7717
Espírito Santo	0.4219	0.6676	0.6496	0.6732	0.7401	0.805
Rio de Janeiro	0.6349	0.6279	0.8854	0.845	0.8646	0.8806
São Paulo	0.607	0.6786	0.809	0.7776	0.7984	0.795
Sudeste	0.6352	0.6953	0.8266	0.7722	0.8004	0.8037
Paraná	0.5306	0.7373	0.7621	0.7242	0.7849	0.8006
Santa Catarina	0.4794	0.8433	0.7395	0.7647	0.743	0.754
R. Grande do Sul	0.6185	0.8548	0.7911	0.7658	0.7788	0.7951
Sul	0.6604	0.8116	0.7676	0.7591	0.7767	0.7949
Mato Grosso do Sul		0.3579	0.5854	0.7768	0.7116	0.7384
Mato Grosso	0.0027	0.6196	0.7448	0.6403	0.6383	0.7283
Goiás	0.2032	0.6997	0.7591	0.7199	0.7766	0.7795
Distrito Federal	0.6818	0.3746	0.821	0.757	0.7388	0.7745
Centro Oeste	0.6426	0.6062	0.784	0.739	0.7383	0.77

Source: <https://www.gov.br/inep/pt-br/areas-de-atuacao/pesquisas-estatisticas-e-indicadores/censo-da-educacao-superior/resultados> (microdata). Prepared by the authors.

As for the behavior of graduate courses and research groups (Table 7), a more continuous process of decrease is observed throughout the analyzed period. There is some level of maintenance of the concentration until the second half of the 1990s, with the increase of the participation of the states of greater participation CR5 (+), but the process of decline is more regular at the end of this decade, maintaining itself from then on. The degree of intensity of the fall is greatest between 2005 and 2010/2011 and from this period onwards the decrease occurs at a slower level.

**Table 7. Concentration Indexes for Stricto Sensu Postgraduate Courses and Research Groups**

Stricto Sensu Postgraduate Courses					Research Groups				
Years	CR5	CR5(-)/CR I-J	Theil		Years	CR5	CR5(-)/CR I-J	Theil	
1998	0.5368	0.0000	0.0802	0.8296	1993	0.5340	0.0157	0.0763	0.8491
1999	0.5115	0.0000	0.0761	0.8424	1995	0.5115	0.0180	0.0734	0.8641
2000	0.5094	0.0000	0.0761	0.8431	1997	0.5210	0.0210	0.0730	0.8635
2001	0.4817	0.0092	0.0705	0.8628	2000	0.4379	0.0878	0.0596	0.9131
2002	0.4525	0.0320	0.0656	0.8826	2002	0.3896	0.2661	0.0525	0.9386
2003	0.4338	0.0435	0.0622	0.8960	2004	0.3991	0.1464	0.0523	0.9417
2004	0.4263	0.0573	0.0610	0.9060	2006	0.3588	0.2021	0.0476	0.9578
2005	0.4158	0.0617	0.0590	0.9110	2008	0.3256	0.2325	0.0460	0.9628
2006	0.3775	0.1500	0.0525	0.9428	2010	0.3161	0.2706	0.0443	0.9699
2008	0.3530	0.1943	0.0491	0.9545	2014	0.2895	0.3144	0.0425	0.9771
2009	0.3429	0.2069	0.0480	0.9574	2016	0.2867	0.3390	0.0422	0.9785
2010	0.3336	0.2276	0.0465	0.9624					
2011	0.3212	0.2414	0.0457	0.9652					
2012	0.3137	0.2587	0.0451	0.9676					
2013	0.3186	0.2468	0.0453	0.9665					
2014	0.3146	0.2536	0.0450	0.9674					
2015	0.3175	0.2449	0.0449	0.9677					
2016	0.3114	0.2594	0.0444	0.9693					
2017	0.3093	0.2847	0.0437	0.9728					
2018	0.3124	0.2777	0.0440	0.9717					
2019	0.3052	0.3438	0.0429	0.9768					

Source: Available in: <https://geocapes.capes.gov.br/geocapes/> and <http://lattes.cnpq.br/web/dgp/por-uf>. Consulta em 28.03.2021. Prepared by the authors.

The joint analysis of the results presented in Tables 6 and 7 allows us to point out that there are three moments about the evolution of the asymmetries of the institutions that most directly produce the disparate indicators of C, T & I: higher education institutions; undergraduate courses; graduate courses and research groups. A first moment until the end of the 90's and beginning of the 2000's, where it is possible to identify some still positive oscillations of the concentration process. In the beginning of the first decade of the year 2000 until approximately the beginning of the following decade, the process of deconcentration is more accentuated, although there is some fluctuation. Finally, from the year 2012 onwards, a last period is identified where the fall is more continuous, but at a slower pace.

It seems to us that this process is also related to the dissemination of other institutions of the Local Innovation Systems, in particular, the Foundation for the Support of Research and Business Incubators that gained great momentum in the first decade of the 2000s between the North and Northeast regions.

The Table 8 shows the average growth rate of the evolution of the increase in institutions: HEIs; On-Campus Courses Higher Education; Stricto Sensu Postgraduate Courses and Research Groups among the three periods highlighted above. It is clear that between the years 2000 and 2011 with greater intensity and between the years 2012 and 2019 with less intensity the institutions located in the North-Northeast regions present growth rates higher than those located in the Southeast and South regions, reflecting if the behavior of the concentration indicators as observed before.

**Table 8: Average Growth Rates over Selected Periods**

Growth Rate Higher Education Institutions					
Region	North	Northeast	Southeast	South	Midwest
Until the end of nineties	7.89	11.26	3.11	5.38	10.05
2000-2011	11.77	10.68	5.77	8.17	6.18
2012-2019	3.12	4.22	-0.56	0.14	2.63
Growth Rate Higher Education Institutions					
Region	North	Northeast	Southeast	South	Midwest
Until the end of nineties	7.51	11.83	8.20	9.51	9.90
2000-2011	11.30	11.40	10.78	8.94	9.85
2012-2019	2.41	4.63	1.09	1.70	3.95
Stricto Sensu Postgraduate Courses					
Region	North	Northeast	Southeast	South	Midwest
Until the end of nineties	8.33	8.38	7.24	11.52	9.09
2000-2011	17.16	11.47	5.58	9.48	11.75
2012-2019	6.82	5.20	3.55	5.37	5.15
Research Groups					
Region	North	Northeast	Southeast	South	Midwest
Until the end of nineties	18.73	22.80	17.06	20.93	17.52
2000-2010	15.01	11.36	6.70	10.35	11.94
2010-2016	8.84	6.26	3.16	4.84	5.71

Source: Prepared by the authors.

## 5. FINAL REMARKS

The results presented from the behavior of the concentration indicators considered show at least three distinct phases when considering the regional differences that these indicators describe in the analyzed period, for the variables considered: higher education institutions, classroom courses, graduate programs and research groups. The first period, which extends to the end of the 1990s, is marked by a high regional concentration in the Southeast and South regions. A second period, between the first decade of the 2000s and the beginning of the following decade, where there is a more intense deconcentration process. And, finally, the last period starting in the year 2012, where the fall is more regular, but at a slower pace. For the first phase, we can call it stabilization of the concentration, for the second, intensive deconcentration and for the last, extensive deconcentration.

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## HOW COOPERATION WITH UNIVERSITIES CAN AFFECT THE CORPORATE COMPETITIVENESS?

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### ABSTRACT

Higher education institutions (HEIs) are one of the key actors of the social and economic development. There are two classical roles of the universities, such as the education and the research; in the past two decades the third mission role has appeared, too. Nowadays these three roles mean the triple role of HEIs. The third mission role has different kind of approach, but in general it means all missions of the HEIs which are not related directly to the education and research. On the one part the third mission is related to the Triple Helix model, on the other part it can be all of the activities of the HEIs which are not related directly to the scientific activities. All in all, the third mission means those activities of the HEIs which are for the society and for the economy.

In the past two decades more and more HEIs identify their activities related to this third role. They realize that being part of the social and economic life could be an investment into the future and help them to be embedded in the settlement, region, country, etc. where they operate. The third mission means different kind of activities from supporting the local communities to taking part in the development of the companies. The presentation focuses on the latter, and would like to give answers to the question: How the HEIs-companies relations and cooperation can contribute to the corporate competitiveness? I believe that these relations can have an effect on the competitiveness, because they help companies to find good business solutions, to find new methods for development or to open new ways of management.

There are wide range of potential activities which can be part of the third mission activities, such as organizing workshops, trainings; taking part in common projects, supporting students practice, etc. These relations could be important for HEIs, because they will be closer to what the market desires and will know better the current issues in the for-profit era. These relations are good for the companies because they can use the knowledge of the researchers, they can cooperate with students and they can use these activities to be a better one in the market, so to be more competitive. The aim of the presentation is to show the third mission activities which are related to the HEIs-companies relations and to show how they could contribute to the competitiveness. The presentation demonstrates guidance for also practitioners and researchers and it also adds to the literature some possible good examples about managing HEIs-companies relations in the framework of the third mission.

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## MIGRATION AND INNOVATION: MEASURING THE EFFECT OF SKILL-SPECIFIC FLOWS ON PATENTS, TRADEMARKS AND DESIGNS ACROSS ITALIAN PROVINCES

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### ABSTRACT

This paper investigates the effect of both international and interregional migration data, differentiated by educational attainment, on the generation of new knowledge on the receiving Italian provinces (NUTS-3). The research extends previous analysis focalized on patents statistics by using other intellectual property rights (IPRs), i.e. trademarks and design, to capture different shades of the innovative process. Using a dynamic panel models of simultaneous knowledge production function equations (KPF) between 2003-2012, we employ three separate IPRs as innovative output. As for the inputs, we include, as our variable of interest, the share of international and interprovincial migrants, divided by educational level (e.g. Hunt and Gauthier-Loiselle 2010; Miguélez and Moreno 2013; Gagliardi 2015; Bratti and Conti 2018). The model includes also "traditional" knowledge inputs such as investment in research and development (R&D), human capital endowment, population density, labour market characteristics (employment in manufacturing and services) and the degree of openness of the provinces to foreign markets.

Our results indicate that, when migration flows are broken down by educational attainment, the multi-faceted role of different skills on innovation emerges very clearly. First, as far as international migration is concerned, no positive or negative significant consequences were found on the patent productivity of the destination provinces, a finding that confirms the previous results by Bratti and Conti (2018). Nevertheless, for trademarks and design a positive relationship with highly-educated migrants - and a negative one for medium/low-educated migrants - was found. These differences suggest that the use of other intellectual property rights, in addition to patents, allows to grasp more widely a latent and heterogeneous performance of innovation in the provinces and thus have a better understanding of the consequences of knowledge flows. As for interregional migration, highly-educated migrants had a positive effect on patents and trademarks, but not design. Medium/low-educated migrants had, instead, a negative effect on all three IPRs, suggesting that large inflows of med-low-educated migrants may induce a higher employment of unskilled labour in traditional non-innovative sectors hampering the provincial capacity to innovate.

By providing a more detailed picture of the relation between migration and innovation, this article may help policy makers in their endeavour to find the appropriate migration policies to foster local economic growth and innovation. This is particularly important in countries, such as Italy, characterised by a North-South dualism. Our contribution points also to the fact that using only patents to account for innovation might not be enough anymore. To appropriately account for the quality of the new ideas, policymakers must consider the use of different indicators of innovation as well as differentiating by group and skills of migrant. Furthermore, the empirical methodology can become a useful tool for regional migration policy strategies since the use of the three IPRs are already implemented by the European Commission in their Regional Innovation Scoreboard (RIS) to measure the innovation performance of regions.

## National Session: SS49 - Sharing Economy and Urban Sustainability in Thailand



The Thailand Section of  
Regional Science Association International

11:00 - 12:15 Friday, 28th May, 2021

Room Agadir

<https://us02web.zoom.us/j/81254577425>

Chair Nij Tontisirin

## EMERGING PATTERNS OF URBAN PUBLIC SPACES IN THE SHARING ECONOMY

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### ABSTRACT

The advance in digital and telecommunication technology has given rise to the sharing economy to utilize idling capacities of assets and resources. For urban areas where resources are agglomerated and shared, the concept of sharing economy is highly relevant, especially in urban public spaces. This is particularly significant in many cities of the developing world, where the provision of quality public spaces is a goal for improving quality of life and urban sustainability for all.

Using Bangkok as a case study representing a city in the emerging economy, this study aims to characterize urban public spaces in two key dimensions, accessibility and ownership, in order to better understand the current usages of these shared urban public spaces. The study also reviews several case studies of sharing public space platform from cities around the world and explore the patterns of activities and spaces in Bangkok with potentials for a pilot area of sharing public space platform. By using extensive questionnaire surveys and in-depth interviews with community leaders, urban dwellers' needs for public spaces and their online platform engagement for outdoor activities are identified. Together with the interviews with major land/space owners, event-organizers, and urban advocates, the results of the study show the greater needs of urban dwellers for accessibilities to public spaces and identify the urban spaces with high development potentials. Opportunities and challenges in deploying sharing economy system to provide additional urban public spaces for the city are highlighted as a policy recommendation toward more efficient usages of public spaces and an inclusive society that could lead to urban sustainability.

## BANGKOKIAN'S COMMUTING MODE CHOICE BEHAVIOR: READY FOR A SHIFT TOWARDS SHARED MOBILITY?

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### ABSTRACT

The economy has transitioned from owning to sharing underutilized goods and services to improve efficiency. Vehicles cause negative externalities – too many of them are on the streets. Shared mobility encourages private idling vehicles to be used to its full capacity, decrease the overcrowded modes of public transportation, and improve accessibility and connectivity to public transportation.

We aim to understand the mode choice behavior of commuters in Bangkok when shared mobility is present and the metro system is extended through the revealed preference (RP) questionnaire and stated preference (SP) experiment. The aim of this paper is not to gain the most efficient design of the SP experiment, though we did not overlook the importance of the experimental design and intend to achieve robust results with least complexity in addition to the reliability supported by the RP data. Random designs are empirically evidenced to be no less robust than other designs such as the abundant use of orthogonal designs and the emerging use of efficient designs. Hence, we carefully design our experiment by eliminating dominant alternatives and ensuring utility-balance and attribute level-balance. Also, using real data from the Bangkok Household Travel Survey (2017) to set the attribute levels.

Commuter's choice is dependent on their captivity and nested into single-mode and multi-modes transport from origin to destination for their current travel behavior. For the choice experiments, the modes considered are private vehicle (car, motorcycle), public transport (bus, metro), shared mobility (ride-hailing, shared-taxi), and multi-modes (a transit from the motorcycle taxi or shared taxi to the metro system). The travel time is used as a factor linkage. Other mode-specific attributes cover ride fare, fuel cost, toll fee, parking fee, and the crowdedness of public transport and shared taxi. Descriptive statistics are presented to find the socioeconomic and travel characteristics of commuters that are likely to use shared mobility modes. The logistic regression analysis will be performed in the next stage to confirm the results with this stage and estimate the value of time saved, including the mode alternative travel attributes that are important for mode-shifting decisions.

Bangkokians commonly live in a 2-person household and typically value the travel time, convenience, and safeness rather than privacy or comfortability. Travel cost is more important to public transit (mainly bus) users than to private vehicle users. This supports using shared mobility since owning a private car is inefficient for small families and commuters care less about riding alone. However, affordable ecocars and the relatively costly public transports other than the low-quality bus encourages Bangkokians to drive alone in their own car, even when they are commuting within inner Bangkok, where various modes exist. In order to encourage shifts toward more sustainable modes, we suggest increasing private vehicle ownership and usage cost such as congestion and parking pricing.

## FROM SHARING ECONOMY TO PEER-TO-PEER ACCOMMODATIONS: A CASE STUDY OF THAILAND

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### ABSTRACT

Sharing economy has recently shaped a new direction of economic activities. Sharing economy is broadly defined as the value created from underutilized assets in a form of peer-to-peer (P2P) exchanges. Since sharing economy enable these assets to be accessible to others, it leads to reduced needs for ownership of these assets. Particularly, accommodation industries have been transformed in the sharing economy, from hotels/hostels to P2P accommodations, which can offer unique experiences or socializing opportunities, yet affordable, for consumers. For P2P accommodations, exchanges for stay can vary diversely; Exchanges medium can be monetary or non-monetary. In addition, an emergence of digital technologies enables sharing economy to expand beyond its localized territories. Globally known P2P accommodations platforms includes Airbnb, Couchsurfing, and Onefinestay, while there are also regional P2P platforms such as Agoda Home or Favstay in the Southeast Asian region.

With over 38 million foreign visitors in 2019, Thailand has been one of the world's tourist destinations for its rich history and culture, culinary, tropic climate, and affordability. Accommodations in Thailand ranges from luxury hotels to affordable hostels. Since 2012, Airbnb has entered P2P accommodations in Thailand. In 2019, there were over 99,000 accommodations listed on Airbnb in Thailand. Yet, little has known about the impacts of global sharing economy platforms for accommodations on local economy and communities as well as on the localized legal challenges.

The objective of this study is to explore the P2P accommodation industry in Thailand to better understand its localized characteristics and implications on the housing industry. The analysis uses both listing and host information on Airbnb website because it holds the largest market share in Thailand. The data are drawn from many tourist's destination cities in Thailand, including Bangkok, Pattaya, Chiang Mai, Phuket, Cha Am, and Hat Yai. The results show that there are great variations in P2P accommodation characteristics and pricing in these cities. The results also suggest that P2P accommodation has become a new model for hospitality businesses in Thailand, rather than a pure sharing economy as the P2P accommodations first emerged.

## WALKING DISTANCE IN TROPICAL-CLIMATE CENTRAL BUSINESS DISTRICT DURING LUNCH TIME: A CASE STUDY OF BANGKOK

**Shusak Janpathompong<sup>1,2,3</sup>, Sutee Anantsuksomsri<sup>1,4</sup>, Akinobu Murakami<sup>3</sup>**

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### ABSTRACT

During a working day, going out for a meal at “lunch break” is a routine of most workers and, in fact, it represents the longest break within a working day and allows freedom to them for their desire activities. This research focuses on office workers’ walking distance during their “lunch break”, in CBDs of the tropical climate of Bangkok. The study areas are three major business areas in the inner area of Bangkok: Silom-Sathorn, Ploenchit, and Asoke. The result shows that the average walking distance is approximately 300 meters. However, workers significantly perceived their walking distance to be much error than the actual distance with the average of approximately 175 m. Using cluster analysis, the result shows the patterns of how office workers perceived their walking distance in relation to physical environment of their walking routes: thermal comfort, pavement condition, sidewalk obstruction, traffic safety, grade change, and walking distance itself.

The constant hot climate of Bangkok is expected to be the most concerned when people go out for their lunch time. Instead of thermal comfort that people in Bangkok always complain, a sidewalk obstruction is the most important factor that alters how workers perceived their walking distance in the CBD of Bangkok. Walking distance, pavement condition, and grade change also play important roles in their walking perception. However, traffic safety is less of the concern due to the crowded Bangkok’s CBDs during lunch hours. The results can be used to assess the walkability index and as guidelines for improving urban conditions of the CBD making the more pleasant CBD for better lunchtime spending.

## CO-EVOLUTION OF FOOD DELIVERY SERVICES AND RESTAURANTS IN THE SHARING ECONOMY: A CASE STUDY OF BANGKOK, THAILAND

**Yuri Mansury<sup>1</sup>, Sunattha Reangsirikan<sup>2</sup>, Supapitch Intarasut<sup>2</sup>, Sutee Anantsuksomsri<sup>2,3</sup>**

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### ABSTRACT

Technological advances have made it easier to build settlements and cities, protect ourselves from disasters and diseases, farm and harvest, produce and work, and put foods on our tables for thousands of years. However, for the past 25 years, technology has changed immensely, especially in information and communication technology. The internet and smartphones have facilitated us to access information and services easier and faster. In previous years, the food delivery service has been one of the most popular businesses before and during the COVID-19 pandemic. In Thailand, the market value of the service has increased from around 24 billion Bahts in 2014 to around 70 billion Bahts in 2020. The service has not only changed customer behaviors and operations of restaurants, but also urban sustainability. This study focuses on the development and roles of food delivery service in the context of the urban economy in Thailand as well as the impacts of the service on customers, restaurants, and food deliverers in Bangkok. In addition, the study aims to provide guidelines in physical and socioeconomic contexts of sustainable urban development.

The results from the studies of customers, food deliverers, and restaurants show that people are likely to order food deliveries rather than have dining services at restaurants due to the increasing number of available delivery services of restaurants on delivery platforms and their public health issues during the COVID-19 pandemic. The food deliveries reveal that the average number of delivery trips has been much higher since 2020, and the ranges of food delivery service have been wider due to the higher demands of foods from popular restaurants. In addition, the number of food deliveries has been dramatically increasing during the pandemic. On the other hand, the number of restaurants has been decreasing due to the impact of the pandemic. The restaurants have had to adapt themselves to delivery services. For example, some restaurants no longer have storefronts and seats to operate their services. Cooking and delivery services in “ghost kitchens” can be operated anywhere in urban areas. The changes in food delivery service and restaurant supply chains will have impacts on the urban economy in terms of consumption behaviors, employment, and public safety of the city.

## **Regular Session: RS12.4 - Spatial implications of climate and environmental change**

**11:00 - 12:15 Friday, 28th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/86828580970>**

**Chair Yufei Wei**

## ASSESSMENT AND MAPPING OF THE VULNERABILITY TO EROSION AND GULLYING IN THE RURAL COMMUNE OF EL FAID

Ali Azedou, Abdellatif Khattabi, Said Lahssini, Mohamed Sabir

Ecole Nationale Forestière d'Ingénieurs, Morocco

### ABSTRACT

Erosion is the main threat to sustainable water and soil management in Morocco. It has a negative impact from an environmental, social and economic point of view. Located in the Souss-Massa hydrographic basin, the rural commune of El Faid remains an area where gully erosion is strong, causing devastating floods for agricultural land and infrastructure. This study aims to map the areas with high susceptibility to erosion in order to propose gully correction interventions to reduce the risk of flooding. First, we analyzed the vulnerability to erosion at the scale of the commune's territory and then we diagnosed the gully process based on a gully inventory already established and validated in the field. The RUSLE model was used to map erosion vulnerability. Second the dynamics of the evolution of the beds of the main wadis crossing the territory of the commune were analyzed to illustrate the extent of the erosion/flooding phenomenon. We determined the main predisposing factors for soil erosion and gulling, and then, for each factor we drew the corresponding map by determining the interaction of each factor with its corresponding phenomenon.

## CONTRIBUTION OF A NEW-DESIGN MULTIFUNCTIONAL ARTIFICIAL REEFS TO THE SUSTAINABLE MANAGEMENT OF COASTAL AREAS

[Isabel de Almeida](#)

CIAUD, ISCTE-IUL, Portugal. Lusiada University, Portugal

### ABSTRACT

Coastal territories are the focus of constant antagonism and conflict. The lack of integrated management of maritime and terrestrial resources causes serious tension among various sectors of activity (fisheries, agriculture and services). Consequently, the sustainable development of the coastal areas is put on hold. So, how to find a sustainable solution that balances the need to preserve the shoreline and economic development (local or regional)? Scientific knowledge about climatic changes, theoretical background in shorelines infrastructures construction, coastal engineers' awareness, controlling, monitoring and managing of coastal related operations could not avoid a relevant impact on coastal sustainability. Coastal resources are under increasing pressure and specific management programs strive to protect coastal resources for future generations while balancing today's competing economic, cultural and environmental interests. This management programs are determined to balance all the dimensions of the coastline importance (Tourism, Resource Extraction, Wildlife Habitat, Settlements and Industry). These interventions are socially important: they are concerned with the fair allocation/use of coastal resources while sustainably managing these areas so that they can be used by future generations. Sustainable coastal management should involve all parties in the decision-making process so that resources are used fairly without permanent damage. Without sustainable coastal management, there could be a loss in a country's economy and, even, no economic growth. The problem of coastal erosion has been sharpening in Europe. Several publications discuss pressure situations and erosion processes across the entire coastline, pointing to critical situations together with the densification of coastal urban areas partly due to successive waves of human migration towards coastal areas and estuaries. Portugal owns 2830 km of coast, islands included, and is one of the European countries where the growth of coastal urban areas was faster, the growth of population along the shoreline was higher, the most agricultural area along the coast was lost to other uses, and evident loss of dunes is due to construction/exploitation. So, how to find a sustainable solution that balances the need to preserve the shoreline and economic development, either local or regional? Rock walls, breakwaters or groynes usually serve the purpose of protecting land from erosion and/or enabling safe navigation into harbours and marinas, but other commercial value and multi-purpose recreational and amenity enhancement objectives can also be incorporated into coastal protection and coastal development projects. Submerged breakwaters (also called multifunctional artificial reefs (MFARs)), made partially from sludge muds resulting from dimensional stone cutting process, could be an interesting and efficient strategy, not only to protect a coastal system but because recycling and incorporating such wastes into building materials is a practical solution for pollution problems from stone industry. Moreover, MFARs will improve the bathing conditions of some coastal zones and cope to enlarge sea biodiversity. This research main objective is to find a sustainable solution that balances the need to preserve the shoreline in a sustainable way by enhancing the use of stone cutting sludge waste in the production of MFARs, reducing both the environmental impact and the production costs.

## SCALING OF URBAN HEAT ISLAND AND NO<sub>2</sub> WITH URBAN POPULATION: A META-ANALYSIS

[Yufei Wei](#)<sup>1</sup>, [Geoffrey Caruso](#)<sup>1</sup>, [Rémi Lemoy](#)<sup>2</sup>

<sup>1</sup>University of Luxembourg, Luxembourg. <sup>2</sup>University of Rouen, France

### ABSTRACT

Due to urban population growth worldwide, thermal anomalies and toxic air pollution are increasing concern for citizens. Despite this increasing challenge and indications, there is still no consolidated understanding of the effect of city size on urban heat island (UHI) and nitrogen dioxide (NO<sub>2</sub>) pollution. Meanwhile, nowadays cities are viewed as organisms where their magnitude of socio-economic outcomes changes along with their population size, and these changes can be generalized by scaling laws. However, we find most studies dedicated to UHI or NO<sub>2</sub> consider only a single city or a few cities within the top ranks of specific world regions or globally.

We fill this gap by conducting a qualitative synthesis of the literature and performing a statistical meta-analysis from published work with the aim to uncover scaling laws of UHI and NO<sub>2</sub> with the population size of cities. Under the Preferred Reporting Items for Systematic Reviews and Meta-Analysis (PRISMA) guideline, we collect and filter about 500 research outcomes on UHI and NO<sub>2</sub> from Scopus and Google Scholar. We select 22 articles at the stage of qualitative synthesis and summarize them based on their measurement types and geographical locations. The qualitative synthesis of UHI studies includes 384 nonduplicated cities from Asia, Europe, North America, and Oceania. 52 cities are measured by car traverse, 12 cities are measured by monitoring stations, and 328 cities are measured by remote sensing. The qualitative synthesis of NO<sub>2</sub> studies includes 1653 nonduplicated cities from Asia, Europe, Africa, North America, and South America. 4 cities are measured by handy sampler, 61 cities are measured by monitoring stations, and 1588 cities are measured by remote sensing.

Then, for meta-analysis, we group those 22 articles and conduct ANalysis Of VAriance (ANOVA) to identify significant model specifications (linear, semi or double log relations). Through ANOVA we identify significant relations of maximum UHI intensity and logarithmic maximum UHI intensity with logarithmic population size among 52 nonduplicated cities in Asia, Europe, North America, and Oceania. These 52 cities are all measured by car traverse. We also find significant relation of logarithmic annual mean NO<sub>2</sub> surface concentration with logarithmic population size among 24 nonduplicated Asian and European cities. 2 cities are measured by handy samplers, and 23 cities are measured by monitoring stations.

The results of meta-analysis show moving from a city with a population of 100-thousand to a city with a population of 1 million, the max UHI intensity increases by 2.66 °C, the annual mean NO<sub>2</sub> surface concentration increases by 14.95 g/m<sup>3</sup>. Moving from a city having a population of 1 million to a city with a population of 10-million, the max UHI intensity increases by 3.87 °C, the annual mean NO<sub>2</sub> surface concentration increases by 21.72 g/m<sup>3</sup>. Thus, larger cities have higher levels of UHI effects and NO<sub>2</sub> pollution. We also give the progress of verifying the NO<sub>2</sub> scaling using census data and in-situ and RS-measured NO<sub>2</sub> data at the level of Urban Atlas 2012.

## **Special Session: SS29 - Strengthening the resilience of socio-ecological systems**

**11:00 - 12:15 Friday, 28th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89457821343>**

**Chair Sumana Bandyopadhyay**

**INEVITABLE TRADE-OFF BETWEEN ECONOMIC DEVELOPMENT AND ENVIRONMENTAL PROTECTION FROM ISLAND UTILIZATION: EXPERIENCES FROM CHINA**

**Dou Shiquan**

China University of Geosciences, China

**ABSTRACT**

An island is an important part of the global ecosystem. Islands are faced with an inevitable tradeoff between economic development and environmental protection. This article is concerned with the sustainability of island utilization. The paper chose eight island counties from China as a case study to analyze the relationship between economic development and environmental conservation in long-term series. The habitat quality and nighttime light data are used to value the ecosystem quality and human activities scale, respectively. To further explore the impact of human activities on the island ecosystem, we select a typical tourist island for microscopic analysis. This paper reveals the temporal and spatial changes of the island ecosystem under human pressure on a micro-scale. The ecological footprint, habitat quality, and social network location data are used to support the research. We identify, quantify, and spatially exhibiting the damage generated by human activities and revealing the relationship between this ecosystem change and human activities. The result reveals that 1) Humans bring more pressure on the island's ecosystem; 2) Island has the potential risk of over-exploitation. 3) The island ecosystems face a higher utilization intensity than that of land. We analyze the challenges and opportunities faced by islands. The paper reflects the trade-off between economy and development is essentially a choice between the short-term and long-term interests of humans. We build a sustainability action system to support island development.

## RIOTS IN MUMBAI: COMPLEX INTERACTION OF VULNERABLE COMMUNITIES

Abdul Shaban

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### ABSTRACT

Varshney (2002) argues that about 95% of Hindu-Muslim riots in India till 1995 have been in Urban Centres, especially major urban centres of the country. Mumbai has been one of the Western Indian megacities which has faced highest numbers of Hindu-Muslim communal violence with devastating consequences. These violence in the city have been analysed through various lens including Hindus and Muslims as two opposing blocks pervaded by political interests. However, the complex relations between Hindu lower castes and Muslims have not been examined in detail as has been done elsewhere specifically in the case of Gujarat riot in 2002 (Shah 2002). The present study, therefore, attempts to examine the complex relations which have unfolded between the lower caste Hindus and Muslims in the city and how does that translate in turning the lower caste Hindus into 'foot soldiers' to attack Muslims. This is important in the backdrop of the fact that Hindu lower castes and Muslims have largely have similar lower level of development be it education, employment, housing, or household asset base. Many scholars and political parties have attempted to draw possibility of class-based alliances between them and occasionally these alliances have worked as in Gujarat during 1970s and 1980s, in Uttar Pradesh during 1980s and 1990s or in Bihar for a long time from 1970s to till date.

The question then is what prompts them to cannibalise their own class? Whether religion-based identity become a stronger marker during riots than class identities? How are the caste barriers overcome during these riots and ideologies of a sections of upper castes is accepted by the lower caste Hindus, who otherwise are in conflict with them to secure their own social space within the caste hierarchy? How and why everyday normal social transaction between lower marginalised caste Hindus and Muslims breaks down during the riots? How are the spaces occupied by the Hindus and Muslims get designated during the violence and bodies inhabiting these spaces get marked and identified?

The present paper is structured along these important questions. The data for the paper are drawn from relevant studies on Hindu-Muslim riots in the city since 1901 till date. However, special focus has been on the Hindu-Muslim riots during 1992-93 in the city, which was one of the most violent riots city experienced after the independence. The study has used the ethnography and indepth interviews with Hindus and Muslims in different localities of the city (specially in Dharavi and Byculla, the two localities which witnessed massive violence but are inhabited by the marginalised sections of the population from both the Hindu and Muslims) to understand the spatial interactions/conflicts and boundary formations during the communal riots.

The study employs various theoretical postulates to explain the causes of the riots and that range from electoral return theory of Wilkinson (2002), civic association theory of Varshney (2002), essentialism, constructivism, instrumentalism, and institutionalism (Upadhyay and Robinson 2012) to 'aspiration for a broader identity and a larger political role' theory by Engineer (1994).

**SPATIAL JUSTICE, RESILIENCE AND SUSTAINABILITY. REVELATIONS  
OF THE EVOLUTION OF THE POPULATION HIERARCHY OF THE  
REGIONS OF PORTUGAL**

**Tomaz Dentinho**

University of the Azores, Portugal

**ABSTRACT**

The article studies the evolution of the population hierarchy of the regions of Portugal to understand the role of geography, history and related political and economic developments affect the hierarchy of city regions. The work suggests the estimation of resilience and sustainability indicators based, respectively on the standard deviation of the population weight of each city region from the long-term weight of the city region. With the support of the instrumental Zipf's Curve - that relates city region hierarchy with the respective population weight - the analysis shows that there is a growing urban concentration since the sixties of the XX Century, faster during left driven government and the European integration. The approach method also shows that big and small city regions are more vulnerable than medium city regions, that geography measured by remoteness and latitude have a negative influence in vulnerability and the same happens with the fast growth of sprawling suburbs and changeable port city regions. Non-Sustainability, measured by the distance to the long-term weight of the city-region and its actual weight reasserts the profile of winners and losers of changes in the political economic regime.

**OPTIMAL OPENNESS FOR SUSTAINABLE DEVELOPMENT OF PEOPLE  
AND PLACES**

**Tomaz Dentinho**

University of Azores, Portugal

**ABSTRACT**

The paper chapter addresses the question of how open should and city-region be? The approach is rooted in the literature on Spatial Interaction Models subject to environmental, institutional, economic and technological constraints. The argument begins with the formulation of an open spatial interaction model with two channels: Cardo for the internal interactions constrained to environmental and technological restrictions and Decumanus for the external interactions limited by institutional and economic limitations. Results indicate that there two interdependent components for the optimal openness. First, the structural spatial interaction of the region, or the length of Cardo and Decumanus, or on the relative structural centrality of the city-region. Second, the multiplier effects of external flows that depend on the technological, institutional and economic constraints.

## National Session SS48A - Arctic regions: economic, climate and epidemiologic challenges



**11:00 - 12:15 Friday, 28th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88511789571>**

**Chair Alexander Pelyasov**

## RUSSIAN ARCTIC REGIONS AND COVID-19 CHALLENGES

[Alexander Pilyasov](#)

Lomonosov Moscow State University, Russian Federation

### ABSTRACT

The regions of the Russian Arctic, due to a younger population and a less densely populated space, as a whole, showed a lower (COVID-dependent) excess mortality rate in 2020 than the rest of Russia. However, against the background of generally better COVID-situation within the Arctic zone of the Russian Federation itself, inside the Arctic the picture was highly contrasting. First, the regions where resource “growth poles” and the rotational work organization were the first to face a pandemic back in the spring of 2020. Several shift camps of Arctic resource corporations “blazed” to such an extent that a local quarantine regime was introduced in order to avoid contamination of the rest of the Arctic region. Then, general recommendations were adopted on restrictions for shift camps during a pandemic of the state agency for control of the epidemiological situation (Rospotrebnadzor). Against this background, many Arctic regions introduced stricter restrictions on shift camps, up to a two-week quarantine for everyone who came here from outside. However, the regional peak of excess mortality was observed in the Arctic territories not in the first wave, which captured the most contact-intensive and permeable regions of the center, large urban agglomerations of the country, but already in the summer and autumn of 2020, during the second wave, which came here with some lag behind more densely populated areas. In general, larger urban regions of the Arctic have suffered from the pandemic more than sparsely populated and small urban regions, for example, the Chukotka Autonomous Okrug, rural Yakutia, etc. In the Republic of Sakha-Yakutia, for example, in the main regional law on covid restrictions, the Law on High Preparedness, it was expressly stated that all quarantine measures do not affect “areas with limited terms for the delivery of goods”, that is, roadless, remote, inaccessible.

## RUSSIAN CENTRAL REGIONS AND THE ARCTIC PERIPHERY UNDER THE COVID-19 2020 PANDEMIC

[Nadezhda Zamyatina](#), [Boris Nikitin](#)

Lomonosov Moscow State University, Russian Federation

### ABSTRACT

The usual approach to assessing the spread of a pandemic in space is through the cells of administrative-territorial entities, regions and municipalities. Our approach is completely different. We were interested in the place of the city, the region in the system of settlement of the country. The most important result of the 2020 pandemic, manifested in the Russian space, was that it further exacerbated the gap between the centers and the periphery of Russia. The consequences of the pandemic, its perception, discipline in the implementation of official restrictions differed radically between the centers and the periphery of the country. The centers reacted according to the formats of neighboring European states: the thoroughness of the implementation of restrictions, the re-profiling of hospitals, bans on mass events, etc. On the other hand, the peripheral territories, while formally duplicating the restrictions of the federal authorities, in fact observed them much weaker, with a certain serenity towards mortal risk. With this approach, the Russian pandemic space reveals the negative effects of large urban agglomerations, the phenomena of mass migrations from large cities to summer cottages during a pandemic, etc.

## TYOLOGY OF THE RUSSIAN AND ARCTIC REGIONS UNDER THE CONDITIONS OF COVID-19 PANDEMIC

Yegor Kotov, Ruslan Goncharov, Yuriy Kulchitskii, Varvara Molodtsova

Higher School of Economics University, Moscow, Russian Federation

### ABSTRACT

Intensive socio-economic interactions are a prerequisite for the innovative development of the economy, but at the same time, they are a cause of increased epidemiological risks. The same spatial processes, features of the labor market and sectoral structure, as well as government policy measures that contribute to an increase in the density and intensity of socio-economic contacts in an urbanized area, can both increase economic returns and increase risks in the event of a crisis. The pandemic forces us to reconsider many of the views on socio-economic development, innovation processes, the viability of territories, and the role of territorial structures of the economy and society in these processes.

A set of local conditions affects the intensity of socio-economic interactions and the stability of the region. The intensity of interactions influences the severity of the impact of a pandemic. Excess mortality is the most revealing and accessible indicator reflecting the severity of the pandemic in the region. Thus, the regions can be divided into types by the nature of socio-economic interactions that explain the level of excess mortality.

When developing the typology, statistical methods of data analysis were used - factorial and regression, cluster analysis, as well as spatial analysis of open data. The typology was based on indicators characterizing: migration flows, the socio-demographic composition of the population, income level and data on the structure of employment of the population, the level of economic development of the region and digitalization, the level of transport, climate, commercial activity, the provision of medical care, the number of search queries for the selected keywords. In total, about 170 indicators were considered, for each of which an individual relationship with the target variable was analyzed, after which a shortlist of 95 key factors was formed.

The excess mortality was modeled on the Manski model, which allows one to take into account the local and global effects of the neighborhood of regions. The final model, explaining the level of excess mortality by region, determined the role of climatic and socio-economic factors.

Based on the factors selected by the model and the target variable, the regions were divided into types. The results obtained can serve as the basis for several new fundamental and applied research, in particular, they are planned to be used to develop territorially differentiated measures to regulate socio-economic interactions, labor markets, and the sectoral structure of the local economy, aimed at achieving a balance between economic development and minimizing epidemiological risks.

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# PARALLEL SESSIONS (18)

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## **National Session: SS41 - Regional perspective of the different global crisis for small countries in 21 century – case study of Croatia**



HRVATSKA SEKCIJA EUROPSKOG  
UDRUŽENJA REGIONALNIH  
ISTRAŽIVANJA

**13:15 - 14:30 Friday, 28th May, 2021**

**Room FIPE**

**<https://us02web.zoom.us/j/83755472428>**

**Chair Vinko Mustra**

## REGIONAL INEQUALITIES IN CROATIA VS. CEE COUNTRIES – WHAT TO EXPECT AFTER THE CORONA CRISIS

Dubravka Jurlina Alibegovic<sup>1</sup>, Katarina Marošević<sup>2</sup>

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### ABSTRACT

Most Central and Eastern European countries (CEE) record significant differences to European Union average, according to various indicators. Croatia is not an exception. Namely, Croatia also records significant sub-national inequalities i. e. regional inequalities, with respect to different level of socio-economic development. In this paper inequalities are presented among CEE countries and NUTS 2 level of CEE countries. This paper presents results of research on measuring inequalities according to composite index of (regional) development of CEE countries and gives a perspective of inequality expectations in the post-corona period. It gives an overview of most used indicator of GDP per inhabitant in order to gain insight into the changes that happened during three year period time (2017-2019). The growth of GDP per inhabitant can be observed, but it is lagging behind most CEE countries compared to EU 27 average (of 2020), and even their lagging behind of most of them compared to average of CEE countries. Based on mentioned, an adequate suggestions are drawn out and elaborated on. It is important to emphasize that calculation of composite development index is not used for the same period since the development index is created according to the latest available data nor it is used for the regional perspective, but for the development index of certain cities. Therefore, it is a novel that can be used and serve to the economic policy decision makers. Furthermore, certain expectations are drawn for institutional, economic and social level.

### KEYWORDS

CEE countries, NUTS 2, inequalities, composite development indicator

### 1. INTRODUCTION

Achieving an even level of development is a joint goal of various national economies and their parts. Therefore, academic and professional literature is plentiful in research regarding the subject of disparities. However, when looking from the perspective of European Union, it is apparent that there is an obvious east-west division. After the transition period countries of Central and Eastern Europe (CEE) have tried to manage and achieve contemporary modern economic transformation. Some of them had complex unsolved questions – war, economic system transformation, external debt, centralization and many others. Taking into account their lower development level compared to their western neighbours, in order to become a part of European Union they accepted the rules they needed to accomplish and even nowadays remained in subordinate position. On their path to better life standard, some of them have adapted much better and closer to that aim, considering the measure of GDP per inhabitant. In order to compare CEE countries, the aim of this paper is to present today's differences among CEE according to GDP per inhabitant and to make a ranking of CEE countries according to calculated development index of CEE countries and cluster CEE countries NUTS 2 level according to achieved GDP per inhabitant. According to mentioned aim adequate measures can be created, directed to the institutional, economical and social level.

The structure of the paper is as following – after introduction, the second part of the paper gives theoretical perspective of regional inequalities among and in CEE countries and their importance. The third part of the paper is focused on empirical analysis, where after presenting differences on GDP per inhabitant level among CEE countries and differences among GDP per inhabitant of NUTS 2 of CEE countries, the chapter presents methodology and data regarding composite index of regional development calculation for CEE countries and the results are presented. The fourth chapter is based on the main and major contributions in the field of regional development differences.

### 2. REGIONAL INEQUALITIES AMONG AND IN CEE COUNTRIES: THEORY AND LITERATURE REVIEW

Regional inequalities can be defined differently. They most often refer to regional income inequalities within countries. Convergence (or divergence) of interregional income inequalities is mostly analysed by variation between regional incomes per capita, or related inequality measures (Rietveld, 1989). There are theories that have different approaches in addressing regional inequalities. The World Bank favours the theory of new economic geography school that underlines the influence and efficiency of large metropolitan areas and the need to support them for aggregate wellbeing. This theory suggests how historical events can form economic geography, and how ongoing differences in creating parameters can generate change in spatial formation (Krugman, 1989). In the other hand, the OECD has different approach and favours location-based regional policy that relates to place specificities and territorial resources, designed in a transparent and comprehensive way by local actors with the support from multi-level governance. Location-based regional policy is also

accepted in a certain way in the European Union (EU). The goal of the EU Cohesion Policy is overall harmonious development and reduced disparities between levels of development of the various regions and the backwardness of the least favoured regions. In conducted studies Bachtler (2010: 54) indicated a shift in the model of regional policy in Europe, including trends in regional policy design and delivery at national and European Union level, and explained how the principles of regional location-based policy operate in practice. McCann and Varga (2017) showed important elements of the reformed EU Cohesion Policy to provide a consistent overall context. Although its goal is to encourage growth and development in all member countries, including CEE countries, some of the key elements in the reforms, contribute to achieving that goal by introducing smart specialization approach to policy prioritization and resource allocation, the underlying location-based reason for the policy, and general results orientation and evaluation of the policy. The policy objective is equality of regional per capita income. More precisely, the goal is to achieve close to uniformity of income at NUTS2 level. Disparities among NUTS2 regions are measured using different indicators (per capita income, unemployment, educational accomplishment, R&D investment and other). Studies has shown that goals of the implemented EU regional policy have not been achieved and that there are inequalities in regional development among European regions.

Boldrin and Canova (2001) conducted research on results of EU regional policies by measuring income and labour employment dispersion across NUTS 2 regions of the EU. They concluded that result of EU regional policy is neither convergence nor divergence within Europe. Recent research on regional inequalities introduces new approaches in analysis of existing regional economic divergence in Europe. Iammarino, Rodriguez-Pose and Storper (2018) elaborated on the presence of several different modes of regional economic performance in European regions that cannot be explained by current theories. They suggested a different approach to analyse regional inequalities and recommend measures for strengthening the most developed European regions in the one hand and promoting less-developed regions in the other hand. The authors introduced a new approach and labelled it as "location-sensitive distributed development policy".

In literature we can find many articles that explain and report disparities between Eastern and Western Europe and increased regional differentiation within the CEE countries. Focus on societal, economic and political situation in CEE countries is significant on academic (Meyer, 2000; Grieveson et al., 2019), but also on professional and organizational level (f. i. European Parliament, 2015). It was like that with the question of inequalities from the very beginning of the CEE countries transition process - and it is becoming more and more important (Heyns, 2004; Fuest, Niehues and Peichl, 2013; Perugini and Pompei, 2015). Besides, since potential new crises and threats are constantly occurring, Schweiger and Visvizi (2018) warn on having diverse effects on different countries, especially on some CEE countries. Therefore, Schweiger (2018) emphasises that in years to come CEE countries should position themselves as this will substantially influence the direction of the European Union. Their peripheral position in economic, social, and increasingly in political terms, should not be allowed (Schweiger, 2018). It is important to bear in mind that European Union has a huge impact on CEE countries institutions and an impact on the entire range of public policies in CEE countries, setting more than 80 percent of economic regulations. "European Union conditionality might be encompassing, but it may not be effective in particular issue areas or countries and policy or institutional changes in particular issue areas may not be causally related to it" (Schimmelfennig and Sedelmeier, 2005: 2). When speaking of determinants and the evolution of income disparities across regions within CEE countries, they are investigated by Chapman and Meliciani (2018). One of the topics relates to analysis on levels of income inequality and poverty in CEE countries (Förster, Jesuit and Smeeding, 2003), territorial and non-territorial forms of social inequalities (Heidenreich, 2003), the relations between the level of economic growth in CEE countries and economic inequalities (Suszynska and Wojciech, 2017), territorially unbalanced growth in CEE countries because of the structural problems of old industrial regions, enormous rural areas and regions located on the EU's borders, huge differences in social, cultural and geographical characteristics, declining or stagnating regions or economic peripherality faced with negative effects of rural depopulation, "brain drain", disinvestment and unemployment and below-average levels of socio-economic well-being (Smetkowski, 2013).

Conducted research of regional development in CEE showed that the countries observed an increase in the level of regional disparities, mostly because of the rapid development of their capital city regions (Capello, 2007; Smetkowski, 2013). The level of regional disparities in gross domestic product (GDP) per capita differed from country to country. Ezcurra, Pascual and Rapu (2006) elaborated on the progress of territorial imbalances in per capita income in the CEE countries by distribution dynamics of factors such as national component, spatial location, productive structure, agglomeration economies and the percentage of GDP dedicated to investment. To reduce regional disparities, countries provide various regional policy measures. These measures mainly relate to support for new employment and investment in research and development that indirectly influences economic growth at the regional level. The EU also pursues regional and structural policies that stimulate economic growth in member states. Boldrin and Canova (2001) submit research evidence that EU regional and structural policies are intended to redistribute and have minor relationship with fostering economic growth.

Last several months we find in the literature more and more research focused on the impact of COVID-19 on health and everyday life of urban residents, measures taken by states, regions, cities, and municipalities to provide adequate living and working conditions for residents in the pandemic circumstances. It predicts more research on the environmental, socio-economic, cultural, demographic, fiscal, and financial impacts of COVID-19 on the overall development of countries, and especially the impact on regional disparities in development in CEE countries. In this research we try to provide an overview of COVID-19 impacts related to regions and regional inequalities in CEE countries by reviewing recently published literature. In addition, we intend to present some quantitative evidence on differences in regional development

in CEE countries and the impact of COVID-19 on selected indicators of social and economic development. In territorial sense, according to Römisch (2020: 3) there are big intra-country differences caused by COVID-19 related to the degree of the regions' participation in global value chains, their pattern of specialisation, their degree of urbanisation, the quality of governance and whether or not they are pandemic hotspots. Therefore, Römer (2020:4) emphasizes that Böhme and Besana construct an index measuring the regions' exposure and sensitivity to the COVID-19 crisis, creating 9 categories of the index where results in the context of regions of CEE countries were the following: the coastal Croatian as well as the Western Slovenian region are particularly vulnerable to the COVID-19 crisis. Potentially strong effects could also occur in the industrially strong regions in Czech Republic and Slovakia. By contrast, Polish and especially Hungarian regions are estimated to be relatively resilient to the pandemic. Besides, there are eleven regional characteristics particularly useful in assessing a territory's sensitivity to lockdown measures (European Committee of the Regions, 2020: 33): the share of employment in risk sectors, reliance on tourism, reliance on international trade, the share of people at risk of poverty and social exclusion, the share of youth unemployment, the share of employment in micro-enterprises, the share of self-employment, cross-border employment, regional GDP per capita, national debt, quality of government. Analysing available literature, the core of research on the impact of COVID-19 on regional level relates to several thematic areas, namely: (1) socio-economic impacts, (2) job losses and increase in unemployment, (3) restrictions in intercity travel, touristic sector, and restaurant industry, (4) culture and entertainment industry. As this implies a different research review, the first area covers topics related to different socio-economic factors which affect the current level of diversity in CEE countries and in particular the differences in development between different regions. The social consequences of the COVID-19 pandemic have been discussed in context of many countries, including CEE countries. Attention is given to negative impacts, but there are also surveys discussing positive social activities driven by the pandemic crisis. Several studies have analysed different issues caused by long-term structural inequalities.

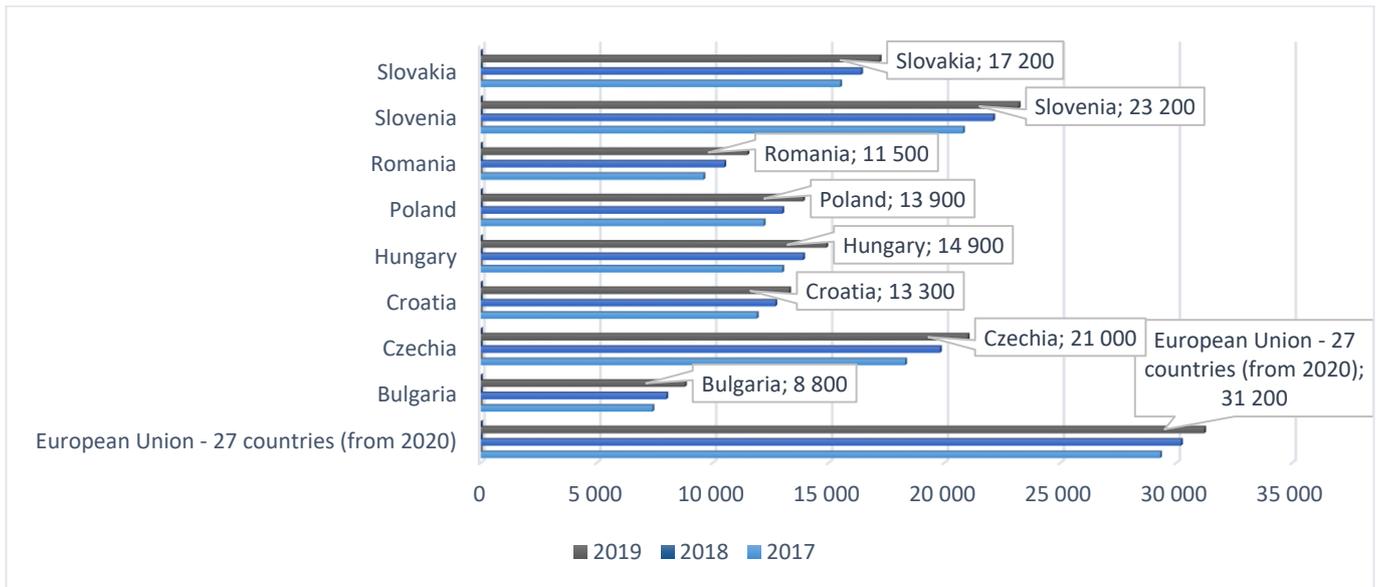
Differences in regional development are described by numerous indicators, from differences in regional GDP per capita, economic strength index, unemployment rates, regional distribution of health care institutions and their equipment and human potential for providing necessary health care in pandemic times, differences in providing public services in culture, different level of education, environmental protection, transport connections to different fiscal capacities and the level of fiscal decentralization in individual countries. The results of all these studies can be used for post-COVID regional development planning and decrease of regional inequalities in CEE countries. Besides, not only that identifying differences is preferable, but is almost a must in detection of right path in achieving development. Having in mind that differences in identification are possible in various ways the upcoming parts of the chapter deal with analysis of differences between CEE countries – on NUTS 1 and NUTS 2 level according to development index calculation, and also of differences on NUTS 2 level of CEE countries, clustering them below EU 27 average (of 2020) according to the GDP per capita.

Generally, present experience indicates that the COVID-19 crisis can serve as an excellent opportunity for public decision makers in all CEE countries to make new strategic decisions and launch a series of measures to achieve strong, and sustainable development at regional and national level – with special emphasis on institutional, economical and social level.

### **3. ANALYSIS OF REGIONAL DIFFERENCES AMONG CEE COUNTRIES AND IN NUTS 2 CEE COUNTRIES LEVEL**

#### **3.1. Analysis of differences between CEEs**

There is a whole constellation of differences that can be identified at various levels, after which this chapter is going to focus more on the economic ones and economic perspectives. When speaking of GDP per capita differences among CEE countries in the period 2017-2019 according to Eurostat all CEE countries GDP per inhabitant are far below EU 27 average (31.200) based on 2020 (Figure 1). According to 2019 data, there are also significant differences among CEE countries. GDP below 10.000 EUR per inhabitant is also noted, although in one among CEE countries Bulgaria (8.800); GDP from 10.000 - 20.000 is noted in most CEE countries, Romania (11.500), Croatia (13.300), Poland (13.900), Hungary (14.900), Slovakia (17.900) and above 20.000 in Czechia (21.000) and Slovenia (23.200).



**Figure 1: GDP per inhabitant in chosen CEECs, 2017-2019**

Source: Eurostat, Gross domestic product (GDP) at current market prices by NUTS 2 regions (online data code: NAMA\_10R\_2GDP), [https://ec.europa.eu/eurostat/databrowser/view/NAMA\\_10R\\_2GDP\\_custom\\_874936/default/table?lang=en](https://ec.europa.eu/eurostat/databrowser/view/NAMA_10R_2GDP_custom_874936/default/table?lang=en)

Keeping in mind above mentioned data and ranks, it is obvious that most CEE countries (five out of eight) are also below CEE GDP per capita average, which for 2019 was 15.475 euro per inhabitant. On the NUTS 2 level of CEE countries according to GDP per capita for 2019 there are significant differences. If we cluster NUTS 2 into four groups, less than 10.000, from 10.000-20.000, from 20.000-30.000, above 30.000; noting that the EU 27 average (for 2020) was 31.200, there were only three NUTS 2 of CEE countries close or above this average – Praha (46.400), Budapest (30.900) and Bratislavsky kraj (39.700), while most NUTS 2 of CEE countries are in the rank of 10.000-20.000 EUR per inhabitant. There is a few NUTS 2 in the rank of 20.000-30.000, but unfortunately for some countries (f. i. Bulgaria) many of NUTS 2 are in the lowest rank, below 10.000 or, as in case of Romania, there is a similar number of NUTS 2 regions in the lowest group below 10.000 as in the rank of 10.000-20.000.

Since GDP per capita is mostly the measure used, there are obvious differences that do exist according to this indicator. However, taking into account that GDP per capita does not take into account components other than economic ones, upcoming chapter presents methodology and results of the index of regional development in the selected CEE countries.

### 3.2. Methodology and data

In this part of the study, we started from the assumption that among CEE countries there are differences in development at the regional level that are influenced by numerous factors. To determine the extent to which individual factors contribute to the level of development of NUTS 2 regions in the eight analysed countries, we proceeded to create our own regional development index. In the selected CEE countries – Hungary, Poland, Slovakia, Czech Republic, Croatia, Slovenia, Romania, and Bulgaria – we have measured the level of regional development in NUTS 2 regions using customized formed composite index of regional development by authors Jurlina Alibegović, Slijepčević and Šipić (2013). Index of regional development consists of two parts. The first part consists of seven regional development indicators: demographic, social, economic, educational, environmental, transport and ICT indicators. The second part of the index consists of democracy indicators: share of regional self-government budget revenues and expenditures in gross domestic product (GDP) (see Table 1).

**Table 1: Structure of composite index of regional development at NUTS 2 level**

Indicator	Name of variable	Source
<b>Regional development</b>		
Demographic indicator (ponder 10%)	Fertility rates by age and NUTS 2 region, total	EC, Eurostat, Regional statistics by NUTS classification, <a href="https://ec.europa.eu/eurostat/">https://ec.europa.eu/eurostat/</a>
Social indicators (ponder 10%)	Health personnel by NUTS 2 regions, medical doctors, per 100,000 inhabitants	
	Hospital beds by NUTS 2 regions, per 100,000 inhabitants	
Economic indicators (ponder 20%)	Long-term unemployment (12 months and more) by sex, age, educational attainment level and NUTS 2 regions, % of active population	
	Employment in technology and knowledge-intensive sectors by NUTS 2 regions and sex (from 2008 onwards, NACE Rev. 2), % of total employment	
	Gross domestic product (GDP) at current market prices by NUTS 2 regions, euro per inhabitant	
Educational indicators (ponder 10%)	Population by educational attainment level, NUTS 2 regions (%), tertiary education level, level 5-8, ISCED 2011, from 25 to 64 years	
Environmental protection indicators (ponder 10%)	Municipal waste by NUTS 2 regions - pilot project dana, waste generated, 1,000 tonnes	
Transport indicators (ponder 10%)	Stock of vehicles by category and NUTS 2 regions, all vehicles	
ICT indicators in communication between citizens and public administration (ponder 10%)	Individuals who used the internet for interaction with public authorities, % of individuals	
<b>Democracy</b>		
Fiscal capacity indicators (ponder 20%)	Share of local budgets revenues in GDP	IMF, Government Finance Statistics (GFS), <a href="https://data.imf.org">https://data.imf.org</a>
	Share of local budget expenditures in GDP	

Source: Authors' systematisation.

The composite index of regional development was calculated based on sub-national (regional) statistics collected by European Commission, Eurostat, Regional statistics by NUTS classification that was developed within Eurostat regions statistics<sup>215</sup>. These databases consist of a wide variety of data for the regions and cities across Europe. To calculate the fiscal capacity of sub-national government units we used data from the Government Finance Statistics (GFS)<sup>216</sup> composed by the International Monetary Fund (IMF). Share of local budgets revenues and expenditures in GDP was used as a measure of fiscal capacity for sub-national government in analysed country.

In calculation of the composite index of regional development at NUTS 2 level for eight CEE countries we used the weighted procedure, where weights represent an equal portion (10 percent) of all regional development indicators, with exceptions being economic indicators (unemployment rate, tertiary educational accomplishment, and GDP per capita by NUTS 2) and democracy index. For these two groups of indicators weights were 20 percent because they have a stronger impact on the economic situation and development at regional level in a particular country. Higher unemployment at regional level has a great negative influence on existing and potential regional development. On the other hand, higher share of inhabitants with university diploma has a positive influence on development in the region. Higher share of regional self-government budget revenues and expenditures in general government revenues and expenditures as well as greater share of regional self-government budget revenues and expenditures in GDP shows a higher degree of decentralization in the country which means a potential larger influence on possible regional development.

We used the share of regional budget revenues and expenditures in GDP as indicators of democracy because these data are available for all NUTS 2 regions in eight explored countries. Based on the IMF GFS database, there are differences between countries regarding the current level of fiscal decentralization. Jurlina Alibegović, Slijepčević and Šipić (2013) clarified that a larger value of that indicator in the composite regional development index means a better difference between centralized and decentralized countries, since in more decentralized countries regional authorities exercise greater influence on decisions affecting (positively or negatively) regional development.

### 3.3. Results

Results of the development level of CEE countries is given in the Table 2 measured by composite index of regional development. The analysed countries are divided into three groups measured by the composite index of regional development. The first group of countries has composite index of regional development under 20 and presents countries with the lower level of regional development. Four countries are represented in this group – Bulgaria, Croatia, Slovakia,

215 <https://ec.europa.eu/eurostat/web/regions/data/database>.

216 <https://data.imf.org>.

and Slovenia. The second group of countries consists of three countries – Romania, Hungary, and Czech Republic. This is a group of countries with index of regional development between 20 and 40 and represents medium level of regional development. Poland has the highest value of regional development index (above 40) and present a country that is the most developed at the regional level.

**Table 2: CEE composite regional development index**

Countries grouped by the level of composite index of (regional) development	Composite index of (regional) development
<b>Under 20</b>	
Croatia	16.09
Bulgaria	16.39
Slovakia	18.89
Slovenia	19.15
<b>Between 20 – 40</b>	
Romania	21.60
Hungary	21.93
Czechia	24.39
<b>Above 40</b>	
Poland	41.00

Source: Authors' calculation based on Eurostat, and IMF data.

Two types of data were used to calculate the regional development index, one referring to relative amounts (percentages or shares), while the other indicates actual data in units of measure. Therefore, the regional development index at the national level for each analysed country does not indicate the sum of the indexes calculated for NUTS 2 regions in the country. Both indexes (the one at the national level and the one at NUTS 2 level) were calculated using the same weights. Data presented in the Table 3 shows ranking of NUTS 2 regions according to the regional development index. Presented data indicated that NUTS 2 regions from almost all analysed countries belong in the group of regions with low level of development measured by used data. The highest ranked regions according to the index used are three regions that comprising the capital area in Czech Republic (Praha), Hungary (Budapest) and in Slovakia (Bratislavský kraj). Praha is ranked as the first NUTS 2 region in the regional development index.

**Table 3: Ranking of NUTS 2 regions according to the regional development index**

NUTS 2 regions	Composite index of regional development
RO31 Sud – Muntenia	7.78
RO22 Sud-Est	8.07
RO21 Nord-Est	8.18
BG31 Severozapaden	8.25
RO41 Sud-Vest Oltenia	8.35
PL62 Warminsko-Mazurskie	8.72
PL43 Lubuskie	8.88
RO42 Vest	8.93
BG32 Severen tsentralen	8.99
RO12 Centru	9.03
PL52 Opolskie	9.04
PL92 Mazowiecki regionalny	9.35
RO11 Nord-Vest	9.51
BG34 Yugoiztochen	9.51
PL84 Podlaskie	9.56
BG33 Severoiztochen	9.79
PL72 Swietokrzyskie	9.79
PL82 Podkarpackie	10.04
PL61 Kujawsko-Pomorskie	10.21
BG42 Yuzhen tsentralen	10.27
PL81 Lubelskie	10.48
PL42 Zachodniopomorskie	10.56
PL71 Łódzkie	10.80
PL41 Wielkopolskie	11.12
PL63 Pomorskie	11.29
PL21 Malopolskie	12.07
PL51 Dolnoslaskie	12.39
HU23 Dél-Dunántúl	12.40
PL22 Slaskie	12.61
HU32 Észak-Alföld	12.83
HU33 Dél-Alföld	12.97
HU31 Észak-Magyarország	13.08

NUTS 2 regions	Composite index of regional development
CZ04 Severozápad	13.12
HR03 Jadranska Hrvatska	14.07
CZ03 Jihozápad	14.44
SK02 Západné Slovensko	14.46
HU22 Nyugat-Dunántúl	14.69
HU21 Közép-Dunántúl	14.95
HR04 Kontinentalna Hrvatska	15.32
SK03 Stredné Slovensko	15.76
HU12 Pest	15.77
SK04 Východné Slovensko	15.98
PL91 Warszawski stołeczny	16.03
CZ02 Střední Čechy	16.19
CZ05 Severovýchod	16.29
CZ08 Moravskoslezsko	16.50
BG41 Yugozapaden	16.59
SI03 Vzhodna Slovenija	16.85
RO32 Bucuresti – Ilfov	16.90
CZ07 Střední Morava	17.10
CZ06 Jihovýchod	17.45
SI04 Zahodna Slovenija	20.30
SK01 Bratislavský kraj	22.06
HU11 Budapest	23.48
CZ01 Praha	25.30

Note: The latest available data in databases were used, and did not contain changes in the number of NUTS 2 regions in Croatia. Besides, the table 3 presents ranks according to achieved score of the country, not individual NUTS 2 of a specific country, but the scores are listed. Source: Authors' calculation based on Eurostat, and IMF data.

#### 4. CONCLUSION

Allmost all CEE countries or their NUTS 2 regions are lagging behind compared to western neighbours and their NUTS 2 regions. Keeping in mind that every crisis brings along some new circumstances economies need to deal with, CORONA-19 as a one of this centuries hardest social, health, economic and other aspects crisis, is the one that needs adequate attention. Although differences among CEE countries are evident on various levels – as well on the NUTS 2 level of CEE countries – and they have been evident even before the crisis, it is expected they are going to rise more and more in all segments. Therefore, after this crisis, it can be expected that differences on various levels will keep growing, having in mind following perspectives especially influencing territory's sensitivity to lockdown measures of COVID-19 crisis that need to be managed (according to the theoretical part mentioned in the paper): a) to take care of employment and sectors that were hit by the COVID-19 crisis and regarding special sensitive groups by appropriate active measures, b) to attempt to encourage domestic unemployed people to participate in retraining in order to encourage new products and industries, c) to engage people already hit by the poverty or that are in the group of poverty to engage in available projects, if they are able, d) to take care of the quality of public services to ensure equal access to the necessary public services and goods to all.

The most used indicator in economic sense for registering present differences is GDP, and therefore this measure was used to see the changes in the period 2017-2019. Although there is growth of GDP per inhabitant registered in mentioned time period, the differences that occur for mentioned period are evident. Having in mind that life standard and human life does not only consist of economic perspective, development index was calculated for all CEE countries. The results are not much different from the perspective given only from the GDP per inhabitant. Therefore, although economic side of life satisfaction is not the only one, it is very important in order to have opportunity to change all other aspects. Speaking of differences, development index results speak of a great differences in NUTS 2. Therefore, development index could definitely be used on NUTS 1 level and NUTS 2 level in order to consider economic and social side of certain achieved level and stage and is usually a key factor for economic policy decision makers.

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## ASSESSING TRANSPORT ACCESSIBILITY OF ISLANDS FOR ECONOMIC RESILIENCE: EMPIRICAL FINDINGS FROM CROATIAN ISLANDS

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### ABSTRACT

Great volatility and uncertainty during last decades has been characterized by highly heterogeneous territorial impacts and promoting the resilience concept for understanding the factors behind these fluctuations.

Most of the studies have been driven by dominant narrative of urban economics and focusing and promoting large and dynamic metropolitan areas. However, recent studies underlined lack of urban dominance over rural regions; especially during periods of crisis (Giannakis. & Bruggeman, 2019).

While transport infrastructure and accessibility can contribute to production of heterogeneous socio-economic effects among territories (Van Wee, 2016; Guzman et al, 2017), past studies have given almost no attention to the role of transportation accessibility on building resilient regional economy (Chacon-Hurtado et al, 2020). This has been especially the case for spatial units heavily defined by transport accessibility - islands. (Karampela et al, 2014). Under the discontinuous space context, constraints of scale economies, micro-climate, and spatial reach of networks, accessibility has unique role for the island communities (Karampela et al, 2014; Birgilito et al, 2018).

In this paper, we fill this gap by exploring the relationship between regional resilience and the degree of transportation accessibility for the islands. By focusing on the resistance and recovery phase of resilience among islands in Croatia in period 2007-2017, we provide profound foundation for development and policy discussion.

Our empirical findings indicate higher level of resilience for less isolated islands, especially as a result of faster recovery after economic downturns. However, degree of transportation accessibility doesn't play important role for resistance among our spatial units.

Finally, study provide clear insights for policy makers in delivering more effective development policy measures during turbulent periods for unique spatial units – islands.

## DUTCH DISEASE AND RESILIENCE – THE CASE OF CROATIA

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### ABSTRACT

The concept of the Dutch disease was for the first time used by "The Economist" in 1977 to describe the sharp rise in wealth in the Netherlands during the 1960s caused by the discovery of large gas reserves. After the discovery, there were negative effects on the Dutch production, mainly through the subsequent appreciation of the real exchange rate. Namely, as the revenue from exports rose, Dutch guilder appreciates having detrimental effect on other industries. Similarly, the rapid growth of the tourism sector can have possible negative effects as well. The availability of natural resources (such as national parks, nature parks, beaches, sunshine hours etc.) becomes a comparative advantage of the tourist product with subsequent specialization in tourism, neglecting other sectors with all the negative aspects such as real appreciation of domestic currency (decline in competitiveness), low growth rates of the industrial production, artificially high real wages, reallocation of production factors from tradable to non-tradable sector, the drop in the relative productivity of the tradable sector and similar. Such a scenario is possible to be seen in coastal part of Croatia and therefore the aim of this paper is to research possible indications of Dutch disease in Adriatic region of Croatia on the county level. Moreover, the aim is to scrutinize resilience power of those counties, especially in the context of current COVID-19 pandemic situation. Results of the paper should provide valuable information to policy makers whether there is a need to take a necessary policy decisions with the aim of managing negative consequences timely and preventing slower economic growth in the future.

## THE ROLE OF POLICY SUPPORT IN THE DEVELOPMENT OF REGIONAL HEALTH TOURISM – THE STATE OF THE ART IN CROATIAN REGIONS

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### ABSTRACT

The changes in lifestyles of modern travellers (globalization, less free time, more stress, etc.) have induced the rise in the health tourism demand globally (Hall, 2011). A new concept in the tourism sector regarding health tourism development is present in the last decade (Connell 2011). This concept relates to active promotion of health tourism on national level and to high national support through the development of health tourism infrastructures and policies (Mainil et al., 2017). The rationale behind this support is in perception of health tourism as a generator of regional economic growth (European Union, 2016). According to Mainil et al. (2017) health tourism supports development of quality value-added products and services in a destination by mobilizing specific local resources and by contributing to smart regional specialization. Hence, health tourism helps diversification of tourism products, reduces seasonality and vulnerability of a destination in general and in times of crisis when reduction in general tourism demand occurs.

The purpose of this research is to analyze whether the improvement in national policies induces the rise in the efficiency of health tourism services providers in Croatia. More precisely, the panel DEA was used to analyze the relative technical efficiency of the providers of health tourism services, special hospitals and natural spas, in Croatia. The analysis is performed for 8-year period. The results indicate that in the analyzed period, due to the innovation in services, the shift in efficiency level and in efficiency frontier is achieved. Furthermore, by analyzing all of the Malmquist index components, results reveal that special hospitals and natural spas in Continental Croatia have achieved better results in term of technical efficiency, in relation to those in Adriatic Croatia. Knowing that the rise of efficiency of health care facilities can be brought by supportive actions of public and private sector, the study indicates that the national health-tourism policies are more favourable for special hospitals and natural spas in Continental Croatia. Moreover, it can be concluded that present economic policy is actively meeting and responding to multiple challenges the health care infrastructure is facing, which influences the reduction on regional disparities and vulnerabilities in Croatia.

## REORIENTATION AS A TOOL FOR RECOVERY: ANALYSIS OF REGIONAL ECONOMIC RESILIENCE IN CROATIAN NUTS 3 REGIONS

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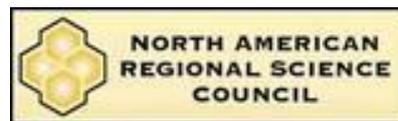
### ABSTRACT

Recently, since the 2010s, regional economic resilience has been a specific interest of the researchers' focus. Among many, one of the pioneer, yet most comprehensive definitions was offered by Martin in his research from 2012 when he explained that regional economic resilience could be viewed through the capacity of a regional economy to reconfigure, that is adapt, its structure (firms, industries, technologies, and institutions) to maintain an acceptable growth path in output, employment, and wealth over time. In the same research, Martin identified four dimensions of the regional economic resilience: i) resistance (the vulnerability or sensitivity of a regional economy to external shocks, for example, recession), ii) recovery (speed and degree of recovery from such shocks), iii) reorientation (the degree to which the regional economy goes through structural changes and adjusts after the shock), iv) renewal (continuation of the growth path of the regional economy before the shock).

Following Martin's division of the resilience's dimensions, this paper focuses on reorientation and recovery. Precisely, it aims to investigate if reorientation affects the recovery in Croatian NUTS 3 regions. As noticed by Đokić, Fröhlich, and Rašić Bakarić in their research from 2016, the latest global financial crisis harmed Croatian national and regional development and led to significant regional disparities. This paper analyzes recovery and reorientation in Croatian NUTS 3 regions and sets up the model to investigate the impact of reorientation on the recovery process in Croatian NUTS 3 regions. In the context of resilience, recovery has been proxied by many authors (for example Romão in 2020, Muštra, Šimundić and Kuliš in 2020, Giannakis and Bruggeman in 2017 and 2020). The possible indicator could be the ratio of the values of the employment change in the year (or years) of the economic recovery period and the starting year of the crisis period. On the other side, the indicator for reorientation can be calculated following the example of the research performed by Ženka, Pavlík and Slach in 2017 as Finger-Kreinin index of structural shifts in employment (or possibly in GVA).

Data will be collected from Croatian Bureau of Statistics (CBS) for a period of ten years (2009-2018). The analysis is based on a panel data approach. The dynamic panel data model is formed to estimate the effects of regional reorientation on the recovery in 21 Croatian NUTS 3 regions. The model is tested using standard diagnostic tests for dynamic panel data analysis. Results are expected to show the positive impact of reorientation on recovery in Croatian NUTS 3 regions. Furthermore, the descriptive analysis made in the paper identifies the best performing regions and best performing sectors. Empirical conclusion alongside descriptive analysis offers valuable insight for policymakers: the reorientation, including key structural changes, as a tool for regional recovery. Those findings are of big importance considering the latest global crisis due to the coronavirus pandemic. Finally, this paper is one of the rare attempts which investigates regional economic resilience in Croatian regions.

## **National Session: SS65 - Urban Neighborhoods: Accessibility, Segregation, and Neighborhood Change**



**13:15 - 14:30 Friday, 28th May, 2021**

**Room NEREUS**

**<https://us02web.zoom.us/j/85127009544>**

**Chair Neil Reid**

**ARE HISTORIC DISTRICTS A BACKDOOR FOR SEGREGATION? YES AND  
NO**

**Jamie Bologna Pavlik<sup>1</sup>, Yang Zhou<sup>2</sup>**

<sup>1</sup>Texas Tech University, USA. <sup>2</sup>University of North Texas, USA

**ABSTRACT**

Historic districts preserve the heritage of designated areas and attract tourism income. However, these districts also come with restrictions and increased housing prices that could cause segregation. We study how two historic district programs impact residential segregation in Denver. We find that homebuyers are more likely to be White within historic districts, but that the official historic designation has no effect on this probability. Similarly, we find that most transactions flow from White sellers to White buyers, regardless of official designation. Thus, while historic districts tend to be more segregated, official designation does not seem to amplify this existing problem.

## PREDICTING NEIGHBORHOOD CHANGE: CHALLENGES, OPPORTUNITIES, AND POSSIBLE NEW DIRECTIONS

[Isabelle Nilsson](#), [Elizabeth Delmelle](#)

University of North Carolina at Charlotte, USA

### ABSTRACT

Gentrification and back to the city movements has gained traction in cities across the United States over the past several decades. However, recent disruptive events such as the COVID-19 pandemic may have changed residential location preferences and subsequently altered the neighborhood change process. These shifting geographies can have important consequences for people's lives and is continuing to challenge long-term plans and investments of planners and local policy makers. Hence, understanding and predicting shifting residential sorting patterns and subsequent neighborhood outcomes has become increasingly important. In this paper, we review the current state of knowledge on predicting neighborhood change and stability. This is followed by a discussion of methodological and data challenges and opportunities in predicting neighborhood change. Finally, we present a new approach based on text and attribute data from property advertisements and publicly available, frequently updated mortgage application data. The usefulness of this method is demonstrated in a case study on Charlotte, North Carolina, a rapidly growing city in the southeastern United States. We begin by classifying neighborhoods into five classes of neighborhoods based on who is applying for mortgages in the neighborhood. We then use machine-learning techniques and information from property advertisements to predict the racial and socioeconomic composition of mortgage applicants at the neighborhood scale. We examine common words used to market different types of neighborhoods and the relative importance of various terms in discriminating neighborhood types. Despite the small sample, we are able to achieve relatively high predictive power. We are also able to show that the inclusion of neighborhood and street names increased the predictive strength, especially in the case of white and higher-income neighborhoods where highly regarded neighborhoods are marketed more heavily. We end the paper by discussing the potential and limitations of these data sources and methods in predicting neighborhood change. As a proof of concept, the blending of these two datasets proves effective in identifying currently gentrifying neighborhoods and show promise for revealing urban dynamics in more real time than relying on retrospective census surveys.

## DOES RIDESOURCING PROVIDE EQUITABLE ACCESSIBILITY?

[Sicheng Wang](#)

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### ABSTRACT

In this study, we conduct a comprehensive evaluation of the accessibility offered by ridesourcing services. We measure ridesourcing accessibility by applying gravity-based metrics that include the attractiveness and travel impedance factors. We use transportation network providers' data for Chicago to calculate the average travel times between origins and destinations for ridesourcing trips. Travel impedance factors are computed based on the real travel times. Both the employment volume by sector and points of interest locations are used to measure the opportunity attractiveness. We estimate accessibility for three types of non-work destinations: healthcare facilities, restaurants, and grocery stores, and compare the accessibility between ridesourcing and transit. Given the presence of spatial autocorrelation in our data, we estimate both ordinary least squares regression models and spatial autoregressive models to examine the associations between ridesourcing accessibility and census tract-level demographic and socioeconomic indicators. We find that ridesourcing has a less equitable distribution compared to transit, based on the median household income of census tracts and minority populations. Ridesourcing accessibility is also negatively associated with the percentages of three age groups (0 - 5, 6 - 17, and 65 plus) but positively associated with the percentage of zero-vehicle households. These results provide guidance for policy makers on the inequities associated with new mobility options and how best to offer improved accessibility for disadvantaged populations.

## **Regular Session: RS03.5 - Knowledge and innovation**

**13:15 - 14:30 Friday, 28th May, 2021**

**Room Casablanca**

**<https://us02web.zoom.us/j/83488693367>**

**Chair Isabel de Almeida**

## THE IMPORTANCE OF DESIGN AS A CREATIVE PROCESS IN BUSINESS SCHOOLS: HOW TO FILL THE DESIGN/BUSINESS KNOWLEDGE AND COMMUNICATION GAP?

[Isabel de Almeida](#)

CIAUD, ISCTE-IUL, Portugal. Lusiada University, Portugal

### ABSTRACT

In most Business Schools (BS), Design in business education plays a minimal role. It is neither part of the core basic learning courses nor part of the electives. No courses in design, corporate identity, graphic design, communication design, environmental design, or product design were found in this study. When business students are enrolled in design principles, they learn it loosely, as part of new product development or entrepreneurship classes. Business teachers simply assume that when corporate design decision-making is needed, the managers will simply ask a designer. However, designers are not educated in business and business managers are not educated in design. Without design in the curriculum, BS is far away from the real business world. Therefore, why BS does not change the curriculum to meet the real business-world needs? The current study addresses the (i) perceptions of business education and training experts; (ii) accreditation and curriculum requirements; and (iii) scientific journal articles, books on current standards and processes in business education. The curriculum specifications for business programs are generally established by the International Association for Management Education (AACSB). Our results reveal that the AACSB demanding: the business curriculum should include "accounting, economics, mathematics, statistics and behavioural science" alongside "basic written and oral communication skills and quantitative analysis". No mention of design or quality analysis is done. Moreover, the specific content of the course does not matter for the accreditation process. Instead, the business programs evaluation is performed following their goals. Design and design management were not mentioned when comparing goals and curricula from several Portuguese business schools. In our research, when business teachers were questioned about the hypothesis of curriculum changing, one of the most cited answers was that 'Someone should have a vision. If there is no leader, nothing will happen' However, to develop non-traditional curricula, it requires efforts from all, and several faculty members, particularly the teachers, are overstretched. Likewise, it is much easier to teach the same subject multiple times. We conclude that the teacher's passion for design must be sufficiently robust to drive change. But, in another hand, the business students must demonstrate curiosity and willingness to engage. When a new course is introduced in a traditional curriculum it will be appreciated, and the first criterion is the extent of demand for it. An average of 30 students must enrol. The second is concerning the professor and the new course must be well taught. If both conditions are met, they can continue. But the new and real-world-touching courses are always introduced as electives, and students put a lower priority on electives than on core needs - the compulsory courses. As a result, what needs to be done to overcome the curriculum stalemate, the priority of the students, and the burnout of the faculty members? What could cause business schools to change? What would make possible the inclusion of design in Business curricula, despite the above- mentioned obstacles? The present work is a search for adequate answers.

## CITIZENS CO-PRODUCTION IN URBAN INNOVATION: CRITICAL PERFORMANCE FACTORS

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### ABSTRACT

Urban places that facilitate experimentation and innovation in urban sustainability solutions, are quickly increasing in number in Europe today. Such places are strongly needed given rigidity of the socio-technical systems involved and complexity in multi-stakeholder situations. Which factors are critical in their performance, however, are hardly known. First, we address transitions in socio-technical systems and potentials of experimentation in so-called protected places or 'niches'. Secondly, to improve understanding of these places, the core concept of 'citizens co- production' in innovation is discussed, as it has developed on the basis of various societal trends, for example, emphasizing that users are important sources of innovation (user-centered innovation) and emphasizing the larger societal role of universities and democratization of science. Next, derived from literature and case study analysis, a set of critical performance factors of these initiatives, is designed and discussed. We divide them into factors concerning stakeholders involved and factors concerning the solution. This is followed by an illustration with three types of urban projects, namely, citizen science, living labs and technology incubation. The sectors involved in our analysis are sustainable energy and sustainable (inclusive) healthcare. All in all, experimentation is needed to identify whether the solution works (solves problems) on a larger scale and real-life setting/time, matches with different urban context, matches with specific user needs and viable business models, can deal with restrictions from regulation, standards etc., and contributes to a wider transition in cities.

## E-COMMERCE IN SOUTH AFRICA: BUSINESS PRACTICES IN CUSTOMER ACQUISITION AND RETENTION

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### ABSTRACT

Internet reaches 57% of SA's population, a sizeable number for the continent. This has influenced businesses to use the Internet for customer acquisition and retention, but research suggests that issues such as privacy and trust are preventing the rapid spread of e-commerce in the nation. To overcome customer's privacy concerns, businesses provide policy statements indicating how customer's personal information will be used for business purposes. However, comprehending the legal language of the privacy policy makes it a difficult task for the customer. The consequence, 71% of the customers do not complete web forms and provide the needed information for e-commerce transactions.

It is the argument of this paper that behavioural economics principles would help in designing web-form that would facilitate customer engagement with businesses, overcome trust issues; the premises of the argument, BE principles and contextual influences relevant for web-form completion are highlighted.

### KEYWORDS

Marketing, Nudges, Permission

### 1. INTRODUCTION

The battle for customer acquisition and retention has resulted in a plethora of marketing messages, a lot of clutter has ensued. To differentiate themselves, companies are finding innovative ways to communicate, acquire, and retain customers. Online permission-based marketing (OPBM) is one of these avenues; it enables firms to target customers with tailored marketing communications (Godin 1999). Personal information collected using a web-form is often used to tailor content of the message to the customer; personalized marketing communications have a greater likelihood of being processed (Terres, Klumpe, Jung & Koch 2019:4;).

In general, time constraints could prevent the customer from filling out the web-form or opt-in to the marketer's communication. It is the argument of this paper that registration costs, including time spent by the customer in filling out the web-form, could be minimised using behavioural economics tactics such as heuristics, message framing and anchoring as well as default options. While qualitative discussions on how nudges can assist in overcoming customer's privacy concerns exist (see for example, Acquisti et al (2017:20), little or no research has been directed to design and test these nudges in an empirical setting. This research is an initial attempt in filling this gap in knowledge.

### 2. LITERATURE REVIEW

Today's interconnected networks of computers provide companies great opportunities to interact with customers. The interaction requires that a customer accepts a firm's invitation to receive messages at a specified time, frequency and communication channel (Kiran & Kishore 2013:115; Chaffey & Ellis-Chadwick 2016:313). Privacy concerns and beliefs such as that the communication will be intrusive are found to prevent customers from engaging with the business online (Krafft, Arden & Verhoef 2017:50).

To overcome customers' privacy concerns, businesses often provide a privacy policy link for customers to read about the intended use of their shared personal information. However, comprehending the legal language of the policy makes it a difficult task for the customer (Zimmer, Arsal, Al-Marzoug, Moore & Grove 2010:397; Martin, Borah & Palmatier 2017:21). This is where behavioural economics (BE) could help.

Economics is a science which studies relationship between ends and scarce means (Williams, Liu, Muir & Waxman 2018:178). Classical economic theory is premised on the notion that individuals are rational agents following their own interests in making decisions between these ends and scarce means. However, BE argue that individual behaviour deviates from normative principles of economic behaviour; people in general don't process lots of information before they make decisions as such they rely on mental shortcuts or heuristics for decision making (Thaler 2017:767).

BE recognizes individuals' cognitive biases in making decisions; for example, that individuals tend to discount the value of far-off loss at the expense of immediate rewards (Guthrie 2017:701). In business, 'nudges' are used to guide these decisions toward immediate rewards. A nudge is defined as "any aspect of choice architecture that alters the customer's behaviour in a predictable way without forbidding any options or significantly changing their economic incentives" (Thaler 2017:17). For example, customers can be nudged to opt-in to business's OPBM by discounting the fear of privacy invasion (a long-term problem) for the immediate benefit of receiving new product information, for example (Berg 2014:223).

Xu, Dinev, Smith & Hart (2011:812) experimented with heuristics (third-party approval) and observed positive customer responses. Xu et al 2011:812 demonstrated that when third party seal of approval (logo) is displayed, respondents shared their personal information with an intention to receive marketing communications. Other studies have successfully used BE principles to influence individuals to engage in fitness-related activities and reduce hospital claims (Lambert, da Silva, Patel, Fatti, Kolbe-Alexander, Noach, Nossel, Derman & Gaziano 2009: 6), reduce water usage, reduce electricity consumption, and change driver behaviour to reduce accident claims (Guszcza & Portillo 2015:66). BE principles have also been influential in steering one's behaviour toward a certain goal. For example, Hou (2017:210) demonstrated how technology-interface cues influenced customer's food ordering amounts from an online food ordering website. A combination of default and anchoring nudges on credit card repayment was found to have increased the minimum repayment amount among customers (Key & Wang 2014:17). Also framing prices as gains, for example, three items for the price of two, were found to have increased product purchases among customers (Berg 2014:226; Welch 2010:1). An investigation nudging household water conservation used households' social norms and financial savings as frames and the results reduced water consumption levels among households by 1.5 percent (Brent, Lott, Taylor, Cook, Rollins & Stoddard 2016:29).

In summary, the principles of BE that inform web-form design suggest:

- (i) displaying third party privacy seal of approval simplify customer decision making when faced with the question of personal information disclosure and permission granting – principle of heuristics.
- (ii) Purchase options can be framed either as a gain or loss for the customer. In general, customers can be influenced about their product choice by framing marketing communications in a positive way (David & List 2015:388) – principle for framing messages.
- (iii) Individuals place higher value for their tangible possessions, for more than what they are worth at the marketplace (endowment effect). This is one reason for customer unwillingness to share personal information. The endowment effect could be overcome by anchoring a positive statement which the customer can use a reference point to adjust behaviour by sharing personal information and opt-in (Strack & Mussweiler 1997:440)-principle of anchoring.
- (iv) As mentioned earlier, privacy policies are ineffective because they are hard to read (full of technical jargon) and lengthy (Madden et al 2013:30). These problems have resulted in development of privacy nudges (Wang et al 2013:15). De-coupling privacy policy into short statements and setting them as default, opt-in agreements are tactics related to the principle of nudges.

Given the above principles of BE and the efficiency of nudges in the previous studies, we posit that web-form interface designed with principles of BE could influence customer to share personal information and opt-in to OPBM (Krebs 2013:2; Szaszi, Palinkas, Palfi, Szollosi & Aczel. 2018:355). A web-form, when deployed ethically, should elicit positive customer responses, for example, positive attitude towards the marketer. However, research suggests that most web-forms in use today on the African continent deter positive customer responses (da Veiga, 2018: 350). To elicit positive responses, web-forms need to be developed, incorporating BE principles of nudges (Krebs 2013:2). Since Africans are no different from other nationalities in terms of privacy concerns (Pelteret & Ophoff 2016: 280; Tshiani & Tanner 2018: 65), the following hypotheses are presented.

### 3. THEOREMS

Attitude toward online advertisements is negative in SA (Worku, Shitamin, Mebrate & Andaregie 2020:9); privacy issues of control are perceived important for South Africans (Beneke 2015:12). The online behaviours of most South African can be segmented into two groups: privacy pragmatists and privacy fundamentalists. Privacy pragmatists believe in privacy as a right, whereas privacy fundamentalists believe in privacy as a right and personal responsibility (Ponciano, Barbosa, Brasileiro, Brito & Andrade 2017:5). The members of these groups are typically aged between 18-34 years, an age group that is economically active and an important for online business (Ponciano et al 2017: 6).

To address the privacy concerns of the groups, established BE principles such as nudges and endowment effect can be used. Thus,

**Theorem:** For Privacy groups, to share personal information and grant permission to engage with the marketer online, salience of heuristics, framing of positive popup message, anchoring of a gain statement, and decoupling and default of privacy policy and opt-in options are pre-requisites. It is necessary to define these constructs before we hypothesize. Table 1 below provide definition of each construct with an example.

**Table 1: Nudges**

Nudges	Definitions	Examples
Heuristics	A stimulus such as a trust symbol used to provide positive reinforcement for customer behaviour.	
Defaults	Pre-selecting options by setting default choices on the assumption that the customer will accept the defaults.	<input checked="" type="checkbox"/> I consent to receiving communication for marketing activities. <input checked="" type="checkbox"/> I consent to profiling activities. <input checked="" type="checkbox"/> I consent to receiving communication from third parties for marketing activities.
Framing	An act of designing a decision frame in a way that influences an individual's behaviour to respond in a positive.	"Saves 200 lives" sounds better than "400 people will die".
Anchoring	A deliberate presentation of certain information to serve as a reference point to ease the burden of decision making.	"Most customers benefited from our services by sharing biographical information".
De-coupling	Simplification of information considered to be time consuming and difficult to read and comprehend in a short period of time.	I consent to receiving communication for marketing activities. I consent to profiling activities. I consent to receiving communication from third parties for marketing activities.

Source: Adapted from Weinmann, Schneider & Vom Broke (2016: 433-436); Acquisti, Adjerid, Balebako, Brandimarte, Cranor, Komanduri, Leon, Sadeh, Sleeper, Wang & Wilson (2017:41); Eigenbrod & Janson (2018:6).

**4. HYPOTHESES**

**4.1 Heuristics**

On-screen opt-in decisions require a customer to make judgments, decisions and choices about uncertain future events. Heuristics assist in ensuring a customer make appropriate choice decisions (Acquisti, Adjerid, Balebako, Brandimarte, Cranor, Komanduri, Leon, Sadeh, Sleeper, Eigenbrod & Janson 2017:5). For example, the impact of store atmospherics, specifically ambient scent, colour and imagery, were found to act as primes to nudge shoppers to healthier food purchasing within a supermarket context (Phillips 2017:173). Online usage of contextual clues-heuristics is demonstrated by Wang et al. (2014:2368); in their study, nudges on Facebook were used to remind users about the audiences for their post (showing five profile pictures-nudge). The study found the nudges to be beneficial for Facebook users, especially for the users who post personal thoughts (Wang et al 2014:2374). Generalizing these findings to the present study suggests that:

**H1.** *The display of a third-party seal of approval on a web-form will facilitate opt-in to online permission-based marketing.*

**4.2 Framing**

Businesses frame communication messages to nudge customers to make positive choices. Huber, Jung, Schaule & Weinhardt (2019:5) posit framing as a "conscious formulation and description of the decision situation" with the goal of encouraging customers to act in a certain way. For example, a social framing 'nudge' to steer website visitors to accept a cookie may be framed by stating "majority of users like the visitor had accepted the cookie" (Coventry, Jeske, Blythe, Turland & Briggs 2016:6). Framing of consent options has shown a significant impact on customer privacy choices (Hermstruwer 2017:19). Bertrand, Karlan, Mullainathan, Shafir & Zinman (2010:302) studied the usage of framing advertising content. Bertrand et al (2010:286) framed a direct mail flyer for a short-term loan advertisement by stating "A special rate for you", "A low rate for you", and the advertisement had a two week deadline for clients to respond. The study found advertising content had a statistically significant effect on short-term loan take-up among South Africans. Framing a request as a gain seem to result in positive response than a negative frame. This makes framing effects most effective when combined with a default, pre-checked box after the frame statement. For example, a customer can be presented with a positive choice frame like "I would like to benefit from tailored communication messages ". A statement framed as a 'gain' will influence the customer to try to not lose that gain (Hermstruwer 2017:20). This study posits that framing will increase customer opt-in.

**H2.** *Framing a statement as a gain for the customer will increase customer opt-ins to OPBM.*

**4.3 Anchoring**

Contextual cues influence individuals' behaviours in making decisions. Customers are found to use the first available information as a reference point to decide on the next presented choices (Acquisti et al 2017:7). This reliance on

presented information is labelled ‘anchoring’. Acquisti et al. (2017:18) study found that online customers disclosed sensitive information such as home address when it was stated that other customers have provided such information. Hou (2017:202) conducted a field study to test the impact of anchoring-heuristic cues on a food-ordering website. An anchoring-heuristic was implemented by showing participants the “average number of cookie other users ordered”; participants ordered less food when a low starting anchoring cue was set up (Hou 2017:209). The importance of anchors in eliciting positive customer responses is further illustrated by Keys and Wang’s (2014:18) study that used two anchoring statements for credit card customers. Customers were sent two different anchoring statements of “Late payment warning” stating that the customer will incur a penalty of \$35 for late payment”, and another statement with the caption “minimum payment warning” which stated that the customer will pay less in interest and pay off balance sooner. As expected by the researchers, credit card customers paid more than the minimum before the due date. Hence:

**H3.** *Utilising anchoring tactics in the web-form will increase customers to opt-in to OPBM.*

#### 4.4 De-coupling of privacy statement

Typically, an online customer has little or no time to click and read privacy statements and thoroughly analyse every bit of information. Often, a business’s privacy policy is clouded by semantics legal jargon and lengthy statements, hidden behind a website link; thus, rendering the intended objective of privacy statements ineffective (Barth 2008:75). De-coupling the privacy statement into subsets for customers can assist the customer in processing the information quickly (Hermstruwer 2017:21). Hence:

**H4.** *Displaying of de-coupled privacy statements will influence customers to opt-in to OPBM.*

#### 4.5 Defaults

The use of de-coupled privacy statements is important but not enough for a time-pressed customer to act on an opt-in request such a web-form. Displaying de-coupled privacy statements with an activated default has proved successful in eliciting positive response (Ghesla, Grieder & Schmitz 2019:10). Activated defaults reduce cognitive efforts of having to manually choose to opt-in to different options (Wroblewski 2008:239). In one study, more than double the number of people approved pro-social giving compared to the no default option (Ghesla et al. 2019:10). Since defaults simplify customers’ cognitive effort, the following hypothesis is stated:

**H5.** *Activated opt-in defaults on decoupled privacy statements of a web-form will increase the number of customers opting-in to the OPBM.*

The above hypotheses are proposed as a guideline to design a web-form employing behavioural economics principles of nudges. It is not the intention of this paper to test the hypotheses, but to put BE principles of nudges in a practical way. Below we explain the web-form example design on where and how the nudges have been incorporated.

### 5. PROPOSED WEB-FORM DESIGN

The web-form given below, designed using BE principles, will be field tested for effectiveness in influencing potential customers to share their personal information and opt-in to OPBM. Top left is display of third-party seal of approval is the heuristics nudge; followed by a frame nudge in the form of a popup message when the individual is about to make a selection of his/her preferred medium of communication to steer him/her to provide an e-mail address above all other choices. An anchor nudge is highlighted in red colour to nudge potential customers to share a WhatsApp number or cell number to avoid missed messages. Business’ privacy policy has been decoupled into three short statements and default is the opt-in to OPBM.



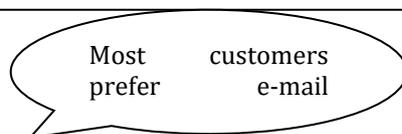
#### PERSONAL INFORMATION

TITLE

Drop down menu

FIRST NAME

SURNAME



PREFERRED MEDIUM OF COMMUNICATION FROM US

E-MAIL

MS/WHATSAPP

CELLPHONE

r

PLEASE PROVIDE CONTACT DETAILS FOR YOUR PREFERRED MEDIUM.

Providing at least two contact details increase our chances of reaching you at the most convenient time.

E-MAIL ADDRESS

WHATSAPP NUMBER

CELLPHONE NUMBER

BELOW FIELDS ARE OPTIONAL

ADDRESS

Address Line 1

Address Line 2

Postal Code

City

Province

TYPE OF ENQUIRY/FEEDBACK

I CONSENT TO MARKETING ACTIVITIES.

I CONSENT TO MARKETING ACTIVITIES.

I CONSENT TO THE COMMUNICATION TO THIRD PARTIES FOR MARKETING ACTIVITIES.

Submit

## 6. SUMMARY AND CONCLUSION

The internet enables businesses to collect customer information for personalization purposes, but customers believe that data collection instrument, most often a web-form, is insecure in its current design. Seventy one percent of the customers do not complete web forms and provide the needed information for e-commerce transactions. Privacy concerns, registration efforts, and the customer's belief that the communication will be intrusive are often used to explain customer's negative behaviours to engaging with the business online. This research proposes application of behavioural economics principles on a web-form.

It is essential for e-commerce businesses to engage in ways in which they are perceived to be preserving potential customers privacy rights and freedom while encouraging them to opt-in to OPBM. Unless online businesses employ nudges on web-forms, there will be little to no return on investment.

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## ANALYSIS OF NON-TECHNICAL INNOVATION, KNOWLEDGE PRODUCTION AND PROXIMITY THEORY IN THE SUCCESS OF TURKISH SERIES

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### ABSTRACT

For TV series exports, Turkey was in second place after the United States in 2018. Turkey's exports were 350 million \$ while it was only 10 million \$ in 2008 (AA, 2018).

In addition to factors such as content structure, type, star cast, high budget, creative and innovative perspective, the feedback provided by the audience through various network tools such as social media was also determinant in this success (García, 2016). Cultural, geographical, cognitive, and technological proximity types have been effective in the creation of information in this process where information dissemination is effective (Boschma, 2005). Especially in geographical proximity, it plays an important role in information sharing, transfer, and technological development (Huber, 2012) and the main point here is tacit knowledge (Gertler, 2003).

The TV series sector in Turkey brings the question of the effect of non-technical innovation to this success to the mind. In this study, different from previous studies, the role of non-technical innovation (marketing and organizational innovations) (OECD et al., 2006) in the success of Turkish TV series will be estimated within the framework of a probit model (Long & Freese, 2001) within the scope of knowledge production and proximity theories.

The dependent variable is a dummy indicating if the series is exported or not. The explanatory variables are IMDB score, type of series, a dummy for the director representing tacit knowledge, a dummy indicating the type of scenario, the distance between Turkey and the top importer representing the geographical proximity, and the number of influencer comments as an indicator of non-technical innovation.

The empirical results indicate that non-technical innovation, tacit knowledge, and product innovation increase the probability of export of a series while the distance has a negative impact.

### KEYWORDS

Geographic proximity, Non-technical innovation, Turkish Series, Tacit Knowledge

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## **Regular Session: RS13 - Spatial planning**

**13:15 - 14:30 Friday, 28th May, 2021**

**Room Marrakech**

**<https://us02web.zoom.us/j/82899500055>**

**Chair Jan Wolf**

## SMART SUSTAINABLE SATELLITE CITIES: THE DAISY FLOWER CONCEPT

Faisal Awadallah

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### ABSTRACT

This paper provides an overview of the alarming urban traffic congestions, which is an international phenomenon. It studies the effects of urban congestion on travel delay, air pollution, energy consumption, and general cost for government agencies and the individual traveler. In addition, to the effect of urban congestion on city development and general quality of life. The paper addresses various urban planning and transportation options to reduce motorized traffic congestion, particularly, reduction of the number and duration of vehicular trips in order to achieve a sustainable urban transport system. The paper analyzes the various environmental concerns that result from the various modes of transportation, especially during traffic congestion. It stresses the positive significance of walking, bicycling, and increasing the reliance on public transport, and making it more affordable and attractive for commuters. Smart cities are not particularly renowned for technological advancement. Viable technological advancement moves rapidly to all cities; however, a smart city is a sustainable, environmentally friendly and provides an overall good quality of life. Smart cities are mainly achieved through appropriate land use mixtures and appropriate transportation facilities that encourage walking and bicycling and limit usage of the private auto. An urban planning concept of a new satellite city is introduced using the "Daisy concept". In this concept, an urban satellite city is inspired from a daisy flower, where a flower's petals represent the mix land uses that provide for most daily activities of a household. The center of a daisy flower represents the satellite's city central business district, which is connected to the major urban center and major airport via commuter rail. The Daisy concept outlines conceptual plans for mixed land use clusters (petals) connected to the satellite city center. The residences within the clusters are within walking distance to employment offices, schools, light shopping, and recreation. The daisy concept emphasizes walking bicycling facilities particular sufficient width sidewalks, which include designed areas for walking and for bicycles. While the center of each residential 'petal' has employment offices and light commercial areas with wide sidewalks that also include street furniture, such as café' seating areas. In addition, at the daisy city center, it is pedestrian only streets with provisions for off-street parking along the circumferential road surrounding the core of the satellite city. Environmentally friendly trams that do not have overhead cable (having ground protected power lines) to avoid visual pollution are envisioned. Public transit policy and pricing would highly encourage usage, especially when coupled with providing sufficient parking spaces and drop-off and pick-up locations for employees coming from outside satellite city; in addition to parking regulations for residents that encourage auto sharing and renting and limit usage of private auto within the daisy city. Planning is a key issue in introducing smart cities, but policy, citizen awareness campaigns, regulations and enforcement are all essential in making smart cities functional and sustainable.

## SPATIAL EQUITY IN CONTEXT: PERCEPTIONS AND PREFERENCES IN THE PLANNING OF PRIMARY SCHOOLS

**[Ian Wolf](#), [João Lourenço Marques](#), [Fillipe Feitosa](#)**

Research Unit on Governance, Competitiveness and Public Policies (GOVCOPP) of the University of Aveiro, Portugal

### ABSTRACT

Equity has long been considered and overarching policy goal in spatial planning, where it expresses the idea of justice in the management of property rights, the distribution of public resources or the location of spatial amenities and disamenities. While there is a broad consensus regarding the importance of equity in planning decisions, there are multiple challenges in defining its meaning in practice. These challenges are, partly, conceptual and regard the principles that best express a broad idea of justice, their formulation, or how to prioritize them when they conflict, leading to an extensive debate in the literature (where authors such as Rawls or Amartya Sen stand out). But even if assuming a given set of principles, this does not automatically provide a clear way for assessing the justice of planning decisions, which tend to be the outcome of broad compromises between policy goals and interests, and reflect practical considerations, which are very dependent on the specific policy and context. There are, therefore, no simple answers to questions such as: What criteria best express equity in a given planning decision? How to consider, and weight, different groups' advantages or disadvantages? What are the relevant thresholds for considering a state-of-affair equitable or inequitable? This stresses the relevance of discussing spatial equity in real planning contexts and the importance of taking into account the conceptions and preferences of local stakeholders and decision-makers. This work contributes to this discussion by analyzing principles of spatial equity in the accessibility to primary schools at the local scale. For this, first, a conceptual discussion of principles of justice and the way they can be applied to inequalities in the accessibility to spatial services was made. Second, a questionnaire was applied to territorial agents involved in a school planning exercise in a municipality in Portugal. This allowed to assess: what these agents consider to be the most relevant policy goals for the spatial planning of primary schools; what is the relative importance of spatial equity compared to other policy goals; what specific principles best express equity in the spatial distribution of primary schools. Third, an exploratory digital tool was applied to evaluate the agents' preferences regarding the balance between accessibility and costs – how are cost-minimizing and accessibility-maximizing solutions ranked in a pair-wise comparison.

## **Regular Session: RS01.3 - Entrepreneurship**

**13:15 - 14:30 Friday, 28th May, 2021**

**Room Agadir**

**<https://us02web.zoom.us/j/81254577425>**

**Chair Sebastien Bourdin**

## DO REGIONAL ENTREPRENEURIAL ECOSYSTEMS ALWAYS CONTRIBUTE TO REGIONAL ECONOMIC PERFORMANCE?

Sebastien Bourdin

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### ABSTRACT

In a recent body of the entrepreneurship literature, an attention is paid to the role of entrepreneurial ecosystems (EEs) and their contribution to relevant economic outcomes (Stenholm et al., 2013; Lafuente et al., 2018 ; Szerb et al., 2019 ; Lafuente et al., 2020). Rather than using standard entrepreneurship metrics, these studies point to the need to analyze the entrepreneurial context. The premises of these works can be found in the paper of Gnyawali and Fogel, who defined the dimensions of the entrepreneurial context as early as 1994. It includes socio-economic factors, the entrepreneurial and commercial skills of the project promoters, the level of financial assistance, and institutional and governmental policies and procedures (Bonnet et al., 2005).

However, research at national level appears insufficient at present, and the benefits of entrepreneurship can be better captured at sub-national level (Acs and Armington, 2004). Several researchers, such as Audretsch and Keilbach (2005) analysing the German regions or Sterlacchini (2006) for European regions, showed that differences in growth trajectories can be explained by different levels of business creation. We go further than previous research, however, as instead of directly using "new business creation" as an explanatory variable to explain spatially differentiated regional levels of economic performance, we use EEs. Thus, our research questions seek to understand the links between EEs and regional economic performance. We also examine whether there is spatial heterogeneity in these links since recent work suggests that the optimal level of entrepreneurship is heterogeneous across territories and that entrepreneurship rates are not always linked to economic performance (Prieger et al., 2016; Lafuente et al., 2018 and 2020).

We measure EE quality using the REDI developed by Ács et al. (2017), which, from this standpoint, is a crucial indicator of regional economies in the sense that opportunity entrepreneurship stimulates regional economic performance (Shane, 2012, Szerb et al., 2019).

We therefore consider the REDI from an econometric approach that links regional economic outcome with EEs. We propose a local variation of the 'classic' spatial econometric models by adopting a 'local' one, in other words, a geographically weighted regression (GWR) in order to examine the issue of non-stationarity of regional development. This is particularly relevant as EEs are defined as unique (Acs et al., 2017; Szerb et al., 2019) and are thus likely to have different effects on regional economic performance.

The originality of our contribution is threefold. It consists of (i) analyzing to what extent there is heterogeneity in the influence of entrepreneurship on economic performance at a regional level, (ii) assessing the spatial dimension of this non-linearity of effects, and (iii) taking EEs – rather than the traditional new start-up rate – into consideration as an explanatory factor for regional economic performance. It is also original in that it is conducted across all regions of the EU and examines whether the choices made by the European Commission via The Entrepreneurship 2020 Action Plan are likely to generate the effects expected by the Cohesion Policy guidelines for 2014-2020 and after.

## INTERNAL REGIONAL COMPETITIVENESS: LOMBARDY, A MULTI-SPEED REGION?

[Federico Fantechi](#), [Ugo Fratesi](#)

Department ABC - Architecture, Built environment and Construction engineering - Politecnico di Milano, Italy

### ABSTRACT

The paper analyses regional competitiveness at sub-regional level through a novel methodology which adopts a matching design. By using firms-level data for Lombardy, a large and competitive European region, the analysis shows that the different territories of the region are differently competitive in different industries, and that static and dynamic analysis provide different results. A cumulative effect is shown to exist, by which firms located in the metropolitan area of Milan are more competitive and increasingly as such in time. Additionally, important differences also arise between the other provinces and, in most cases, cumulative effects are present also among them, with more positive dynamics arising in places where specialisation and static competitiveness are high. The differences between territories, and the centripetal effects, are also evident when the analysis is performed by adopting a territorial classification based the National Strategy for Inner Areas and on the degree of urbanization. These results are especially relevant to the design of Smart Specialisation Strategies, because they show, on one hand, that Nuts2 regions may be strongly dis-homogeneous inside and, on the other, that cumulative processes may leave territories behind inside the regions.

**THE RESILIENCE OF THE CULTURAL AND CREATIVE INDUSTRIES IN ITALY IN THE FACE OF THE GREAT RECESSION: A GEOGRAPHICAL EXPLORATION**

**Maria Giovanna Brandano, Giulia Urso**

Gran Sasso Science Institute, Italy

**ABSTRACT**

The cultural and creative industries (CCIs) have been subject to increasing policy and academic attention in the past years. The sector has been seen variously as a stimulus for urban regeneration and, more broadly, for local and regional development. Very interestingly, in U.K. and other EU countries, the cultural economy has been one of the few sectors that has weathered the storm of the 2008 Great Recession.

Starting from the curiosity that these premises arise and from the paucity of studies to date on the Italian CCIs, we analyze the resilience of the sector in the face of the economic-financial shock in order to ascertain whether this was the case also in Italy and whether the reaction to the disturbance shows spatial patterns. To this end, we use data from Aida-Bureau van Dijk database on more than 181,000 enterprises observed for the time span 2010-2018. The number of employees as well as the number of CCIs enterprises are gathered for 18 Nace Rev.2 sectors, in order to better disentangle the contribution of each sub-sector to the growth of the industry. Information is available at firm level, but to the purpose of this paper it is used at provincial (NUTS-3) level. Using a System Generalized Method of Moments (GMM-SYS) approach, and after controlling for socioeconomic characteristics, the determinants of the CCIs growth are analyzed.

We ultimately contribute to the still under-researched debate on the role of CCIs in regional economic resilience proposing some reflections also on their ability to reactivate more rural regions, hence usefully informing policies.

## EU MACRO-REGIONAL STRATEGIES AND THE SMART SPECIALISATION STRATEGY: SYNERGIES

Donato Iacobucci, Roberta Ruggeri

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### ABSTRACT

The aim of this paper is to provide a first assessment of the potential synergies and actual integration between the EU macro-regional strategies and the Smart Specialization Strategy (S3). S3 was a major novelty for the allocation of cohesion funds in the 2014-2020 programming period; It required countries and regions to identify key areas where public and private investment in R&D and innovation should be focussed. Macro-regional strategies emerged during the last decade as a way of addressing common challenges faced by defined geographical areas, including EU members and third countries to strengthening cooperation and contributing to achieving economic, social and territorial cohesion. This paper analyses the overlapping and synergies between S3 and EU Strategy for the Adriatic and Ionian Region (EUSAIR) in the 2014-2020 programming period and discusses the problems that emerged for effective integration between the two strategies.

### Short introduction

S3 has started before the establishment of the Macro-regional strategies and before the adoption of Agenda 2030. The EUSAIR, as well as the other 3 existing strategies (Baltic Sea Region, Danube Region, Alpine Region), emerged as a way of addressing common challenges faced by defined geographical areas, including EU members and third countries to strengthening cooperation and contributing to achieve economic, social and territorial cohesion. At the crossroads of innovation policy and regional development, S3 has become a guiding concept to make Europe more cohesive and, at the same time, to foster regions' competitiveness. It has been adopted by some 180 national and regional institutions within the EU as well as candidate countries and regions. It will remain at the basis of national and regional innovation policy in the new programming period.

In the post-covid-19 crisis and the challenges brought about by the digital and green revolution, it would be important to capitalise on the synergies between the two main pillars of the EU regional development strategy. Exploiting the potential synergies between these two strategies may foster inter-regional cooperation while contributing to sustainable regional growth and economic and social cohesion.

This paper will review the past achievement as well as the challenges and opportunities that are arising in the new programming period (2021-2027).

## **Special Session: SS17.2 - Data science, machine learning and big data for regional Sciences**

**13:15 - 14:30 Friday, 28th May, 2021**

**Room Fes**

**<https://us02web.zoom.us/j/86828580970>**

**Chair Jean-Claude Thill**

## BUILDING A SPATIAL LAKEHOUSE SYSTEM OPTIMIZED FOR MOBILITY DATA

[Soukaina Ait Errami](#)<sup>1</sup>, [Hicham Hajji](#)<sup>1</sup>, [Kenza Ait El Kadi](#)<sup>1</sup>, [Hassan Badir](#)<sup>2</sup>

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### ABSTRACT

With the exponential growth of location-related data, building systems that support these types of data presented a real potential to gain richer insights. Data Warehouses presented earlier the pillar of the decision support system. Thus, their spatial extension helped integrating the spatial dimension in the decision building process. However, with the emergence of Big Data, spatial data start also being produced at huge rates especially with the expansion of IoT and GPS tracking devices. The Spatial Data Warehouses showed several limitations such as the inability to support streams of IoT data and lack of scalability. Data Lakes emerged as a new technology trying to address the scalability issues and lack of flexibility related to Data Warehouses. They are defined as a repository containing data of any type and any structure. The flexibility and cost-effectiveness of data lakes were the principal reasons behind its propagation in the decision support landscape. Data Lakes presented a suitable environment for the complex queries and heavy storage of the Spatial Big data such as the storage and analytics of mobility data. Data Lakes give access to practically unlimited storage and support applying distributed analytics and advanced analytics and machine learning. However, they also showed some consistency issues. The next step, in the data architecture maturing, was the Data Lakehouse systems. The Data Lakehouse systems have the benefits of both systems; Data Warehouses and Data Lakes. The Data Lakehouse's goal is to unify all the enterprise's data workloads in the same platform. They are based on a table format storage layer implementing governance and ACID properties on top of a Data Lake. The Data Lakehouse is a combination of governed and reliable Data Warehouses and flexible, scalable, and cost-effective Data Lakes. As the location-related data is frequently an object of regulation rules, the Data Lakehouse is more compliant than the previously mentioned systems. The existing works didn't address the Spatial Big Data requirements within the Data Lakehouse. In our paper, we are going to address this aspect by presenting the different components and best practices for building a Data Lakehouse architecture optimized for the storage and computing of Spatial Big Data. The paper goes through the successive components of the Data Lakehouse and details the methods of adapting this component with the Spatial Big Data requirements going from ingestion to advanced analytics and visualization using the most suitable open-source systems for each step on the pipeline.

## EXPLORING NEW DEEP LEARNING ARCHITECTURES FOR BUILDING FOOTPRINT EXTRACTION

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### ABSTRACT

Mapping the building footprints can play a crucial role in urban dynamics monitoring, disaster management and transportation planning. Available free building footprints, like OpenStreetMap, provide manually annotated building footprint information for some urban areas, however, most frequently it doesn't cover entirely urban areas in many parts of the world and is not always available. Therefore, high-resolution Remote Sensing imagery, with a huge potential for meaningful ground information extraction, can be considered as an alternative and a reliable source of data for building footprint generation.

Therefore, the aim of the study is to explore the use of satellite imagery data and some of the state-of-the-art deep learning tools to fully automate building footprint extraction. To better understand the usability and generalization ability of those approaches, this study proposes a comparative analysis of the performances and characteristics of one of most recent deep learning models such as Attention-Unet for building footprint generation.

## DELINEATING FINE-SCALE URBAN FUNCTIONAL USE FROM POINTS OF INTEREST DATA WITH NEURAL NETWORK MODEL

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### ABSTRACT

Urban function has been studied in both urban planning and geographic information science for decades. Understanding urban functional use not only provides a geospatial feature for urban modelling but also helps to detect urban problems, evaluate planning strategies and support policy-making especially in highly urbanised and densely populated metropolitan areas (Batty, 2012; Arsanjani et al., 2013). Different from the traditional studies focusing on physical environment with remote sensing data such as land use classification and land use boundary detection, studies now focus on socio-economic characteristics of land/building functional use with detailed and fine-scaled crowdsourced data, i.e. social media data, points of interests and other open-source and volunteered datasets (Crooks et al., 2015; Frias-Martinez and Frias-Martinez, 2014; Zhi et al., 2016). Among these sources, points of interest (POIs) are popularly applied in understanding urban functional use (Niu and Silva, 2019). POIs refer to point-based locations such as commercial property, public spaces, transportation facilities, etc. associated with detail including location, name, postcode, address, and so on. The distribution of POIs and combination between POIs varies in different urban areas. This variation reflects the preference of urban activities and indicates the pattern of urban functional use at a larger scale. Moreover, POIs are highly disaggregated data with precise location and can be applied at a variety of scales. However, previous work neither frequency-based approach nor neural word embedding such as Word2Vec considered the spatial relationship between POIs in the context of the first law of geography. In this paper, we recognised the capabilities of neural word embedding in delineating urban functional use from POIs and introduce neural network model (Doc2Vec) with sentence/paragraph feature input in the context of geographic space. This paper chooses the metropolitan area of London as the study area. This paper employs POIs from Ordnance Survey, which is the national mapping services in for Great Britain. This taxonomy is three levels, including nine groups and 52 categories and 582 classes. For each item in this POI dataset, it contains information such as Identified code, name, coordinates, address, postcode, telephone number, brand, and so on. Specifically, the dataset used in this case study is updated in March 2019 with 420,559 POIs throughout the London metropolitan area. Since this paper recognised the advantage of Doc2Vec model in term of presenting the relationship between POI categories with considering the spatial heterogeneity, we apply the model to POIs data by conducting nearest neighbour query of POIs based on London road network (40,000 random points), POIs sequences construction with local tags, vectorisation for POI categories by cosine distance, evaluation of Doc2Vec and clustering urban functional areas with K-means. The contribution of this paper is to introduce a new data source and a new tool for understanding the dynamics of urban functional use from bottom-up and provide a tool to predict and monitor the impact of urban dynamics.

## **Special Session: SS09 - Regional, national and supranational identities: determinants and policy implications**

**13:15 - 14:30 Friday, 28th May, 2021**

**Room Essaouira**

**<https://us02web.zoom.us/j/89457821343>**

**Chair Giovanni Perucca**

**PERCEPTION OF THE EU BY TURKISH CITIZENS: INDIVIDUAL CHARACTERISTICS AND LOCAL ECONOMIC PROSPECTS**

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**ABSTRACT**

This study investigates the individual and local determinants of the EU support in a candidate country. The main objective is to focus on the uneven economic development trajectories of Turkish regions and to question whether local economic conditions have influence on the individual level of support to the EU. Controlling for a host of individual characteristics, our results show that regional differences in per capita income, unemployment and employment rate matters. Those regions with lower income and worse labor market outcomes have higher EU support. These results are robust in static and dynamic sense, suggesting that the current economic conditions and the evolution of long-run regional declines both shape the regional discontent in Turkey. Our prior knowledge from the developed EU countries validate that left behind places create the so-called discontent by opposing to integration and globalization. However, our results from a developing country show that disadvantageous left behind places demand for a change of the status-quo. In the Turkish case, observed discontent acts as a major motive to support the EU integration at the regional level.

## PROTESTS ACROSS LATIN AMERICA: ARE URBAN AND RURAL AREAS DIFFERENT?

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### ABSTRACT

The emerging literature on social discontent argues that left behind areas are more likely to vote for anti-system parties, with unemployment, education, wealth, and age playing a significant role. Latin America, however, is a special case. In the region, the rise of the middle class followed the growth of commodities' prices and international liquidity. The new middle class, largely located in urban areas, is generally fragile since part of it is unable to meet class transitions towards higher education levels or better job conditions, largely benefitting from public social programmes. With the end of the commodity boom and the contraction of the public spending, the mobilizations occurred essentially across this class. The aim of our paper is to i) examine if the share of people protesting varies across rural and urban areas and ii) which are the drivers of these protests. To reach this aim, we employ survey data for 2019 Latin American Public Opinion Project. Our preliminary results show that there are some shared factors affecting the probability to protest in urban and rural areas. Among these, we find that rising income, interest in politics, crime and internet use increase the probability of participating into protests. On the other hand, we also find evidence of drivers that differ between urban and rural areas. In the former, education, trust in public institutions, the intention to emigrate and the perception that government should implement strong policies to reduce income inequality motivate protests, while decreasing income is a driver only in the rural areas. These results may be useful to set appropriate policies to mitigate the rising discontent in the region.

### KEYWORDS

Urban, rural, protests, Latin America

### 1. INTRODUCTION

The year 2019 has been called by some *the year of social discontent* due to the spread protests across the world. While for some it can be difficult to point out to a generalized explanation (Rachman, 2019), the UNDP (2019), has argued that there is a connecting thread: inequality. Inequality beyond traditional measures, and inequality beyond the economic realm.

The emerging literature on social discontent argues that discontent encompasses behaviour against the status quo caused by high territorial disparities between those regions left behind and those that prosper. One way this has been studied is through voting behaviour (Rodríguez-Pose, 2018) and its drivers (Dijkstra et al. 2020), as well as by exploring how different inequality measures at different geographical units of analysis might explain social discontent (McCann, 2020). According to these authors, left behind regions are more likely to vote for anti-system parties, with unemployment, education, wealth, and age playing a significant role.

Despite high levels of inequality is a common cause of discontent in Europe and in Latin America, it is worth noting that, in the former it appears as comparatively recent phenomenon. Indeed, the term *declining* places highlights that they were once economically dynamic and prosperous territories, now left behind (Rodríguez-Pose, 2018). On the other hand, high inequality is a long-dated feature of Latin America (Williamson, 2015), and data shows that despite it has been significantly reduced, its levels are still unacceptable.

In Latin America, between 2003 and 2013, the rapidly rising price of commodities (Gruss, 2014) and international liquidity contributed to the rise of the middle class in the region, which nearly doubled in size between 2002 and 2014, representing one third of the population by the end 2014. This new middle class is, however, fragile since part of it was unable to meet class transitions towards higher education levels or better job conditions (Ferreira et al., 2013). Moreover, the greatest part of people who moved out of poverty, jumped into the economically vulnerable group with considerable risk of going back into it (Ferreira et al., 2013). As noted by Biekart (2015), since this group has been largely benefited from public social programmes, it becomes the most demanding and pressing for governments. As a result, since the end of the commodity boom, the mobilizations across the region have been essentially led by the middle class.

This growth of middle class occurs in urban areas (Stampini et al., 2016), where, 81 percent of Latin America's population is living (UN-DESA, 2019). According to Ferreyra and Roberts (2018), on average, 7.16 percent of household heads age 25–35 years have migrated within their countries in the period 2009–2014. Of them, the most skilled are likely to migrate to large urban areas than to medium or small urban areas (except in Ecuador, El Salvador, and Paraguay), where there are higher education returns. This might be the reason why, according to Vakis et al. (2016), urbanized areas are also characterized by a lower share of poverty. Indeed, poverty incidence has historically been higher in rural areas; however, in the past decade it has increased relatively more in urban areas, marking important inequalities not only between urban

and rural areas, but also within urban territories (CEPAL, 2019). Cities in Latin America, indeed, are known to be divided, unequal, and spatially and socially segregated (CEPAL, 2014; UN-HABITAT, 2012). In this context, the analysis of political discontent cannot prescind from the geographical component.

Thus, in this paper, we want, first, to understand if there is a systematic difference between the share of people participating to protests across urban and rural areas and, second, to explore what are the main factors affecting the probability of taking part to protests. To achieve this aim we will use data from Latin American Public Opinion Project (LAPOP) for year 2019.

The paper is organized as followed: in the next section methodology and variables are presented, in the third the main results are discussed and the last section concludes.

## 2. MODEL AND VARIABLES

Since our dataset includes observations at the individual level nested at the country level, we employ a multilevel model to account for country-level variance. The model is as follows:

$$Protest_{i,j} = \mathbf{X}\beta_{i,j} + \gamma_j + \varepsilon_{i,j}, \quad (1)$$

where  $i$  denotes the individual observation and  $j$  the country.  $Protest_{i,j}$  is a dummy variable taking value 1 if the respondent took part to a street protest, 0 otherwise;  $\mathbf{X}$  is a vector of individual characteristics;  $\gamma_j$  is the random intercept representing level 2 (nation-specific) residuals.  $\varepsilon_{i,j}$  are level 1 (individual-specific) residuals. These are assumed to be mutually independent and normally distributed with zero mean and variance equal to  $\sigma^2$ . Level 2 residuals are assumed to be uncorrelated with  $\varepsilon_{i,j}$ , mutually independent, and normally distributed with zero mean and variance equal to  $\tau^2$ .  $\varepsilon_{i,j}$  residuals represent the unexplained variability of the individual discontent after considering measurable individual characteristics clustering, whereas  $\gamma_j$  residuals represent unexplained heterogeneity at the national level.

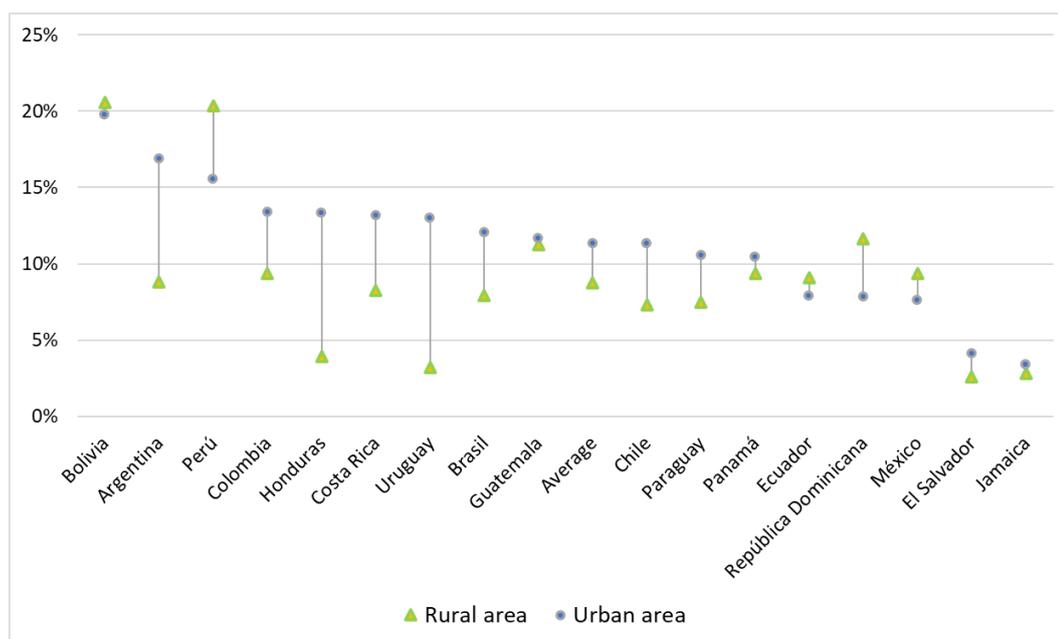
In particular, in vector  $\mathbf{X}$  we have the following variables:

- Sex, age, number of children, education, and ethnicity that identify personal characteristics of the respondents. We do not have a priori expectations for the first three variables, while we could guess that a better education could lead to take part to protests as it may express higher discontent, as shown by Rodríguez-Pose et al. (2019), among others. Regarding ethnicity, where mestizos is taken as a reference category, we expect that in particular being an indigenous would trigger a higher probability to participate to protests.
- A set of variables related to trust in institutions are the following: trust president, trust media, trust supreme court justice, trust in elections, trust parliament, trust peaceful demonstrations. We expect that all of them with expect for the latter have a negative effect on the participation to protests.
- Three variables regard ideology/perspectives: interest in politics, which is expected to play a positive role together with the intention to emigrate, and the fact of thinking that the government is implementing policies against inequality, which we expect a negative effect on the likelihood of participating to protests.
- Another set of factors regards economic and social characteristics: income, the expected trend of the household income in the next 2 years (improving, worsening or remaining stable, taken as a reference), as the fact of having experienced a violent crime in the last year, expected to increase the probability of protesting, and the fact of having internet in the house, which can be seen as a tool for getting information otherwise not available from standard media.

Finally, the same regression models are run for the whole sample of 19,962 observations, and separately for the 14,915 respondents belonging to urban areas, and for the 5,047 living in rural areas.

## 3. RESULTS

Figure 1 shows a first overview of the phenomena, with the share of people taking part to protests being systematically higher in urban areas in all countries, except for few exceptions. This empirical regularity is confirmed by the Pearson's Chi-squared test with Yates' continuity correction, whose p-values  $< 0.01$  ( $X^2 = 27.064$ ) reports that there is a statistically significant difference in the probability of taking part to protests between urban and rural areas, when the full sample is examined.



**Figure 1: Share of people taking part to protests in 2019 by area**

In Table 1, the Chow test for parameters instability confirms that they are systematically different between urban and rural area. However, some variables have common sign and significance. In particular, rising income, being of indigenous ethnicity, having an interest in politics, being victim of a crime and having access to the internet at home increases the probability of participating in protests to an equal extent in urban and rural areas. On the contrary, trust in media and in the president decrease the likelihood of protesting.

Other factors affecting the probability to protest have different effects in urban and rural areas. What motivates protests in urban but not in rural areas is education, trust in public institutions, the intention to emigrate and the perception that the government should implement strong policies to reduce income inequality. Decreasing income, on the other hand, is a driver only in the rural areas, but not in urban areas.

**Table 1: estimation results**

	Whole sample	Urban areas	Rural areas
Intercept	-0.0290 (0.0171) *	-0.0440 (0.0197) **	0.0136 (0.0296)
Female sex	0.0012 (0.0043)	0.0014 (0.0050)	0.0027 (0.0080)
age	0.0002 (0.0001) *	0.0002 (0.0002)	0.0005 (0.0003)
education	0.0032 (0.0006) ***	0.0042 (0.0007) ***	0.0003 (0.0012)
Number of children	-0.0001 (0.0017) *	-0.0005 (0.0021)	0.0026 (0.0031)
Ethnicity: white	-0.0107 (0.0055) *	-0.0153 (0.0064) **	0.0016 (0.0110)
Ethnicity: Indígenas	0.0592 (0.0084) ***	0.0454 (0.0109) ***	0.0753 (0.0133) ***
Ethnicity: Black	0.0144 (0.0096)	0.0198 (0.0112) *	-0.0189 (0.0174)
Ethnicity: Mulata	0.0001 (0.0103)	0.0042 (0.0119)	-0.0216 (0.0197)
Ethnicity: other	0.0086 (0.0106)	0.0065 (0.0126)	0.0087 (0.0190)
income	-0.0006 (0.0005)	-0.0008 (0.0006)	-0.0002 (0.0008)
trend household income in next 2 years: improves	0.0191 (0.0054) ***	0.0164 (0.0062) ***	0.0260 (0.0107) **
trend household income in next 2 years: worsens	0.0088 (0.0050)	0.0057 (0.0059)	0.0177 (0.0091) *
violent crime 12 months: yes	0.0425 (0.0048) ***	0.0411 (0.0055) ***	0.0486 (0.0103) ***
Internet in your house: yes	0.0147 (0.0048) ***	0.0137 (0.0056) **	0.0164 (0.0097) *

	Whole sample	Urban areas	Rural areas
interest in politics: a lot	0.1501 (0.0069) ***	0.1688 (0.0081) ***	0.0814 (0.0134) ***
interest in politics: something	0.0521 (0.0060) ***	0.0529 (0.0070) ***	0.0523 (0.0115) ***
interest in politics: little	0.0316 (0.0053) ***	0.0345 (0.0063) ***	0.0209 (0.0097) **
Emigration intention: yes	0.0227 (0.0049) ***	0.0243 (0.0058) ***	0.0154 (0.0095)
You think gov. implemented policies against inequality	0.0021 (0.0012) *	0.0037 (0.0015) **	-0.0024 (0.0023)
Trust president	-0.0071 (0.0013) ***	-0.0081 (0.0016) ***	-0.0038 (0.0025)
Trust media	-0.0096 (0.0013) ***	-0.0102 (0.0015) ***	-0.0058 (0.0025) **
Trust supreme court justice	0.0034 (0.0016) **	0.0034 (0.0019) *	0.0026 (0.0030)
Trust elections	0.0001 (0.0014)	-0.0003 (0.0017)	0.0003 (0.0026)
Trust parliament	-0.0011 (0.0016)	-0.0005 (0.0019)	-0.0034 (0.0028)
Trust peaceful demonstrations	0.0092 (0.0008) ***	0.0098 (0.0009) ***	0.0065 (0.0016) ***
<b>Random Effects</b>			
$\sigma^2$	0.09	0.09	0.08
$\tau_{00}$	0.00 pais	0.00 pais	0.00 pais
ICC	0.02	0.02	0.02
N	17 pais	17 pais	17 pais
Observations	19,962	14,915	5,047
Marginal R <sup>2</sup> / Conditional R <sup>2</sup>	0.063 / 0.077	0.074 / 0.089	0.036 / 0.053
AIC	7557.668	6074.262	1426.937
Chow test parameter instability (p-val.)	112.4691 ( $<0.01$ )		

Note: \* p<0.05 \*\* p<0.01 \*\*\* p<0.001.

#### 4. CONCLUSIONS

Results show that significant differences in the share of people taking part to protests exists between urban and rural areas in Latin America. In particular, the share of people participating to protests is higher in urban than in rural areas. Some variables contribute to explain the likelihood of participating to protests in both areas, while other are peculiar of urban or rural places.

In light of the results, policies aimed at strengthening middle class in urban areas are needed, improving the match between education levels and improved job conditions, improving institutional quality fighting inequality. Furthermore, place-based policies with the aim to avoid migration from urban areas should be implemented. In doing this, particular attention has to be put on the role of expectations, rather than actual levels of income, given that bad economic outlooks are strongly associated to the likelihood of taking part to protests.

Finally, what is needed, especially in light of the recent Covid-19 pandemic and of its social consequences is a strong institutional foresight capacity aiming at improving trust and expected living conditions.

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## APPENDIX A

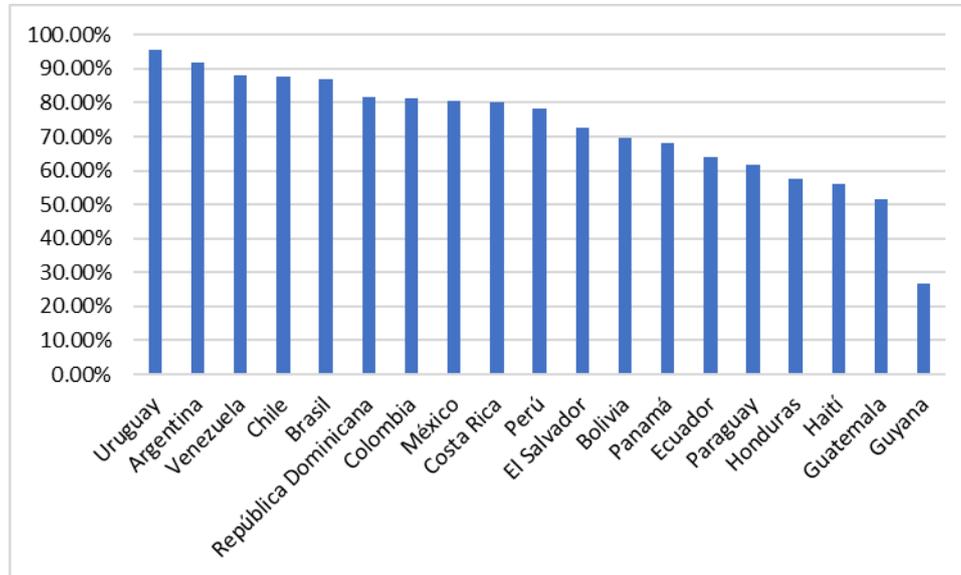


Figure A1: Share of people living in urban areas in 2019

## THE URBAN-RURAL POLARISATION OF POLITICAL DISENCHANTMENT: AN INVESTIGATION INTO SOCIAL AND POLITICAL ATTITUDES IN 30 EUROPEAN COUNTRIES

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### ABSTRACT

Despite the prevalent focus upon increasing political divisions between urban and rural Europe, relatively little research has explored whether there is a systemic urban-rural divide in the political and socioeconomic attitudes of citizens across the entire continent. This paper aims to fill this gap. Drawing on individual-level data from the European Social Survey, it explores potential linkages between place of residence and individual attitudes. Our results show that there are strong, and statistically significant, differences between the populations in these different settings. On average, rural dwellers show stronger levels of dissatisfaction with democracy and lower trust in the political system. Yet, while we uncover stark differences in attitudes towards migration and globalisation, we do not find significant variation on some social and economic issues traditionally at the core of left-right cleavages. And our analysis suggests that this spatial divide does not operate in a binary fashion. It is more of a continuum, running on a gradient from inner cities to metropolitan suburbs, towns, and the countryside. The differences are explained by both composition and contextual effects, and underscore the importance of moving beyond 'standard' trade-offs between so-called 'people-based' versus 'place-based' policy approaches to territorial inequality.

### Keywords

Urban-rural divide; regional inequality; geography of discontent; Europe.

### 1. INTRODUCTION

While, for much of the Twentieth Century, political scientists tended to assume that political cleavages in western democracies revolved around differences in class position and attitudes towards distributional questions and the role of the state, in recent decades there has been a growing emphasis on those associated with various kinds of group identity, and, latterly, with the importance of place (Glaeser and Ward 2006; Kenny 2014; Kriesi 2010). In the US, a large body of work has documented how political differences are increasingly driven by a distinctive – and deepening – geographical cleavage, with almost all large cities being Democratic strongholds and rural counties being a cornerstone for the Republicans (Gimpel and Hui 2015; McKee 2008; Monnat and Brown 2017; Morrill, Knopp, and Brown 2007; Scala and Johnson 2017; Tam Cho, Gimpel, and Hui 2013).

Across Europe too, notable recent political events, such as the UK 2016 Brexit vote, and the 2018 *Gilet Jaunes* protests in France have shed light on marked political divergences between urban and rural places. Yet, despite growing evidence from individual countries such as the UK (Becker, Fetzer, and Novy 2017; Carreras, Irepoglu Carreras, and Bowler 2019; Garretsen et al. 2018; Goodwin and Heath 2016; Jennings and Stoker 2016; Lee, Morris, and Kemeny 2018; MacLeod and Jones 2018), France (Eribon 2013; Guilluy 2016; Ivaldi and Gombin 2015) and Italy (Agnew and Shin 2017, 2020; Rossi 2018), relatively little research has explored in a systematic way whether the growing political divide between urban and rural areas mapped in some countries is apparent across the whole continent. Indeed, given the prevalent focus upon Anglo-American comparisons within the Anglophone literature, there is a pressing need to consider whether the same phenomena are discernible across Europe.

The current paper aims to fill this gap. Drawing on individual-level data from the European Social Survey (ESS), it provides systematic comparative evidence across 30 European countries over the period 2002-2018. We explore links between place of residence and attitudes on a range of different socioeconomic and political issues. To anticipate our conclusion, we find that there is a strong and significant divide between the political outlooks of urban and rural Europe. But this divergence is not best seen in binary terms, and is better understood as a gradient running from inner cities to metropolitan suburbs, towns, and the countryside (as anticipated by Scala and Johnson, 2017). We show how, compared to dwellers in inner urban cores, respondents living in suburbs, towns and rural areas are more likely to be conservative in their orientation, dissatisfied with the functioning of democracy in their country, and less likely to trust the political system, even though they are – strikingly -- more likely to participate in it, especially by voting. However, while our analysis highlights some stark geographical variances in attitudes towards migration and globalisation, we do not find significant variation on issues which have traditionally been at the core of left-right cleavages, such as support for welfare state redistribution. And, finally, we show that these differences are explained by compositional *and* contextual effects.

This article contributes to the growing literatures in the neighbouring disciplinary fields of geography and political science devoted to the spatial dimensions of political disenchantment in three distinctive ways. First, in line with a growing emphasis in much social scientific research on a widening ‘cosmopolitan-nationalist’ polarization, we show how differences associated with the urban/rural continuum are significant across a range of attitudinal dimensions. Most recent studies of the ‘geography of discontent’ (McCann 2019; Rodríguez-Pose 2018) consider the evidence supplied by voting patterns in elections and referendums. Yet, such events may well be linked to candidate-related factors and contingent political developments, and may relate only indirectly to underlying shifts in popular attitudes (Abrams and Fiorina 2012; Ford and Jennings 2019). In fact, many political scientists suggest that electoral campaigns do not change public opinion that much but, rather, ‘activate’ some considerations over others (Mutz 2018), increasing the extent to which particular issues matter for voters when they choose a candidate. It is, therefore, important to understand in more depth the factors explaining the underlying dynamics of public opinion. We seek to address this challenge using attitudinal data, and our findings suggest that the linkage between place of residence and political attitudes is not confined to attitudes towards iconic and contentious questions such as the EU (Dijkstra, Poelman, and Rodríguez-Pose 2019) or migration (Maxwell 2019). Instead, we conclude, it encompasses a wider range of political and socioeconomic issues including perceptions of political behaviour and trust in political institutions. There are intimations in these results, we suggest, of distinct worldviews that are manifested by spatially segmented parts of the population of many developed democracies.

Second, in line with the work of Scala & Johnson (2017) on the US, we show that the geographical divide in European political attitudes should not be thought of as a dichotomy between urban and rural places – as suggested for instance by Cramer (2016) in relation to the US – but conceived instead as a gradient. This finding is in line with some recent analyses which underline the importance of inequalities within urban places (Baum-Snow, Freedman, and Pavan 2018) and suggest that, as a result, residential segregation between inner urban areas and suburbs is on the rise across many European cities (Musterd et al. 2017). We point to the merits of applying a more finely grained geographical lens to the contemporary urban-rural divide in Europe, arguing in particular for more nuanced, place-sensitive typologies.

Third, we provide a preliminary analysis of the factors that may be most significant in explaining the differences along the urban/rural continuum. In his analysis of attitudes to immigration, Maxwell (2019) argues that differences between urban and rural areas are more strongly driven by sociodemographic characteristics – that is, by compositional effects and the geographical sorting of people with different attributes and outlooks – than by the influence of place of residence over individual outlooks. In contrast, we underline how attitudes vary across sociodemographic *and* geographical dimensions. We show that while people’s attitudes are heavily stratified by key individual observable characteristics, such as age, education, and occupational status, there is a non-negligible correlation between places and their inhabitants’ attitudes towards various political and social issues (Agnew 1987). This conclusion has important implications for the ongoing debate about what kinds of policy solutions are best equipped to address growing territorial inequalities, and whether these should be place-sensitive or not (cf. Barca, McCann, & Rodríguez-Pose, 2012; Crescenzi & Giua, 2019; Iammarino, Rodríguez-Pose, & Storper, 2019).

Further research, we suggest, is needed to disentangle potential compositional effects based on unobservable – rather than observable – characteristics such as intrinsic ‘cognitive underpinnings’ (cf., for example, Lee et al., 2018; Zmigrod, Rentfrow, & Robbins, 2018). And analysts should also explore in more depth the mechanisms through which the kinds of setting in which people live can influence the development of individual traits, especially during early-age socialisation (Bosquet and Overman 2019; Hackman and Farah 2009; Rentfrow, Gosling, and Potter 2008). Yet, irrespective of whether divides in attitudes are driven by compositional effects or by the contextual influence of places on people, marked demographic sorting and the overlapping of territorial and attitudinal cleavages signal a deepening geographical fracture in European societies which, in the long term, may have significant implications for the challenges of generating social cohesion (Wilkinson 2018) and addressing the implications of rising disenchantment with democracy (Foa et al. 2020). The paper is structured as follows. Section two reviews the existing literature on the urban-rural polarisation, and develops our main, empirical hypotheses. Section three describes the data and the analytical strategy that we have employed. We then present the key results in section four, and discuss the implications of our findings in section five. In the final section, we offer some discussion of their implications in relation to ongoing policy debates, and suggest areas where further research would be profitable.

## 2. POLITICAL POLARISATION ALONG THE URBAN-RURAL DIVIDE

The polarization of electorates across the urban-rural divide is by no means a new, or recent, phenomenon. At the peak of the industrial revolution, between the end of the Nineteenth Century and the beginning of the Twentieth, many European and North American countries were divided politically between the interests of rural and small-town dwellers, engaged in agricultural production, and those of urban residents, experiencing rapid technological and socioeconomic change and a new spatial economic order dominated by manufacturing in large urban agglomerations (cf. Lipset and Rokkan 1967; Vidal de la Blache 1913).

In the second half of the Twentieth Century this stark divide faded partially, as sharper political cleavages, which reflected economic issues, class divisions and the role of the state in society, emerged (Lipset and Rokkan 1967). Yet, across many advanced economies, the processes of economic globalisation over the last three decades have generated new socio-economic divides (Ford and Jennings 2019) and contributed to the emergence of a new dimension of political conflict, cutting across these older divisions. Although the extent and nature of this divide remains contested among social scientists (Norris and Inglehart 2019), a growing number of studies show that the classic class-based Left-Right cleavage

in party competition is today overlaid by a new division based on education and cultural attitudes. Scholars support this claim with reference to survey data (Tabellini and Gennaioli 2018), the positioning of political parties (Inglehart and Norris 2016), and the composition of party supporters (Piketty 2018).

Three accounts figure prominently in this debate, each proposing a distinct explanatory framework to explain this new cleavage: “materialism” as opposed to “post-materialism” (Inglehart 1977, 1990, 1997); the divide between “winners” and “losers” of globalisation (Kriesi 1998, 2010); and a “transnational” conflict of values between “liberals” and “conservatives, authoritarians, and/or nationalists” (Hooghe and Marks 2018; De Vries 2018). While each approach emphasizes a specific trigger, the literature overall points to the increasing salience of geography in relation to this new attitudinal cleavage, and to growing political disagreements between cosmopolitan, highly educated, and socially progressive urbanites, and nationalist and socially conservative residents of ‘hinterland’ areas. The determinants of the recent rise in populism and anti-establishment sentiments across many established democracies are numerous and interlinked.<sup>217</sup> Support for right-wing populist parties relates to a number of variables including age, ethnicity, education and employment. Yet, these fault lines are characterised by many commentators as linked to a distinctive geographical divide, with political differences among inhabitants in urban and rural places becoming increasingly marked.

In the US, a significant amount of work has documented how electoral politics falls increasingly into distinctive spatial patterns, with almost all large cities being Democratic strongholds and rural counties being the cornerstone for the Republicans (Gimpel and Hui 2015; Monnat and Brown 2017; Morrill, Knopp, and Brown 2007; Rodden 2019; Scala and Johnson 2017). While a broad division between ‘blue’ and ‘red’ America has been observed for some decades (Abramowitz and Saunders 2008),<sup>218</sup> the emergence of a salient divide between urban and rural areas has become more palpable over time, and was particularly clear during the 2016 presidential campaign (McKee 2008; Wilkinson 2018). Analysing recent opinion polls and the latest US presidential elections, Scala and Johnson (2017) for example identify a consistent gradient of conservative sentiment from the most urban to the most rural counties on a wide range of socioeconomic issues. Their results show that differences in outlook remain statistically significant even after controlling for factors such as education, income, age, ethnicity, and religion.

Across Europe too, there are signs that many different political systems are adapting to this new cleavage, and an increasingly spatially divided electoral geography is emerging (Agnew and Shin 2020; Hooghe and Marks 2018). France is a much-cited exemplar of this trend. There is a growing political divide between the large urban centres – ‘globalised’, ‘gentrified’, and increasingly inhabited by cosmopolitans and ‘bobos’ (bourgeois bohemians) – and the *banlieues* populated by immigrants of recent arrival, and the remaining medium and small-sized cities and rural areas, where long-time immigrants and the ‘white’ working classes experience economic decline and are increasingly disaffected with the political system (Bacqué et al. 2016; Cusin, Lefebvre, and Sigaud 2016; Eribon 2013; Foa et al. 2020; Guilluy 2016; Ivaldi and Gombin 2015).

Similarly, England has witnessed a gradual ‘bifurcation’ (Jennings and Stoker 2016) in political terms between people with higher education and good employment opportunities who live in metropolitan areas and those living in ‘backwater’ areas associated with economic decline, hostility to immigration and the EU, and a stronger sense of English identity (Garretsen et al. 2019; Kenny 2014, 2015). While there is a strong regional dimension to the geography of discontent in Britain (Garretsen et al. 2018; McCann 2016, 2019; Tyler et al. 2017), in the UK and elsewhere, the urban-rural fault-line has become increasingly prominent.

Some research into the causes of these spatialized political patterns suggests that the urban-rural political divide has become more intense in recent decades. Exploring a rich dataset on referendum results at the municipal level, Mantegazzi (2018)’s work on Switzerland for example provides a compelling picture of the growing geographical polarisation which, since the 1970s, characterises Swiss politics. This increasingly leads to a distinctive pattern, with voters in large cities positioning themselves in a ‘Left-liberal’ space as opposed to ‘Right-conservative’ municipalities that are increasingly clustered in rural areas.

But whilst many commentators observe this pattern in a few, paradigmatic countries, little research has explored whether there is a systemically rooted urban-rural divide in political and socioeconomic attitudes across the whole European continent. And there is still considerable disagreement about the causal dynamics and processes underpinning this division. Two broad explanatory accounts of his deepening divide, respectively focused on composition and contextual effects, are most notable within current academic literature.

The first of these relates to the spatially heterogenous distribution of individuals with different characteristics (composition effects). Research on political disenchantment and populism primarily identifies the archetype of the anti-system supporter based on age, education, and income (Becker, Fetzer, and Novy 2017; Dijkstra, Poelman, and Rodríguez-Pose 2019; Essletzbichler, Disslbacher, and Moser 2018; Ford and Goodwin 2014; Goodwin and Heath 2016). As an example, ‘typical’ ‘left-behind’ Brexit supporters have been described as “older, working-class, white voters [...] who live on low incomes and lack the skills that are required to adapt and prosper amid the modern, post-industrial economy” (Goodwin and Heath, 2016, p. 325).

217 In the last years the literature on populism has thrived. See, inter alia: Akkerman, Mudde, & Zaslove, 2013; Ford & Goodwin, 2014; Guiso, Herrera, Morelli, & Sonno, 2019; Inglehart & Norris, 2016; Jens Rydgren, 2010; Kriesi, 2014; Rodrik, 2018; Rooduijn, van der Brug, & de Lange, 2016; Van Gent, Jansen, & Smits, 2014; Zaslove, 2008.

218 Some scholars have challenged the view of America as a country divided into two clearly distinct and politically homogeneous areas (cf. Fiorina & Abrams, 2008; Fiorina, Abrams, & Pope, 2010; Glaeser & Ward, 2006).

Composition effects may be amplified because of increasing demographic ‘sorting’ among voters along spatial lines (Bishop 2009) – which occurs primarily through the dynamic self-selection of younger, more educated and socially liberal individuals in large, urban cores. While the extent of demographic sorting dynamics and their influence on political outcomes is debated (cf. Abrams & Fiorina, 2012), recent research has established that voters relocating across different US counties are influenced by the partisan composition of their destinations (McDonald 2011; Tam Cho, Gimpel, and Hui 2013). Some researchers contend that this pattern reflects a hardwired preference for homophily – the tendency to favour the presence of others with similar tastes and preferences (Gimpel and Hui 2015; Motyl et al. 2014; Schelling 1971). Others highlight the dramatic transformations that have occurred in the last decades in the technical structure of the economy, and the increased returns which these have brought to those with higher levels of human capital as key factors (Keuschnigg 2019; Moretti 2012). In this changing social landscape, large urban areas incubate more economic opportunities and attract those with greater skills, while, conversely, smaller towns, rural areas and cities with an outdated industrial mix become increasingly ‘left behind’, losing their younger, more skilled populations and facing economic stagnation or decline (Lee and Luca 2019; Wilkinson 2018). The increased wage bonuses and productivity associated with high skills and education (Baum-Snow, Freedman, and Pavan 2018) may have amplified the geographical self-selection of the highly educated and more liberal-minded into larger urban cores. Driven by these deeply rooted economic dynamics, spatial sorting effects can lead to a growing urban-rural divergence in values and attitudes.

The second explanation focuses on the socio-economic trajectory of places and their contextual role in shaping individual attitudes. Across Europe, there is increasing economic divergence between core cities and areas that are lagging behind in economic terms (Iammarino, Rodriguez-Pose, and Storper 2019). Commentators hence point to an emerging ‘geography of discontent’, reflecting the unhappiness of people living in places which are stagnating or facing comparative economic decline (Garretsen et al. 2018; Los et al. 2017; McCann 2019). Rodríguez-Pose (2018, p. 201) for example shows how “[i]t has been thus the places that don’t matter, not the ‘people that don’t matter’, that have reacted”. Rising opportunities and growth in thriving urban cores not only attracts younger, more educated and more liberal individuals, but also contributes to shifting urban dwellers towards more progressive social values (Friedman 2005) and cosmopolitan preferences (Vertovec and Cohen 2002). Conversely, declining or stagnant material prospects in peripheral towns and rural places tend to generate a growing sense of disaffection, anxiety and resentment, driving citizens to adopt a more protective, “zero-sum, ‘us or them’ frame of mind” (Wilkinson, 2018, p. 5). Lee et al. (2018), for instance, show that in the Brexit referendum, support for Leave was notably higher for those living in the same county in which they were born than those who had left their county of birth. Importantly, the correlation between residential immobility and Leave voting was only strong in peripheral places where wages had stagnated after the 2008 crisis (Crescenzi, Luca, and Milio 2016), or in areas which had experienced steep recent increases in the number of immigrants moving to them. In times of growing economic inequality, residents of rural areas and small towns seem to have moved towards increasingly socially conservative and anti-liberal positions.

Place-dependent grievances are not confined to economic issues. The differences between urban and rural life, and feelings among rural and town dwellers that their places have been neglected by economic and political elites, have led to growing resentment based on cultural-identity issues which shape a growing sense of mutual alienation (Lichter and Ziliak 2017). As Cramer (2016) argues, what may look like disagreements over specific policy preferences can often be traced back to this more fundamental difference of worldview, which is rooted in questions about identity and contending “ideas about who gets what, who has power, what people are like, and who is to blame” (Cramer, 2016, p 5). In her (ibid.) account, ‘rural consciousness’ develops out as an attachment to place, and is linked to a sense that politicians and decision-makers systematically ignore peripheral places, failing to provide them with their fair share of resources, and to acknowledge their distinct lifestyles and values. Identities rooted in peripheral places seem to have, at least partly, come to shape the political preferences of a much larger group of people.

In summary, there is considerable evidence within a wide-ranging body of literature to support the contention that there is a clear political fracture between metropolitan and rural (and semi-urban) communities. But, as yet, it remains unclear whether this pattern works similarly across the European continent. One study – Maxwell (2019) – has provided a body of comparative evidence about popular attitudes towards immigration in European countries. Our analysis builds on his work, seeing to explore a broader range of socioeconomic and political issues, and testing whether differences on these are also reflective of spatial differences. Drawing on the existing literature, our first research hypothesis is the following: H.1 = There are discernible differences in the collective outlooks of people who live in urban and rural places.

But, as Scala & Johnson (2017) suggest in relation to the US case, it may be misleading to think of the urban/rural divide in dichotomous terms. ‘Rural America’ is an elusive and deceptive term, incorporating a great diversity of types of place (ibid.). Similarly, even within metropolitan areas, there are significant differences between urban cores and suburbs (Baum-Snow, Freedman, and Pavan 2018; Musterd et al. 2017). Drawing on such insights, our second research hypothesis is the following:

H.2 = the urban/rural divide is best understood as a continuum rather than a dichotomy.

In addition, we aim to provide a preliminary exploration on the determinants of attitudinal differences across places, distinguishing between composition and place effects, based on our attitudinal data. We test whether differences in attitudes across the urban/rural continuum might not be exclusively explained by compositional effects – that is, by the sorting of younger, more educated and economically better off individuals in large urban centres. Our last two hypotheses are the following:

H.3 = differences in attitudes across the urban/rural continuum are explained by compositional effects.

H.4 = differences in attitudes across the urban/rural continuum are not exclusively explained by composition effects and, hence, are linked to some of the intrinsic characteristics of places.

### 3. RESEARCH DESIGN

#### 3.1 Data

We analyse pooled, cross-sectional individual-level data from the European Social Survey. Since its inception in 2002, the Survey has conducted, every other year, face-to-face interviews across most participating countries. We exploit data on the EU27 Member States plus the UK, Norway and Switzerland from all the nine available waves, covering the period 2002-2018. The Survey is representative of all persons aged 15 and over, regardless of their nationality or language (we exclude respondents below 18). Individuals are selected through a multi-stage random probability sampling procedure. The ESS uses sampling designs where some groups or regions have higher probabilities of selection. To reduce sampling errors and potential non-response bias, we apply country-specific ESS post-stratification weights constructed using information on age, gender, education, and region.<sup>219</sup> Furthermore, we also apply country population size weights to account for the fact that countries participating in the ESS have relatively similar net sample sizes (roughly between 900 and 2700 individuals per country) even if the size of their general population varies considerably (e.g. from 1.1 million residents in Estonia to 71 million in Germany during ESS wave 8). These weights ensure that each country is represented in proportion to its actual population size.

#### 3.2 Model and Estimation strategy

To test our research hypotheses, we estimate the following equation:

$$Y_{i,t}^j = \beta_1 U_{i,t} + \beta_2 X_{i,t}^L + \alpha_c + d_t + \varepsilon_{i,c,t} \quad (1)$$

Where  $Y$  is a vector of ordinal variables measuring individual attitudes on each issue  $j$  of person  $i$  in the ESS wave  $t$ .  $U$  is our main regressor of interest, and represents a categorical variable indicating whether each respondent resides in a big city (the baseline category), in the suburbs/outskirts of a big city, in a town/small city, in a country village, or in a farm/home in the countryside. Alas, due to the nature of the data we cannot control for more fine-grained geographical determinants. While this is a potential limitation of the analysis, in our approach we follow earlier work on the urban/rural divide (Maxwell 2019) and aim to maximise the cross-country coverage offered by the ESS.

$X$  is a vector of sociodemographic controls  $L$  which may affect individual attitudes. European countries are highly unequal in many geographical (e.g. land size) and socioeconomic aspects. We hence add state fixed-effects (FE)  $\alpha_c$ , which are included to absorb any country-specific idiosyncrasies. We also add ESS wave fixed-effects  $d_t$ , to account for cross-sectional common shocks throughout the years.  $\varepsilon_{i,c,t}$  is the error term. We adopt robust standard errors in all regressions. Each of the dependent variables  $J$  included in the vector  $Y$  is either a dummy or ordinal categorical. In these cases, adopting a linear regression model (cf., for instance, Maxwell, 2019) would be inappropriate because the assumptions of OLS are violated. We hence estimate model (1) by means of a logit estimator when the outcome is binary, or by means of a proportional odds estimator (ordinal logit) when the outcome is ordinal categorical. In the second case, we assume that, for each outcome  $j$ , there is only one model and one set of coefficients, and the only dependent variable parameter to change across the values of the explanatory ordinal variable are the specific intercepts  $\alpha$  (the cut-off points) – what is called the proportional odds assumption. Brant tests, available on request, confirm the assumption is not violated (significant at the 1% confidence level).

It is important to bear in mind that this analysis does not claim to provide a causal interpretation of the link between place of residence and political attitudes. Instead, it seeks to present a broad and systematic analysis of a set of quantitative, stylised facts, which might well be explored in more depth, with the use of more advanced causal-inference tools, in future research.

#### 3.3 Variables and definitions

$Y$  is a vector of either binary or ordinal categorical variables measuring individual attitudes on each issue  $j$  of person  $i$  in the ESS wave  $t$ . We consider ten issues, grouped along two main dimensions:

*Attitudes towards the political system and political engagement.* We are, first, interested in the link between place of residence and individual attitudes towards the political system, as well as the ways in which people engage with politics. We focus on attitudinal responses and views of modes of political behaviour as these are also revealing expressions of deeper-lying attitudes towards the political system. We explore, specifically, the extent to which people engage via conventional political channels, such as voting, and the extent to which respondents evince trust in political parties, since recent research has identified a close correlation between discontent with the parties and a deeper mistrust of the political system (Bromley-Davenport, MacLeavy, and Manley 2019; Cramer 2016). Relatedly, we explore the extent to which people feel satisfied with the way in which democracy functions in their country. To provide a comparison, we also present evidence on how people feel satisfied about their life more generally, in order to help us understand better the nature and extent of individual satisfaction and dissatisfaction with politics.

*Attitudes towards specific issues.* We are also interested in exploring how people in different places along the urban/rural continuum respond to specific socioeconomic questions. We first consider people's self-placement along the left-right political spectrum, and then explore their attitudes in three areas: welfare state support, which is conventionally treated

<sup>219</sup> Cf. <https://www.europeansocialsurvey.org/methodology>, accessed on 5 July 2019.

as integral to the left/right divide; law and order, and trust in the police, drawing on the extensive literature on the rise of ‘authoritarian values’ (Foa and Mounk 2016); and attitudes towards globalisation, which we consider via perceptions of immigrants and attitudes towards the EU, where we draw from an emerging literature on a new ‘transnational cleavage’ in politics (Ford and Jennings 2019; Hooghe and Marks 2018). Political disenchantment has been widely interpreted as an essentially populist reaction against elite politicians who are perceived as being increasingly globalist in their orientation by those more inclined to identify with national identities and social traditions (Goodhart 2017; Inglehart and Norris 2016, 2017), and our findings shed light on the geographically rooted nature of these beliefs.

As anticipated,  $U$  represents a categorical variable indicating whether each respondent resides in the inner part of a large city (the baseline category), the suburbs/outskirts of a big city, a town/small city, a country village, or a farm/home in the countryside. Out of the total pooled sample, 19.46% of respondents report that they live in a big inner city, 12.04% in suburbs, 30.59% in towns or small cities, 31.41% in a country village, and 6.5% in a farm or isolated home in the countryside.

$X$  is a vector of individual sociodemographic controls  $L$  which may affect attitudes, and for which micro-level information is available. In particular,  $X$  includes the following covariates:

*Age.* Following a pattern clearly established in the literature, we may expect attitudes to be highly stratified by age groups, with younger generations being more likely to embrace cosmopolitan and progressive views (inter alia: Goodwin & Heath, 2016; Harris & Charlton, 2016) and, at the same time, being less engaged in electoral politics, given their familiarity with social media and less conventional forms of political engagement (Foa et al. 2020). The variable is expressed in Ln.

*Gender.* As customary, we control for the gender of the respondent.

*Educational attainment.* Some contributions to the growing literature on political discontent have established a positive association between lower degrees of education and higher levels of anti-establishment feeling, as well as more nationalistic/inward-looking sentiments (inter alia: Becker et al., 2017; Dijkstra et al., 2019). We hence control for respondents’ highest level of education attainment by including dummy variables for each of the ISCED (International Standard Classification of Education) levels.

*Native.* We add a dummy for people born in the country of residence, as we may expect this variable to affect our outcomes.

*Employment status.* We similarly include dummy variables for each of the following statuses: employed in paid work, education, unemployed - looking for job, unemployed - not looking for job, permanently sick or disabled, retired, in community or military service, housework or looking after children, and other.

*Occupation.* The literature on political discontent has linked growing resentment with economic insecurity in sectors and occupations under higher threat from automation and trade competition (Autor et al. 2016; Ballard-Rosa et al. 2017; Colantone and Stanig 2018). We hence additionally include dummies for each different type of occupation. We follow the International Labour Office’s (ILO) two-digit ISCO-08 (International Standard Classification of Occupations) codes, distinguishing between each of the 50 different categories (out of the 96 codes) represented in the ESS sample.

*Unemployment spells.* While employment status captures current unemployment, we include a dummy for respondents who, in previous years, have been unemployed for more than three months.<sup>220</sup>

*Partner’s unemployment.* We also include a dummy if a respondent’s partner is unemployed.

*Benefits.* We control for whether the main source of household income claims state benefits. We include this variable, as well as the following ones, to account for potential divides between “winners” and “losers” in the contemporary economy.

*Household income feelings.* We create a dummy capturing whether respondents feel that life with their present household income is difficult or very difficult.

*General economic satisfaction.* The variable captures the overall level of individual satisfaction towards the national economy.

Research on the “geography of discontent” has pointed to a link between political disenchantment and relative regional economic status and decline (McCann 2019; Rodríguez-Pose 2018). In the final part of the analysis we will hence also include three regional-level economic indicators which may affect individual attitudes. (While for most countries the ESS matches respondents to their NUTS2 level region, in some cases persons are matched with either NUTS1 or NUTS3 regional identifiers. See Appendix A.1 for more details.) The variables we consider are:

*Average regional per-capita GDP.* This is included to account for the overall economic development of the region where respondents live.

*Regional per-capita GDP growth.* We control for changes in GDP levels over the previous four years.<sup>221</sup>

*% ratio regional per-capita GDP / national average.* We add a measure of relative regional economic wealth.

Appendix A.2 reports key weighted summary statistics, while Appendix A.3 provides a detailed description for each variable.

## 4. RESULTS

This section presents the baseline results of our analysis. In Table 1, we explore the overall differences in attitudes that we find along the urban/rural continuum, when not controlling for composition effects. For each issue  $j$ , the table presents the proportional odds ratios (i.e. the exponentiation of the ‘raw’ logit/ordinal logit coefficients) of respondents

<sup>220</sup> Data on long-term unemployment is unfortunately missing for the majority of respondents.

<sup>221</sup> We calculate variations over an even-numbered interval of years so that the measure coincides with ESS waves.

living in each of the geographical categories compared to respondents residing in large urban cores, the baseline category. In all models, we include country and year fixed-effects.

**Table 1. Place of residence and individual attitudes: robust logit / ordinal logit estimates**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Attitudes towards the political system					Attitudes towards specific issues					
	Voted in elections	Trust in parties	Satisfaction with democracy	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.102*** (0.038)	0.902*** (0.021)	0.961* (0.022)	1.049** (0.024)	1.169*** (0.026)	1.012 (0.024)	1.016 (0.023)	0.837*** (0.019)	0.806*** (0.019)	0.830*** (0.018)
Town	1.029 (0.027)	0.884*** (0.016)	0.895*** (0.016)	1.038** (0.018)	1.180*** (0.021)	0.941*** (0.017)	1.035** (0.018)	0.716*** (0.013)	0.701*** (0.013)	0.802*** (0.014)
Village	1.150*** (0.030)	0.821*** (0.015)	0.849*** (0.015)	1.169*** (0.020)	1.366*** (0.024)	0.937*** (0.017)	1.063*** (0.018)	0.633*** (0.011)	0.602*** (0.011)	0.710*** (0.012)
Rur. house	1.335*** (0.069)	0.838*** (0.027)	0.829*** (0.026)	1.271*** (0.041)	1.572*** (0.051)	0.967 (0.032)	1.075** (0.033)	0.619*** (0.020)	0.544*** (0.018)	0.649*** (0.020)
Observations	244,690	222,293#	244,690	244,690	244,690	244,690	244,690	244,690	244,690	244,690
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. ctrl's	no	no	no	no	no	no	no	no	no	no
Econ. status	no	no	no	no	no	no	no	no	no	no

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # Not available for ESS wave 1.

The first four columns of Table 1 report outputs for attitudes towards modes of political engagement and the political system, and illuminate the extent to which people engage via ‘traditional’ political channels such as voting (column one), whether they trust political parties (column two), or whether they are satisfied with democracy in their country (column three). And, as a point of comparison, we also report respondents’ satisfaction with life (column four). Column five provides insights into people’s self-placement on the left-right spectrum, while the last five models focus on specific socioeconomic issues. Models six and seven, respectively, focus on attitudes towards welfare state support and trust in the police. Finally, the last three models report results relating to the ‘transnational cleavage’, namely perceptions towards immigrants (columns eight and nine) and attitudes towards the EU (trust in the European Parliament, column ten). The results broadly confirm our prior assumptions, and provide strong evidence in support of hypothesis H.1. Across most issues covered, there are stark and statistically significant differences between urban and rural places. Besides, in line with hypothesis H.2, Table 1 shows that the divide in attitudes is a gradient linked to urban density, running on a continuum from inner cities to suburbs, towns, villages, and isolated rural houses.

Controlling for country and year idiosyncrasies, respondents living outside large inner cities are, on average, significantly more likely to vote. At the same time, however, they tend to show less trust towards the political system. For instance, the odds of somebody voting, or reporting a one-unit higher level of trust in parties (which is measured on a scale 0-10), if they live on a farm or in an isolated rural area (the last category), are, respectively, 33.5% higher and 16.2% lower than those of an average resident of a large urban core. These results suggest that, while levels of trust in the political system are lower in rural areas, in these places traditional modes of political engagement are more prevalent.<sup>222</sup> Our results, more generally, confirm that the residents of these places are far less likely to engage in non-conventional political behaviours, like signing petitions and boycotting products.<sup>223</sup> But they are also, paradoxically, more sceptical than their urban counterparts about the political system and the choices it presents them with.

In line with characterisations of a cosmopolitan/conservative divide between large urban centres and elsewhere (Guilluy 2016), the results of column five show that people living in urban fringes, towns and the countryside are significantly more likely to identify as conservatives, tending to place themselves on the right of the political spectrum. As an example, the odds of a person living in a country house feeling one-unit closer to the political right on the left-right spectrum (which is measured on a scale 0-10, where zero is left and 10 is right) is 57.2% higher.<sup>224</sup>

Interestingly, however, we do not find any substantial difference in support for the welfare state (model six), an issue which has traditionally played an important role in left-right political cleavages in western democracies, or, indeed, in the trust they place in the police. It may well be that in the era of populism, worries about welfare and law and order are no longer a source of significant divergence between those who live in different parts of a country.

By contrast, results from the last three models provide clear evidence of a stark urban/rural divide on issues associated with the new ‘transnational cleavage’ (Hooghe and Marks 2018; Kriesi 2010). The results of columns eight and nine show significant differences in attitudes towards international immigration. As an example, compared to an inner-city dweller, the odds for a rural home resident reporting a one-unit higher level of belief in the positive role of migration in enriching

222 Levels of trust in parties are virtually identical to levels of trust in politicians. By contrast, levels of trust in the national parliament are slightly lower, consistent with the hypothesis that disenchanted rural dwellers may be more trustful of individuals or specific political parties than the political system overall. These additional results are available on request.

223 These additional results are available on request.

224 Results not presented but available on request equally show statistically significant differences on matters such as family issues and women rights.

the national culture (measured on a scale 0-10) are more than 55% lower. A very similar picture emerges with respect to attitudes towards the EU (column ten).

In Appendix B.1 we plot the predicted probabilities for models three and eight from Table 1. The graphs provide visual evidence of the differences in attitudes across the urban/rural continuum.

In table 2 we test hypotheses H.3 and H.4, and present the results, controlling for individual observable characteristics. We are unable to control for unobservable factors such as cognitive traits and personality types. Nevertheless, we work from the assumption that any residual correlation between place of residence and attitudes that is not explained by personal socioeconomic characteristics might well be related to places, and their contextual effects. With the exception of life satisfaction and, partially, also for trust in the police, for all other outcomes the differences across places after conditioning on individual covariates reduce in magnitude and significance, lending support to hypothesis H.3.

**Table 2. Place of residence and individual attitudes: robust logit / ordinal logit estimates controlling for sociodemographic and economic individual characteristics**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Attitudes towards the political system	Attitudes towards specific issues									
	Voted in elections	Trust in parties	Satisfaction with democracy	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.068* (0.038)	0.934*** (0.022)	0.994 (0.022)	1.064*** (0.024)	1.129*** (0.025)	1.043* (0.025)	1.021 (0.023)	0.905*** (0.020)	0.882*** (0.020)	0.888*** (0.020)
Town	1.058** (0.029)	0.947*** (0.017)	0.971* (0.017)	1.110*** (0.020)	1.144*** (0.021)	1.019 (0.019)	1.071*** (0.019)	0.841*** (0.015)	0.824*** (0.015)	0.893*** (0.016)
Village	1.189*** (0.033)	0.882*** (0.016)	0.919*** (0.016)	1.252*** (0.022)	1.272*** (0.023)	1.022 (0.019)	1.094*** (0.019)	0.793*** (0.014)	0.769*** (0.014)	0.811*** (0.015)
Rur. house	1.262*** (0.068)	0.903*** (0.030)	0.897*** (0.029)	1.392*** (0.046)	1.389*** (0.046)	1.051 (0.035)	1.094*** (0.035)	0.800*** (0.026)	0.738*** (0.024)	0.768*** (0.025)
Observations	244,690	222,293#	244,690	244,690	244,690	244,690	244,690	244,690	244,690	244,690
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Econ. status	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # Not available for ESS wave 1.

In Appendices A.4 and A.5 we break down the results of Table 2, respectively controlling for only sociodemographic or only economic observables, to explore the extent to which composition effects are linked to demographic factors such as education, age, and indigeneity, as opposed to labour market and economic factors. The results suggest that both groups of regressors are important in explaining attitudinal differences along the urban/rural continuum (in fact, including either group leads to relatively similar reductions in the size of the urban/rural coefficients). Among the economic regressors, additional tests we ran suggest that only employment status and sector of occupation play a role in mediating the link between place of residence and individual attitudes, while proxies for individual deprivation such as being dependent on public benefits, anxiety about household income and overall satisfaction with the economy, have a very minor mediating effects.<sup>225</sup>

In Appendices A.6 and A.7 we stratify the sample of Table 2 respectively distinguishing between Western European countries (EU14 Member States plus UK, Norway, and Switzerland) and the 13 countries which joined the EU in the 2004/07 enlargements, most of which were formerly part of the Eastern Bloc. The outputs suggest how attitudinal heterogeneity along the urban/rural continuum is particularly pronounced across all the countries of Western Europe. By contrast, EU13 Members show significantly less marked differences.

In Appendices B.2, B.3, and B.4 we then plot the predicted probabilities for models three and eight of Table 2. In each of the appendices we plot probabilities distinguishing between age groups, educational attainments, and occupation, and holding other variables constant at their means. As the results suggest, the role of age, education and occupation in explaining variation in attitudes is significantly larger than the residual variation attributable to idiosyncratic place effects. Hence, the findings from Table 2 suggest that attitudes are significantly stratified by sociodemographic measures, as suggested, for instance, by Maxwell (2019).

Nevertheless, we underscore how, even after controlling for individual observable characteristics, places still have a non-negligible correlation with people’s political attitudes, especially on issues such as voting behaviours (column 1 of Table 2), left-right placement (column 5), and migration and globalization (i.e. the dimensions relating to the ‘new transnational cleavage, columns 8 to 10). For instance, compared to an inner-city dweller, even after controlling for individual observables, the odds for a rural home resident reporting a one-unit higher level of satisfaction with democracy in their country (measured on a scale 0-10) are more than 10% lower, while the odds of them reporting a one-unit higher level of belief in the positive role of migration in enriching the national culture (measured on a scale 0-10) are more than 26% lower. In other words, we do not fully reject hypothesis H.4, but instead conclude that, while

225 These additional results are available on request.

compositional effects are very important in shaping attitudes, they are not sufficient to explain the urban/rural divide in political views in these European countries.

To understand what may explain the link between place and individual attitudes, we finally estimate equation (1) controlling for sociodemographic observables and economic status while also adding regional economic characteristics. Before wave 4 the ESS did not report respondents' region of residence. Besides, not all individuals are matched with a regional identifier, while we do not have regional economic data for the latest ESS wave 9. We are hence able to merge regional-level characteristics to only waves 4-8 and a sub-set of respondents. (For comparison, Appendix A.8 re-estimates the regressions of Table 2 on the restricted sample. With the exception of 'Satisfaction with democracy', which loses significance, results are overall similar to those from the full sample.) Results, reported in Appendix A.9, suggest that controlling for regional economic dynamics has only a minor effect on the link between place of residence and individual socio-political attitudes. Additional tests we ran equally suggest that the regional economic variables do not act as moderators, as their interactions with place of residence are statistically insignificant.<sup>226</sup> While some recent analyses of the "revenge of places that don't matter" (Dijkstra, Poelman, and Rodríguez-Pose 2019; Rodríguez-Pose 2018) have underlined a link between contemporary political grievances and territorial economic stagnation and decline, we conclude that differences in attitudes along the urban-rural continuum are primarily linked to cultural-identity issues, as highlighted for example by Cramer (2016).

## 5. DISCUSSION AND IMPLICATIONS FOR POLICY

These findings carry significance for debates prevalent in both academic and policy circles in relation to two broad, related phenomena. One is the growth of political disenchantment in many non-metropolitan locations across Europe, and the fertile soil this provides for nationalist and populist parties and causes. The other is the growing debate across Europe and other mature democracies about what kinds of policy agenda and political response are required in order to re-engage the inhabitants of what are commonly termed 'left-behind' places.

In relation to current debates about the underpinnings and scope of political disenchantment, our findings suggest the importance of a place-sensitive conception of this phenomenon, and simultaneously serve to undermine overly generalised characterisations of 'rural consciousness' or 'left-behind' disillusion – concepts that have become staples of media commentary and figure in academic analysis (Cramer 2016; Harris and Charlton 2016). The clear gradient that we identify in terms of political attitudes and social values, and their correlation with different spatial scales and kinds of community – ranging from metropolitan centres at one end of the spectrum through to more remote, rural areas at the other – suggest the need for a more detailed and contextual understanding of the geography of disillusion (see also Rossi 2018). These findings also underscore the importance of a deep appreciation of the underpinning economic and cultural dynamics which are generating such disparate and rivalrous social outlooks in different parts of these countries. While our study is not designed to resolve the question of causality, its main findings lend support to the contention that composition effects are necessary, but not sufficient, to explain differences in attitudes across the urban/rural continuum. Even though attitudes are highly stratified by individual characteristics such as age, educational attainments, and occupation, place still appears to have a non-negligible correlation with the values and outlook of a large number of citizens. More work is needed to understand better the mechanism through which this relationship works. Recent research has shown how place of birth and the context where individuals spend their "impressionable years" – i.e. the period of late adolescence and early adulthood during which people form durable political attitudes (Jeannet and Drazanova 2019) – have a significant influence in moulding both observable characteristics such as education (Bosquet and Overman 2019) and unobservable cognitive characteristics and capacities (Rentfrow, Gosling, and Potter 2008). Even in some of the most dynamic and developed economies in the world, it appears that where you are born and grow up is one of the most important facts about the life of any citizen, and this should give policy-makers food for thought. There are large numbers of people resident in areas where trust in politics and the political system is low, and where socially liberal values have only a thin presence. Yet, successful majoritarian politics require that parties of the political mainstream find ways to win the support of many of these voters, while also pursuing policies – in areas like climate change or migration – which may well be anathema to many of them.

This challenge connects with the second main implication of these results. This concerns the growing political focus upon the 'left behind' – a category that is both ubiquitous and contested. Our analysis suggests that there are degrees of 'left behindness' in terms of political worldviews, and that a firmer appreciation of the geographical specificities of different rural areas, towns and cities is integral to a more contextually informed and tailored policy responses to the challenges posed by inter- and intra-regional inequality (Iammarino, Rodríguez-Pose, and Storper 2019; Rossi 2018). For instance, research has shown how the European Cohesion Policy has contributed to generating economic growth in rural areas close to urban agglomerations, but not in those farther away from cities (Gagliardi and Percoco 2016). Hence, 'place-sensitive' development policies require a deeper and more contextual appreciation of the different patterns of economic development apparent in different places (Dijkstra, Garcilazo, and McCann 2013; Iammarino, Rodríguez-Pose, and Storper 2019). And, following recent debates about how best to tackle inter-territorial inequalities, our findings underscore the importance of moving beyond 'standard' trade-offs between so-called 'people-based' and 'place-based' policy approaches (Barca, McCann, and Rodríguez-Pose 2012; Kline and Moretti 2014) and support the idea of integrated policy frameworks that bring together individual (micro) and territorial (meso) logics (Iammarino, Rodríguez-Pose, and Storper 2019).

<sup>226</sup> They are available on request.

Finally, this paper offers a challenge to the ingrained tendency in the worlds of Anglophone scholarship and media punditry to foreground the UK and the US as the leading exemplars of the political disruption associated with rapid techno-economic change in the contemporary period. Our results lead instead to the conclusion that there are important trends and dynamics at work across nearly all developed European economies that are exercising a powerful impact upon the public attitudes and social orientations of people resident in these different contexts. Of course, there are still key differences of political economy, history and institutional structure at work in these different countries and regions, and these need to be given due analytical consideration. But the common patterning of these results, and the close linkages they suggest between the size and kinds of community in which many people live, and how they feel about their country and its politics, lead us to conclude that the Anglo-American bias inherent in much discourse on the 'left behind' needs to be challenged. Understood as a wider phenomenon, we are much more likely to grasp the underlying economic and cultural dynamics that are driving and perpetuating these spatially embedded patterns of political disillusion.

## 6. CONCLUSION

Drawing on individual-level data from the European Social Survey (ESS), this paper explores linkages between place of residence and attitudes on a range of different socioeconomic and political issues, providing systematic comparative evidence across 30 European countries over the period 2002-2018. We find both that there is a strong and significant divide between urban and rural Europe, and that this is not best seen in binary terms but as a gradient running from inner cities to metropolitan suburbs, towns, and the countryside. We also show that these differences are best explained by a mixture of composition and contextual effects, rather than through an emphasis on either of these kinds of factor alone.

Our analysis shows how the link between place of residence and political attitudes is not confined to attitudes towards iconic and contentious questions such as the EU (Dijkstra, Poelman, and Rodríguez-Pose 2019) or migration (Maxwell 2019). Instead, we conclude, it encompasses a wider range of political and socioeconomic issues. In particular, we show how, compared to dwellers in inner urban cores, respondents living in suburbs, towns and rural areas are systematically more likely to identify as right-wing, dissatisfied with the functioning of democracy in their country, and less likely to trust the political system. But they still tend to be more likely to vote, a finding which has an important bearing on current debates about the future of democratic politics (Runciman 2018). And, while we uncover stark differences in attitudes towards migration and globalisation along geographical lines, we do not find significant variation on issues which have traditionally been at the core of left-right cleavages, such as support for welfare state redistribution. This too is an important finding which may add weight to the claims of those analysts who maintain that the emergence of new cleavages – around age, identity and place – in democratic politics has resulted in the depoliticisation of some of the questions which were pivotal to the political alignments and identities of earlier periods (Ford and Jennings 2019; Kriesi 2010; De Vries 2018).

Second, in line with the work of Scala & Johnson (2017) on the US, we show that the geographical divide in European political attitudes should not be thought of as a dichotomy between urban vs. rural places but, instead, as a gradient. Our analysis suggests that there are degrees of 'left behindness' in terms of political worldviews, and that a firmer appreciation of the geographical specificities of different rural areas, towns and cities is integral to a more contextually informed and tailored policy responses to the challenges posed by inter- and intra-regional inequality (Iammarino, Rodríguez-Pose, and Storper 2019; Rossi 2018).

Finally, we provide a preliminary analysis of the factors that may be most significant in explaining differences along the urban/rural continuum. We contribute to an on-going debate about whether these are driven by sociodemographic characteristics – that is, by compositional effects and the geographical sorting of people with different attributes and outlooks – or by place effects (Abreu and Öner 2020; Maxwell 2019). On the basis of our finding, we underline how attitudes vary across both sociodemographic and geographical dimensions. And, we show that while people's attitudes are heavily stratified by key individual observable characteristics, such as age, education, and occupational status, places still have a non-negligible correlation with people's attitudes on a variety of political and social issues. This conclusion, we suggest, carries implications for ongoing debates about what kinds of policy programmes are best equipped to address growing territorial inequalities. Moreover, place-sensitive development policies will have to be developed in a way that integrates an understanding of the different levels of economic development of places, but also their degree of urbanisation and proximity to urban agglomerations. Gagliardi and Percoco (2016), for instance, show how the EU Cohesion Policy has benefitted rural areas close to large cities but not more remote areas, which hence need to be the target of specific policy measures. Additionally, we observe the importance of moving beyond 'standard' trade-offs between so-called 'people-based' versus 'place-based' policy approaches (Barca, McCann, and Rodríguez-Pose 2012; Kline and Moretti 2014) and, by contrast, point to the need to develop integrated frameworks combining both individual (micro) and territorial (meso) logics (Iammarino, Rodríguez-Pose, and Storper 2019).

The paper does not claim to provide a causal interpretation of the link between place of residence and political attitudes, but, instead, seeks to present a broad and systematic analysis of a set of quantitative, stylised facts. Each of these could be explored in more depth, and with the use of more advanced causal-inference tools. Future research could in particular explore how and why the kinds of setting where people live can influence the development of individual traits, especially during early-age socialisation (Bosquet and Overman 2019; Hackman and Farah 2009; Rentfrow, Gosling, and Potter 2008). Besides, further work is needed to disentangle potential compositional effects based on unobservable – rather than observable – characteristics such as intrinsic 'cognitive underpinnings' (cf., for example, Lee et al., 2018; Zmigrod, Rentfrow, & Robbins, 2018).

Overall, we find that, irrespective of whether divides in attitudes are driven by compositional effects or the contextual influence of places on people, marked demographic sorting and the overlapping of territorial and attitudinal cleavages signal a deepening geographical fracture in European societies which, in the long term, may have significant implications for the challenges of generating social cohesion and renewing the legitimacy of democratic politics (Wilkinson 2018).

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## ANNEXES

**Table A1. Regional levels of the ESS microdata (available for waves 4 to 8)**

Country	ESS4	ESS5	ESS6	ESS7	ESS8
Austria				<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Belgium	<a href="#">Nuts 1</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Bulgaria	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>		
Croatia	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>			
Cyprus	<a href="#">Lau</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>		
Czechia	<a href="#">Nuts 2</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Denmark	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	
Estonia	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Finland	<a href="#">Nuts 2</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
France	<a href="#">Nuts 1</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Germany	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>
Greece	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>			
Hungary	<a href="#">Nuts 2</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Iceland			<a href="#">Nuts 3</a>		<a href="#">Nuts 3</a>
Ireland	<a href="#">Nuts 2</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Italy			<a href="#">Nuts 2</a>		<a href="#">Nuts 2</a>
Latvia	<a href="#">Nuts 3</a>				
Lithuania		<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Netherlands	<a href="#">Nuts 3</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Norway	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Poland	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Portugal	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Romania	<a href="#">Nuts 2</a>				
Slovakia	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>		
Slovenia	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Spain	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
Sweden	<a href="#">Nuts 2</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>	<a href="#">Nuts 3</a>
Switzerland	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>	<a href="#">Nuts 2</a>
United Kingdom	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>	<a href="#">Nuts 1</a>

**Table A2. Weighted descriptive statistics**

Variable	Obs.	Mean	SD	Min	Max
Domicile: inner city	246,467	0.198	0.398	0	1
Domicile: suburbs	246,467	0.124	0.329	0	1
Domicile: town	246,467	0.310	0.462	0	1
Domicile: village	246,467	0.302	0.459	0	1
Domicile: rural house	246,467	0.066	0.249	0	1
Age	246,467	2.008	0.783	1	3
Gender	246,467	1.498	0.500	1	2
Education attainment	246,467	3.438	<b>2.191</b>	0	7
Employment status	246,467	3.003	2.574	1	9
Occupation ISCO code	246,467	47.743	24.744	0	96
Native	246,467	1.061	0.240	1	2
Unemployment spells	246,467	1.716	0.451	1	2
Partner's unemployment	246,467	0.019	0.137	0	1
Benefits	246,467	0.040	0.196	0	1
Household income satisfaction	246,467	0.208	0.406	0	1
General economic outlook	246,467	4.743	2.469	0	10
Regional per-capita GDP (Ln)	103,816	9.928	0.723	7.580	11.219
Change in regional per-capita GDP	103,816	1.982	0.806	1	3
Regional/national per-capita GDP % ratio	103,816	97.196	29.001	42.814	231.282
Voted in elections	246,467	1.819	0.385	1	2
Trust in parties	224,067	3.665	2.316	0	10
Satisfaction with democracy	246,467	5.347	2.447	0	10
Satisfaction with life	246,467	7.086	2.137	0	10
L-R placement	246,467	5.104	2.186	0	10
Welfare state support	246,467	2.168	1.046	1	5

Trust in the police	246,467	6.233	2.418	0	10
Migration good for economy	246,467	5.049	2.394	0	10
Migration good for culture	246,467	5.653	2.500	0	10
Trust in the EP	246,467	4.493	2.389	0	10

**Table A3. Detailed description of variables.**

Variable	Type, range	ESS question / data source
Domicile	Discrete, categorical	"Which phrase on this card best describes the area where you live? A big city; suburbs or outskirts of a big city; town or small city; country village; farm or home in the countryside."
Age	Categorical	Age group of respondents: 18-39; 40-59; over-60.
Education attainment	Discrete, categorical	"What is the highest level of education you have successfully completed? [Coded according to ISCED levels.]"
Employment status	Discrete, categorical	"Using this card, which of these descriptions applies to what you have been doing for the last 7 days? Paid work; education; unemployed looking for job; unemployed not looking for job; permanently sick or disabled; retired; community or military service; housework or looking after children; other."
Gender	Discrete, categorical	Gender of respondent.
Native	Discrete, categorical	"Were you born in [country]?"
Occupation	Discrete, categorical	"What is/was the name or title of your main job? In your main job, what kind of work do/did you do most of the time? What training or qualifications are/were needed for the job? [Coded according to two-digit ISCO08 codes.]"
Unemployment spells	Discrete, 0/1	"Have you ever been unemployed and seeking work for a period of more than three months?"
Partner's unemployment	Discrete, 0/1	"Which of the descriptions on this card applies to what he/she has been doing for the last 7 days? Unemployed and actively looking for a job".
Benefits	Discrete, 0/1	"Please consider the income of all household members and any income which may be received by the household as a whole. What is the main source of income in your household?" [Unemployment, redundancy benefits, any other social benefits or grants].
Household income satisfaction	Discrete, 0/1	"Which of the descriptions on this card comes closest to how you feel about your household's income nowadays?" [Difficult / very difficult on present income].
General economic outlook	Discrete, 0/10	"On the whole how satisfied are you with the present state of the economy in [your country]?"
Regional per-capita GDP	Continuous	Ln average regional per-capita GDP. Data from Cambridge Econometrics.
Change in regional per-capita GDP	Continuous	Overall percent variation over the previous 4 years of the regional per-capita GDP, divided by three terciles (below 1.33%, between 1.34 and 7.17%, above 7.18%). Own calculation on data from Cambridge Econometrics.
Regional/national per-capita GDP % ratio	Continuous	% ratio of average regional-per capita GDP over national average. Own calculation on data from Cambridge Econometrics.
Voted in elections	Discrete, 0/1	"Some people don't vote nowadays for one reason or another. Did you vote in the last [country] national election in [month/year]?"
Satisfaction with democracy	Discrete, 0/10	"On the whole, how satisfied are you with the way democracy works in [your country]."
Satisfaction with life	Discrete, 0/10	"All things considered, how satisfied are you with your life as a whole nowadays?"
Trust in political parties	Discrete, 0/10	Using this card, please tell me on a score of 0-10 how much you personally trust each of the institutions I read out. 0 means you do not trust an institution at all, and 10 means you have complete trust.... Political parties?"
L-R placement	Discrete, 0/10	"In politics people sometimes talk of "left" and "right". Using this card, where would you place yourself on this scale, where 0 means the left and 10 means the right?"
Trust in the police	Discrete, 0/10	"Using this card, please tell me on a score of 0-10 how much you personally trust each of the institutions I read out. 0 means you do not trust an institution at all, and 10 means you have complete trust... The police?"
Welfare state support	Discrete, 0/5	"Using this card, please say to what extent you agree or disagree with each of the following statements. The government should take measures to reduce differences in income levels".
Migration good for economy	Discrete, 0/10	"Would you say it is generally bad or good for [country]'s economy that people come to live here from other countries?"
Migration good for culture	Discrete, 0/10	"And, using this card, would you say that [country]'s cultural life is generally undermined or enriched by people coming to live here from other countries?"
Trust in European Parliament	Discrete, 0/10	"Using this card, please tell me on a score of 0-10 how much you personally trust each of the institutions I read out. 0 means you do not trust an institution at all, and 10 means you have complete trust... The European Parliament?"

**Table A4. Place of residence and individual attitudes: robust logit / ordinal logit estimates controlling for only individual demographic characteristics (and not individual economic status variables)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Attitudes towards the political system	Attitudes towards specific issues									
	Voted in elections	Trust in parties	Satisfaction with democracy	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.080** (0.038)	0.937*** (0.022)	0.999 (0.022)	1.078*** (0.024)	1.141*** (0.026)	1.048** (0.025)	1.028 (0.023)	0.901*** (0.020)	0.873*** (0.020)	0.889*** (0.019)
Town	1.043 (0.028)	0.942*** (0.017)	0.966** (0.017)	1.098*** (0.019)	1.148*** (0.021)	1.003 (0.019)	1.066*** (0.019)	0.819*** (0.015)	0.802*** (0.015)	0.884*** (0.016)
Village	1.194*** (0.032)	0.907*** (0.017)	0.957** (0.017)	1.284*** (0.023)	1.310*** (0.024)	1.028 (0.019)	1.116*** (0.020)	0.779*** (0.014)	0.744*** (0.013)	0.823*** (0.015)
Rur. house	1.272***	0.936**	0.940*	1.410***	1.493***	1.068**	1.123***	0.773***	0.691***	0.777***

	(0.067)	(0.031)	(0.030)	(0.046)	(0.049)	(0.035)	(0.035)	(0.025)	(0.022)	(0.024)
Observations	244,690	222,293#	244,690	244,690	244,690	244,690	244,690	244,690	244,690	244,690
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. dem. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. econ. status	no	no	no	no	no	no	no	no	no	no

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # Not available for ESS wave 1.

**Table A.5. Place of residence and individual attitudes: robust logit/ordinal logit estimates controlling for only individual economic status variables (and not demographic characteristics)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Attitudes towards the political system	Attitudes towards specific issues									
	Voted in elections	Trust in parties	Satisfaction with democracy	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.101*** (0.038)	0.916*** (0.021)	0.971 (0.022)	1.055** (0.024)	1.141*** (0.025)	1.030 (0.025)	1.015 (0.023)	0.877*** (0.020)	0.851*** (0.020)	0.859*** (0.019)
Town	1.095*** (0.029)	0.924*** (0.017)	0.936*** (0.017)	1.098*** (0.019)	1.160*** (0.021)	0.998 (0.019)	1.060*** (0.018)	0.793*** (0.014)	0.779*** (0.014)	0.855*** (0.015)
Village	1.242*** (0.034)	0.850*** (0.016)	0.872*** (0.016)	1.234*** (0.022)	1.301*** (0.024)	0.993 (0.019)	1.076*** (0.019)	0.721*** (0.013)	0.702*** (0.013)	0.763*** (0.014)
Rur. house	1.415*** (0.075)	0.866*** (0.028)	0.847*** (0.028)	1.365*** (0.045)	1.420*** (0.047)	1.019 (0.034)	1.079** (0.035)	0.727*** (0.024)	0.670*** (0.022)	0.710*** (0.023)
Observations	244,690	222,293#	244,690	244,690	244,690	244,690	244,690	244,690	244,690	244,690
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. dem. ctrls	no	no	no	no	no	no	no	no	no	no
Ind. econ. status	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # Available for ESS waves 4 to 8.

**Table A.6. Place of residence and individual attitudes: robust logit/ordinal logit estimates for EU13 Countries, controlling for sociodemographic and economic individual characteristics**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Attitudes towards the political system	Attitudes towards specific issues									
	Voted in elections	Trust in parties	Satisfaction with democracy	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.022 (0.000)	1.066 (0.056)	1.003 (0.047)	1.017 (0.050)	0.994 (0.053)	0.993 (0.053)	0.955 (0.046)	1.011 (0.049)	1.040 (0.050)	0.926 (0.045)
Town	1.178 (0.000)	1.023 (0.030)	1.026 (0.029)	1.107*** (0.031)	0.973 (0.028)	0.845*** (0.026)	1.052* (0.029)	1.032 (0.029)	0.994 (0.029)	1.006 (0.029)
Village	1.260 (0.000)	1.098*** (0.034)	1.029 (0.031)	1.212*** (0.036)	1.061** (0.031)	0.794*** (0.025)	1.122*** (0.032)	0.959 (0.028)	0.893*** (0.027)	0.951* (0.028)
Rur. house	1.204 (0.000)	1.201 (0.135)	1.097 (0.122)	0.932 (0.103)	1.062 (0.108)	0.917 (0.102)	1.130 (0.125)	0.950 (0.107)	1.063 (0.115)	1.112 (0.121)
Observations	68,727	65,203#	68,727	68,727	68,727	68,727	68,727	68,727	68,727	68,727
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Econ. status	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # Not available for ESS wave 1.

**Table A.7. Place of residence and individual attitudes: robust logit / ordinal logit estimates for EU14 Countries plus UK, Norway and Switzerland, controlling for sociodemographic and economic individual characteristics**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
Attitudes towards the political system	Attitudes towards specific issues									
	Voted in elections	Trust in parties	Satisfaction with democracy	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.048 (0.043)	0.899*** (0.023)	0.976 (0.024)	1.068*** (0.027)	1.176*** (0.030)	1.091*** (0.029)	1.027 (0.026)	0.852*** (0.021)	0.832*** (0.021)	0.863*** (0.021)
Town	1.019 (0.034)	0.920*** (0.020)	0.952** (0.020)	1.113*** (0.023)	1.198*** (0.026)	1.077*** (0.024)	1.076*** (0.023)	0.785*** (0.017)	0.774*** (0.017)	0.862*** (0.018)
Village	1.151*** (0.040)	0.832*** (0.018)	0.889*** (0.019)	1.258*** (0.027)	1.340*** (0.029)	1.094*** (0.025)	1.089*** (0.023)	0.737*** (0.016)	0.724*** (0.016)	0.780*** (0.017)
Rur. house	1.226*** (0.072)	0.874*** (0.031)	0.877*** (0.030)	1.419*** (0.051)	1.444*** (0.052)	1.095** (0.040)	1.099*** (0.038)	0.760*** (0.027)	0.700*** (0.025)	0.738*** (0.025)
Observations	175,963	157,090	175,963	175,963	175,963	175,963	175,963	175,963	175,963	175,963
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Ind. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes
Econ. status	yes	yes	yes	yes	yes	yes	yes	yes	yes	yes

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # Not available for ESS wave 1.

**Table A.8. Place of residence and individual attitudes: robust logit / ordinal logit estimates replicating the results of Table 2 on the restricted sample used in Appendix A.8 (ESS waves 4 to 8 only).**

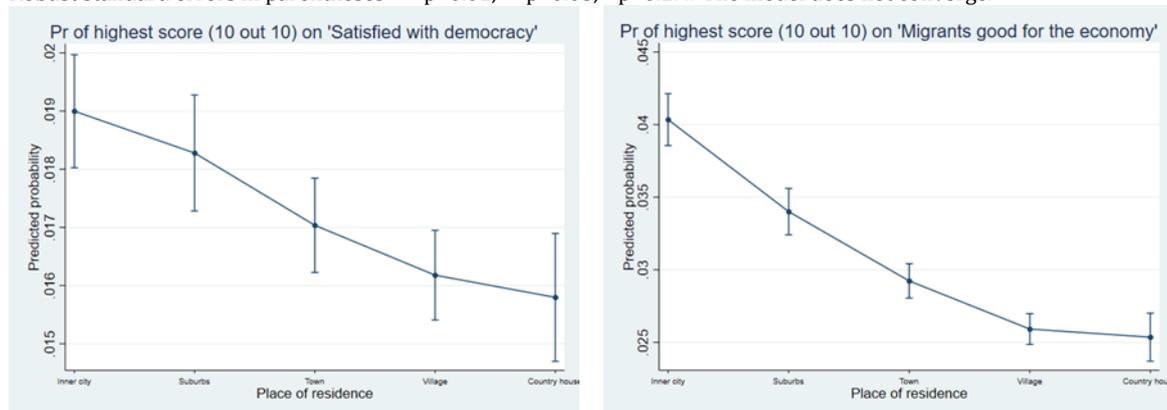
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Attitudes towards the political system				Attitudes towards specific issues					
	Voted in elections	Trust in parties	Satisfaction with dem.	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.008 (0.056)	0.974 (0.033)	1.015 (0.036)	1.065* (0.037)	1.113*** (0.038)	1.051 (0.038)	0.988 (0.034)	0.918** (0.032)	0.925** (0.032)	#
Town	0.977 (0.040)	0.955* (0.025)	0.957* (0.026)	1.093*** (0.029)	1.177*** (0.032)	1.023 (0.029)	1.043 (0.028)	0.836*** (0.023)	0.807*** (0.022)	#
Village	1.113** (0.047)	0.894*** (0.024)	0.910*** (0.024)	1.210*** (0.033)	1.289*** (0.035)	1.046 (0.029)	1.057** (0.028)	0.799*** (0.022)	0.775*** (0.021)	#
Rur. house	1.231*** (0.098)	0.949 (0.044)	0.913* (0.045)	1.405*** (0.070)	1.412*** (0.070)	1.102* (0.056)	1.082* (0.051)	0.780*** (0.038)	0.765*** (0.038)	#
Observations	103,816	103,511	103,816	103,816	103,816	103,816	103,816	103,816	103,816	#
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Ind. dem. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Ind. econ. status	yes	yes	yes	yes	yes	yes	yes	yes	yes	#

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # The model does not converge.

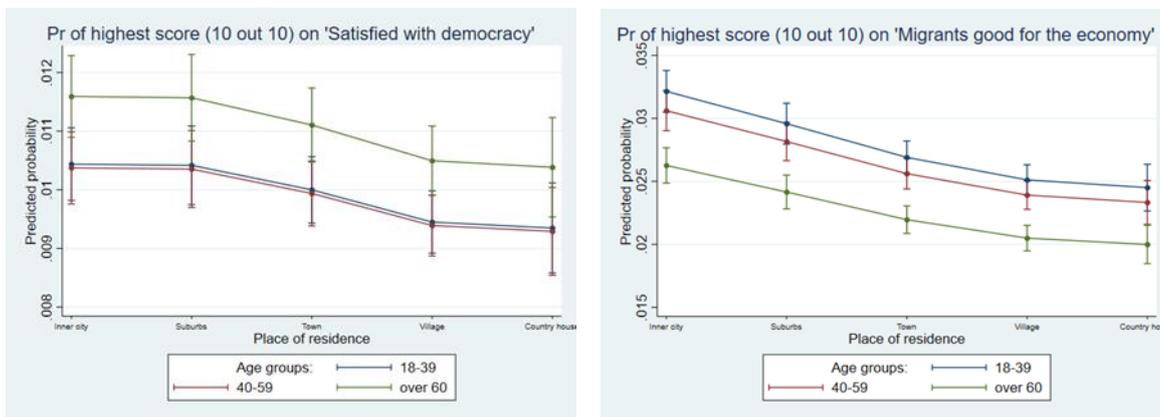
**Table A.9. Place of residence and individual attitudes: robust logit / ordinal logit estimates adding regional economic variables among the regressors (data available for ESS waves 4 to 8 only)**

	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)
	Attitudes towards the political system				Attitudes towards specific issues					
	Voted in elections	Trust in parties	Satisfaction with dem.	Satisfaction with life	L-R placement	Welfare state support	Trust in police	Migration good for economy	Migration good for culture	Trust in EU Parl.
Suburbs	1.008 (0.056)	0.972 (0.033)	1.007 (0.035)	1.071* (0.037)	1.116*** (0.038)	1.064* (0.039)	0.984 (0.034)	0.910*** (0.032)	0.917** (0.032)	#
Town	0.997 (0.042)	0.975 (0.026)	0.971 (0.026)	1.106*** (0.030)	1.191*** (0.032)	1.047 (0.030)	1.029 (0.028)	0.863*** (0.024)	0.826*** (0.023)	#
Village	1.134*** (0.048)	0.911*** (0.025)	0.921*** (0.025)	1.224*** (0.034)	1.304*** (0.036)	1.071** (0.031)	1.043 (0.028)	0.821*** (0.023)	0.789*** (0.022)	#
Rur. house	1.265*** (0.101)	0.974 (0.046)	0.934 (0.046)	1.419*** (0.071)	1.430*** (0.072)	1.124** (0.058)	1.068 (0.050)	0.820*** (0.040)	0.795*** (0.040)	#
Observations	103,816	103,511	103,816	103,816	103,816	103,816	103,816	103,816	103,816	#
Country FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Year FE	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Ind. dem. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Ind. econ. status	yes	yes	yes	yes	yes	yes	yes	yes	yes	#
Reg. ec. ctrls	yes	yes	yes	yes	yes	yes	yes	yes	yes	#

Robust standard errors in parentheses \*\*\* p<0.01, \*\* p<0.05, \* p<0.1. # The model does not converge.

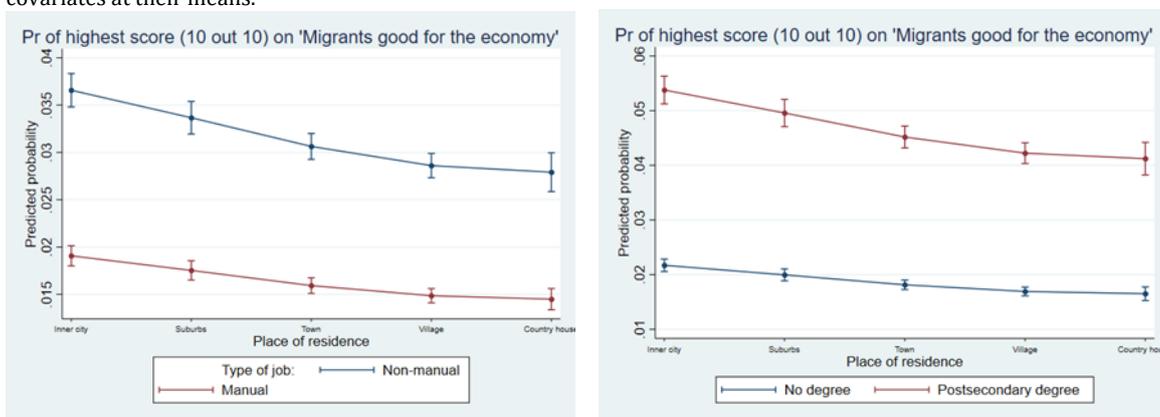


**Figure B.1. Place of residence and individual attitudes: Adjusted predicted probabilities for 'Satisfaction with democracy' and 'Migration good for the economy' (based on columns three and eight of Table 1)**



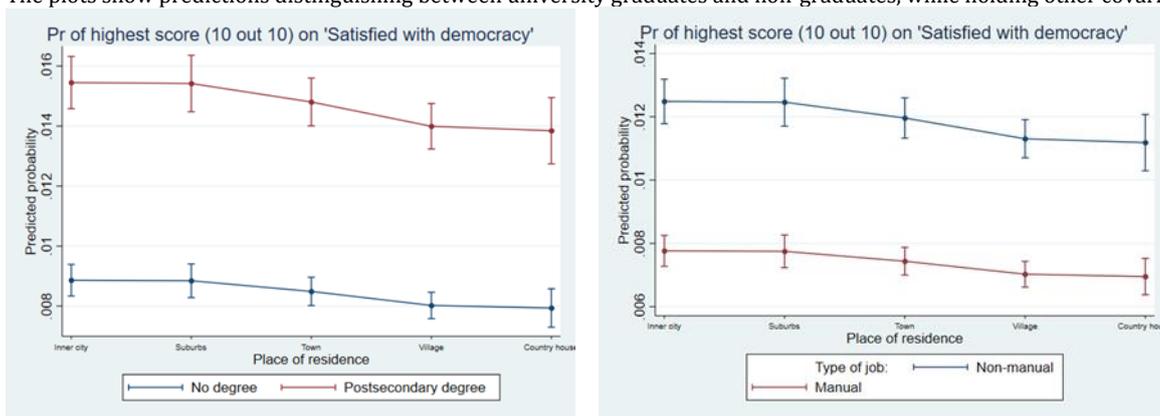
**Figure B.2. Place of residence and individual attitudes: Adjusted predicted probabilities for ‘Satisfaction with democracy’ and ‘Migration good for the economy’ controlling for individual observable characteristics (based on columns three and eight of Table 2)**

The plots show predictions distinguishing between three age groups (group 1: 18-39; group 2: 40-59; group 3: over-60), while holding other covariates at their means.



**Figure B.3. Place of residence and individual attitudes: Adjusted predicted probabilities for ‘Satisfaction with democracy’ and ‘Migration good for the economy’ controlling for individual observable characteristics (based on columns three and eight of Table 2)**

The plots show predictions distinguishing between university graduates and non-graduates, while holding other covariates at their means.



**Figure B.4. Place of residence and individual attitudes: Adjusted predicted probabilities for ‘Satisfaction with democracy’ and ‘Migration good for the economy’ controlling for individual observable characteristics (based on columns three and eight of Table 2)**

The plots show predictions distinguishing between manual and non-manual occupations, while holding other covariates at their means

## ALTRUISM IN THE TIME OF COVID-19: WE ARE ALL IN THIS TOGETHER, BUT WHO IS WE?

Gianluca Grimalda<sup>1</sup>, Nancy R. Buchan<sup>2</sup>, Orgul D. Ozturk<sup>2</sup>, Adriana C. Pinate<sup>3</sup>, Giulia Urso<sup>3</sup>, Marilynn B. Brewer<sup>4</sup>

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### ABSTRACT

The unfolding COVID-19 pandemic poses the most serious existential threat to contemporary societies since WWII. This is likely to have wide-ranging consequences for patterns of cooperation and social cohesion within and between countries. Crises such as these heighten the tension between individual and collective interests, distilling the essence of a social dilemma.

The goal is to gauge the extent to which people act altruistically rather than selfishly as a function of their exposure to the COVID-19 pandemic, and, more specifically, toward which group such altruism is directed. Our study consisted of two online experiments conducted in the U.S. and Italy to evaluate the extent of altruism in the form of charitable giving, and whether such altruism has a more parochial or cosmopolitan character. In the context of an online survey, participants were given an unexpected monetary bonus and then asked whether they wished to donate some or all of the bonus and, if so, choose to which one of three charitable organizations -one international, one national, and state (U.S.) or regional (Italy) level- providing aid to those affected by the COVID-19 pandemic. Any amount donated was matched by the researchers so that the contribution to the selected charity was doubled. In order to assess the causal influence of construal of the ingroup on prosocial decision-making, our study included an experimental manipulation intended to "prompt" the participant to think about the pandemic crisis in terms of one of the three levels of inclusiveness.

Several patterns in our study are observed in both countries, lending robustness to our results. In particular, the willingness to benefit most the group at the lowest levels of inclusiveness -state/region-, the tendency for people more exposed to COVID-19 to donate more, and the moderating effect exerted by social identity. Nonetheless, contributions to more inclusive groups – national and international – were also substantial and larger in Italy than the U.S., suggesting that inclusiveness may be affected by contextual factors such as the uneven regional distribution of the threat in question, the time of the outbreak, and the nature of governmental response to the pandemic.

Our research provides a deeper understanding of the influence of pandemic-induced trauma on attitudes and behaviour, and seems to infer that even if global effort is constructed to address the current and other ongoing global crises. The preference for helping at the local level (state in the U.S. and region in Italy) should also be considered when designing relief packages and appeals for aid. Many global leaders have lamented the current failure of multi-lateral governance in addressing the spread of COVID-19, let alone facing up to other global challenges affecting our planet. Our findings suggest that whatever global effort is constructed to address the current and other ongoing global crises, it will have to consider the markedly parochial character of cooperation observed in our study.

**IDENTITY AND PLACE: HOW DO TERRITORIAL CHARACTERISTICS  
AFFECT PRO-GROUP BEHAVIOURS?**

**Giovanni Perucca**

Politecnico di Milano, Italy

**ABSTRACT**

A broad literature focused on the effects of group identity on individual behaviour. Among other things, these studies pointed out that when identity is made salient, group members tend to cooperate more among them. Moreover, they systematically tend to favour in-group members over out-group individuals. Few recent works suggested that territory matters in understanding the mechanisms through which identity leads to cooperation. This study focuses on this issue, presenting the results of a natural experiment.

## **Regular Session: RS15.4 - Theoretical and empirical urban economics**

**13:15 - 14:30 Friday, 28th May, 2021**

**Room Lagouira**

**<https://us02web.zoom.us/j/88511789571>**

**Chair Martijn Smit**

## IS COVID-19 THE GREAT EQUALIZER? HETEROGENOUS IMPACT OF MOBILITY RESTRICTIONS IN A METROPOLITAN AREA

[David Castells-Quintana](#)<sup>1</sup>, [Paula Herrera-Idárraga](#)<sup>2</sup>, [Luis Quintero](#)<sup>3</sup>, [Sinisterra Guillermo](#)<sup>4</sup>

<sup>1</sup>Universidad Autónoma de Barcelona, Spain. <sup>2</sup>Universidad Javeriana, Colombia. <sup>3</sup>Johns Hopkins University, USA. <sup>4</sup>Universidad Javeriana, Colombia

### ABSTRACT

The capacity of areas within a city to comply with mobility restrictions aimed at curbing the COVID-19 pandemic is crucial to the local dynamics of the disease. In this paper, we study the efficacy of policies implemented to restrict mobility and their impact on the COVID-19 expansion, and how this impact depends on socioeconomic differences across within-city locations. To do so, we rely on unique and novel data showing changes in movements at highly disaggregated spatial levels. We use data from Bogotá to explore the relationship between mobility restrictions, as one of the main Non-Pharmaceutical Interventions implemented, people's mobility, and the expansion of the COVID 19 pandemic. Bogotá implemented a general lockdown, followed by district-specific restrictions and subsidies. We find that the general lockdown imposed in the city significantly reduced mobility (by about 47%). By contrast, the marginal impact of district-specific restrictions and subsidies is found to be small. When looking at heterogeneous impact across locations, we find that poorer locations, with a higher share of informal workers, as well as those where households who have deficient infrastructure, reacted significantly less to mobility restrictions.

**GAINS FROM AGGLOMERATION: EVIDENCE FROM MANUFACTURING PLANTS IN THE RUSSIAN EMPIRE**

[Vera Ivanova](#)

HSE University, Russian Federation

**ABSTRACT**

I study the location patterns and the effect of agglomeration on plant-level productivity of manufacturing industries in the Russian Empire. The analysis is based on a novel micro-geographical dataset on the population of Russian manufacturing plants in 1908, augmented with geo-coded data on Imperial railroads and province-level indicators. Using continuous distance measures of geographic concentration, I show that most industries in the Russian Empire were localized at distances about 100--200 km. Also, I reveal coagglomerated industry pairs forming input--output linkages. I estimate impacts of location characteristics of each plant on plant-level productivity. I find that a firm-level TFP is bell-shaped with respect to the number of plants of the same industry in the same geographic area. I reveal a strong positive impact of closeness to railroads on firm-level productivity. These findings reflect non-trivial interplay between agglomeration and dispersion forces to which my estimation results impart empirical content.

**WHO'S RIGHT, WEBER OR GLAESER?****Andrea Caragliu<sup>1</sup>, Martijn Smit<sup>2</sup>, Frank van Oort<sup>3</sup>**

<sup>1</sup>Politecnico di Milano, Italy. <sup>2</sup>Utrecht University, Netherlands. <sup>3</sup>Erasmus School of Economics and Institute for Housing and Urban Development Studies (IHS), Erasmus University Rotterdam, Netherlands

**ABSTRACT**

Recent evidence about the relative strength of localization and urbanization economies is rather contradictory. Most empirical work on agglomeration economies has been devoted to the analysis of pure density mechanisms, which actually subsume two possible amenity effects. On the one hand, vast empirical evidence suggests the importance of productivity-enhancing features of spatially concentrated settlement structures, which attract profit-maximizing firms despite the costs associated to large population concentrations. On the other hand, cities also function as major market areas, concentrated in space and thereby offering within a limited area a large number of consumption possibilities.

These two strands of literature have seldom spoken and to date the relative importance of these sources of agglomeration benefits is not yet clear. In this paper we address this gap. We exploit two large data bases comprising (i.) 70 per cent of all house transactions in the Netherlands in the period 2005-2011, and (ii.) ORBIS data covering balance sheets of Dutch firms in the period 2005-2011. We also merge these two main data sources with Statistics Netherlands neighborhood data from the Wijk- en Buurtkaart, data on monuments from the Cultural Heritage Agency, and, lastly, LISA data of all registered firms in the Netherlands.

The paper provides two main contributions: (i.) We measure the intensity of the productivity effect of consumption and production-related advantages for the Dutch case, and (ii.) We observe whether the relative intensity of the two effects change over the observed time span, following recent theoretical predictions, that suggest the growing importance of consumption amenities as sources of agglomeration benefits (Glaeser et al., 2001; Koster et al., 2019). This empirical framework is for the first time to date explored by looking at the three main indicators of relative locational advantages, i.e. house prices, firm productivity, and worker wages, thus providing evidence on all three main sources of income (rent, profits, and wages, respectively).

Our findings suggest that both consumption and production-related externalities are reflected in house prices, firm productivity, and wages. In particular, urban land rent increases with the intensity of competition, as well as with the presence of local consumption amenities (major monuments, theatres, and restaurants). Firms also tend to be more productive when located closer to sources of consumption amenities, although the evidence is less compelling.

Results are robust to a number of robustness checks, as well as to the use of Instrumental Variables, with soil composition and historical population density as the two main instruments. Instead, we find little evidence of a relative decline of the importance of production externalities with respect to consumption amenities.

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## PLENARY SESSION V

14:45 - 15:45 Friday, 28th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/82346302075>

### Keynote Speech



*Human capital migration, innovation and sustainability: some reflections on what we know and our future challenges*

**Prof. Alessandra Faggian**

Gran Sasso Science Institute, Italy

**Chair Eduardo A. Haddad**, University of São Paulo, NEREUS, Brazil

**Discussant Daniela L. Constantin**, Bucharest University of Economic Studies, Romania

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## CLOSING CEREMONY

15:45 - 17:15 Friday, 28th May, 2021

Room Marrakech

<https://us02web.zoom.us/j/82346302075>

### Final Speeches



**Eduardo Haddad**  
President, Regional Science  
Association International



**Abdellatif Khattabi**  
Chair, Local Organising Committee  
President, Moroccan Regional  
Science Association



**Andrea Caragliu**  
Executive Director, Regional  
Science Association International

# List of authors

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The ID code is stated for participants mentioned in the programme; ordered by the Last Name

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