

2<sup>nd</sup> International Conference on

# Environmental Sustainability Through Waste And Recycling

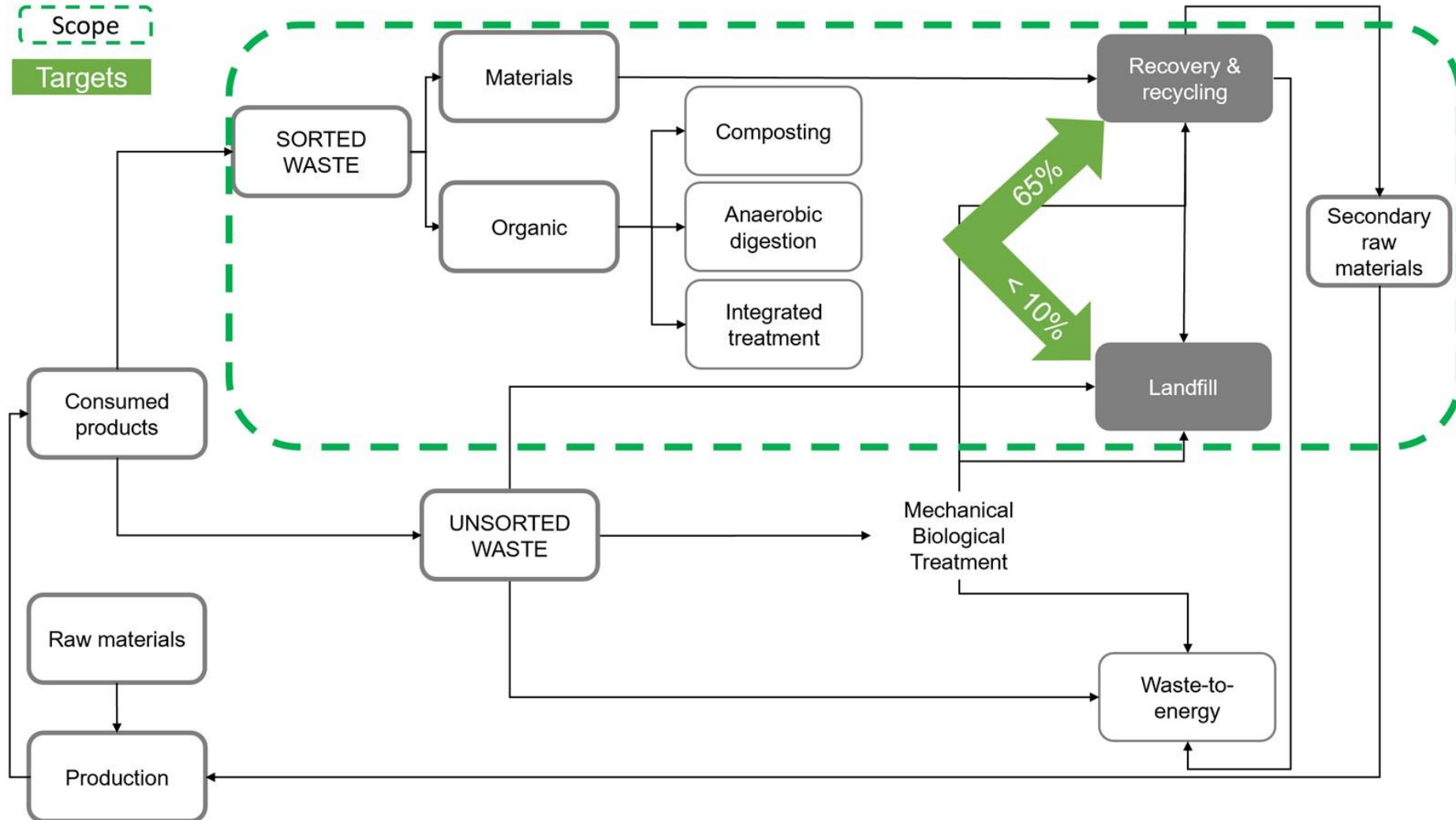
## Assessing the Cost and Environmental Benefits of Unit Pricing in Municipal Solid Waste Management: *Insights in the Wake of New Regulations*

Prof. Giacomo Di Foggia and Prof. Massimo Becaarello

University of Milano-Bicocca



# Background



# Modern MSW Charging Schemes

## Aim:

- Outperform traditional metrics (e.g., property size, number of residents, socioeconomic conditions).

## Goal:

- Encourage users to improve separate collection and recycling through economic incentives.

## Common Funding Models:

- Fixed fees (simple, steady revenue) and quantity-based fees (charges based on amount and type of waste).

## Quantity and Quality-Based Approaches:

- Increase waste management performance and apply the polluter-pays principle.

## UP Concept:

- Charges proportional to the actual use of MSW management service, reducing environmental and economic costs.

## Challenges:

- Transition costs, operation management issues, service organization challenges.

## Policy Implications:

- When UP schemes can boost environmental performance, support waste prevention, and align with circular economy goals?

- Data Integration: Combined datasets from different domains.

- Datasets:

- PER\_QUANTITY: Waste management costs per quantity of waste.
- PER\_CAPITA: Costs normalized per capita.
- QUALITY: Quality and performance information on waste.
- UNIT\_PRICING: Information on municipalities with UP schemes.
- GEOSPATIAL: Geographic information.
- ECO: Public finance information.

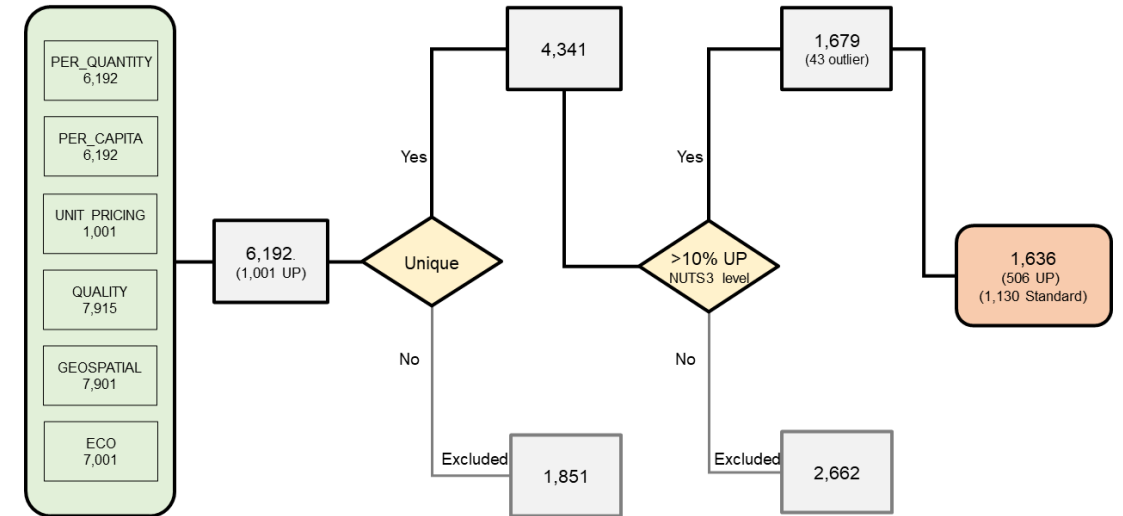
- Sources: Italian Institute of Environmental Protection, municipality websites, Italian Statistical Institute, Italian Economic Ministry.

- Stratification:

- Group 1: Standard fees.
- Group 2: UP scheme.

- Criteria: Geographical representativity and stratification based on administrative units (regions, provinces, metropolitan areas).

- Analysis Level: Local Administrative Units (LAUs) and NUTS 3 areas.



# Research questions

## RQ1

- **Link between UP Schemes and Sorted Waste Collection**
  - H1: Group 2 (UP scheme) has higher environmental performance than Group 1.

## RQ2

- **Impact on Per Capita Waste Generation**
  - H2: Group 2 (UP scheme) generates lower per capita waste than Group 1.

## RQ3

- **Impact of UP on Total Cost of Management**
  - H3: Total cost of MSW management is lower in Group 2 (UP scheme) than in Group 1.

## RQ4

- **Impact of UP on Specific Services and Phases of Waste Management**
  - H4: UP schemes affect specific phases of municipal waste management services.

## RQ5

- **Impact of Regulatory Framework**
  - H5: The regulatory framework is effective only under specific conditions.

# Results

- **Environmental Performance:**

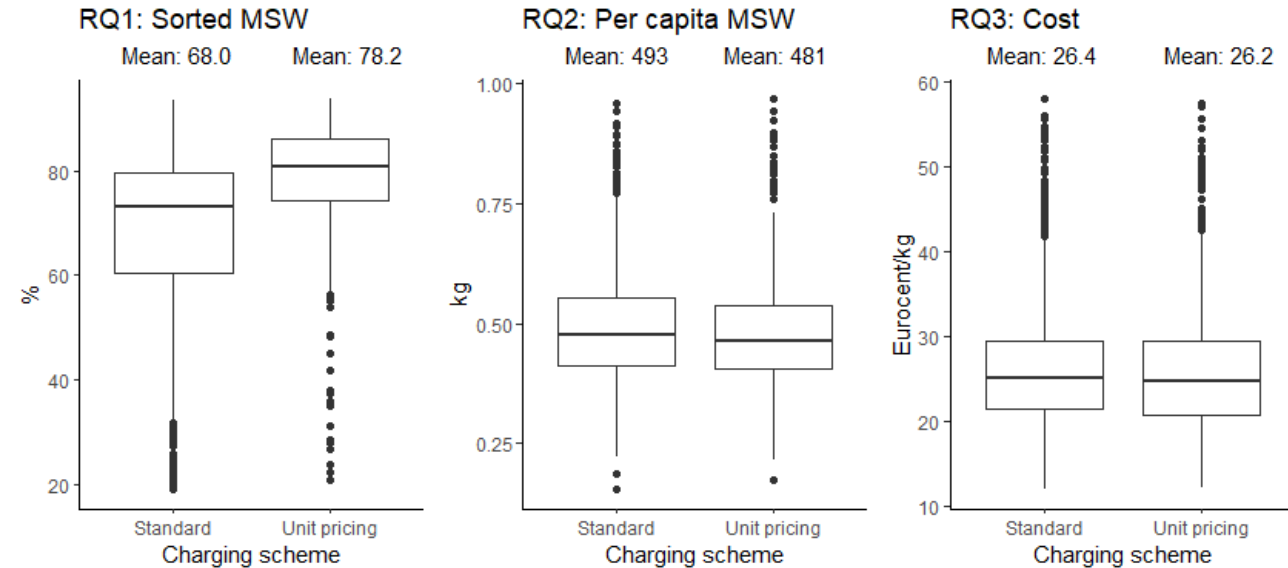
- Group 2 (UP scheme) is associated with a 4% higher environmental performance.
- Per capita generation of MSW is 12 kg lower in Group 2.

- **Cost of MSW Management:**

- Average cost per kg of waste is slightly lower in Group 2 (-0.2 Eurocent/kg).
- No significant difference in the true means of cost between Group 1 and Group 2.

- **Hypothesis Testing (Table 2):**

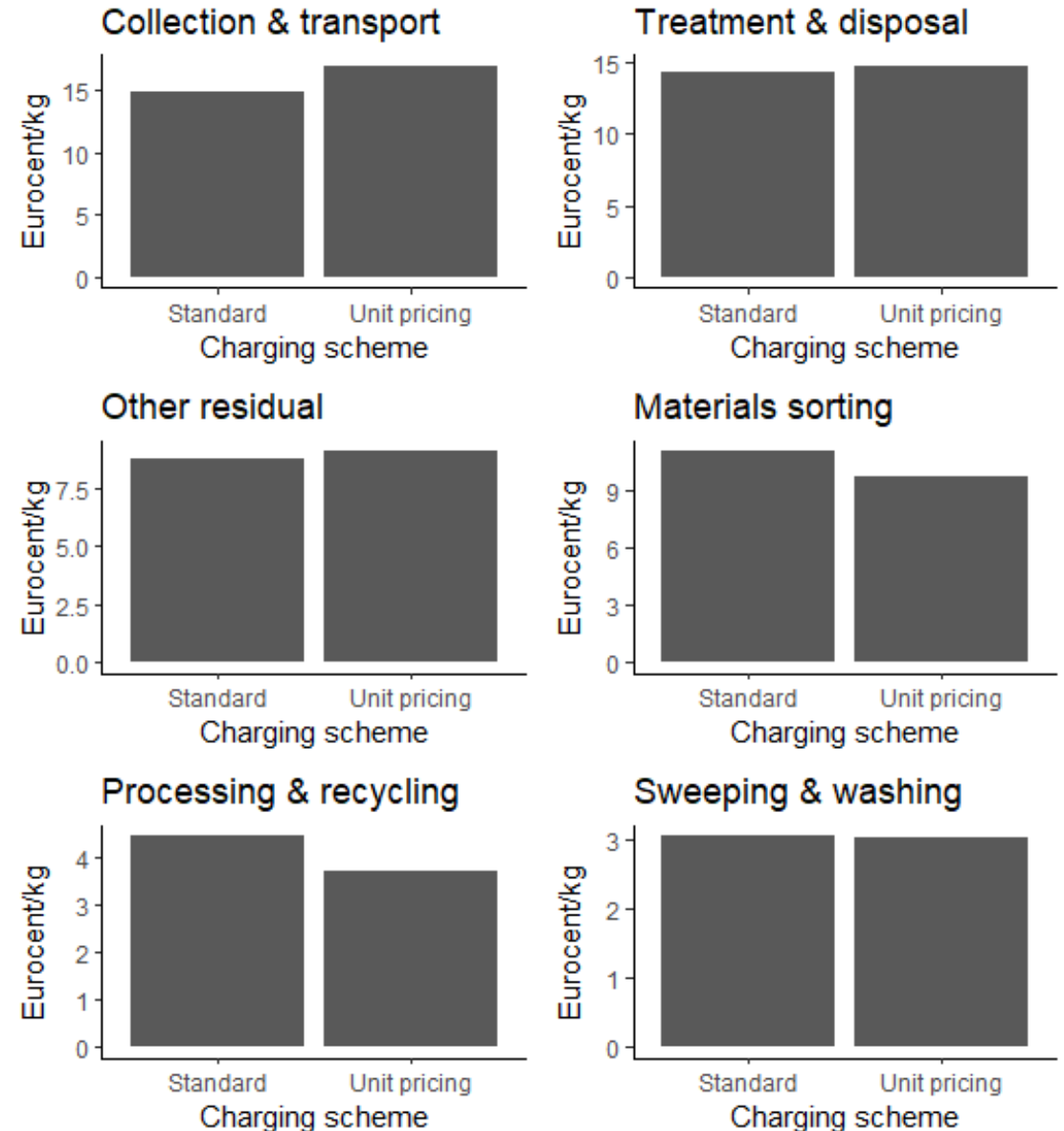
- RH1: Significant difference in sorted share between groups, with Group 2 performing better.
- RH2: Significant difference in MSW generation between groups, with Group 2 generating less.
- RH3: No significant difference in MSW management cost between groups.



RH	H1	t	df	p value
RH1	The difference in sorted share between Group 1 and Group 2 is < 0	-14.43	1344	2.2e-16***
RH2	The difference in MSW generation between Group 1 and Group 2 is > 0	1.939	990	0.02639***
RH3	The difference in MSW management cost between Group 1 and Group 2 is > 0	0.307	863	0.3791

# Results (2)

- **Impact of UP Schemes on Sub-Costs:**
  - UP schemes affect only part of the service costs.
  - Some costs are common and not attributable to specific activities.
- **Positive Effects of UP Schemes:**
  - Collection and transport costs increased from 14.9 to 16.9 Eurocent/kg.
  - Treatment and disposal costs increased from 14.2 to 14.7 Eurocent/kg.
  - Other costs of residual waste management increased from 8.74 to 9.11 Eurocent/kg.
- **Negative Effects of UP Schemes:**
  - Materials sorting costs decreased from 11 to 9.65 Eurocent/kg.
  - Processing and recycling costs decreased from 4.45 to 3.71 Eurocent/kg.
  - Sweeping and washing streets costs remained almost unchanged at approximately 3.05 Eurocent/kg.



# Results (3)

InCTOTab	Coefficient	Robust std. err.	t	P> t	[95% conf. interval]	
InCTOTab L1.	.9325843	.0056073	166.32	0.000	.9215917	.9435769
Indens	-.0028682	.0008285	-3.46	0.001	-.0044924	-.001244
coast	.0048723	.002659	1.83	0.067	-.0003405	.0100851
payt_d	-.014658	.0020703	-7.08	0.000	-.0187166	-.0105994
newlaw	-.063244	.0381302	-1.66	0.097	-.137995	.0115071
capacityx	-.0368064	.0057251	-6.43	0.000	-.0480299	-.0255829
lnrevpc	.0151237	.0033044	4.58	0.000	.0086457	.0216018
lnmsw_pc	.0499681	.0062148	8.04	0.000	.0377846	.0621517
year						
2017	-.0466627	.0373073	-1.25	0.211	-.1198004	.0264751
2018	-.0371613	.037674	-0.99	0.324	-.111018	.0366953
2019	-.0390823	.0375233	-1.04	0.298	-.1126435	.0344789
2020	-.0144261	.0376406	-0.38	0.702	-.0882172	.0593651
2021	.0520611	.0048617	10.71	0.000	.0425302	.061592
2022	0	(empty)				



# Conclusion



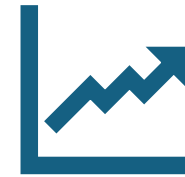
**UP schemes can improve the MSW  
managemet quality**

probably not the cost)



**UP schemes work better under  
specific considtions**

Regulatory framework, treatment capacity



**Market condition particularly  
important**