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ORIGINAL PAPER

Spatial consequences of tax reforms on tax compliance: econometric evidence from the Italian Minimum Taxpayer Regime

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Abstract

This paper investigates the consequences of the introduction of Italy's 2008 flat–rate tax regime for self-employed earning less than 30 thousand Euros on tax compliance, combining counterfactual, spatial and temporal modeling. Using data from the Labour Force Survey on regional self–employment and administrative data on taxable income, we implement a Difference-in-Differences design to estimate the behavioral responses of self–employed taxpayers at the provincial level. To account for spatial and temporal dependence, we extend the standard DiD specifications with hierarchical spatio–temporal clustering. Results reveal the ambiguous consequences of the reform. On the one hand, it has encouraged individuals to underreport earnings in order to remain below the 30 thousand Euro threshold. On the other hand, it has favored the tax compliance of new self-employed workers, as our findings reveal a negative relationship between the proportion of self-employed individuals and tax evasion. We also observe unintended consequences of the reform in terms of heterogeneous spatial dynamics. In particular, low-income regions have been especially affected by the proportional rate regime, whereas limited evidence of behavioral adjustment has emerged in high-income areas.

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The effectiveness of the analysed policy is also affected by the traditional north–south divide.

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1 Introduction

The decision to evade taxes is influenced by a broad set of incentives, both individual and social. Among the most direct determinants are statutory tax rates, which generate behavioral responses such as adjustments in labour supply, effort, occupational choice, and avoidance strategies (Saez et al. 2012; Bosch and de Boer 2019). These reactions, in turn, affect taxable income and the elasticity of the tax base (Kleven and Schultz 2014). Moreover, the intensity of these responses varies across institutional and territorial contexts, depending on enforcement capacity, social norms, and local economic structures (Hemel and Weisbach 2021; Besley et al. 2023).

In recent years, public economists acknowledged the structural nature of tax evasion, along with its persistence, and strong territorial heterogeneity (Alm and Yunus 2009; Pickhardt and Seibold 2014; Carfora et al. 2018), by emphasizing that evasion is not only a microeconomic behavioral issue, but a territorial phenomenon (Slemrod 2019; Alm 2019). Accordingly, the determinants of compliance remain deeply embedded in the structure of local economies, occupational composition, and institutional quality (Argentiero et al. 2024).

In terms of occupational structure, it has been shown that most of the lost fiscal revenues come from self-employed workers (Engström and Hagen 2017), who usually lack withholding tax and third-party reporting, exhibit systematically higher levels of non-compliance than employment or pension income (Kleven et al. 2011; Pomeranz 2015; Almunia and Lopez-Rodriguez 2018). In turn, the composition of self-employment has changed profoundly over the last two decades, with the rise of knowledge-intensive, service-oriented, and skill-dependent occupations (Autor et al. 2003; Deming 2017). These transformations have created new, sometimes unexpected, forms of informality: sectors relying heavily on interpersonal or negotiation skills often escape effective monitoring due to the intangible nature of their transactions (Artavanis et al. 2016). At the same time, other components of human capital, particularly skill families, influence individual propensity for tax compliance through both economic and psychological channels (Andrighetto et al. 2016; Abeler et al. 2019). Notably, individuals with high cognitive competence can reduce the expected costs of tax evasion thanks to a better understanding of tax regulations and loopholes, while also more consciously assessing the reputational and credit-access benefits of accounting compliance (Artavanis et al. 2016).

In this context, self-employment represents a unique laboratory for understanding the evolution of tax evasion in advanced economies with strong territorial polarization, such as Italy, where the "unobserved economy" still accounts for a significant portion of national income. Understanding the territorial heterogeneity of tax evasion is crucial to designing effective, equitable and neutral policy interventions oriented to reduce tax evasion (Carfora et al. 2018; Argentiero et al. 2020). Estimates by the Ministero

Dell'Economia e delle Finanze (2024) indicate a total fiscal gap of more than €90 billion in 2021, nearly one-third of which (i.e., €32 billion) originates from personal income taxes, of which 90% comes from self-employment and small-business income (Ministero Dell'Economia e delle Finanze 2024).

At the policy level, the European taxation landscape has been shaped by the introduction of simplified or flat-rate regimes intended to broaden the tax base, stimulate labour supply, and favor voluntary compliance. Specifically, Italy's 2007 "minimum taxpayer scheme" (MTS)–later replaced by the 2015 'regime forfettario'–sought precisely this balance between lower marginal tax rates and reduced administrative complexity in exchange for higher compliance and greater transparency. In particular, according to the reform, self-employed workers with a gross annual income of less than €30,000 had the option to switch from a progressive tax rate to a proportional tax rate, enjoying a significant reduction in accounting requirements. However, the objective of such a type of reform may not be achieved when tax rates differ greatly between income types as the reduced tax rate may crowd out the tax morale of tax payers that are not eligible to enjoy the benefits of the policy intervention (Grundmann and Lambsdorff 2017). Moreover, as already observed, the response to tax reform is likely to be influenced by spatial heterogeneity, particularly with regard to occupational and industrial structures, income levels and social capital. Overall, this could lead to asymmetric territorial effects on tax compliance. This is particularly true when the reform sets an income threshold for taxpayer eligibility, as in the case of the Italian MTS, and in the Italian context, where subnational disparities and occupational heterogeneity generate additional layers of complexity (Baldini et al. 2009; D'Agostino et al. 2021; Argentiero et al. 2024).

The present study addresses the above issue by answering the following research questions: (i) Do proportional rate regimes stimulate tax compliance?; (ii) Are such effects homogeneous across regions? The empirical investigation covers the period from 2004 to 2015 and specifically seeks to estimate the effect of MTS on tax-evasion at provincial level. The channel through which the reform may affect taxpayers compliance is twofold. Firstly, it may alter the relationship between declared taxable income and tax evasion (effect at the intensive margin). In this regard, taxpayers may be willing to disclose more of their income in light of the change in the marginal tax rate. Alternatively, the presence of an income threshold as an eligibility criterion may cause taxpayers to underreport their income in order to remain below the legal threshold of €30,000. Secondly, the reform may alter the proportion of self-employed individuals in the local labour market, which could affect tax evasion (effect at the extensive margin). Notably, an increase in the proportion of self-employed workers may reduce tax evasion due to a corresponding reduction in the size of the underground economy, but it could also lead to an increase in tax evasion if it makes self-employment more appealing to individuals who were previously employed by a firm and subject to third-party reporting. Methodologically, the reform represents a plausibly exogenous policy shock that created an institutional discontinuity (in terms of tax rate) from a well-defined point in time (2008 in our case) that can be exploited within quasi-experimental identification strategies to analyse the changes in tax evasion rates associated with such discontinuity. This approach is consistent with the empirical literature that uses dis-

crete tax reforms as institutional shocks to study taxpayers' behavioral responses (Saez et al. 2012; Kleven and Schultz 2014).

Accordingly, the empirical analysis combines an event-study design for panel data and a Difference-in-Differences (DiD) framework to assess the impact of the MTS reform. We then investigate territorial heterogeneity through sample splits based on both conventional geographical macroregions and geographically-informed spatio-temporal clustering (Cerqueti and Mattera 2025; Morelli et al. 2025, 2026). Spatio-temporal clustering analysis is not used as a separate identification strategy, but as a complementary tool to explore whether the estimated effects display systematic territorial heterogeneity across provinces with similar temporal trajectories and geographic proximity.

Our main findings reveal that the introduction of MTS had an ambiguous effect on tax evasion, with a nuanced and spatially stratified picture emerging. On the one hand, it decreased tax evasion through participation in self-employment (the 'extensive margin'), primarily in low-income provinces where administrative burdens had previously discouraged formalisation. However, in the same regions, the policy seems to have prompted taxpayers to under-report their income (intensive margin) in order to remain within the eligibility range, i.e. declaring annual earnings below €30,000. Conversely, wealthier territories (northern and central regions) exhibited weaker responses at the intensive margin, suggesting potential saturation of compliance incentives engendered by the income threshold. However, spatio-temporal clustering distinguishes between urbanized northern provinces and other wealthy areas, showing relative policy effectiveness at the intensive margin in the former compared to the latter. Occupational composition also matters, with self-employed individuals working in creative occupations responding positively to the reform. Overall, this evidence suggests that, while designed as a neutral policy, tax reductions and simplifications can generate unexpected spatial effects. Indeed, rather than uniformly enhancing compliance, it may reshape the geography of tax evasion and amplify regional inequalities in fiscal behavior. This study therefore contributes to the literature by providing new insights into how income, occupational structure, local skills and institutions can mediate national policies, yielding outcomes that diverge from standard theoretical predictions.

The paper is structured as follows. Section 2 reviews the literature. Section 3 describes the dataset and the descriptive statistics, Sect. 4 presents the empirical strategy. Section 5 discusses the results. Section 6 concludes.

2 Literature review

The link between self-employment income and tax evasion is one of the most well-established in the tax literature (Slemrod 2007; Alm 2019). Even in countries characterized by low aggregate tax evasion, remarkable levels of non-compliance are reported in the business or self-employment sector (Kleven et al. 2011). Indeed it has been extensively shown that, when third-party reporting is used, tax evasion is virtually nonexistent, while it increases dramatically when taxable income is self-declared (Kleven et al. 2011; Pomeranz 2015; Alstadsæter et al. 2019). This evidence also explains why the sectors with the highest incidence of self-employment, professional

services, retail, construction, and catering, are also those with the highest estimated tax evasion (Artavanis et al. 2016; Carfora et al. 2018). Estimated evasion rates among self-employed range between 20% and 50% of true income (Artavanis et al. 2016; Engström and Holmlund 2009). To improve the precision of these estimates, subsequent research has exploited longitudinal data and permanent-income measures to account for transitory income shocks (Engström and Hagen 2017), while incorporating register-based consumption proxies, such as pleasure boat ownership, to better capture hidden income (Engström et al. 2023). These latter studies converge on an average under-reporting of about 25–30% of true income, reinforcing the view that excess consumption among self-employed households mainly reflects income concealment rather than preference heterogeneity.

A related stream of research focuses on the relationship between tax evasion and the employment structure. Boerma et al. (2022) extend optimal taxation theory to a multidimensional skill setting, where cognitive and manual skills jointly determine workers' responses to taxation. Their model shows that ignoring workers' heterogeneity leads to suboptimal policy design, as tax distortions differ across skill types. This contribution strengthens the link between occupational heterogeneity and the fiscal response mechanisms emerged in the empirical literature. In this regard, cognitive skill-intensive activities have been shown to weakly or negatively correlate with tax evasion indicators, likely due to the reputational effect and the greater degree of formalization required to access credit (Artavanis et al. 2016). In the Italian context, Argentiero et al. (2024) found that local labour markets with a higher incidence of soft and horizontal skills exhibit higher levels of tax evasion, consistent with greater discretion and the difficulty of monitoring undocumented interpersonal transactions. In this context, psychological and behavioral aspects also play a role. Laboratory experiments have shown that the propensity for honesty and reputational sensitivity are heterogeneous across individuals and countries (Andrighetto et al. 2016; Abeler et al. 2019). Complementing these findings, Engström et al. (2015, 2022) use administrative tax-return data to examine how loss aversion shapes compliance behavior. In this regard, they find that taxpayers react more strongly to potential losses than to equivalent gains, showing higher compliance when tax changes are framed as losses, even under moderate tax-rate variation.

Territorial features have also emerged as crucial in the analysis of tax evasion (Alm and Yunus 2009; Herwartz et al. 2015). Besides the share of self-employed, other typical local determinants of tax evasion include social capital, the effectiveness of local audits, the incidence of agriculture on regional value, added, the share of self-employed, firm size, crime rates, and GDP growth. Territorial features are also encompassed in those studies analysing the role of cultural and informal institutions in gauging tax compliance. Cheng et al. (2024) exploit a historical boundary between Confucian and non-Confucian regions in China to show that cultural norms can act as persistent informal enforcement mechanisms, especially among small local firms. Overall, the presence of weak institutional contexts or permissive social norms, especially at the local level, can reduce the moral costs of lying, increasing the economic convenience of tax evasion.

In the Italian case, provincial and regional studies (Argentiero et al. 2020, 2024) confirm that the share of self-employment and the local production and occupational

structure explain a significant portion of the variance in the tax gap, which ranges from 10% to 70% of declared taxes and from 3% to 9% of value added. These differences are associated with contextual factors such as institutional quality (Nifo and Vecchione 2014), social capital (Buonanno et al. 2009), and territorial tax enforcement (Carfora et al. 2018). Carfora et al. (2018) show that the intensity of regional tax controls in Italy reduces tax evasion only in the presence of adequate local administrative capacity. Bosco et al. (2025) provide complementary evidence on the behavioral responses to income taxation in Italy. Using a TWFE DiD approach around the personal income tax reforms, they show that higher tax rates temporarily reduced self-employment and regional GDP growth, therefore confirming that labour supply and entrepreneurial activity react strongly, although transitorily, to tax changes, and supporting the relevance of heterogeneous treatment effects in subnational analyses.

The interplay between self-employment, skills and territorial institutions shows that tax compliance is not just an individual decision. Policies designed to simplify taxation interact with deeply rooted spatial structures, producing outcomes that differ from those predicted by theory. In particular, the impact of such policies is likely to be gauged by three spatially-driven dimensions:

1. Structural, linked to the presence or absence of third-party reporting and the degree of formalization of markets;
2. Behavioral, determined by social norms and individual preferences for honesty;
3. Skill-based, with the interaction between soft, horizontal, and cognitive skills shaping the economic and psychological convenience of tax evasion.

These dimensions and their interactions must therefore be considered when analysing the effectiveness of tax reforms that reduce the marginal tax rate to encourage tax compliance. In particular, introducing new tax regimes, such as a proportional tax system, can have a wide range of consequences, some of which have already been considered in the literature. The theoretical basis for evaluating these responses lies in the analysis of taxable income elasticity. Kleven and Schultz (2014) estimate the elasticity of taxable income as a mean to assess the welfare cost of taxation, provided that behavioral responses encompass all adjustment margins, including evasion and avoidance. Specific aspects have been highlighted by Mill and Schneider (2023), who conducted a large-scale real-effort experiment on an online labor market, showing that allowing limited opportunities for evasion can paradoxically increase labour supply and expected tax revenues. Their findings suggest that, under certain conditions, the perceived fairness and flexibility of tax enforcement can enhance overall compliance, aligning behavioral incentives with fiscal efficiency. In the same vein, Grundmann and Lambsdorff (2017) experimentally find that high tax rates induce evasion only if lower tax rates are applicable to other categories of income earners. More recently, it has been shown that entrepreneurial tax evasion may dampen the positive output effects of moving from a progressive to a flat tax system, while simultaneously mitigating the rise in wealth inequality (Fernandez-Bastidas 2023). The same author also highlights how the level of tax evasion and its distribution across occupations can shape the allocative and distributive consequences of fiscal reforms, and eventually the evaluation of policy interventions introducing flat tax regimes.

In this regard, a research gap lies in linking the structural features of local economies with taxpayers' behavioural response to tax reform. Furthermore, the literature has not explicitly distinguished between the income-based response (intensive margin) and the decision to become self-employed (extensive margin) when assessing the impact of tax reforms. On the one hand, income-based economic mechanisms concern the amount of labour supplied by individuals who are already self-employed, as well as the potential under-reporting phenomenon associated with an income threshold. On the other hand, variation in the self-employment rate refers to the decision to offer labour, which affects the propensity to evade taxes differently according to the applicable tax regime for self-employment. Integrating micro-founded and territorial approaches, this study assesses how the structure of local labour markets may influence the behavioural response to tax reforms at both margins, specifically examining the impact of introducing proportional tax regimes on regional tax evasion.

3 Dataset and descriptive statistics

3.1 Data

Our empirical analysis is based on several data sources that allow us to build up a unique panel dataset covering the years from 2004 to 2015 for the 103 Italian Provinces existing in 2001.

The first data source is the yearly estimation of tax evasion implemented by the *Italian Revenue Agency* (in Italian referred to as the *Agenzia delle Entrate*) at provincial level. From this dataset, we draw the propensity to evade taxes for each Italian Province, measured through two different ratios: on the one hand, tax evasion as a share of total tax collections; on the other hand, the share of tax evasion over the value added. We choose the former as our proxy of tax evasion as it reports the ratio between the tax gap, i.e., the difference between potential taxable revenues estimated based on national accounts with the revenues actually declared by taxpayers, and the spontaneous tax revenues (Lyssiotou et al. 2004; Martinez-Lopez 2013). This approach is widely used in the empirical literature on tax compliance and allows capturing various forms of tax non-compliance, including under-reporting and participation in the underground economy (Slemrod 2007; Alm 2019). Such measure enables us to assess the gap between the potential collection of taxes, according to National Accounts data, and the effective tax revenues voluntarily declared by taxpayers in the Province. It must be acknowledged that this measure of tax evasion has some limitations as it does not allow for a perfect distinction between illegal tax evasion, legal tax planning and potential reporting errors. However, these limitations are common to most aggregate tax evasion gap measures used in the empirical literature. Furthermore, in our empirical context, such potential measurement errors should not compromise the identification of the reform's effects, as our econometric strategy relies on temporal variations within provinces. Any relatively stable measurement error over time would be absorbed by province and time fixed effects, and would not be correlated with the introduction of the MTS reform.

The second dataset is provided by the *Italian Labour Force Survey*, named "Rilevazione Continua delle Forze di Lavoro" (RCFL), whose microdata are gathered by the National Institute of Statistics (ISTAT). It provides detailed information about workers' characteristics and job positions, including educational attainments, occupations, and the industry of the employing firm. Among others, we used quarterly waves of surveys that have been conducted from 2004 to 2015, involving more than 100 thousand workers per wave, aggregating each variable at the province level. From this dataset, we computed in particular the share of self-employed and part-time workers, the average educational attainment, the share of female workers, and the industrial structure of local economies in terms of employment shares in each macro-sector.

The above dataset was then merged with two other publicly available datasets. The first database concerns the figures on personal taxable income aggregated at the municipal level, as provided by the Italian Ministry of Economics and Finance. After aggregating them at the provincial level, we considered the average taxable income declared by self-employed for our empirical analysis. The second dataset is the Survey on Italian Professions ("Indagine Campionaria delle Professioni" - ICP) performed by the National Institute of Analysis of Public Policies (INAPP) in 2013 to identify the constituent tasks and skills of each of the 800 job titles included in the Italian occupational classification. Interviewed workers were asked to self-assess their degree of utilization of knowledge, skills and the constituent tasks to be performed on their respective job posts. Drawing upon the skill families already put in place by the Occupational Information Network (ONET) (Gregory et al. 2019; Fleisher and Tsacoumis 2012), OECD (2016), and the European Union (CEDEFOP 2013), we run a PCA, extracted four components (> 75% of explained) and labeled them as follows: Component1 = cognitive skills; Component2 = technical skills; Component3 = horizontal skills; Component 4 = soft skills.[1] The main disadvantage of our skill-based indicator is that skill demand remains constant within each occupation over time. Unfortunately, we cannot address this issue as the subsequent ICP survey was conducted in 2021, which is outside our observation period. Nevertheless, our indicator can measure variations in skill demand between occupations over time, which is the most important source of variability in the short term.

Other publicly available information included in the dataset concerns the socio-economic characteristics of Italian Provinces (Maranzano et al. 2025; Monturano et al. 2025b, a; Bergantino et al. 2026b, a), including per capita GDP and social capital (i.e., share of cooperatives), as made available by ISTAT, as well as the information on the institutional environment by using the ad-hoc indicator (i.e., the Institutional Quality Index-IQI) developed by Nifo and Vecchione (2014) at the Italian provincial level. The inclusion of institutional variables in our analysis fits with another stream of literature that showed the importance of the institutional setting in driving individuals'

[1] Cognitive skills involve the use of logical, intuitive, and abstract/creative thinking, like understanding a written text, mathematics, science, and active learning. Technical skills refer to activities like quality control, monitoring machines, and maintenance. Horizontal skills include capabilities like negotiating, monitoring, managing time, human, and financial resources. Soft skills are related to social perception, coordination with others and persuasion, while technical skills include design, programming, evaluating systems and installing (Cattani and Pedrini 2021).

and firms' compliance behavior (Cummings et al. 2009; Andrighetto et al. 2016; Zhang et al. 2016).

The description and source of the variables used are reported in the Table 1.

3.2 Descriptive statistics

Table 2 shows the essential descriptive statistics of tax evasion, self-employment incidence (extensive margin) and income (intensive margin) at the provincial level during each observed year. The average tax gap with respect to declared taxes remained substantially stable between 2004 and 2015, decreasing by only one percentage point from 43% to 42%. However, it is worthwhile noticing that between 2007 and 2012 tax evasion significantly dropped, then bouncing back to the initial level in 2013. During the same period self-employed income experienced an increase, reaching the peak of € 40,336 in 2011, whereas the share of self-employed decreased from 25% in 2004 to 21% in 2015. As displayed in Fig. 1, the spatial variability throughout the provinces is remarkable for all these variables (see also Fig. 7 in Appendix A for their dynamics over time). In particular, self-employment income and tax gap share clearly follow a north–south divide, while self-employment share is higher in peripheral non-urban provinces, with a noteworthy density in northern Puglia, Calabria, and western Sicily. These stylized facts indicate that the structural features of local economies can play a substantial role in driving the propensity to evade taxes and the individual decision to work as self-employed.

Table 3 presents the descriptive statistics of all the main variables. Variability is particularly higher for the tax gap share, whose standard deviation is 337 equal to 0.12 (coefficient of variation = 0.29). Moving to the occupational structure, we observe that on average 24% Italian workers are self-employed, with a wide range across provinces. As far as industries are concerned, the majority of the self-employed workers is employed in the construction and the retail sectors (37% overall), while manufacturing accounts for 12% of the workforce. The analysis of workers' characteristics highlights some common features of the local labour markets, namely the low share of females and the high average age. Institutional quality reveals a deeper territorial division in all the dimensions taken into account: quality of governance (IQI), social capital (workers' cooperatives), environmental awareness (recycled waste), and criminal rates (theft). Finally, entrepreneurial dynamism and financial soundness appear to be the most discriminating factors, with some provinces enjoying a virtuous circle, and others characterized by firms' foreclosures and financial distress. Most disaggregated descriptive analysis is reported in Table 11 in the Appendix A, which reports the statistics divided by treated and untreated provinces.

4 Empirical strategy

The empirical analysis aims to estimate the impact of the introduction of the MTS, which was enacted in 2007 and entered into force in 2008 (Law 244/2007), on tax compliance dynamics at the provincial level. The MTS introduced a set of advantages

Table 1 Definition and sources of variables

Variable	Definition	Source
Outcome		
Tax_gap_share	Tax gap relative to total tax collections	Italian Revenue Agency
Treatment		
Self-employed_income	Average declared income of self-employed taxpayers	Italian Ministry of Economy and Finance (MEF)
Skill variables		
Self-employment_share	Share of workers who are self-employed relative to total employment	ISTAT – Labour Force Survey
Technical_skills	Share of workers employed in occupations intensively using technical skills	ISTAT – Labour Force Survey
Cognitive_skills	Share of workers employed in occupations intensively using high cognitive skills	ISTAT – Labour Force Survey
Horizontal_skills	Share of workers employed in occupations intensively using transversal skills	ISTAT – Labour Force Survey
Soft_skills	Share of workers employed in occupations intensively using soft skills	ISTAT – Labour Force Survey
Other variables		
Share_cooperative_employees	Share of employees working in cooperative firms	ISTAT – Territorial Database for Development Policies
Thefts_per_1,000_inhabitants	Number of reported thefts per 1,000 inhabitants	ISTAT – Territorial Database for Development Policies
Recycling_rate	Share of recycled waste collected relative to total waste production	ISTAT – Territorial Database for Development Policies
Provincial_institutional_quality_index	Composite index measuring institutional quality at the provincial level	Institutional Quality Index Database
Firm_net_entry_rate	Difference between newly registered and closed firms relative to the total number of firms	ISTAT – Territorial Database for Development Policies
Loan_default_rate	Share of bank loans classified as non-performing relative	ISTAT – Territorial Database for Development Policies

Table 1 continued

Variable	Definition	Source
Female_employment_share	Share of employed women relative to total employment	ISTAT – Labour Force Survey
Average_age	Average age of the employed population	ISTAT – Labour Force Survey
Educational_attainment	Average level of educational attainment among employed workers	ISTAT – Labour Force Survey
Average_weekly_hours_worked	Average number of weekly hours worked by employed individuals	ISTAT – Labour Force Survey
Agriculture_share	Employment share of workers employed in agriculture	ISTAT – Labour Force Survey
Extractive_industries_share	Employment share of workers employed in extractive industries	ISTAT – Labour Force Survey
Manufacturing_share	Employment share of workers employed in manufacturing industries	ISTAT – Labour Force Survey
Construction_share	Employment share of workers employed in the construction industries	ISTAT – Labour Force Survey
Trade_and_repair_share	Employment share of workers employed in wholesale and retail trade and repair activities	ISTAT – Labour Force Survey
Transport_and_logistics_share	Employment share of workers employed in transportation and logistics services	ISTAT – Labour Force Survey
Accommodation_and_food_services	Employment share of workers employed in accommodation and food service activities	ISTAT – Labour Force Survey
Information_and_communication	Employment share of workers employed in information and communication activities	ISTAT – Labour Force Survey
Financial_and_insurance_activities	Employment share of workers employed in financial and insurance activities	ISTAT – Labour Force Survey
Professional_scientific_technical	Employment share of workers employed in professional, scientific and technical activities	ISTAT – Labour Force Survey
Public_administration_and_other_services	Employment share of workers employed in public administration and other service activities	ISTAT – Labour Force Survey

Note: all the variables are measured at the provincial level

Table 2 Evolution of tax evasion, self-employment share and self-employment income over time

Years	Self-employed_income	Tax_gap_share	Self-employment_share
2004	30649	0.43	0.25
2005	30829	0.42	0.24
2006	34109	0.40	0.23
2007	35190	0.37	0.23
2008	36633	0.38	0.22
2009	37650	0.42	0.22
2010	39943	0.40	0.22
2011	40336	0.40	0.22
2012	34459	0.40	0.22
2013	33925	0.42	0.22
2014	34207	0.42	0.21
2015	36640	0.42	0.21

for self-employed workers complying with a set of eligibility criteria for the new preferential regime, the most important one was declaring less than € 30,000 gross annual income. The main benefits concern a simplification of both accounting and administrative duties, along with a reduction of the marginal tax burden. In this latter respect, the reform entailed a shift from a progressive tax rate to a proportional tax rate for eligible workers who chose the new regime. The reduction of the marginal tax rate could range between 3% for workers earning less than € 15,000, to 18% for workers earning more than € 28,000. The net tax savings varied by occupation, but could amount to € 1,736 per year for a consultant with a gross annual income of € 30,000, resulting in a reduction in her average tax rate of almost 6%. Subsequently, from 2019, the threshold was raised to €65,000 (Law 195/2018) and then to € 85,000 (Law 197/2022), substantially widening the share of eligible workers. For its features the MTS generated a discontinuous change in incentives for taxpayers through three main channels. Firstly, a change in the average tax rate may influence the decision to become or remain self-employed. Secondly, among self-employed workers, the lower marginal tax rate may affect declared income and reporting behaviour. On the one hand, it may increase the number of working hours and tax compliance for those workers far below the €30,000 threshold. On the other hand, it may prevent self-employed workers to exceed the 30,000 threshold, either by working less or underreporting their income. Thirdly, the different income coefficients and administrative costs applicable to different professions are likely to change the net share of new self-employed workers in each occupation due to the asymmetric effects of the MTS regime on occupations. For all these reasons, the MTS reform represents an exogenous institutional change that created a discontinuity in terms of self-employment income and rate, as well as occupational composition, from a defined point in time (2008). This approach is consistent with the empirical literature that uses discrete tax reforms as institutional shocks to study taxpayers' behavioural responses. The eligibility threshold also allows

Table 3 Descriptive statistics of the main variables

Variables	Mean	Sd	Max	Min
Outcome				
Tax_gap_share	0.42	0.12	0.73	0.10
Explanatory variables				
Treatment				
Self-employed_income	34962.18	7200.09	55933.09	18060.2
Skill interactions				
Self-employment_share	0.23	0.04	0.42	0.15
Technical_skills	0.02	0.01	0.09	0
Cognitive_skills	0.02	0.01	0.14	0
Horizontal_skills	0.02	0.01	0.14	0
Soft_skills	0.03	0.02	0.15	0.01
Controls				
- Institutional quality				
Share_cooperative_employees	4.22	1.46	11.35	1.45
Thefts_per_1,000_inhabitants	20.49	8.84	60.25	2.27
Recycling_rate	34.51	19.46	84.09	1.73
Provincial_institutional_quality_index	0.57	0.25	1	0
- Socio-economic				
Firm_net_entry_rate	0.51	1.31	4.7	−7.09
Loan_default_rate	2.84	2.05	20.18	0.16
- Labour market				
Female_employment_share	0.29	0.04	0.44	0.16
Average_age	45	1.73	50.53	40.14
Educational_attainment	4.71	0.41	6.18	3.53
- Sector				
Average_weekly_hours_worked	54.44	14.46	153.34	36.07
Agriculture_share	0.10	0.07	0.36	0
Extractive_industries_share	0.04	0.06	0.24	0
Manufacturing_share	0.12	0.04	0.32	0.02
Construction_share	0.18	0.08	0.52	0.05
Trade_and_repair_share	0.19	0.10	0.46	0.01
Transport_and_logistics_share	0.05	0.04	0.22	0
Accommodation_and_food_services	0.02	0.02	0.09	0
Information_and_communication	0.02	0.01	0.10	0
Financial_and_insurance_activities	0.15	0.04	0.32	0.02
Professional_scientific_technical	0.04	0.02	0.15	0
Public_administration_and_other_services	0.06	0.02	0.19	0
N.Obs	**1227**			

Source: Authors' elaboration based on data from the Italian Ministry of Economy and Finance (MEF), the ISTAT Labour Force Survey, the Territorial Database for Development Policies, and the Institutional Quality Index dataset

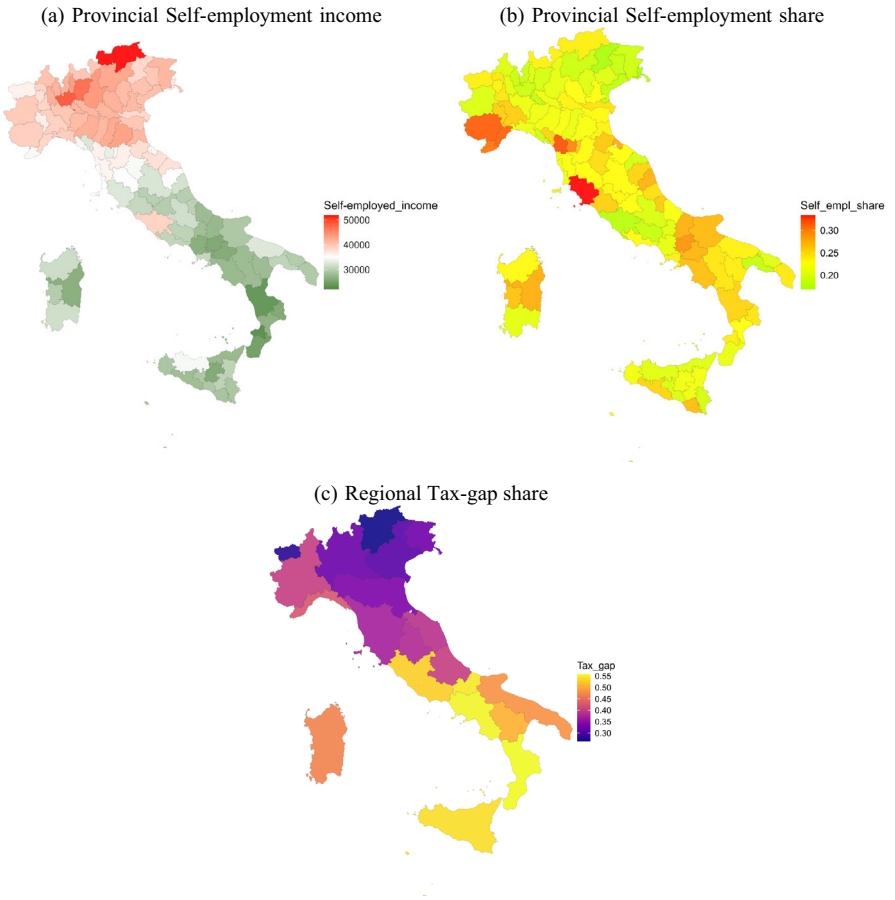


Fig. 1 Spatial distribution of treatments and outcomes variable. **Source:** Authors' elaboration. **Note:** For privacy and data dissemination reasons, the average Tax-gap value is shown on the map at an aggregate regional level

us to categorise provinces as 'treated' or 'untreated' according to their median income prior to the reform when looking at its effect across regions.

This institutional shock can thus be used in quasi-experimental identification strategies to analyse changes in tax evasion rates associated with this discontinuity. The outcome variable is the provincial tax gap share, which captures local tax compliance and evasion through the estimated ratio between evaded taxes and declared taxes. This reflects the regime's effectiveness in shaping taxpayers' behaviour through its main adjustment margins: the positive elasticity of self-employed income with respect to the reduction in the tax rate ('intensive margin'), and the shift into self-employment of workers attracted by the new favourable tax regime ('extensive margin'). Self-employment income and self-employment shares are therefore our main regressors. Regarding the former, we acknowledge that variation in self-employment income may underlie both the income and substitution effects on labour supply, but we can-

not distinguish between these in this analysis. With regard to the latter, an increase in the number of self-employed workers would affect the level of tax compliance in two ways: firstly, it could reduce undeclared work and thus increase tax compliance. On the other hand, a shift from employed to self-employed status could provide an opportunity for workers previously subject to withholding tax to evade taxes. A third channel is the choice of profession for self-employed workers due to the asymmetric rules provided by the MTS regime across occupations. Each occupation usually has different compliance rates according to the observability of tasks and the type of skills required for the job. The occupational composition is therefore likely to change further following the introduction of the MTS, resulting in a change in the tax gap share due to taxpayers' different behaviour across occupations at the extensive margin. Our chosen institutional shock may therefore have affected the regional tax gap via three main channels. However, our focus is on self-employed income and the proportion of the self-employed, since the uneven territorial impact of MTS on tax evasion is most likely to have occurred through these two mechanisms.

Our identification strategy relies on two complementary and mutually reinforcing approaches. On the one hand, we implement a two–way fixed–effects event–study design, which captures the dynamic evolution of outcomes after 2008, i.e. the time of enactment of MTS. On the other hand, we leverage on a Difference–in–Differences (DiD) framework (e.g., Card and Krueger 2000; Roth et al. 2023), estimated both in a binary specification and in a continuous (dose-response) version (Cerulli and Ventura 2021; Bosco and Maranzano 2025). While the event study provides preliminary evidence of the structural break in trends induced by MTS, the Difference-in-Differences (DiD) approach strengthens the identification strategy by explicitly contrasting the treated and control groups, which are determined in different ways for the sake of robustness. We also control for the pre-reform trend of our treatment variables by isolating the pre-reform period in the event study analysis and hypothesising a pre-treatment placebo reform in 2006.

To account for differences in pre-reform exposure and check the impact of MTS on tax evasion ascribable to different pre-reform income levels and occupational composition we also replicate the event-study specification using exposure measures fixed at pre-reform values. Specifically, we use the 2007 provincial exposure, the province-specific pre-reform average, and a dynamic specification interacting each post-reform year with pre-reform exposure. This issue does not apply to DID specification because it already accounts for pre-reform income levels when creating the group of treated and non-treated provinces

Finally, to investigate the estimated spatial heterogeneity further, we performed an additional north–south sample split analysis, e.g. Deleidi et al. (2021), considering the macro-areas that are traditionally characterised by structural economic and institutional imbalances separately. We also control for outliers and regional asymmetric shocks by cross-validating the estimates through a leaving-one-out procedure (Kline et al. 2020; Bates et al. 2024). Moreover, to capture the spatial dependence of the reform's effects, we complement our identification strategy with additional components. Notably, we implement a hierarchical spatio–temporal clustering analysis that groups provinces according to the similarity of their dynamic trajectories and geographic proximity (Wooldridge 2003; Cerqueti and Mattera 2025; Morelli et al. 2025,

2026). By combining the dynamic perspective of the event–study with the counterfactual approach and further integrating spatial clustering, we provide a comprehensive and multidimensional assessment of the effects of the MTS reform, both as an average treatment effect and as a spatially heterogeneous process varying in intensity across provinces.

4.1 Post-reform event study

We start by implementing a two–way fixed–effects event–study design (see Marcus and Sant'Anna, P. H. 2021; Miller 2023; Borusyak et al. 2024; Callaway et al. 2024b) while interpreting the MTS as a common policy shock affecting all Italian provinces. Indeed, before 2008, no province was exposed to the regime due to the absence of any simplified tax regime for self–employed workers. From 2008 onwards, the adjustment margins take strictly positive and continuous values, reflecting the intensity of exposure to the new regime proxied by self-employed shares and self-employed income. This structure allows us to exploit the variation between the pre–reform period (2004–2007) and the post–reform period (2008–2015).

The primary identification assumption is that, in the absence of the reform, fiscal and productive outcomes would have continued to follow the same trajectories observed prior to 2007. The introduction of MTS regime, thus, represents an exogenous policy change that enables a credible estimation of the differential attributable to the reform Argentiero et al. (2020).

The empirical specification takes the following general form:

$$Y_{it}^{k} = \alpha_i^k + \lambda_t^k + \beta_m^k \, P_{it}^{m,k} + \mathbf{X}_{it}' \theta^k + \varepsilon_{it}^k, \tag{1}$$

where Y_{it}^k denotes the outcome in province i and year t estimated under specification k; α_i^k and λ_t^k are province and year fixed effects; $P_{it}^{m,k}$ represents the set of *policy—exposure variables* capturing different dimensions of adjustment m to MTS, such as the share of income from self–employment, the proportion of self–employed workers, and the distribution of skill families across occupations; $\mathbf{X}_{it}$ is the vector of social, economic, and institutional controls as summarized in Tables 3 and 11, while ε_{it}^k is the idiosyncratic error term. Each exposure variable P_{it}^k is defined as:

$$P_{it}^{k} = \begin{cases} 0, & \text{if } t < 2008 \\ \tilde{P}_{it}^{k} \geq 0, & \text{if } t \geq 2008 \end{cases}$$

where $\tilde{P}_{it}^k$ denotes the observed post–reform value of the corresponding indicator. This construction ensures that all provinces are unexposed before 2008 while allowing for heterogeneous post–reform intensity. The equation 1 serves as a general framework for estimation. In practice, we estimate a sequence of progressively richer specifications to assess the stability of the estimated coefficients once additional sources of heterogeneity are introduced.

4.2 Difference-in-Differences (DiD)

To reinforce identification, we complement the event–study analysis with a Difference-in-Differences (see for details Roth et al. 2023; Wooldridge 2023; Callaway et al. 2024a; De Chaisemartin and Haultfoeuille 2024; Wooldridge 2025), framework that exploits variation in provincial income structures prior to reform. The underlying intuition is that provinces with different pre–existing levels of self–employment income may have experienced heterogeneous responses to the introduction of the MTS regime.

We classify provinces into two groups based on their 2007 income distribution: (i) provinces with declared income above the national median form the control group (*Treatment_i*=0), and (ii) those below the median represent the treated group (*Treatment_i*=1), leveraging on the evidence that the national median taxable income in 2007 was approximately €30,000, i.e. the eligibility threshold of MTS. The post–reform period is defined as $Post_t = 1$ for $t \geq 2008$ and $Post_t = 0$ otherwise. The empirical specification is defined as:

$$Y_{it}^{k} = \alpha_i + \lambda_t + \beta^{k} \left(Post_t \times Treatment_i^{k}\right) + \mathbf{X}_{it}'\theta^{k} + \varepsilon_{it}^{k}, \tag{2}$$

where Y_{it}^{k} denotes the provincial tax gap share in specification k, capturing local tax compliance and evasion; α_i and λ_t are province and year fixed effects; and $Treatment_i^{k}$ represents the treatment variable, defined as $Treatment_i^{b}$ in the binary specification ($Treatment_i \in \{0, 1\}$) and as $Treatment_i^{c} = SelfEmployedIncome_{it}$ in the continuous specification. The vector $\mathbf{X}_{it}$ includes socio–economic, structural, and institutional controls described in Table 3 and 11, while ε_{it}^{k} is the idiosyncratic error term.

The coefficient β of the Eq. 2 captures the average impact of the MTS on provincial tax compliance, estimated under two alternative Models: (i) a traditional binary specification, where the treatment is discrete; and (ii) a continuous specification (Cerulli and Ventura 2021; Callaway et al. 2024a), where treatment intensity varies along with the average income from self–employment. This unified formulation allows us to assess both the average discrete effect of the reform and its heterogeneous intensity across provinces, holding other factors constant. Province and year fixed effects control for unobserved heterogeneity and common shocks. As for the event study design, both DiD Models (binary and continuous) are estimated across four specifications k that progressively introduce additional control variables, corresponding to the same structure adopted in the event–study estimations.

The effect of the reform can be expressed in expectation form as:

$$\begin{aligned}\Delta Y^k = &\Big(\mathbb{E}[Y_{it} \mid Treatment_i^k > 0,\ Post_t = 1] - \mathbb{E}[Y_{it} \mid Treatment_i^k > 0,\ Post_t = 0]\Big) \\ &- \Big(\mathbb{E}[Y_{it} \mid Treatment_i^k = 0,\ Post_t = 1] - \mathbb{E}[Y_{it} \mid Treatment_i^k = 0,\ Post_t = 0]\Big),\end{aligned} \tag{3}$$

where ΔY^k denotes the Difference–in–Differences estimator for treatment specification $k \in \{b, c\}$, corresponding to either the binary or continuous case.

As in the event study framework, DiD models are estimated through a sequence of progressively enriched specifications. Specifications are introduced sequentially by adding control blocks, allowing us to assess the stability of the estimated treatment effect across increasingly richer empirical designs.

DID identification relies on two key assumptions: (i) the parallel–trends hypothesis (Freyaldenhoven et al. 2019; Marcus and Sant'Anna, P. H. 2021; Roth and Sant'Anna 2023), and (ii) the absence of anticipatory behavioral responses prior to the introduction of the reform. To assess these assumptions, we combine graphical evidence with a dynamic Difference-in-Differences event–study analysis. Figure 2 reports the average evolution of the provincial tax gap share for treated and control provinces over the period 2004–2015. Both groups display broadly comparable trajectories in the years immediately preceding the reform, suggesting broadly comparable dynamics before the policy intervention. A more transparent diagnostic is provided by the pre-trend event–study specification later illustrated in Sect. 5. The absence of anticipatory effects is tested by augmenting the DID model with terms that capture the differences in slopes between treated and controls. The joint Wald test on the pre-treatment coefficients fails to reject the null hypothesis that the coefficients are jointly 0 when we restrict the pre-period test to $t = -2$ (Table 12 in Appendix B), which is the most relevant for our identification strategy. Accordingly, the results provide no indication of anticipatory effects in the period immediately preceding the reform, thus mitigating pre-trend concerns. Usual placebo tests simulating artificial treatments and pre-policy interventions are then conducted in Sect. 5.2. It is to be noticed that the "strong parallel trends" assumption proposed by Callaway et al. 2024a is not applicable to our DiD design because treatment assignment is based on an initial binary classification of provinces into treated and untreated groups according to whether their median income is above or below € 30,000, i.e. the MTS threshold. Accordingly, the continuous variables considered in the analysis do not determine treatment status and are only used within the treated group, with the non-treated group being assigned the value of 0. Therefore, identification relies on the standard parallel-trends assumption between treated and untreated provinces prior to the reform.

4.3 Assessment of spatial heterogeneity

To explore the potential spatial heterogeneity underlying the main results, and thus detect any unintended spatial consequence of the MTS reform, we complement the empirical analysis with a three-step analysis aimed at assessing and interpreting the heterogeneous regional responses associated with the event–study and Difference-in-

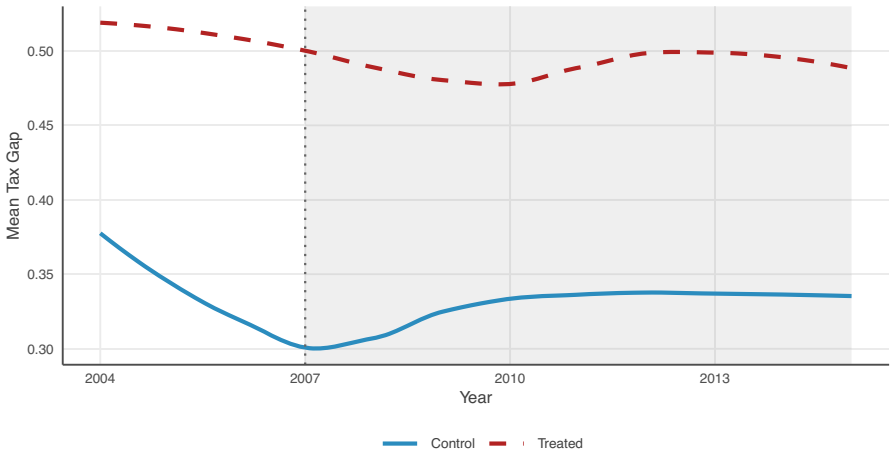


Fig. 2 Average tax_gap_share before and after the 2007 reform by treatment status. **Notes:** The figure illustrates the average tax_Gap_Share for treated (red curve) and control (blue curve) provinces between 2004 and 2015. The shaded area highlights the pre–treatment period immediately preceding the reform (2006–2007), which is used to assess the parallel–trends assumption. Both groups display similar dynamics in the years directly prior to the policy intervention

Differences estimates. Moreover, to address regional variability at the NUTS-2 level, we clustered the standard errors in all the specifications.

First, we examine the traditional North–South divide (e.g. Di Caro and Fratesi 2022; Monturano et al. 2025a), by running separate regressions for these two macro-regions and then interacting the southern macro-regional dummy with our treatment variables within unified specifications to preserve comparability in fixed effects structure with the baseline estimations.

Second, we perform a leave–one–region–out (LORO) robustness exercise in which the baseline event–study specification is re–estimated iteratively while excluding all provinces belonging to a given region r. This procedure follows the general leave–one–out logic widely used in resampling and cross–validation analyses (e.g. Kline et al. 2020; Bates et al. 2024), however we refer the readers to Meyer et al. (2018) and Otto et al. (2024) for a formalization of the leave-location-out approach applied to spatio-temporal data. Let $\hat{\boldsymbol{\beta}}_{(-r)}$ denote the vector of event–time coefficients obtained when region r is removed from the estimation sample. Formally, the coefficients are obtained by estimating the following model on the restricted sample:

$$\hat{\boldsymbol{\beta}}_{(-r)} = \arg\min_{\boldsymbol{\beta},\theta} \sum_{(i,t)\in\mathcal{D},\, i\notin r} \left(Y_{it} - \alpha_i - \lambda_t - \sum_{k\neq -1} \beta_k \left[\mathbf{1}(t - T = k) \times Z_{it} \right] - \mathbf{X}'_{it}\theta \right)^2,$$

where α_i and λ_t denote province and year fixed effects, respectively, T indicates the policy implementation year (2008), Z_{it} represents the treatment exposure variable, and $\mathbf{X}_{it}$ is the vector of control variables. The coefficients β_k capture the dynamic treatment effects at each event time k, with $k = -1$ used as the reference period. If the estimated effects are not driven by any single region, the sequence of coefficients

$\hat{\boldsymbol{\beta}}_{(-r)}$ should remain stable across iterations. We visualize these results by plotting the event–study estimates obtained under each leave–one–region–out iteration together with the baseline event–study estimate computed using the full sample.

Third, we adopt a geographically-informed hierarchical clustering procedure to identify groups of provinces that share similar temporal trajectories in tax compliance and self–employment structure while accounting for their geographical proximity Morelli et al. (2025). This approach moves beyond *ex–ante* administrative partitions, such as the conventional North–Center–South divide, and instead detects clusters of territories that evolve similarly across both temporal and spatial dimensions. Following the spatio-temporal hierarchical clustering approach proposed by Morelli et al. (2025), the algorithm integrates two sources of dissimilarity:

1. the dissimilarity in the temporal dynamics of key variables, here computed by means of a Dynamic Time Warping (DTW) strategy (Sakoe and Chiba 1971, 1978; Berndt and Clifford 1994);
2. the geographical dissimilarity, here defined by the Great Circle (or Geodetic) distance among the provinces' centroids.

Let $D^{(\text{time})} = [d_{ij}^{time}]_{i,j=1,\ldots,n}$ and $D^{(\text{space})} = [d_{1,ij}^{space}]_{i,j=1,\ldots,n}$ be the DTW distance matrix for the variable of interest and the geodetic spatial distances matrix considering a sample of n georeferenced time series, respectively. Notice that, in our specific case study, the indices i and j denote a generic pair of provinces.

The two dissimilarities are linearly combined into a weighted matrix

$$D_\alpha = (1-\alpha)D^{(\text{time})} + \alpha D^{(\text{space})},$$

where $\alpha \in [0, 1]$ controls the relative contribution of geographical proximity to the overall dissimilarity.[2] The Ward-like hierarchical algorithm is then applied to the convex combination D_α instead of being applied separately to the socio-economic dissimilarity matrix $D^{(\text{time})}$ or to the geographical distance in $D^{(\text{space})}$. According to this criterion, provinces exhibiting similar temporal trajectories and geographic proximity are grouped into K clusters using a hierarchical spatio–temporal clustering procedure inspired by the `ClustGeo` framework (Chavent et al. 2018; Morelli et al. 2025, 2026) and extending Ward's minimum–variance method to composite dissimilarities combining spatial and temporal components. We also consider both the univariate and the multivariate time series setting: in the first case, we generate the clusters by combining the geodetic geographical distances with the DTW distances computed for either tax gap share or self–employment income; while in the second case the clusters are obtained by linearly combining the dissimilarity of tax gap share, the dissimilarity of self–employment income, and the geographical dissimilarity.

[2] Notice that $\alpha = 0$ yields a non-spatial solution exclusively based on the information embedded in the variable of interest, whereas $\alpha = 1$ yields a purely geographically-informed one. The weight α should not be interpreted as a measure of the actual relevance of the geographical component in determining the partitions, but exclusively as the weight that the spatial dissimilarity matrix carries in the optimization phase of the within-cluster pseudo inertia. To assess the importance of geography, however, suggest the use of a new indicator, called Joint Inertia, is suggested to quantify the contribution of spatial distances when integrated with other features. Since in this paper the geographically-informed hierarchical clustering plays solely a role of robustness analysis in support of our investigation, this indicator has been disregarded in order to avoid overburdening the text.

The number of clusters (K) and the spatial weight ($\omega_S = \alpha$) are determined in two steps. First, the optimal number of clusters K^* is selected using an elbow rule applied to the increase in the proportion of explained pseudo–inertia. Second, α^* is calibrated by iteratively varying $\alpha \in [0, 1]$ and selecting the value that maximizes the average explained pseudo–inertia (see Morelli et al. 2026; Cerqueti and Mattera 2025; Zammarchi and Maranzano 2026, for recent discussions on the hyperparameters selection). Moreover, a quantile–based reference value, namely α_q with $q = 0.90$, is also computed to ensure robustness against local optima and outliers.

Finally, the event–study and DiD models (Eq. 1, and 2) are re–estimated within the identified clusters, allowing for heterogeneous treatment effects across geographically-and-structurally-homogeneous territories and thus addressing potential endogeneity and omitted variable bias arising from the joint evolution of self–employment income and self–employment share. Indeed, this twofold stratification provides two layers that mitigate spatial-temporal confounding, yielding a consistent, robust and interpretable geography of MTS impacts through sample-split replication of the main regressions.

5 Results

5.1 Main results

Table 4 shows the response of tax evasion to the 2007 reform and displays the results of the fixed effects estimator for the three separate models: (i) effect of MTS on tax evasion at the intensive margin; (ii) effects of MTS on tax evasion at the extensive margin; (iii) effects of MTS on tax evasion via occupational structure. For each model, we also run four specifications (Spec 1-4) adding different sets of controls, as described in Sect. 3: institutional quality covariates (Spec 1), socio-economic covariates (Spec 2), and occupational covariates (Spec 3). The fourth specification (Spec 4) includes all these covariates as controls. Starting from the first model (Model 1), it focuses on taxable income of the self-employed (in log form) as the main regressor and reveals a positive relationship between taxable income and the tax gap share after the reform. In the full specification (Spec 4), a 4.6% increase in the tax gap share is observed alongside a 1% increase in self-employed income. This finding is consistent with the idea that MTS encouraged self-employed individuals to evade in order not to exceed the € 30,000 income statement threshold. Consequently, the average taxpayer opted to evade a greater proportion of their income after the tax reform was enacted. It can be concluded that the tax reform did not achieve its objective at the intensive margin, as the income thresholds may distort taxpayers' incentives and create a cliff in taxable income elasticity with respect to the tax rate (Kleven and Schultz 2014). Conversely, results of Model 2 (effect at the extensive margin) show that a 1% increase in the proportion of self-employment leads to a 9% reduction in the tax gap share in the full specification. After the enactment of MTS, an increase in the proportion of self-employed taxpayers was reported, resulting in a decrease in the tax gap share. Therefore, the MTS seems to reverse the usual relationship between self-employment growth and the tax gap share, as observed in the literature (Engström and Hagen 2017; Almunia and Lopez-Rodriguez 2018), and can be interpreted as the main benefit

Table 4 Estimated tax gap share response to self-employed income, self-employment share and occupational groups after the MTS reform

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Self-employed_income	0.055***	0.051***	0.04***	0.046***
	(0.01)	(0.01)	(0.011)	(0.011)
Model 2				
Self-employment_share	−0.094**	−0.088**	−0.089**	−0.091**
	(0.043)	(0.043)	(0.043)	(0.043)
Model 3				
Technical_skills	0.805***	0.791***	0.587***	0.596***
	(0.168)	(0.171)	(0.194)	(0.192)
Cognitive_skills	0.394	0.351	0.216	0.044
	(0.56)	(0.574)	(0.588)	(0.575)
Horizontal_skills	0.066	0.018	0.106	0.306
	(0.574)	(0.588)	(0.612)	(0.598)
Soft_skills	−0.526***	−0.452***	−0.283**	−0.276*
	(0.107)	(0.108)	(0.143)	(0.141)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: The three regression models are identifiable by blocks of rows separated by horizontal solid lines. Columns refer to the empirical specifications adopted for each model and differ in the set of control variables included, as indicated by black crosses. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. R^2 statistics are not reported, as the focus of the event-study specification lies on the estimated coefficients associated with the reform exposure rather than on overall model fit. Additional diagnostic checks were performed on the residuals, including residual distributions, residual–fitted plots, normal Q–Q plots, and temporal autocorrelation diagnostics (ACF and PACF). Pairwise cross–correlations of residuals across provinces were also computed to detect potential spatial dependence. These diagnostics do not reveal systematic patterns suggesting model misspecification. The complete set of diagnostic plots is reported in Figures 1 to 6 in the Supplementary Materials

brought about by MTS. The entrance of new self-employed individuals, who are expected to earn less than the incumbents, i.e. less than € 30,000, can stimulate the degree of tax compliance, especially if they previously worked in the informal sector. Finally, the third model shows an increase in tax evasion in provinces characterized by a higher proportion of occupations intensively using technical skills and a decrease in tax evasion in occupations requiring soft skills. One possible explanation is that tax reform was ineffective among low-skilled occupations due to lower earnings and challenging working conditions in terms of time and effort, making it difficult to change the behavior of these workers through tax policies. Conversely, soft skills prevail in high-skilled, creative occupations, which are more responsive to the policy and able to grasp its benefits (Deming 2017; Argentiero et al. 2024).

Table 5 Estimated effect of the tax reform on the tax gap share in treated provinces-DID estimator

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Self-employed_income_post_dummy	−0.015***	−0.016***	−0.012***	−0.012***
	(0.004)	(0.004)	(0.004)	(0.004)
Model 2				
Self-employed_income_post	−0.001***	−0.001***	−0.001***	−0.001***
	(0.000)	(0.000)	(0.000)	(0.000)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: The two regression models are identifiable by blocks of rows separated by horizontal solid lines. Columns refer to the empirical specifications adopted for each model and differ in the set of control variables included, as indicated by black crosses. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$. R^2 statistics are not reported, as the focus of the Difference-in-Differences specification lies on the estimated treatment effect rather than on overall model fit (Roth et al. 2023). Additional diagnostic checks were performed on the residuals, including residual distributions, residual–fitted plots, normal Q–Q plots, and temporal autocorrelation diagnostics (ACF and PACF). Pairwise cross-correlations of residuals across provinces were also computed to detect potential spatial dependence. These diagnostics do not reveal systematic patterns suggesting model misspecification. The complete set of diagnostic plots is reported in Figures 1 to 6 in the Supplementary Materials

Results of the DID model (Table 5) show that provinces having a self-employed income below the median (i.e., the treated provinces), diverged from those registering an above-median self-employed income (i.e., the non-treated provinces). Specifically, treated provinces reported a decrease in the tax gap share, regardless of whether the treatment variable was binary or continuous. Together with the previous result (i.e., Table 4), this suggests that the policy's effect was not neutral; that is, in poorer provinces, it partially brought taxable income into light, whereas in richer provinces it did not. Specifically, the effect of the binary variable is −1.2%, while the impact of a 1% increase in self-employed income in treated provinces was −0.1%. The expected incentive to comply only worked in regions where the average income was lower than the legal threshold, presumably because a higher number of taxpayers did not need to understate their income to become eligible for the new regime[3].

To test the existence of pre-reform trends in the adjustment margins and ensure that they capture exogenous variation induced by the reform, we compare the coefficients of our regressions with the coefficients of the same estimate during the pre-reform

[3] To further assess the adequacy of the empirical specification, we conducted a set of residual diagnostics for all estimated models. In particular, we examined the distribution of residuals, residual–fitted plots, and normal Q–Q plots, together with temporal autocorrelation diagnostics based on the ACF and PACF functions. In addition, we computed pairwise cross–correlations of residuals across provinces in order to detect potential spatial dependence. Overall, these diagnostics do not reveal systematic patterns or violations of model assumptions, although residual distributions display slightly heavier tails than the normal distribution. The full set of diagnostic plots is reported in Figures 1 to 6 in the Supplementary Materials.

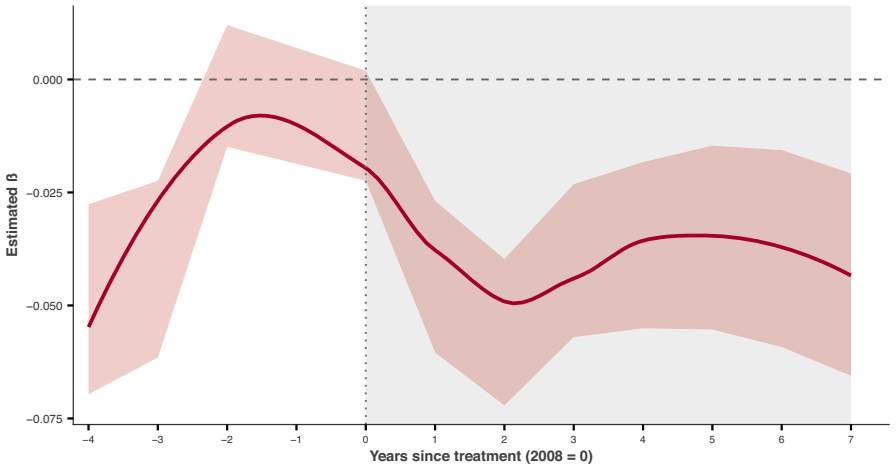


Fig. 3 Dynamic treatment effects of MTS on the provincial tax gap share (event–study estimates). **Notes:** Estimated coefficients from the event–study specification with province and year fixed effects. Confidence intervals denote 95% cluster–robust bands

period. Results are displayed in Table 14 in Appendix B and show that the pre-trend relationship between self-employed income and tax evasion was not significant as well as the relationship between all the skill families and tax evasion. The coefficient attached to self-employment share is even positive, indicating a major impact of the reform at the extensive margin.

We also compare the dynamic effects of self-employed income before and after the reform (Fig. 3). The earliest pre–treatment years display a decreasing pre-trend reduction of the tax gap share in $t-4$ and $t-3$, but such trend disappears in the years immediately preceding the reform. After 2008, the estimated coefficients become persistently negative, indicating that after the introduction of the MTS regime Italian provinces experienced a sustained reduction in the tax gap share relative to the pre–reform trajectory. It is also important to note that the post-reform trend moves in the opposite direction to the t-4 and t-3 trend.

Overall, the persistence of the estimated effects over subsequent years points to a lasting behavioral adjustment rather than a purely temporary response, suggesting that the reform induced a structural improvement in tax compliance. Additional robustness checks restricting the estimation sample to the two years preceding the reform confirm the stability of the estimated treatment effects. The corresponding estimates are reported in Table 13 in Appendix B.

5.2 Robustness checks and sensitivity analysis

Results of our robustness tests basically support our main result. As far as the placebo event study is concerned (Table 6), the relationship between self-employed income and tax evasion would be reversed if the treatment year would be set in 2006, i.e., anticipated by 2 years. In particular, we observe a shift in the sign from positive to

Table 6 Placebo estimates of the tax gap share response to self-employed income, self-employment share and occupational groups

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Self-employed_income	−0.040***	−0.046***	−0.066***	−0.060***
	(0.012)	(0.012)	(0.012)	(0.012)
Model 2				
Self-employment_share	0.018	0.014	0.012	0.014
	(0.045)	(0.046)	(0.046)	(0.045)
Model 3				
Technical_skills	0.799***	0.774***	0.571***	0.594***
	(0.169)	(0.173)	(0.196)	(0.193)
Cognitive_skills	0.440	0.466	0.299	0.123
	(0.554)	(0.565)	(0.579)	(0.568)
Horizontal_skills	−0.161	−0.268	−0.253	−0.042
	(0.564)	(0.576)	(0.602)	(0.589)
Soft_skills	−0.493***	−0.420***	−0.244*	−0.245*
	(0.106)	(0.107)	(0.141)	(0.138)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: Placebo event-study estimates obtained by assigning the reform to a pre-policy year. The three regression models are identifiable by blocks of rows separated by horizontal solid lines. Columns refer to the empirical specifications adopted for each model and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

negative, confirming the idea that the underreporting effect of the €30,000 threshold has been engendered by the MTS reform. On the other hand, self-employment share would not correlate with tax evasion in the placebo hypothesis, contrarily to the negative effects observed in the main estimates. Only for the third model, identifying the relationship between self-employed skill use and tax evasion, the placebo test show a significant pre-trend effect of technical and soft skills, raising doubts on the actual role of the MTS reform in affecting the relationship between the occupational structure and tax evasion.

Then we conduct placebo DID estimates by assigning the reform to pre-policy years in which no policy change occurred and by creating an artificial group of treated provinces. When looking at the results (Tables 7 and 8), the sign of the effect of self-employed income change again, becoming positive in low-income provinces compared to the negative sign reported in Table 5. This evidence confirm the significance of the impact of MTS reform in low-income provinces.

Table 7 Placebo Difference-in-Differences estimates of the tax reform effect artificially anticipating the policy implementation

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Self-employed_income_post_dummy	0.016***	0.015***	0.021***	0.022***
	(0.005)	(0.005)	(0.005)	(0.005)
Model 2				
Self-employed_income_post	0.002***	0.001***	0.002***	0.002***
	(0.0005)	(0.0005)	(0.0005)	(0.0005)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: Placebo Difference-in-Differences estimates obtained by artificially assigning the reform to the pre-policy year 2006. The two regression models are identifiable by blocks of rows separated by horizontal solid lines. Columns refer to the empirical specifications adopted for each model and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The results should be interpreted as a diagnostic check for pre-reform patterns rather than as evidence of treatment effects. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 8 Placebo test using an artificial group of treated provinces

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Placebo_treatment_income_dummy				
	0.015***	0.015***	0.012***	0.011***
	(0.003)	(0.003)	(0.004)	(0.004)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: This table reports a placebo Difference-in-Differences test in which the policy implementation year is kept in 2008, while treatment status is artificially assigned to the opposite group of provinces. Columns refer to the empirical specifications adopted for the model and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The results should be interpreted as a diagnostic check on the sensitivity of the estimates to treatment-group definition rather than as evidence of treatment effects. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Additionally, we construct three alternative control groups to replicate the DiD estimates in order to strengthen the credibility of the Difference-in-Differences identification strategy. First, instead of splitting provinces at the median of pre-reform self-employment income, we construct treatment groups based on terciles and quartiles of the income distribution. Then we exploit the institutional feature of the reform by defining treatment using the income eligibility threshold (€30,000). As shown in Table 9 results obtained using all these alternative thresholds are consistent with the baseline estimates. Moreover, consistently with the idea that the effects increase as long as the per capita income decrease, the magnitude of the coefficients is higher when the treated provinces are those ones falling in the first quartile of the income distribution.

Finally, we conducted a sensitivity analysis to account for the potential impact of the reform on tax evasion, arising from the substantial differences in initial income distribution and occupational composition in local labour markets. This heterogeneous exposure to the change in tax rates created by the MTS regime may therefore constitute an additional source of variation in tax evasion that was not considered in the main empirical analysis. The relevant estimates are reported in Appendix B (Tables 15–16) and show that there is a positive relationship between pre-reform self-employed income and tax evasion, whereas the initial self-employment share does not matter, as the coefficients are never significant (Table 15 in Appendix B). Thus, the effect of the reform is accentuated by pre-reform spatial heterogeneity in terms of self-employment income. The findings regarding self-employment income remain stable when using the 2007 provincial exposure $P^{k}_{i,2007}$, the province-specific pre-reform average $\overline{P}^{k}_{i,pre}$, and the dynamic specification $1(t = s) \times \overline{P}^{k}_{i,pre}$. The dynamic specification also preserves the main qualitative pattern, with the coefficient on self-employed income becoming positive and statistically significant from 2009 onward (Table 16 in Appendix B)

5.3 Territorial Heterogeneity

5.3.1 Regional Heterogeneity

Our focus on regional heterogeneity starts with a geographical split sample procedure in which we separately analyse the impact of the tax reform in northern and southern provinces (Table 10). The side effect of the reform at the intensive margin, as revealed by the event study (Table 4), is concentrated in the southern regions. Three possible interpretations can be given consistently with the existing literature. The first concerns differences in institutional quality and the intensity of tax controls, which may influence the expected cost of tax evasion (Nifo and Vecchione 2014; Carfora et al. 2018). A second channel concerns the productive and employment structure of the regions. In southern regions, micro-businesses and traditional self-employment are more widespread, often characterized by less formalized economic relationships and a lower presence of third-party reporting systems, conditions that facilitate under-reporting (Artavanis et al. 2016; Kleven and Schultz 2014). Finally, a further mechanism concerns the distribution of income with respect to the regime's eligibility threshold. Since the MTS applied exclusively to taxpayers with incomes

Table 9 Difference–in–Differences estimates under alternative income partitioning schemes

Panel A: Terciles	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Self-employed_income_post_dummy	−0.025***	−0.024***	−0.023***	−0.022***
	(0.004)	(0.004)	(0.004)	(0.004)
Model 2				
Self-employed_income_post	−0.002***	−0.002***	−0.002***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Panel B: Quartiles				
	Spec 1	**Spec 2**	**Spec 3**	**Spec 4**
Model 1				
Self-employed_income_post_dummy	−0.040***	−0.037***	−0.035***	−0.037***
	(0.004)	(0.004)	(0.005)	(0.005)
Model 2				
Self-employed_income_post	−0.004***	−0.004***	−0.003***	−0.004***
	(0.000)	(0.000)	(0.000)	(0.000)
Panel C: 30k threshold				
	Spec 1	**Spec 2**	**Spec 3**	**Spec 4**
Model 1				
Self-employed_income_post_dummy	−0.023***	−0.023***	−0.021***	−0.020***
	(0.004)	(0.004)	(0.004)	(0.004)
Model 2				
Self-employed_income_post	−0.002***	−0.002***	−0.002***	−0.002***
	(0.000)	(0.000)	(0.000)	(0.000)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effects	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: Difference-in-Differences estimates obtained using alternative definitions of the self-employment income distribution to classify treated and control provinces. Panel A reports estimates based on terciles, Panel B on quartiles, and Panel C on the €30,000 policy eligibility threshold. Specifications differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The table assesses the sensitivity of the DID estimates to alternative treatment-group definitions. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

below €30,000, provinces with lower average income levels are more exposed to the incentives generated by the regime's access threshold, making strategic reporting adjustments more widespread.

Conversely, the reduction in tax evasion at the extensive margin is significant in both macro-regions, with a similar magnitude (15.7% vs 14.7% in the full specifica-

tions). Therefore, the tax reform mitigated the risk of tax evasion in those provinces characterized by a high incidence of self-employed workers both in the North and in the South. In this case, territorial heterogeneity is less accentuated than in the case of self-employed income. At the occupational level, on the other hand, most of the effects disappear. Only in the northern provinces do we still observe a positive impact of occupations intensively requiring technical skills.

In general, this heterogeneity suggests that the socio-economic spatial disparity observed at macro-regional levels (Ascani et al. 2021; Rodríguez-Pose et al. 2024) significantly affects the behavior of self-employed in terms of tax compliance.

To account for possible shocks at regional level we implement a leave-one-regional-out (LORO) cross-validation exercise in which the model is re-estimated repeatedly while excluding one Italian region at a time (Kline et al. 2020; Bates et al. 2024; Otto et al. 2024). Figure 4 reports the confidence intervals for the LORO event-study for self-employed income (Spec. 1, 3, 5, 7), self-employment share (Spec 2, 4, 6, 8) and for the skill families (Spec 9-12). The estimated coefficients remain significant across Spec 1-8, suggesting that the results are not driven by any single region neither at the intensive not at the extensive margin. This is not the case for Spec 9-12, in which long-term MTS effect seem to be driven by one region with a consequent increase of the average prediction error. Similar results are obtained by the DiD estimates (Fig. 5). The average treatment coefficients significantly differ from zero in most of the cases, losing significance only in Spec 5-8 when excluding Calabria and Emilia-Romagna. From this analysis, we excluded Spec 9-12 for the failure of cross-validation in the LORO event-study.

5.3.2 Spatial clusters

As explained in Sect. 4.3, to further explore spatial heterogeneity in these responses, we complement the empirical analysis with a spatio-temporal clustering procedure, namely the geographically informed hierarchical clustering, that groups provinces according to the joint dynamics of self-employment indicators and geographic proximity. The clustering results, reported in Appendix C for the sake of brevity, reveal patterns that are broadly consistent with the traditional North–Center–South divide in the Italian economy.

Cluster-specific event-study and Difference-in-Differences estimates indicate that the response to the reform is heterogeneous across groups. Southern provinces display stronger adjustments along both the intensive and extensive margins, whereas central provinces exhibit weaker and less systematic responses. These results are consistent with the main findings and provide complementary descriptive evidence on the spatial structure of behavioral responses to the reform; see Tables 4 and 5.

6 Conclusions and policy implications

This paper explored for the first time the impact of 2008 Italian MTS on tax evasion at the provincial level through the variation of self-employment shares (extensive margin) and income (intensive margin). Results show a remarkable spatially heterogeneous

Table 10 Estimated effect of the tax reform in northern and southern macroregions

	South				North			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Model 1								
Self-employed_income	0.092***	0.075**	0.059*	0.069**	−0.007	−0.02	−0.046	−0.001
	(0.033)	(0.032)	(0.032)	(0.033)	(0.031)	(0.03)	(0.03)	(0.031)
Model 2								
Self-employment_share	−0.168*	−0.136	−0.139	−0.158*	−0.16***	−0.15**	−0.177***	−0.147**
	(0.091)	(0.09)	(0.091)	(0.09)	(0.059)	(0.059)	(0.06)	(0.059)
Model 3								
Technical_skills	0.789***	0.834***	0.367	0.27	0.414	0.346	0.863***	0.891***
	(0.304)	(0.292)	(0.338)	(0.342)	(0.263)	(0.261)	(0.304)	(0.298)
Cognitive_skills	0.511	0.601	0.847	0.079	0.292	0.037	−0.036	−0.351
	(1.508)	(1.521)	(1.724)	(1.7)	(0.563)	(0.565)	(0.578)	(0.569)
Horizontal_skills	−0.091	−0.373	−0.799	−0.146	−0.162	−0.083	0.544	0.805
	(1.472)	(1.479)	(1.723)	(1.69)	(0.613)	(0.615)	(0.654)	(0.637)
Soft_skills	−0.561***	−0.562***	−0.325	−0.213	0.123	0.252	−0.089	−0.075
	(0.181)	(0.176)	(0.228)	(0.228)	(0.239)	(0.237)	(0.269)	(0.263)
Institutional quality	X			X	X			X
Socio-economic		X		X		X		X
Labour market and sectors			X	X			X	X
Time fixed-effect	X	X	X	X	X	X	X	X
Provincial fixed-effects	X	X	X	X	X	X	X	X
N.Obs	**432**	**432**	**432**	**432**	**552**	**552**	**552**	**552**

Note: The three regression models are identifiable by blocks of rows separated by horizontal solid lines. Columns refer to the empirical specifications adopted for each model and differ in the set of control variables included, as indicated by black crosses. Columns 2–5 report estimates for the southern sample, which includes Abruzzo, Molise, Campania, Apulia, Basilicata, Calabria, and Sicily; columns 7–10 report estimates for the northern sample, which includes Liguria, Piedmont, Lombardy, Valle d'Aosta, Trentino-Alto Adige, Veneto, and Emilia-Romagna. All specifications include province and year fixed effects. Standard errors are reported in parentheses. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

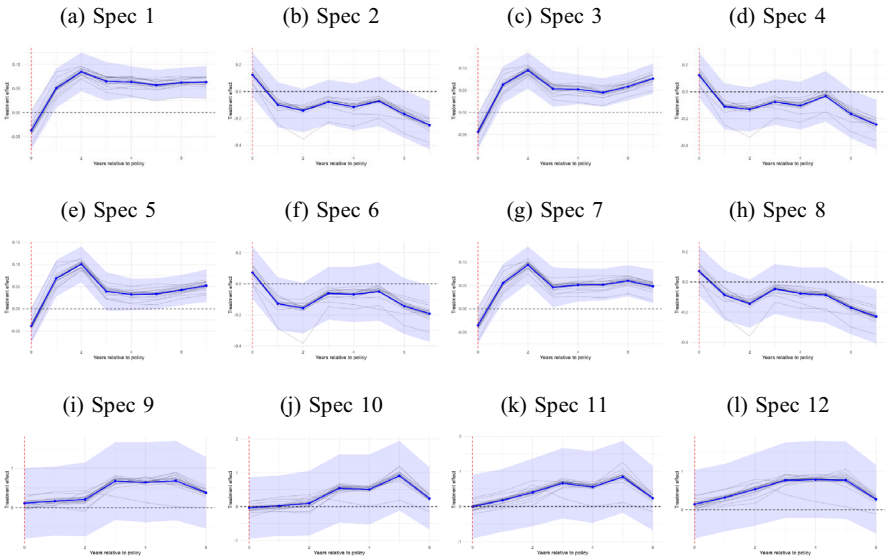
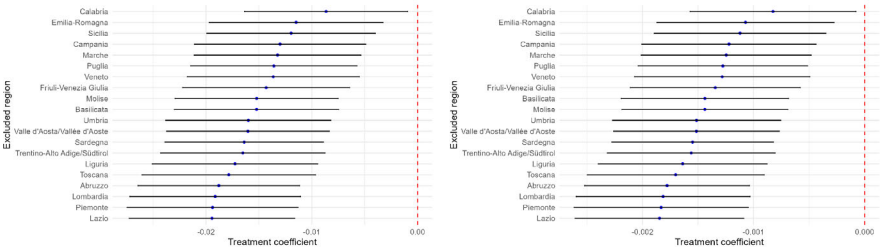


Fig. 4 Leave-one-region-out event study estimates across specifications. **Notes:** The figure reports leave-one-region-out event-study estimates. For each specification, the model is re-estimated excluding one Italian region at a time. Grey lines represent the estimated coefficients from each leave-one-region-out regression, while the blue line reports the average coefficient across all iterations. Shaded areas denote 95% confidence intervals based on the dispersion of the estimated coefficients

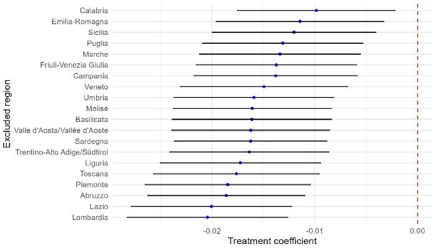
impact of the application of the flat tax rate to Italian self-employed workers earning less than € 30,000.

Our main findings reveal a dual effect of the reform on tax evasion, depending on the adjustment channel. At the intensive margin, MTS paradoxically stimulated tax evasion by presumably inducing self-employed individuals to underreport their increased income from self-employment, which is assumed to increase due to the positive elasticity of labour income with respect to tax rate reductions. Such effect cumulates with the positive relationship between pre-reform income level and tax evasion in the post-reform period as revealed from the sensitivity analysis. Consistently with this latter result, the eligibility threshold, set at €30,000, seems to have boosted self-employed individuals' incentives to evade taxes, at least partially. The income effect associated with the reduction in the statutory tax rate under the new tax regime seems to have induced taxpayers to underreport earnings strategically in order to remain below the eligibility threshold. This behavioural response was particularly prevalent in southern regions, where the increase in self-employed income was associated with the greatest increase in tax evasion. Conversely, northern regions did not show clear responsiveness at the intensive margin, reporting an income-related improvement in tax compliance when the spatial clustering procedure was used to account for territorial heterogeneity. At the extensive margin, however, the reform seems to have achieved its main objective. Indeed, MTS determined a reduction in the tax gap share in provinces with an increasing proportion of self-employed workers. It is suggested that the MTS either induced some self-employed workers to exit the informal sector and regularise their status, or stimulated new self-employed workers to correctly report their income.

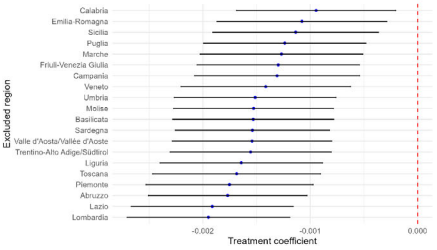


(a) Spec 1

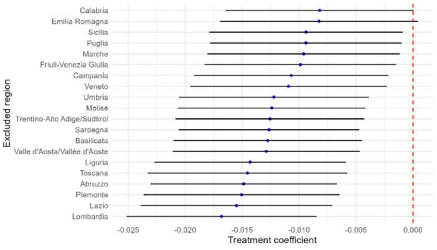
(b) Spec 2



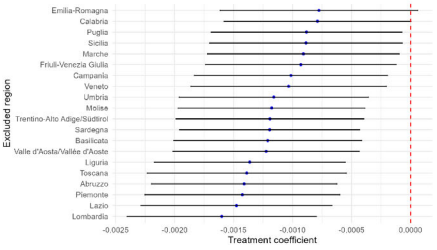
(c) Spec 3



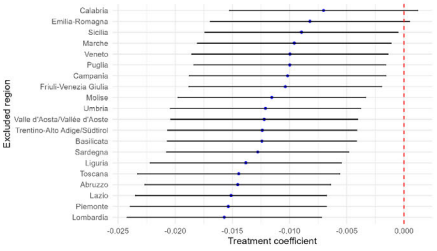
(d) Spec 4



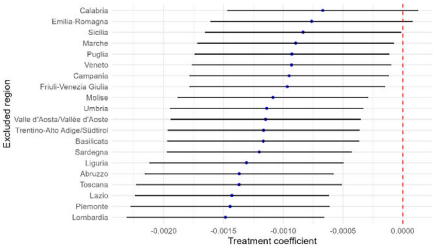
(e) Spec 5



(f) Spec 6



(g) Spec 7



(h) Spec 8

Fig. 5 Leave-one-region-out Difference-in-Differences estimates across specifications. **Notes:** Each panel reports the leave-one-region-out robustness exercise for the Difference-in-Differences specification. For each iteration, the model is re-estimated after excluding one Italian region from the sample. Each point represents the estimated DiD treatment coefficient obtained when a specific region is excluded, while horizontal bars denote the corresponding 95% confidence intervals. The coefficients are reported in Table 17 in the Appendix B

Additional evidence concerns the role of local occupational structure. Notably, provinces in which self-employed individuals relied more heavily on technical skills after the reform exhibited a higher propensity to evade taxes. In contrast, provinces characterised by a greater prevalence of soft skills are associated with higher tax compliance. However, robustness checks indicate that this relationship existed prior to 2008, i.e. before the reform, suggesting that the MTS reform was not the driving factor behind the observed relationship. Furthermore, the LORO event study revealed that the outcome is influenced by the behaviour of a particular region.

Another interesting result emerges from the DiD estimates. The MTS reform was also beneficial at the intensive margin in low-income provinces, since tax evasion decreased in response to positive income variation. Therefore, the MTS appears to have been particularly effective in regions where self-employed income is well below the €30,000 threshold, providing a weaker incentive to underreport income in tax returns in these areas.

Macro-regional sampling confirms the uneven geographical effects of the reform and is consistent with Italy's North–South divide. It reveals that underreporting risk is concentrated in southern regions, whereas benefits are higher in northern regions. These findings essentially remain consistent when provinces are aggregated according to geographical proximity and temporal trajectories through spatio-temporal hierarchical clustering.

Overall, this study provides mixed evidence of the effectiveness of MTS and emphasises the risk that this tax reform could have a divergent spatial influence on tax compliance across different regions. This is reinforced by the outcome of the Difference-in-Differences estimates, which revealed substantial asymmetry in the effects of MTS. An unintended territorial consequence of MTS was to alter the geography of tax evasion, inducing a shift towards compliance in provinces where the labour supply response mainly acted at the extensive margin. Meanwhile, evasion was reinforced in high-income provinces where self-employed income increased after the MTS reform (intensive margin). The associated risk is that a policy designed to encourage tax compliance may inadvertently exacerbate territorial disparities due to spatially heterogeneous pre-existing economic structures. The macro-regional subdivision confirms the seriousness of this issue, showing that the heterogeneous effects of MTS follow Italy's persistent north–south divide.

As far as policy implications are concerned, they are basically twofold. On the one hand, policy makers should introduce new sanctions and intensified auditing actions to prevent underreporting by self-employed workers in presence of income threshold. On the other hand, regional policies should be implemented to address the risk of increased spatial divergence as an unintended consequence of such tax reform.

Finally, it is important to acknowledge the main limitations of our work. Firstly, the provincial tax gap share is based on an estimate from the *Italian Revenue Agency* and does not measure evasion directly. Secondly, territorial aggregation of tax evasion data prevents us from observing the individual response of taxpayers to MTS. This means that we can only observe territorially aggregated behaviors, without being able to assess the impact of the reform at a micro level or distinguish between workers adjusting their income reporting and workers sorting into self-employment. Thirdly, the partial

endogeneity of the treatment with respect to tax evasion reduces the robustness of the causal inference between self-employment income and tax evasion.

Future research could address these issues also looking at the impact of more recent Italian tax reforms targeting self-employed workers, which, among the other changes, have increased the eligibility income threshold to €65,000 in 2019 and €85,000 in 2022. A machine learning approach could be also employed to predict the impact of tax reforms affecting self-employment on income elasticity and tax evasion. Another valuable analysis could examine the impact of MTS reforms on the regional tax burden. This would involve assessing the trade-off between the increase in taxable income associated with an increase in labour supply and a higher level of tax compliance, and the fall in tax revenues caused by the more favourable tax rates awarded by the MTS regime.

Appendix

Appendix A: Additional descriptive evidence

See Table 11, Figs. 6 and 7.

Table 11 Descriptive statistics of the main variables of interest between treated and untreated provinces

Variables	Untreat		Treat	
	Mean	Sd	Mean	Sd
Outcome				
Tax_gap	0.42	0.13	0.41	0.12
Explanatory variables				
Treatment				
Self-employed_income	32771.24	7167.92	36053.63	6967.61
Self-employed_income_post_treat	0	0	36053.63	6967.61
Self-employment_share	0.24	0.04	0.22	0.04
Skill interactions				
Technical_skills	0.02	0.01	0.02	0.01
Cognitive_skills	0.02	0.01	0.02	0.01
Horizontal_skills	0.02	0.01	0.02	0.01
Soft_skills	0.03	0.02	0.04	0.02

Table 11 continued

Variables	Untreat		Treat	
	Mean	Sd	Mean	Sd
Controls				
- Institutional quality				
Share_cooperative_employees	4.23	1.49	4.22	1.44
Thefts_per_1000_inhabitants	21.34	9.64	20.06	8.39
Recycling_rate	25.17	16.28	39.17	19.24
Provincial_institutional_quality_index (IQI)	0.55	0.24	0.59	0.25
- Socio-economic				
Firm_net_entry_rate	1.43	1.15	0.05	1.13
Loan_default_rate	1.55	1.23	3.48	2.07
- Labour				
Female_employment_share	0.29	0.04	0.29	0.04
Average_age	43.84	1.28	45.57	1.63
Educational attainment	4.47	0.35	4.82	0.39
- Sector				
Average_weekly_hours_worked	62.66	17.76	50.34	10.29
Agriculture_share	0.11	0.07	0.1	0.07
Extractive_industries_share	0	0	0.06	0.06
Manufacturing_share	0.12	0.05	0.12	0.04
Construction_share	0.13	0.03	0.21	0.08
Trade_and_repair_share	0.27	0.06	0.15	0.1
Transport_and_logistics_share	0.07	0.03	0.04	0.03
Accommodation_and_food_services	0.03	0.01	0.02	0.02
Information_and_communication	0.03	0.01	0.02	0.01
Financial_and_insurance_activities	0.14	0.04	0.16	0.04
Professional_scientific_technical	0.04	0.02	0.05	0.02
Public_administration_and_other_services	0.06	0.02	0.07	0.02
N.Obs	**408**		**819**	

Source: Authors' elaboration based on data from the Italian Ministry of Economy and Finance (MEF), the ISTAT Labour Force Survey, the Territorial Database for Development Policies, and the Institutional Quality Index dataset

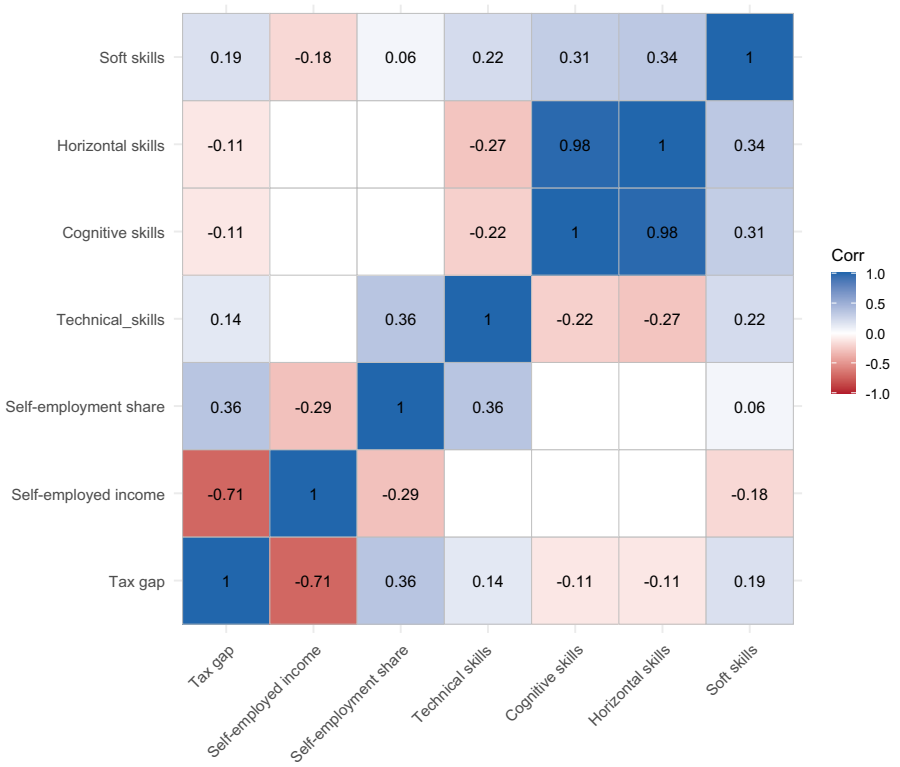


Fig. 6 Correlation matrix among the dependent and independent variables

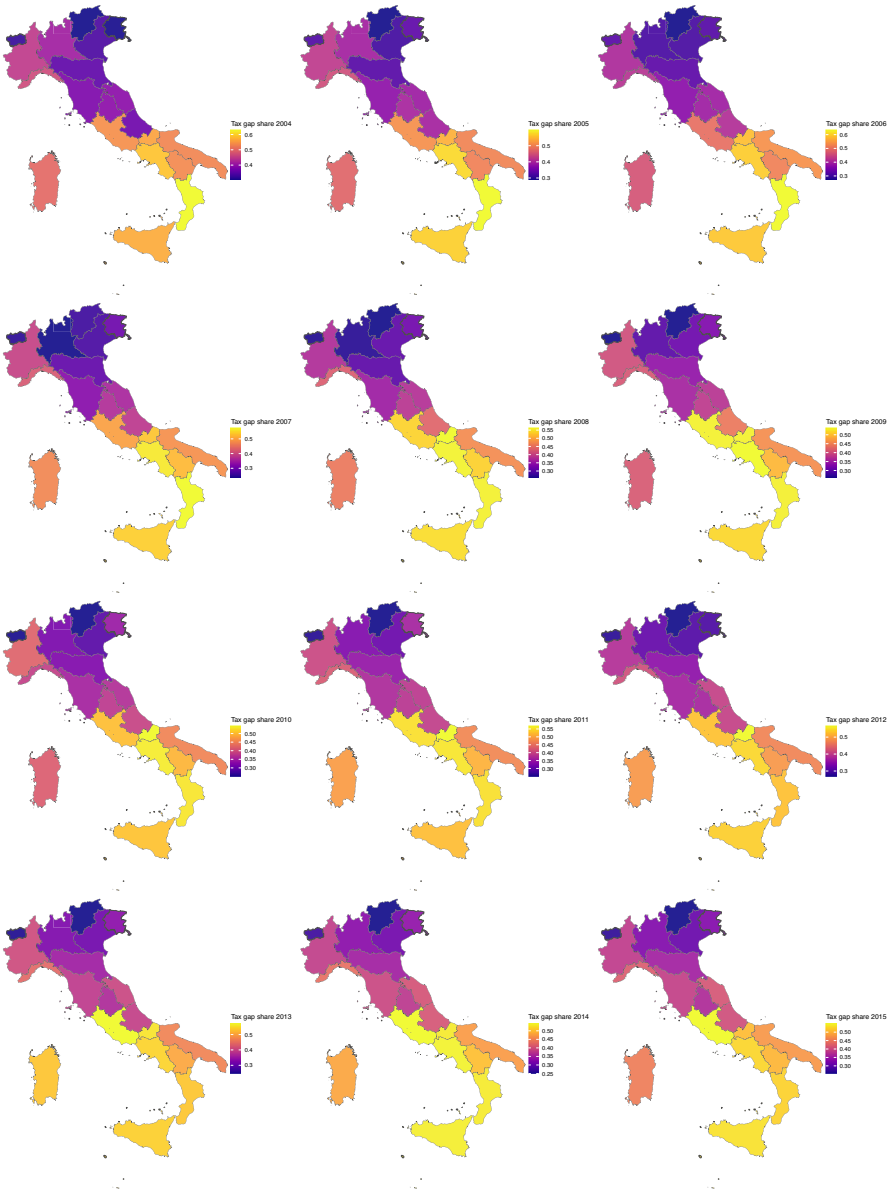


Fig. 7 Spatial distribution of the tax gap share across Italian regions, 2004–2015. **Source:** Authors' elaboration. **Note:** For privacy and data dissemination reasons, the annual average Tax-gap is shown on the maps at an aggregate regional level

Appendix B: Robustness checks

Table 12 Pre–trend diagnostics in the event–study specification

Test	Statistic	p-value
Joint test of pre-treatment coefficients ($t = -4, -3, -2$)	42.04	0.000
Restricted pre-period test ($t = -2$)	0.044	0.833

Notes: The table reports Wald tests for the joint significance of pre-treatment coefficients in the event–study specification with province and year fixed effects. The first test evaluates the joint significance of all pre-treatment coefficients. The second test focuses on the last pre-treatment period, which is the most relevant for identification. The testing strategy follows the approach discussed in Roth and Sant'Anna (2023)

Table 13 Difference-in-Differences estimates using the short pre-treatment window for the parallel-trends assessment

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1	−0.038***	−0.039***	−0.034***	−0.034***
Self-employed_income_post_dummy	(0.006)	(0.006)	(0.006)	(0.006)
Model 2				
Self-employed_income_post	−0.004***	−0.004***	−0.003***	−0.003***
	(0.001)	(0.001)	(0.001)	(0.001)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**927**	**927**	**927**	**927**

Note: Difference-in-Differences estimates obtained using the short pre-treatment window 2006–2007 to assess the parallel-trends assumption. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 14 Estimated tax gap share response to self-employed income, self-employment share and occupational groups in the pre-reform period (2004–2007)

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1				
Self-employed_income	0.000*	0.000	0.000	0.000
	(0.000)	(0.000)	(0.000)	(0.000)
Model 2				
Self-employment_share	0.401***	0.382***	0.314***	0.341***
	(0.113)	(0.117)	(0.119)	(0.116)
Model 3				
Technical_skills	−0.297	0.105	0.262	−0.360
	(0.782)	(0.804)	(0.840)	(0.830)
Cognitive_skills	1.074	0.387	0.168	0.860
	(1.452)	(1.485)	(1.519)	(1.495)
Horizontal_skills	−0.378	0.672	1.047	−0.278
	(1.688)	(1.703)	(1.770)	(1.773)
Soft_skills	−0.540	−0.905	−1.064	−0.459
	(0.804)	(0.825)	(0.834)	(0.831)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**412**	**412**	**412**	**412**

Note: Estimates computed using the pre-reform sample only (2004–2007). The three regression models are identifiable by blocks of rows separated by horizontal solid lines. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The table is intended to assess pre-reform associations between the tax gap share and the exposure variables. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 15 Estimated tax gap share response using fixed 2007 and pre-reform mean exposure definitions

	Fixed 2007				Pre-reform mean			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Model 1								
Self-employed_income	0.058***	0.054***	0.047***	0.050***	0.052***	0.049***	0.042***	0.045***
	(0.009)	(0.009)	(0.010)	(0.010)	(0.009)	(0.009)	(0.010)	(0.010)
Model 2								
Self-employment_share	−0.022	0.006	0.000	−0.010	−0.093*	−0.070	−0.073	−0.084
	(0.050)	(0.050)	(0.050)	(0.049)	(0.055)	(0.056)	(0.055)	(0.054)
Institutional quality	X			X	X			X
Socio-economic		X		X		X		X
Labour market and sectors			X	X			X	X
Time fixed-effect	X	X	X	X	X	X	X	X
Provincial fixed-effects	X	X	X	X	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**	**1236**	**1236**	**1236**	**1236**

Note: This table reports robustness checks for the event-study/TEFW specifications using exposure variables fixed at their 2007 values and exposure variables measured as province-specific pre-reform averages. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The outcome variable is kept in annual levels, as in the baseline specification. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 16 Dynamic pre-reform exposure specification

	Spec 1	Spec 2	Spec 3	Spec 4
Model 1: Self-employed income				
Self-employed_income × 2008	−0.029*	−0.036**	−0.031*	−0.027*
	(0.016)	(0.016)	(0.016)	(0.016)
Self-employed_income × 2009	0.043***	0.053***	0.058***	0.048***
	(0.016)	(0.016)	(0.016)	(0.016)
Self-employed_income × 2010	0.070***	0.078***	0.084***	0.078***
	(0.016)	(0.016)	(0.016)	(0.016)
Self-employed_income × 2011	0.058***	0.048***	0.041**	0.048***
	(0.016)	(0.016)	(0.018)	(0.017)
Self-employed_income × 2012	0.067***	0.056***	0.042**	0.061***
	(0.016)	(0.016)	(0.018)	(0.017)
Self-employed_income × 2013	0.067***	0.054***	0.047***	0.065***
	(0.016)	(0.016)	(0.018)	(0.017)
Self-employed_income × 2014	0.071***	0.066***	0.054***	0.074***
	(0.016)	(0.016)	(0.018)	(0.018)
Self-employed_income × 2015	0.067***	0.078***	0.058***	0.056***
	(0.016)	(0.016)	(0.018)	(0.017)

Table 16 continued

	Spec 1	Spec 2	Spec 3	Spec 4
Model 2: Self-employment share				
Self-employment_share × 2008	0.072	0.087	0.033	0.022
	(0.100)	(0.102)	(0.100)	(0.098)
Self-employment_share × 2009	−0.135	−0.124	−0.122	−0.117
	(0.100)	(0.102)	(0.100)	(0.098)
Self-employment_share × 2010	−0.142	−0.108	−0.120	−0.116
	(0.101)	(0.102)	(0.101)	(0.099)
Self-employment_share × 2011	−0.075	−0.073	−0.060	−0.052
	(0.100)	(0.102)	(0.101)	(0.099)
Self-employment_share × 2012	−0.037	−0.015	−0.011	−0.008
	(0.100)	(0.102)	(0.101)	(0.099)
Self-employment_share × 2013	−0.048	0.008	0.004	−0.035
	(0.100)	(0.102)	(0.101)	(0.099)
Self-employment_share × 2014	−0.192*	−0.174*	−0.161	−0.186*
	(0.100)	(0.102)	(0.101)	(0.099)
Self-employment_share × 2015	−0.198**	−0.161	−0.145	−0.192*
	(0.100)	(0.102)	(0.101)	(0.099)
Institutional quality	X			X
Socio-economic		X		X
Labour market and sectors			X	X
Time fixed-effect	X	X	X	X
Provincial fixed-effects	X	X	X	X
N.Obs	**1236**	**1236**	**1236**	**1236**

Note: This table reports the estimates of the dynamic event-study/TEFW specification obtained by interacting each post-reform year with pre-reform exposure. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The outcome variable is kept in annual levels, as in the baseline specification. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 17 Leave-one-region-out Difference-in-Differences estimates across specifications

Region	Spec1	Spec2	Spec3	Spec4	Spec5	Spec6	Spec7	Spec8
Piemonte	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.02(0)	0(0)
Aosta Valley	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Liguria	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Lombardia	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.02(0)	0(0)
Trentino-Alto Adige	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Veneto	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Friuli-Venezia Giulia	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Emilia-Romagna	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Marche	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Toscana	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Lazio	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.02(0)	0(0)
Umbria	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Campania	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Abruzzo	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Molise	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Puglia	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Basilicata	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Calabria	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Sicilia	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)
Sardegna	−0.02(0)	0(0)	−0.02(0)	0(0)	−0.01(0)	0(0)	−0.01(0)	0(0)

Notes: The table reports leave-one-region-out Difference-in-Differences estimates. Each row reports the estimated treatment coefficient obtained after excluding one Italian region from the sample. Columns correspond to alternative model specifications. Values in parentheses are standard errors. All specifications include province and year fixed effects. The exercise assesses whether the estimated DID effects are driven by any single region

Appendix C: Extended estimates based on spatio-temporal clustering

The results derived from the spatio-temporal hierarchical clustering algorithm discussed in Sect. 4.3, whether referring to self-employed income or self-employment share, lead to consistent findings and show both common patterns and some specificities. In particular, the essential results are reported in Figs. 8 and 9, while extended results on clustering metrics are presented in Figs. 10 and 11. First, in both cases the optimal number of clusters is $K^* = 3$. Unambiguously, when geographical distance is also used as a clustering feature (i.e., $\alpha > 0$), both variables lead to groupings that clearly resemble the north-center-south divide that is typical of Italian socio-economic statistics (Brida et al. 2014; Monturano et al. 2025a) that we previously depicted in Figs. 9 and 8. The average groupwise trends depicted in the right panel of Fig. 8 well represent this division; the plots show that the income of self-employed workers in the three macro-areas is positioned at significantly different levels, with a sharp decline from north to center and from center to south (Mattera 2022).

Although the proportions of self-employed workers generally follow a clear north-center-south structure, they also exhibit a higher degree of blending, with some areas of the center sometimes grouped with the north and others with the south. In any case, the north and south are clearly distinct. In the absence of geographical information (i.e., $\alpha = 0$), the clustering performed on the income of the self-employed is almost the same as that using geographical distances, while the clustering on the share of self-employed workers is quite different. In particular, the bottom graph in Fig. 9 shows that, by ignoring geographical distance in the creation of groups, Ward's criterion generates $K = 3$ groups with similar temporal dynamics (i.e., a downward trend) but clearly distinct with respect to the average level (i.e., the intervals do not overlap). However, the trajectories also show that for a very large number of Italian provinces, represented by groups $g = 1$ and $g = 2$, the weight of self-employed workers in the total number of employed persons continuously decreased between 2004 and 2015 (with an almost exponential decline until the Great Recession), while for the third group, the reduction stopped almost immediately, net of minor fluctuations (Rodríguez-Pose 2018; Hein et al. 2021).

In summary, from a fiscal policy perspective, two insights on self-employed workers clearly emerge. On the one hand, their income dynamics are consistent with the economic cycle and with parallel and non-converging income levels among North, Center, and South; on the other hand, the proportion of Italian self-employed does not seem to follow spatial patterns, such as the north–south divide, nor does it seem to be linked to the business cycle.

In Tables 18 - 21 we report the cluster–specific estimates based on the event–study and DID specifications, as described in the Sect. 4. The reported estimates reveal marked heterogeneity both across clusters and within clusters as the spatial weighting parameter varies.

The results of income-based spatio-temporal clustering are broadly consistent with the income gradients already emerging from the cluster formation (see Fig. 8), but the comparison across $\alpha = 0$, α_q and α^* shows that the embedding of geographical proximity often sharpens or reverses the estimated effects.

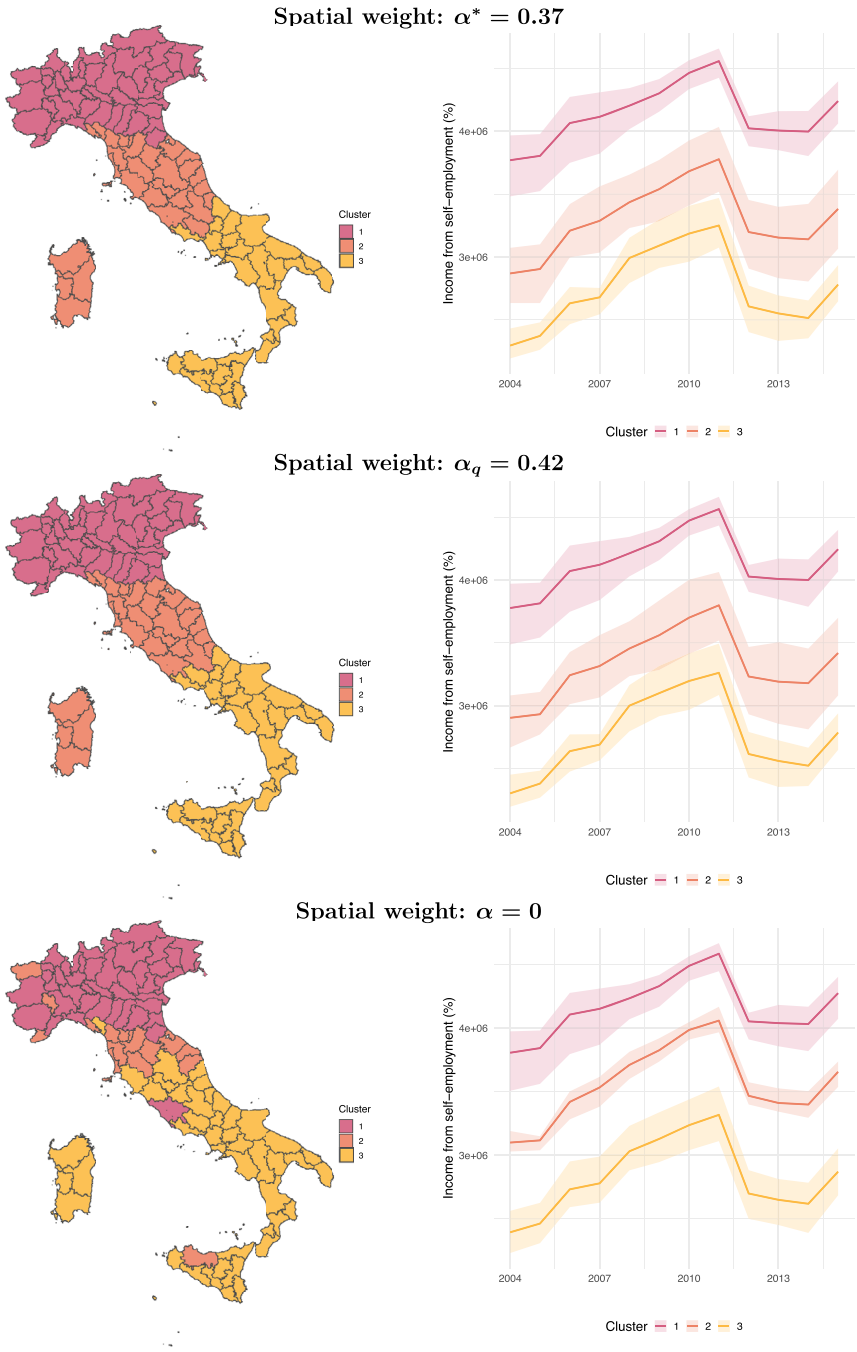


Fig. 8 Income of self-employed workers: spatio–temporal clusters and average trends ($K = 3$) for several values of the mixing parameter α. **Spatial weight: $\alpha^* = 0.37$ Spatial weight: $\alpha_q = 0.42$ Spatial weight: $\alpha = 0$**

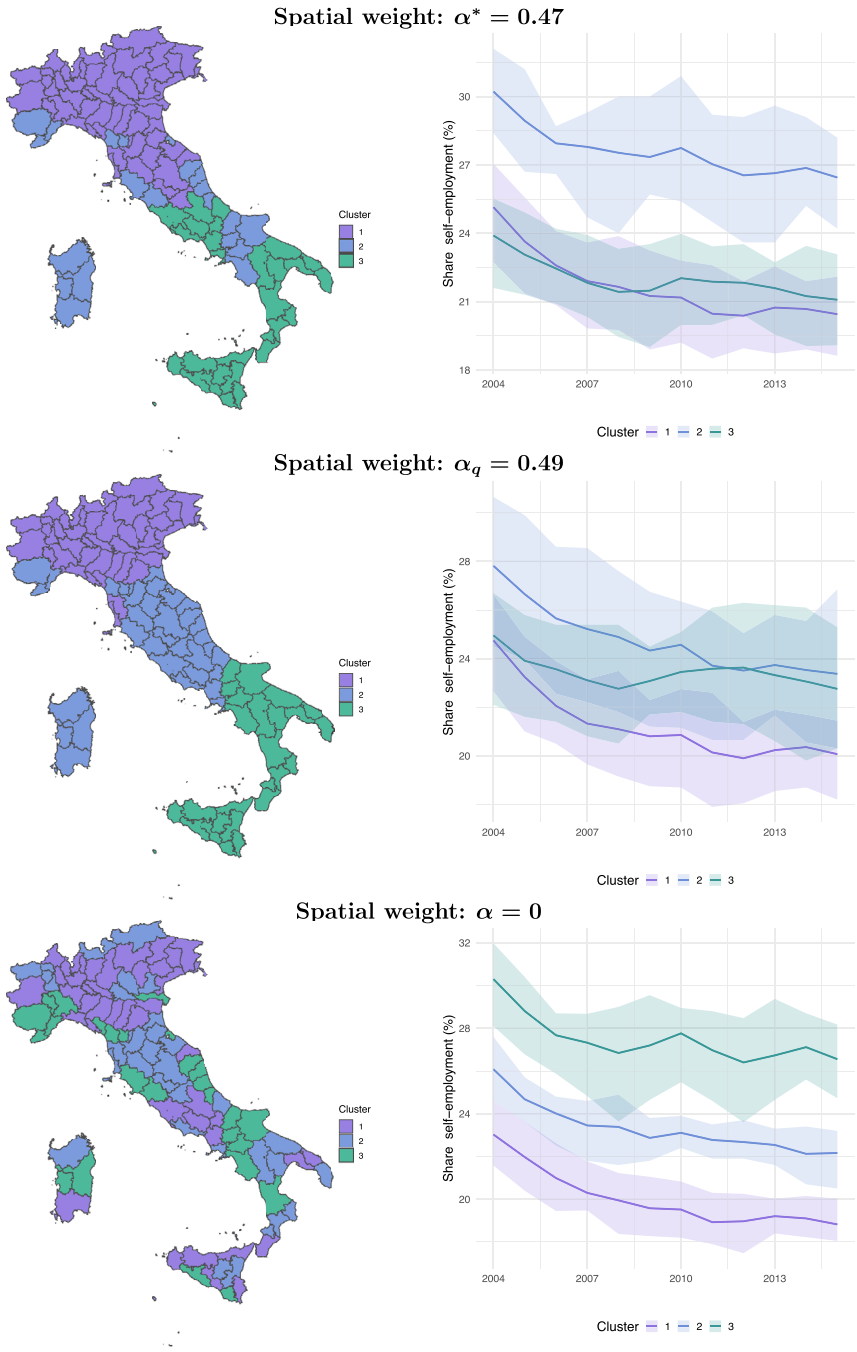


Fig. 9 Share of self–employment: spatio–temporal clusters and average trends ($K = 3$) for several values of the mixing parameter α

Cluster 1 shows in event studies estimation (Table 18) that the coefficient of self–employed income is small and positive when $\alpha = 0$, but becomes negative and statistically significant under α_q and even more consistently under α^*. The transition from a non–spatial to a spatial clustering, therefore, reveals that, once provinces are grouped according to both income dynamics and geographical contiguity, taxpayers in high–income areas exhibit a clearer tendency to adopt compliant behaviors after the enactment of MTS. This interesting finding suggests that the reform is also effective at the intensive margin in this specific group of provinces. The self–employment share, on the contrary, is essentially unrelated to the gap under $\alpha = 0$, while it becomes modestly negative and significant under α_q, before weakening again under α^*. Model 3 confirms the role of occupational composition, with technical skill–intensive jobs generating large positive effects on tax evasion under $\alpha = 0$, which shrink substantially under α_q and α^*. On the contrary, soft–skilled occupations have a negative association with tax evasion, but its magnitude is strong only in the non–spatial specification. Turning to the DID, only when α=0, without spatial dependence, the coefficients are negative and significant, in line with the main results of the estimation (see Table 5). Coefficients become non-significant when the spatial weight increases. This indicates that, when moving from a continuous to a binary environment, spatial contiguity loses importance.

Cluster 2 of Fig. 8 displays an opposite pattern (see Table 18). The coefficient attached to self-employment income is positive and highly significant under $\alpha = 0$, but becomes indistinguishable from zero under α_q and remains small and insignificant under α^*. The extensive–margin variable in Model 2 also oscillates notably, but is never significant. Differently from Cluster 1, spatial contiguities accentuate the territorial heterogeneity making the impact of MTS more blurred. Mildly negative under $\alpha = 0$, essentially null under α_q, and slightly positive under α^*. This evidence confirms that the share of self-employment doesn't contribute to the tax gap share in Central regions. Skill variables in Model 3 further underline the inconsistency of behavioral patterns in this cluster, with coefficients that change sign and precision across α without revealing a stable mechanism. The DID estimation for Cluster 2, in Table 19, confirms the heterogeneity among the α. The post–reform impact is moderately negative under $\alpha = 0$, vanishes under α_q, and becomes positive under α^*, although significance remains fragile. Overall, central provinces do not show a robust adjustment to MTS, and the differences across α reinforce the absence of a unified behavioral response.

Cluster 3 provides the clearest evidence of systematic behavioral reactions, and here the differences across α strengthen the interpretation rather than blur it. In Model 1, for event-studies, the income coefficient is small and only marginally significant when $\alpha = 0$, becomes moderately positive and significant under α_q, and reaches its highest magnitude under α^* (as a main estimation, see Table 4). Southern taxpayers thus display a stronger intensive–marginal distortion when provinces are spatially clustered. Similar results, but in an opposite direction, emerge from Model 2 which shows an even sharper pattern. The self–employment share is insignificant under $\alpha = 0$, strongly negative under α_q, reaching a negative peak under α^*. The extensive margin is concentrated in spatially contiguous provinces belonging to this Cluster, which gathers economically developed regions. Model 3 likewise becomes more stable under spatial clustering, with technical skills having positive effects under α_q and α^*, while

soft–skill occupations systematically reduce the gap with growing precision under the spatial specifications. The DID results completely align with this pattern, with the post–reform effect being null under $\alpha = 0$, modestly negative under α_q, and large and significant under α^*, signalling a clear reform–induced discontinuity once southern provinces are grouped in a spatially coherent way.

Overall, the combined evidence shows that the role of α is not merely technical. Moving from $\alpha = 0$ to α_q and finally to α^* refines the behavioral structure within each cluster. For northern provinces, spatial clustering reveals a beneficial impact of MTS at the intensive margin that is invisible in the non–spatial setting. For central provinces, it exposes the absence of a coherent pattern. For southern provinces, it amplifies both intensive and extensive margin effects, strengthening the interpretation that these areas concentrated the strongest behavioral reactions to the reform across both identification strategies.

The cluster–specific estimates based on the self–employment share, reported in Tables 20 and 21, confirm the heterogeneous behavioral patterns already observed under the income–based clustering, but reveal clearer regional contrasts once the occupational structure of local labour markets is accounted for.

In Cluster 1 (see Fig. 9 for the geographical distribution), both the intensive and extensive margins of self–employment are negatively associated with the tax gap share. In Model 1, the coefficient of self-employed income is negative across all specifications like in the previous clustering procedure, although it partially gains statistical precision only when spatial dependence is introduced (α_q, α^*). Model 2, based on the self-employment share, reinforces this pattern. The effect is strongly negative and highly significant in every specification, ranging roughly from –0.25 to –0.14, with a meaningful weakening when $\alpha \neq 0$. These findings indicate that in northern provinces higher levels of self-employment are increasingly associated with lower underreporting as long as clustering is spatially weighted. Skill-based controls retain their previous patterns. Occupations intensively using technical skills raise, and soft-skill jobs lower, the tax gap share. In the corresponding DID estimates (Table 21), no results are available for $\alpha = 0$. The identification relies on spatial weighting, but post-reform coefficients become positive, once spatial dependence is included (that is with α_q or α^*).

In Cluster 2, both margins display weaker and more erratic behavior. In Model 1, the income of the self-employed does not affect tax evasion significantly for any α. In Model 2, the self-employment share is positive and significant only when $\alpha = 0$, implying that in the absence of spatial effects, higher self-employment corresponds to larger tax gap share, differently from the other clusters and macro-regions. Once spatial weighting is introduced, these relationships become weaker and statistically insignificant, suggesting that spatial spillovers dilute local heterogeneity. The skill variables behave inconsistently across specifications, and the DID estimates remain small and non-significant, confirming the absence of any clear post-reform adjustment in the central regions.

In Cluster 3, the results are the most consistent and spatially responsive. Model 1 shows a positive and significant association between self-employed income and the tax gap share across all specifications, indicating that higher reported incomes of the self-employed coincide with decreasing compliance. Model 2, instead, moves from

Table 18 Event–study estimates of the effects of self–employment income declaration and occupational composition on the tax gap across clusters and spatial weights

	$\alpha = 0$				α_q				α^*			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Cluster 1												
Model 1												
Self-employed_income	0.028*	0.019	0.019	0.027	−0.041	−0.05*	−0.058**	−0.023	−0.06***	−0.062***	−0.065***	−0.047**
	(0.016)	(0.016)	(0.019)	(0.019)	(0.028)	(0.028)	(0.029)	(0.028)	(0.021)	(0.021)	(0.022)	(0.021)
Model 2												
Self-employment_share	−0.155	−0.124	−0.09	−0.107	−0.124*	−0.128*	−0.17**	−0.149**	−0.012	−0.027	−0.059	−0.039
	(0.111)	(0.113)	(0.116)	(0.114)	(0.074)	(0.073)	(0.074)	(0.072)	(0.068)	(0.069)	(0.07)	(0.068)
Model 3												
Technical_skills	0.814***	0.837***	1.23***	1.06***	0.294	0.242	0.495*	0.52*	0.303	0.253	0.514*	0.426
	(0.314)	(0.32)	(0.367)	(0.363)	(0.265)	(0.264)	(0.297)	(0.288)	(0.24)	(0.245)	(0.276)	(0.269)
	−0.061	0.029	−1.618	−1.476	0.188	−0.07	0.138	−0.148	0.133	−0.071	0.038	−0.183
Cognitive_skills	(1.132)	(1.153)	(1.267)	(1.262)	(0.573)	(0.577)	(0.59)	(0.577)	(0.572)	(0.582)	(0.594)	(0.578)
	0.074	−0.068	2.146	1.877	−0.366	−0.201	0.044	0.29	−0.259	−0.219	0.007	0.161
Horizontal_skills	(1.136)	(1.163)	(1.321)	(1.314)	(0.607)	(0.614)	(0.648)	(0.63)	(0.599)	(0.61)	(0.642)	(0.62)
	−0.331*	−0.202	−0.643***	−0.61**	0.188	0.29	0.125	0.074	0.175	0.255	0.031	0.094
Soft_skills	(0.17)	(0.17)	(0.242)	(0.24)	(0.212)	(0.21)	(0.241)	(0.234)	(0.193)	(0.194)	(0.22)	(0.215)
N.Obs	**528**	**528**	**528**	**528**	**516**	**516**	**516**	**516**	**648**	**648**	**648**	**648**

Table 18 continued

	$\alpha = 0$				α_q				α^*			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Cluster 2												
Model 1												
Self-employed_income	0.086***	0.076***	0.05**	0.067***	−0.015	−0.017	−0.02	−0.017	0.015	0.029	0.002	−0.02
	(0.017)	(0.017)	(0.02)	(0.02)	(0.025)	(0.025)	(0.027)	(0.026)	(0.033)	(0.031)	(0.036)	(0.036)
Model 2												
Self-employment_share	−0.062	−0.056	−0.108	−0.157	−0.003	0.05	0.023	0.002	0.057	0.085	0.052	0.017
	(0.119)	(0.12)	(0.12)	(0.117)	(0.066)	(0.069)	(0.073)	(0.07)	(0.094)	(0.093)	(0.105)	(0.107)
Model 3												
Technical_skills	1.314***	1.374***	1.063***	0.857**	−0.047	0.149	−0.2	−0.201	0.255	0.302	−0.626	−0.497
	(0.31)	(0.302)	(0.366)	(0.369)	(0.298)	(0.31)	(0.344)	(0.337)	(0.384)	(0.39)	(0.424)	(0.418)
Cognitive_skills	1.861	2.279	2.852	2.768	−1.045	−0.898	−0.261	−0.847	0.103	0.593	1.692	0.572
	(1.673)	(1.664)	(1.884)	(1.85)	(1.902)	(1.976)	(2.073)	(1.999)	(2.64)	(2.652)	(2.891)	(2.889)
Horizontal_skills	−1.34	−1.941	−2.578	−2.632	0.691	0.413	−0.395	0.431	−0.133	−0.761	−2.652	−1.221
	(1.676)	(1.671)	(1.912)	(1.877)	(1.939)	(2.016)	(2.129)	(2.063)	(2.632)	(2.656)	(2.876)	(2.877)
Soft_skills	−0.844***	−0.853***	−0.528**	−0.411*	0.249	0.318	0.451	0.353	0.283	0.343	0.908**	0.784**
	(0.163)	(0.158)	(0.248)	(0.248)	(0.239)	(0.246)	(0.294)	(0.286)	(0.331)	(0.333)	(0.369)	(0.373)
N.Obs	**396**	**396**	**396**	**396**	**420**	**420**	**420**	**420**	**252**	**252**	**252**	**252**

Table 18 continued

	$\alpha = 0$				α_q				α^*			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Cluster 3												
Model 1												
Self-employed_income	0.037	0.04*	0.025	0.015	0.081**	0.08**	0.071**	0.072**	0.123***	0.092***	0.086***	0.111***
	(0.023)	(0.024)	(0.026)	(0.026)	(0.034)	(0.032)	(0.032)	(0.033)	(0.029)	(0.029)	(0.029)	(0.03)
Model 2												
Self-employment_share	0.075	0.082	0.099	0.097	−0.219**	−0.217**	−0.193**	−0.212**	−0.432***	−0.427***	−0.413***	−0.423***
	(0.083)	(0.087)	(0.092)	(0.091)	(0.099)	(0.091)	(0.093)	(0.099)	(0.109)	(0.108)	(0.11)	(0.11)
Model 3												
Technical_skills	0.347	0.333	−0.244	−0.116	0.943***	0.883***	0.669*	0.612	0.893**	0.804*	0.799	0.846
	(0.31)	(0.324)	(0.337)	(0.338)	(0.308)	(0.305)	(0.372)	(0.377)	(0.45)	(0.435)	(0.505)	(0.518)
Cognitive_skills	0.197	0.105	0.023	−0.164	0.675	0.61	−0.61	−0.488	−0.541	−0.375	−1.153	−1.967
	(0.711)	(0.753)	(0.74)	(0.721)	(1.421)	(1.447)	(1.655)	(1.692)	(1.549)	(1.538)	(1.785)	(1.801)
Horizontal_skills	−0.127	−0.136	−0.5	−0.213	−0.104	−0.197	0.993	0.888	0.875	0.684	1.706	2.358
	(0.768)	(0.816)	(0.788)	(0.777)	(1.36)	(1.381)	(1.632)	(1.649)	(1.505)	(1.503)	(1.795)	(1.797)
Soft_skills	0.115	0.221	0.657**	0.635**	−0.624***	−0.593***	−0.514**	−0.463*	−0.593***	−0.567***	−0.715***	−0.659**
	(0.263)	(0.269)	(0.297)	(0.303)	(0.177)	(0.177)	(0.241)	(0.243)	(0.198)	(0.194)	(0.267)	(0.265)
N.Obs	**312**	**312**	**312**	**312**	**300**	**300**	**300**	**300**	**336**	**336**	**336**	**336**
Institutional quality	X			X	X			X	X			X
Socio-economic		X		X		X		X		X		X
Labour market and sectors			X	X			X	X			X	X
Time fixed-effect	X	X	X	X	X	X	X	X	X	X	X	X
Provincial fixed-effects	X	X	X	X	X	X	X	X	X	X	X	X

Note: Event-study estimates are reported by cluster and spatial-weighting scheme. Columns refer to the empirical specifications adopted for each model and differ in the set of control variables included, as indicated by black crosses. Clusters are defined according to the hierarchical spatio-temporal clustering procedure described in Sect. 4.3. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The clustering analysis is used to explore territorial heterogeneity and should not be interpreted as a separate identification strategy. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 19 Difference–in–differences estimates of the post–reform effects on self–employment income declaration across clusters and spatial weights

	$\alpha = 0$				α_q				α^*			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Cluster 1												
Model 2												
Self-employed_income_post	−0.002***	−0.002***	−0.002***	−0.002***	0.000	0.001	0.001	0.001	0.000	0.000	0.000	0.000
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N.Obs	**528**	**528**	**528**	**528**	**516**	**516**	**516**	**516**	**648**	**648**	**648**	**648**
Cluster 2												
Model 2												
Self-employed_income_post	−0.002***	−0.002**	−0.001	−0.001*	0.000	0.000	0.000	0.000	0.002**	0.002	0.002*	0.003**
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N.Obs	**420**	**420**	**420**	**420**	**396**	**396**	**396**	**396**	**252**	**252**	**252**	**252**
Cluster 3												
Model 2												
Self-employed_income_post	0.001	0.000	0.000	0.001	0.081**	0.08**	0.071**	0.072**	−0.007***	−0.003	−0.004*	−0.007***
	(0.001)	(0.001)	(0.001)	(0.001)	(0.034)	(0.032)	(0.032)	(0.033)	(0.002)	(0.002)	(0.002)	(0.002)
N.Obs	**312**	**312**	**312**	**312**	**300**	**300**	**300**	**300**	**336**	**336**	**336**	**336**
Institutional quality	X			X	X			X	X			X
Socio-economic		X		X		X		X		X		X
Labour market and sectors			X	X			X	X			X	X
Time fixed-effect	X	X	X	X	X	X	X	X	X	X	X	X
Provincial fixed-effects	X	X	X	X	X	X	X	X	X	X	X	X

Note: Difference-in-Differences estimates are reported by cluster and spatial-weighting scheme. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. Clusters are defined according to the hierarchical spatio-temporal clustering procedure described in Sect. 4.3. All specifications include province and year fixed effects. Standard errors are reported in parentheses. For sample-size considerations within each cluster, estimates are reported only for Model 2, based on the continuous treatment specification. The clustering analysis is used to explore territorial heterogeneity and should not be interpreted as a separate identification strategy. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 20 Event–study estimates by self–employment clusters for different spatial weighting schemes

	$\alpha = 0$				α_q				α^*			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Cluster 1												
Model 1												
Self-employed_income	−0.052	−0.06*	−0.059	−0.016	−0.047	−0.065**	−0.076**	−0.03	−0.044	−0.061*	−0.068**	−0.024
	(0.036)	(0.036)	(0.036)	(0.037)	(0.033)	(0.033)	(0.033)	(0.034)	(0.033)	(0.032)	(0.033)	(0.033)
$R\hat{2}$	0.049	0.046	0.081	0.158	0.053	0.047	0.078	0.159	0.051	0.045	0.07	0.15
Model 2												
Self-employment_share	−0.246***	−0.248***	−0.281***	−0.239***	−0.143**	−0.151**	−0.183***	−0.128**	−0.148**	−0.154**	−0.191***	−0.138**
	(0.065)	(0.065)	(0.066)	(0.064)	(0.063)	(0.062)	(0.064)	(0.063)	(0.061)	(0.061)	(0.063)	(0.061)
$R\hat{2}$	0.074	0.07	0.112	0.183	0.06	0.051	0.084	0.165	0.059	0.051	0.08	0.158
Model 3												
Technical_skills	0.294	0.237	0.857**	0.953***	0.401	0.276	0.928**	1***	0.374	0.291	0.92**	1.014***
	(0.323)	(0.321)	(0.365)	(0.36)	(0.317)	(0.313)	(0.365)	(0.356)	(0.309)	(0.307)	(0.359)	(0.351)
Cognitive_skills	0.338	−0.024	0.277	−0.095	0.177	−0.14	−0.059	−0.363	0.241	−0.111	0.005	−0.303
	(0.578)	(0.581)	(0.592)	(0.583)	(0.574)	(0.577)	(0.595)	(0.58)	(0.567)	(0.57)	(0.588)	(0.575)
Horizontal_skills	−0.441	−0.271	0.348	0.582	−0.116	−0.046	0.566	0.9	−0.153	−0.056	0.534	0.866
	(0.666)	(0.669)	(0.711)	(0.692)	(0.666)	(0.669)	(0.711)	(0.687)	(0.657)	(0.66)	(0.704)	(0.682)
Soft_skills	−0.001	0.163	−0.362	−0.445	0.125	0.309	−0.145	−0.204	0.157	0.299	−0.14	−0.217
	(0.287)	(0.283)	(0.322)	(0.315)	(0.283)	(0.279)	(0.32)	(0.311)	(0.277)	(0.274)	(0.315)	(0.307)
$R\hat{2}$	0.051	0.049	0.091	0.173	0.064	0.057	0.094	0.184	0.063	0.057	0.089	0.176
N.Obs	**504**	**504**	**504**	**504**	**516**	**516**	**516**	**516**	**528**	**528**	**528**	**528**
Cluster 2												
Model 1												
Self-employed_income	−0.064	−0.039	−0.06	−0.113	−0.03	−0.039	−0.03	−0.034	−0.025	−0.037	−0.023	−0.026
	(0.081)	(0.08)	(0.082)	(0.086)	(0.035)	(0.035)	(0.036)	(0.035)	(0.035)	(0.036)	(0.037)	(0.036)
	0.037	0.003	0.127	0.186	0.109	0.015	0.064	0.19	0.11	0.014	0.063	0.189

Table 20 continued

	$\alpha = 0$				α_q				α^*			
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
Model 2												
Self-employment_share	0.247***	0.26***	0.261***	0.254**	0.056	0.181**	0.143*	0.057	0.065	0.178**	0.152*	0.062
	(0.087)	(0.081)	(0.093)	(0.099)	(0.078)	(0.081)	(0.086)	(0.084)	(0.076)	(0.078)	(0.084)	(0.082)
	0.077	0.057	0.165	0.211	0.109	0.027	0.071	0.189	0.111	0.027	0.072	0.189
Model 3												
Technical_skills	−0.173	0.024	−0.22	−0.386	−0.325	−0.108	−0.416	−0.291	−0.301	−0.054	−0.34	−0.257
	(0.358)	(0.349)	(0.438)	(0.448)	(0.415)	(0.437)	(0.47)	(0.459)	(0.423)	(0.445)	(0.476)	(0.466)
Cognitive_skills	−3.194	−3.389	−3.1	−3.309	−0.822	−1.881	−0.887	−0.725	−0.808	−1.942	−0.951	−0.635
	(2.634)	(2.635)	(2.784)	(2.87)	(2.18)	(2.281)	(2.406)	(2.289)	(2.227)	(2.33)	(2.457)	(2.338)
Horizontal_skills	2.676	2.898	2.437	2.507	0.48	1.375	0.197	0.301	0.407	1.356	0.172	0.142
	(2.644)	(2.65)	(2.809)	(2.886)	(2.197)	(2.301)	(2.427)	(2.31)	(2.238)	(2.344)	(2.474)	(2.355)
Soft_skills	0.747***	0.649**	0.781**	1.026**	0.149	0.375	0.528	0.292	0.188	0.426	0.595	0.346
	(0.28)	(0.279)	(0.391)	(0.399)	(0.306)	(0.32)	(0.369)	(0.354)	(0.297)	(0.31)	(0.365)	(0.351)
$R\hat{2}$	0.105	0.065	0.155	0.23	0.103	0.07	0.152	0.192	0.118	0.077	0.15	0.196
N.Obs	**528**	**528**	**528**	**528**	**372**	**372**	**372**	**372**	**360**	**360**	**360**	**360**
Institutional quality	X			X	X			X	X			X
Socio-economic		X		X		X		X		X		X
Labour market and sectors			X	X			X	X			X	X
Time fixed-effect	X	X	X	X	X	X	X	X	X	X	X	X
Provincial fixed-effects	X	X	X	X	X	X	X	X	X	X	X	X

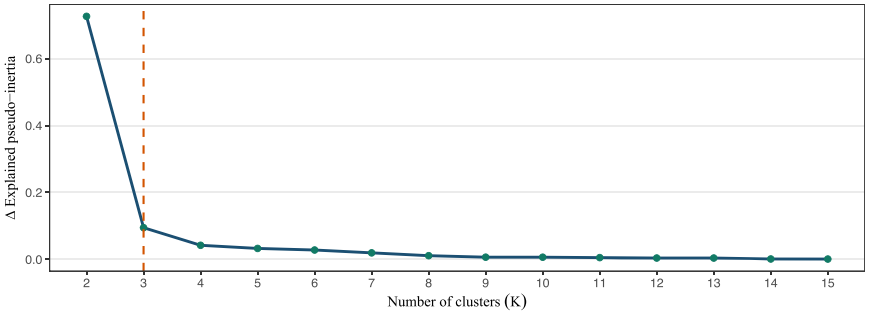
Note: Event-study estimates are reported by cluster and spatial-weighting scheme. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. Clusters are defined according to the hierarchical spatio-temporal clustering procedure described in Sect. 4.3. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The clustering analysis is used to explore territorial heterogeneity and should not be interpreted as a separate identification strategy. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

Table 21 Difference–in–Differences estimates by self–employment clusters under alternative spatial specifications

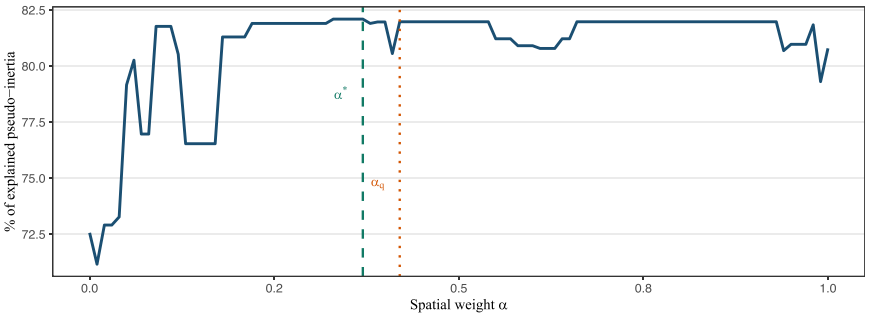
	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4	Spec 1	Spec 2	Spec 3	Spec 4
	$\alpha = 0$				α_q				α^*			
Cluster 1												
Model 2												
Self-employed_income_post	-	-	-	-	0.005***	0.005***	0.007***	0.007***	0.055***	0.055***	0.071***	0.073***
	-	-	-	-	(0.002)	(0.002)	(0.002)	(0.002)	(0.017)	(0.017)	(0.018)	(0.017)
N.Obs	-	-	-	-	**516**	**516**	**516**	**516**	**528**	**528**	**528**	**528**
Cluster 2												
Model 2												
Self-employed_income_post	0.000	0.000	0.000	0.000	−0.001	−0.001	−0.001	−0.001	−0.001	−0.001	−0.002*	−0.001
	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)	(0.001)
N.Obs	**204**	**204**	**204**	**204**	**348**	**348**	**348**	**348**	**348**	**348**	**348**	**348**
Cluster 3												
Model 2												
Self-employed_income_post	0.123***	0.104***	0.062**	0.074***	0.102***	0.096***	0.088***	0.092***	0.091***	0.089***	0.081***	0.082***
	(0.028)	(0.029)	(0.029)	(0.028)	(0.03)	(0.029)	(0.028)	(0.029)	(0.03)	(0.029)	(0.029)	(0.03)
N.Obs	**528**	**528**	**528**	**528**	**372**	**372**	**372**	**372**	**360**	**360**	**360**	**360**
Institutional quality	X			X	X			X	X			X
Socio-economic		X		X		X		X		X		X
Labour market and sectors			X	X			X	X			X	X
Time fixed-effect	X	X	X	X	X	X	X	X	X	X	X	X
Provincial fixed-effects	X	X	X	X	X	X	X	X	X	X	X	X

Note: Difference-in-Differences estimates are reported by cluster and spatial-weighting scheme. Columns refer to alternative empirical specifications and differ in the set of control variables included, as indicated by black crosses. Clusters are defined according to the hierarchical spatio-temporal clustering procedure described in Sect. 4.3. All specifications include province and year fixed effects. Standard errors are reported in parentheses. The clustering analysis is used to explore territorial heterogeneity and should not be interpreted as a separate identification strategy. Significance levels: *** $p < 0.01$; ** $p < 0.05$; * $p < 0.1$

(a) First difference of explained pseudo–inertia by number of clusters (K)



(b) Average proportion of explained pseudo–inertia as a function of α



(c) Average proportion of explained pseudo–inertia by α and number of clusters (K)

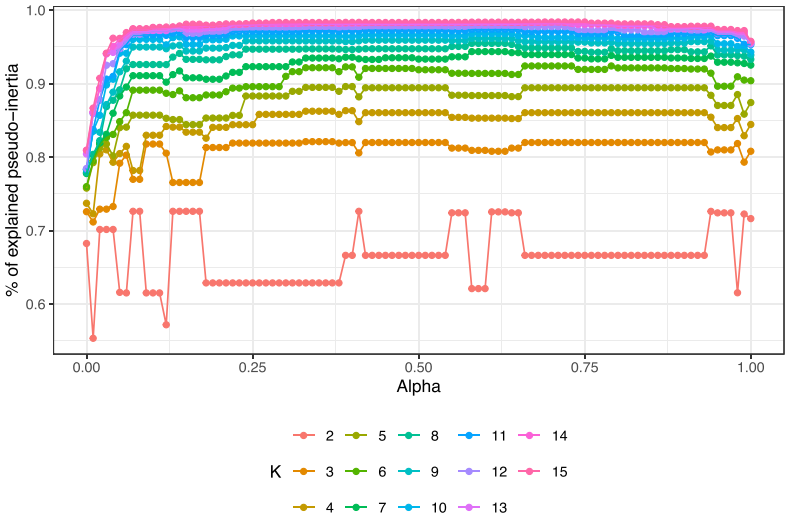
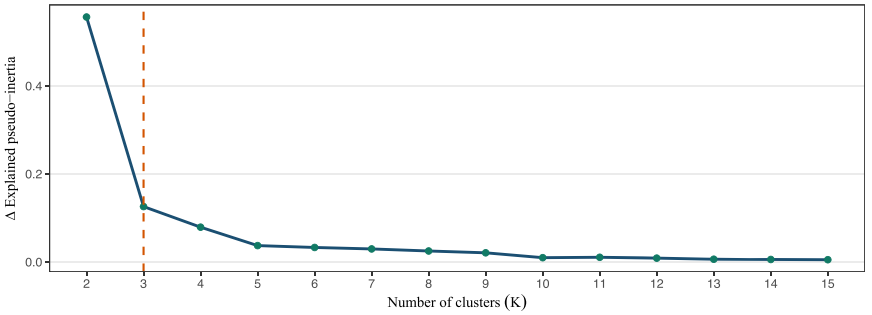
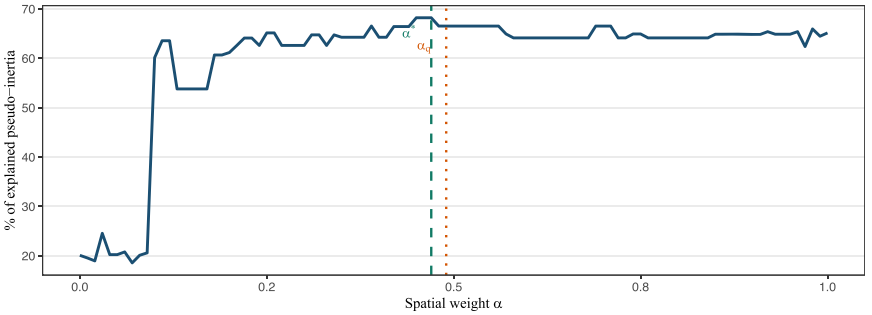


Fig. 10 Metrics of clustering performance and spatial weight calibration of self-employment income

(a) First difference of explained pseudo–inertia by number of clusters (K)



(b) Average proportion of explained pseudo–inertia as a function of α



(c) Average proportion of explained pseudo–inertia by α and number of clusters (K)

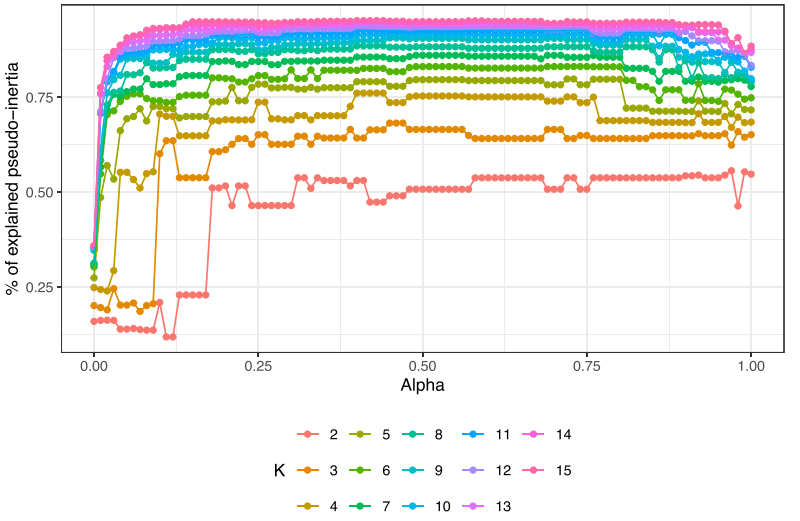


Fig. 11 Metrics of clustering performance and spatial weight calibration of self-employment share

insignificance at $\alpha = 0$ to strongly negative and highly significant effects for α_q and α^*, implying that once spatial dependence is considered, provinces with denser networks of self-employed workers reduce their underreporting at the extensive margin, although to a lower extent than in the income-based spatial clustering procedure. Model 3 confirms that technical skills raise the gap while soft-skills reduce it, a structure that becomes clearer as spatial weights increase. The DID coefficients confirm the negative impact of the reform at the intensive margin under spatially weighted models, revealing that southern provinces, where self-employment is more concentrated, reacted to self-employment income increases with a more intense underreporting.

Overall, clustering by self-employment share rather than income preserves the regional hierarchy observed in income-based results but emphasizing the northern relative stability compared to the southern responsiveness to MTS at both the intensive and the extensive margin. The occupational composition of local economies thus captures complementary dimensions of tax-related behavioral dynamics beyond income levels.

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s00168-026-01546-y.

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Author Contributions The authors jointly conceived the study design, collected and processed the data, implemented the econometric approach, performed the analyses, interpreted the results, and drafted and revised the manuscript. Gianluca Monturano developed the R code and implemented the estimation pipelines used for the empirical analysis.

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Data Availability All scripts were developed entirely by the authors using R. The provincial-level tax evasion data used in the analysis were provided by the Italian Revenue Agency under a non-disclosure agreement with Prof. Bruno Chiarini (University of Naples Parthenope) and therefore cannot be made public. For reproducibility, the replication package includes the code needed to reproduce the empirical analysis and to provide simulated data to check the code consistency and replicate the structure of the empirical workflow. The main code used is publicly available on GitHub at the following link:https://github.com/gmonturano/tax_evation_self_employed.

Declarations

Conflict of interest The authors declare no conflict of interest.

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