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THE GEOGRAPHY OF REMOTE WORK IN EUROPE: AN ANALYSIS USING LFS DATA

Paolo Emilio Cardone

Abstract. This paper explores the evolution of working-from-home (WFH) across EU regions, focusing on the period before, during and after the COVID-19 outbreak from 2019 to 2022, to understand the distribution and determinants of remote work (RW) adoption at the regional level. This analysis of the EU Labour Force Survey reveals a widespread increase in the prevalence of WFH across EU countries, regions and territorial typologies. While RW rates have slightly receded from their peak at the height of COVID-19 restrictions, they remain markedly higher than pre-pandemic levels nearly everywhere in the EU, reflecting a lasting shift in work practices. Despite this common trend, substantial regional disparities persist across Member States, NUTS regions and territorial typologies (cities, towns and suburbs, rural areas). Main findings show geographic disparities at all levels in the adoption of WFH: the RW rate has been higher in Northern EU countries compared to Southern and Eastern ones. Similarly, capital regions had higher prevalence of WFH than other regions in the same country. Finally, WFH is more common in cities than towns/suburbs and rural areas.

1. Introduction

The COVID-19 pandemic triggered a large and sudden shift in the location of work around the world. It has indeed led to a significant increase of working from home (WFH), or more generally remote working (RW)¹, in the EU regions in the efforts of capital to address the disruption of production and consumption, involving space as a key, integral factor, in a new “spatial fix”, reflecting a “destruction of time through space” (Ward, 2020). Because of this, there has been a growing debate on the implications of RW for the geography and role of large cities. Similarly, there has been substantial debate on the extent to which RW may lead to a structural relocation of workers and advanced economic activities from core urban centres towards less densely populated areas (Crescenzi *et al.*, 2022; Fiorentino *et al.*, 2022;

¹ Although WFH, which is defined by Eurostat (2021) as “*doing any productive work related to the person’s current main job at home*” can be performed at home, and RW, which is defined by ILO (2020) as “*any situation where the work is fully or partly carried out on an alternative worksite other than the default place of work*” can be performed across various places, such as coworking places or libraries, in this paper, the terms “WFH” and “RW” are used interchangeably.

Florida *et al.*, 2023; Glaeser, 2022; Grabner & Tsvetkova, 2022; Nathan, 2023; Nathan & Overman, 2020), especially when work is done fully remotely.

Before the COVID-19 crisis, capital regions appear to have been a significant vector of employment polarisation, as they tended to generate a disproportionate share of new employment in well-paid, high-skilled jobs in the services sector, alongside growth in low-paid employment (Eurofound and European Commission Joint Research Centre, 2019). More generally, socioeconomic inequalities have been on the rise in European capital cities, with increasing separation between poor and rich (Musterd *et al.*, 2017). The contribution of global cities to inequality is notably driven by the concentration of financial activities there (Godechot *et al.*, 2023).

Meanwhile, in 2021 only 25% of the EU population lived in rural areas, although they account for more than three-quarters of the EU's territory (Eurostat, 2022).

Because WFH has significant potential implications for regional development and sustainability, it is important to assess how is recent surge has been distributed across European regions. While there is a growing number of studies uncovering the geography of WFH in the United States (Ramani and Bloom, 2021), the cross-country comparative empirical evidence from other Organisation for Economic Co-operation and Development (OECD) countries is, however, still lacking.

This paper contributes to the above literature on the rates and potential of RW from a geographical perspective. Have the levels of RW across regions become more similar after the COVID-19 crisis? Or did the COVID-induced increases in WFH concentrate in some specific regions, exacerbating previous differences?

This paper addresses these questions by using data on the evolution of WFH across European Union regions with a focus on its geographic distribution, from 2019 until 2022, that is before, during and after the COVID-19 crisis.

2. Data and methods

This study aims to document and explain the differences across EU regions in RW rate and how these have changed over time, around the COVID-19 crisis. Of particular interest is the role of geography: to what extent variation in RW rate reflect differences across countries, regions within countries, or between cities and rural areas can be explained by their geographic characteristics. To answer this question, we rely on the European Labour Force Survey (EU-LFS)², which is conducted annually and provides a representative sample of the working-age population. The

² The dataset cannot be shared since it has restricted access. Interested researchers need to apply to Eurostat for microdata access: <https://ec.europa.eu/eurostat/web/microdata/european-union-labour-force-survey>.

EU-LFS cannot be used to track changes over time in individual patterns of WFH, because it is structured as an anonymous cross-sectional survey, not intended for longitudinal analysis. Nevertheless, some aggregate trends emerge on a geographical basis, along three dimensions: national, regional and territorial level. Besides the national level, we consider the NUTS region of the respondent's residence. Additionally, we consider the degree of urbanisation of the respondent's residence, as being either a "city", a "town or suburb" or a "rural area", based on a fine-grained geographical grid of population size and density. This additional classification thus allows to compare similar territories within and across different NUTS regions and countries. In this analysis, we consider the population of interest includes people aged 15 and over, who are employees, excluding self-employed and family workers. The main variable of interest measures how often the respondent reports WFH, with the possible answers "never", "sometimes" or "usually"³. From this variable, we derive a binary indicator equal to one when the respondent reports WFH at least some of the time (sometimes or usually) and equal to zero when they do not ("never"), because it is important to understand whether the company has implemented RW, regardless of whether it is hybrid (sometimes) or fully remote (usually). The RW rate is calculated as the number of individuals sometimes or always work remotely as a percentage of total people employed. The analysis begins with the national scale and then estimates the regional RW rate in 2019 and 2022 (a comparison between the year before the pandemic and the year immediately after), in 2020 (first pandemic year) and annual percentage RW rate change between 2019 and 2020 (due to the first pandemic year), to satisfy the research aim, i.e. to examine how RW unfolds unevenly across space. Aiming to detect spatial interactions, spatial autocorrelation indices (*p-value* and *z-score* of Moran I) were calculated for the RW rate in 2020 and RW rate change 2019-2020 variables at the NUTS2 regional level, using ArcGIS Pro 3.3.

3. The geography of remote work in Europe since COVID-19

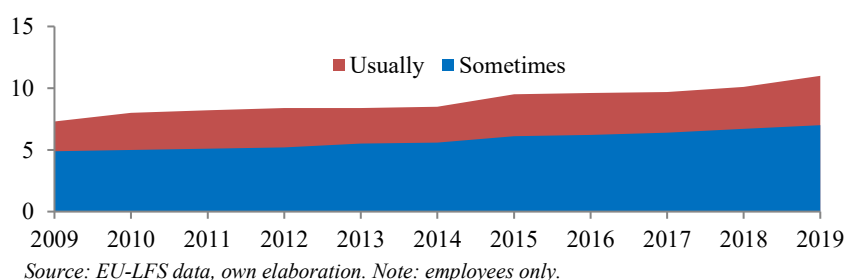
3.1. A brief overview before the COVID-19 pandemic, from 2009 to 2019

In this section, we present a descriptive analysis to outline the evidence for the EU-27 countries on the prevalence of WFH in the workforce before, during and after the COVID-19 pandemic. The focus of the analysis is on dependent employees, i.e.,

³ WFH "usually" in this context means working at home half of the days in a reference period of four weeks preceding the end of the reference week. WFH "sometimes" means working at home less than half of the days worked, but at least one hour during the four-week reference period.

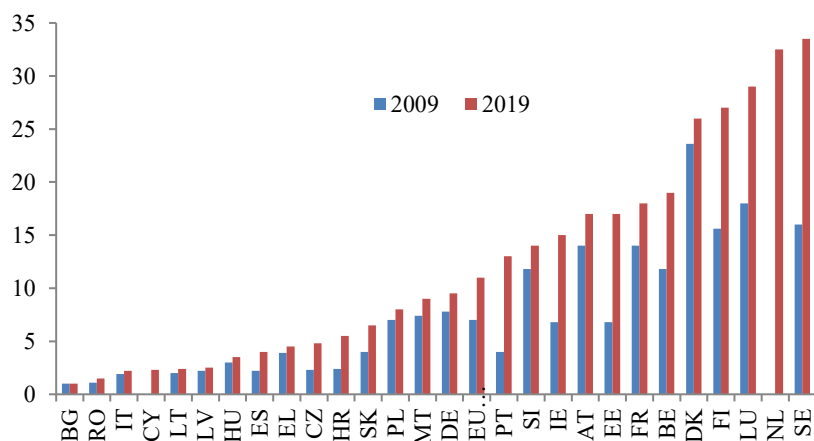
the population of workers who generally rely on their employer's assent to WFH where the post-covid conditions of WFH will be subject to negotiation and consent between workers, employers and their representatives.

Figure 1 – RW rate in the EU-27, 2009-2019 (Values are %).



Before focusing on the evidence during the pandemic, an overview is provided of the evolution of WFH among employees in the EU-27 from 2009 to 2019. In 2009 less than 8% of employees were WFH sometimes or usually. The rate has gradually increased over the years to reach 11% in 2019, just before the crisis (Figure 1).

Figure 2 – RW rate in the EU-27 in 2009 and 2019 (Values are %).



Note: Data on the frequency of WFH in 2009 are not available for the Netherlands and Cyprus. Employees only. Source: EU-LFS data, own elaboration.

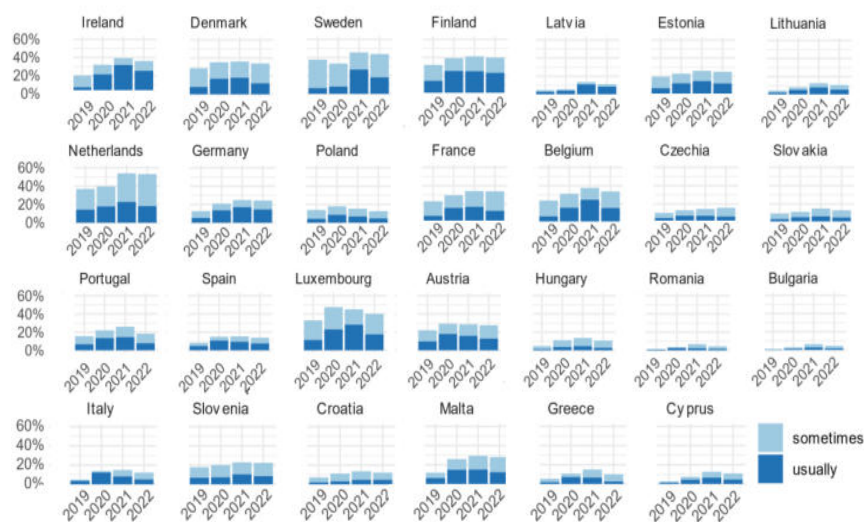
The ability to effectively adapt to large-scale WFH is likely to differ significantly across EU countries. Pre-outbreak, there were large and growing differences in the prevalence of WFH across its Member States. As of 2019, the RW rate was above

25% in most Northern European countries, including Sweden, Finland, Denmark, Luxembourg and the Netherlands, whereas it was below 10% in 15 of the 27 EU Member States, from Bulgaria to Germany (Figure 2). Between these two extremes, there were countries such as Belgium, France and Portugal where the RW rate was between 13 and 19%. Countries in Northern Europe are also those with the largest growth in the prevalence of WFH since 2009, albeit sizable increases also took place in a few other Member States including Portugal, Estonia and Ireland.

3.2. Remote work across EU Member States

As shown by figure 3, RW rate before COVID-19 was around 14% on average across the EU. With the introduction of COVID-19 confinement measures in 2020, it increased markedly in every country (20,8% on average across the EU) and increased even further in 2021 in many countries (24,2% on average). In 2022, after confinement measures were lifted, RW rates decreased slightly everywhere, while remaining well above pre-pandemic levels (22,6% on average).

Figure 3 – RW rate in the EU-27, 2019-2022 (Values are %).



Source: EU-LFS data, own elaboration. Note: employees only.

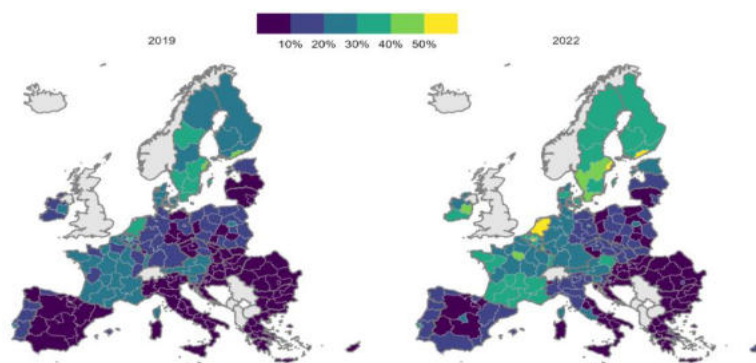
Despite this common trend, the magnitude of changes in RW rates varied across Member States and in some cases so did their timing. Between 2019 and 2020, Luxembourg and Malta recorded the largest absolute increase, over 14 percentage points; they were followed by another small country, Ireland, where the RW rate

increased from 20% to 32%; Italy, Belgium, Germany, Finland and Austria also recorded a noticeable increase (above 7 pp). At the other end, the smallest absolute changes (below or around 2 pp increase) were recorded in Latvia, Romania, Bulgaria, Slovakia and Slovenia. Between 2020 and 2021, with COVID-19 confinement measures still in place and being tightened in some countries, the increases in the RW rate progressively consolidated or remained stable, albeit to a very different extent. Only in three countries the RW rate slightly decreased, notably in Poland (-2,5 pp), Luxembourg (-2,4 pp) and Austria (-0,6 pp); by contrast, in the Netherlands and Sweden, there was a considerable increase (+14 and 13 pp respectively). In 2021, these two countries ranked the highest RW rate (54% and 47%), followed by Luxembourg (45%), Finland (41%), Ireland and Belgium (40%), Denmark (36%) and France (34%). In all other countries the respective rates were below 30%, with most Eastern European, Baltic and Mediterranean countries standing around or below 15%. Romania and Bulgaria continued to record the lowest rate, around 7%, albeit this represents a five-fold expansion on pre-COVID levels, given low starting levels. In 2022, despite of public-health measures were lifted across all Member States, the RW rate reduced only slightly (between 1 and 3 pp in most countries), remaining well above the pre-COVID levels of 2019.

3.3. Remote work across EU NUTS regions

Besides the differences across EU Member States, there was considerable heterogeneity in the prevalence of WFH across regions, as shown by figure 4, based on region of residence of the EU-LFS respondents.

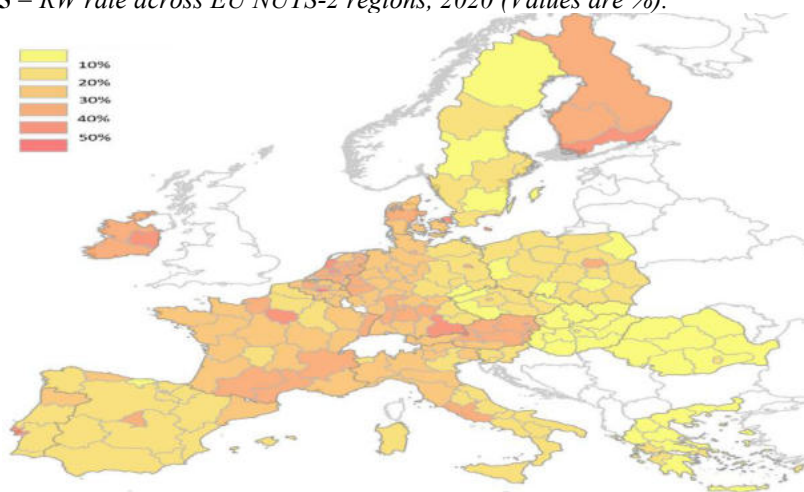
Figure 4 – RW rate across EU NUTS-2 regions, 2019 and 2022 (Values are %).



Note: Regions are NUTS-2 where available. NUTS-1 (Austria and Germany) or Country (Netherlands). Employees only. Source: EU-LFS data, own elaboration.

Before COVID-19, Stockholm and Helsinki were the only NUTS-2 regions with RW rate higher than 40%, standing out also compared to other areas of the country. In Denmark instead, the interregional variability was much less pronounced, with consistently high RW rate in all regions, albeit higher in Copenhagen. In Belgium, RW rate in 2019 was highest in the commuting regions surrounding Brussels, that is Flemish Brabant and Walloon Brabant. In most of Eastern European, Baltic and Mediterranean countries with very low pre-Covid RW rates instead, RW rates were not very different in the capitals or surrounding regions. In Romania and Bulgaria for instance, Bucharest and Sofia region ranked third and second within their countries, with only 1,5% and 1,4% of people WFH, respectively. Within countries themselves, the difference between the regions with the highest and lowest RW rate in 2019 was particularly high in Belgium, Poland, Slovenia (above 20 pp difference), Finland, Slovakia and France (above 14 pp). The pandemic crisis resulted in a significant rise in RW rate in most regions: at the peak of WFH in 2021, 195 out of 202 NUTS-2 regions (96%) had higher RW rates than they did in 2019. By 2022, with the retreat of public health measures, this was still the case for 181 NUTS-2 regions (89%), with most of the exceptions concentrated in Poland and Portugal. Between 2019 and 2022, seven out of the ten NUTS regions that increased their RW rates the most (by 15-22 pp) surrounded national capitals. In summary, within countries, EU regions were more unequal in terms of their RW rate in 2022 than they were in 2019, with capital regions tending to have the highest rates within countries.

Figure 5 – RW rate across EU NUTS-2 regions, 2020 (Values are %).



Note: employees only. Source: EU-LFS data, own elaboration.

RW rate in 2020, first year pandemic, significantly varied across the EU regions (Figure 5). The highest rates are observed in regions of northern and central-western EU, whereas the lowest in central-eastern and south-eastern EU. The top 5 regions included core, metropolitan and well-developed regions, specialized in services and with high rates of high-skilled: Helsinki-Uusimaa (FI), Bavaria (DE), Région de Paris (FR), Prov. Brabant Wallon and Région de Bruxelles (BE), Eastern and Midland (IE). Peripheral, economically weak regions, specialized in manual-work sectors, such as manufacturing, with lower rates of high-skilled, were in the bottom-5 (in Greece, Romania, Hungary, Slovakia and Poland). Figure 5 also indicates a clustering of RW rates in 2020, highlighting the increased likelihood for strong spatial interactions. Indeed, the results of spatial autocorrelation reveal that RW rates in 2020 were spatially correlated (Table 1), as Moran I of RW rate 2020 was statistically significant with a value of 0,25. Moreover, the *z-score* (22,36) indicates a likelihood below 1% for the clustered pattern to be the result of random chance.

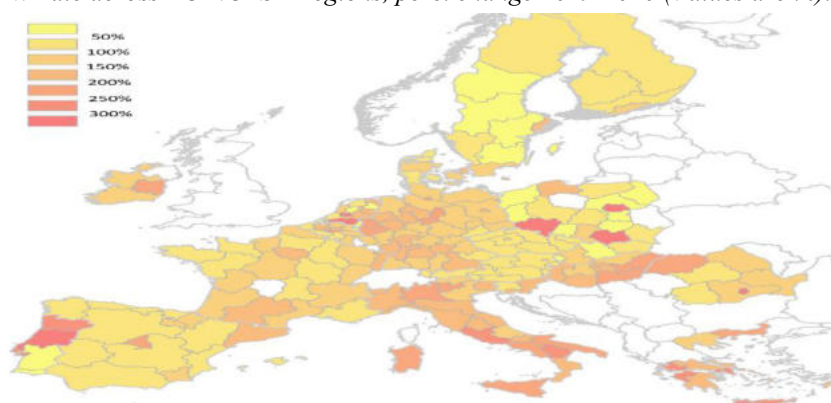
Table 1 – *Spatial autocorrelation statistics: RW rate 2020 and RW rate % change 19-20.*

	RW rate 2020	RW rate % change 2019-2020
Global Moran I	0.25	0.03
p-value	0.00	0.00
z-score	22.36	3.14

Source: EU-LFS data, own elaboration

Focusing on the change of RW rate from 2019 to 2020 (Figure 6), around 90% (189) of the 208 study regions (with available data for both years) saw an increase of RW rate.

Figure 6 – *RW rate across EU NUTS-2 regions, perc. change 2019-2020 (Values are %).*



Note: employees only. Source: EU-LFS data, own elaboration.

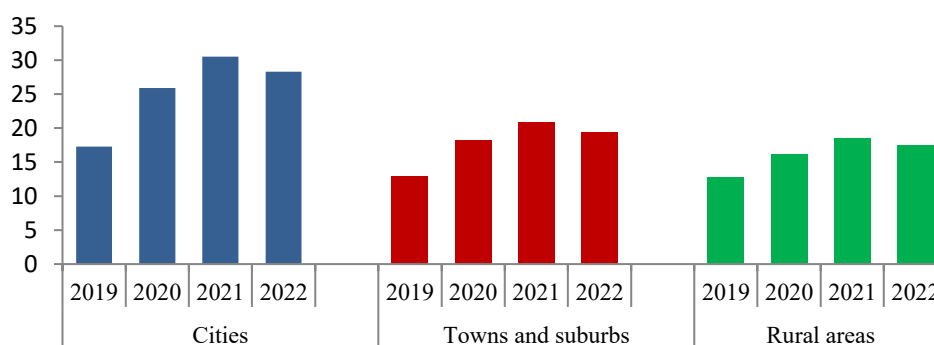
The average change was 152%, clearly indicating COVID-19 as a cornerstone in regional trends of RW (Althoff *et al.*, 2022). RW changes followed clear geographical patterns, with regional labour markets in Italy, France and Greece recording important increases of RW rate, highlighting the significance of the national context.

By contrast, figure 6 also marks stark antitheses among regions within Portugal, Poland and Romania. The change in RW rate from 2019 to 2020 (Figure 6) seems less spatially clustered than RW rate 2020 (Figure 5). This is verified by spatial autocorrelation statistics, indicating the existence of spatial autocorrelation (Moran I = 0,03), which is clearly weaker than for RW in 2020.

3.4. Remote work by degree of urbanisation

As reported in Sostero *et al.* (2020), before the pandemic WFH was much more likely in more densely populated metropolitan areas, than in suburbs and rural areas. During the pandemic, RW rate increased more in cities than in other areas, based on the “DEGURBA” variable⁴.

Figure 7 – RW rate by degree of urbanisation in the EU-27, 2019-2022 (Values are %).



Note: Employees only. Source: EU-LFS data, own elaboration.

In addition to capital regions having notably high levels of remote work, since 2020 there has been a more general divergence across EU NUTS regions: between cities on the one hand and towns, suburbs and rural areas on the other. At EU27 level, RW rate in cities increased from 17,3% in 2019 to 30,5% in 2021, before

⁴ DEGURBA, degree of urbanisation. This LFS variable differentiates between three settlement types with respect to their degree of urbanisation based on population density at Local Administrative Unit level (<https://ec.europa.eu/eurostat/web/nuts/local-administrative-units>). The three categories are “Densely populated / cities”, “Intermediate / towns and cities” and “Thinly populated / rural”.

dropping slightly to 28,3%; this amounts to an overall increase of approximately 9 percentage points between 2019 and 2022 (Figure 7). This compares with an increase of approximately 6,5 percentage points in towns and suburbs and around 4,8 percentage points in rural areas. This relates on the one hand to differences in employment structure: more densely populated, metropolitan areas are richer in the knowledge-based, white-collar services jobs that lend themselves to remote working, while in other area-types jobs that cannot be performed remotely are more common (e.g., agricultural labour in rural areas). On the other hand, it could also be influenced by the availability of digital infrastructure required for much WFH (for example, high speed broadband is more commonly available in cities than in remote rural regions). Moreover, employees working in urban areas usually have higher commuting time than workers working in non-urban areas and are more likely to work from home to avoid commuting (Eurofound, 2022).

4. Discussion and conclusions

This paper investigates the differences in RW rates across country and regions of the European Union (EU-27) from a geographical perspective. Using individual-level microdata from the EU Labour Force Survey, at the country level, RW rate for employees almost tripled from 2009 (the earliest year that Eurostat provides data) to 2022 (from less than 8% to 22,4%), highlighting the significant implications of the pandemic on RW (De Filippis *et al.*, 2020). Around 1 out of 5 employees sometimes or usually worked from home in 2020, with the pandemic-driven increase continuing in 2021 although with some declining trends in 2022, indicating that the COVID-19 effects on RW could be longstanding (OECD, 2020). The countries with the lowest RW rate before 2020, mostly in South-Eastern Europe and the Baltics, grew proportionally faster, hinting at a process of cross-country convergence, though large differences still remain across regions and countries. We also find that nearly every NUTS-2 region in the EU has seen an overall increase in RW rate: in 2021, at the peak of COVID-related confinement measures, the highest RW rates were found in and around Northern European capital regions, where 40-50% of the population works from home at least some of the time, while the lowest rates were found in rural regions of South-Eastern countries. Throughout the EU, RW rate grew more in cities, compared to towns/suburbs and rural areas. This might pose a risk of a territorial divergence, with urban and capital areas disproportionately reaping the benefits of the digital revolution. The closing remarks refer to suggestions for future research. Could WHF lead to an influx of urban workers into rural areas, revitalising them? Certainly, it is worth further examining remote work, when accounting that while a “big exodus” from the cities is not so possible (OECD, 2021), the relocation of

companies in the new, less spatially fixed organization of work could provide valuable insights on the future of socio-spatial inequality. In this context, in Italy many workers are reconsidering their priorities and would like to be able to work from anywhere (Cardone, 2023). A new phenomenon has emerged as result of these changes: *south-working*, people that work mainly remotely for employers located elsewhere, in Northern Italy or abroad. This may represent a positive input for Southern economies, which could attract talent both among those who were part of the “brain drain” and among people who are not originally from the South. An emerging form of remote work that allows employees to work from anywhere (WFA), so that the worker can choose to live in a preferred geographic location, in internal or remote areas and the Southern regions of Italy, in which the educated face continuous pressure for internal migration from South to North.

In conclusion, the rise in WFH has potentially profound implications for the spatial organisation of economic activity and the structure and morphology of regions in the coming years. However, as employers’ and workers’ preferences are still evolving, long-lasting effects are challenging to predict.

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PUBLIC ADMINISTRATION LABOUR MARKET: SKILLS, DIGITAL INNOVATION AND TERRITORIAL DISPARITIES

Francesca Carta

Abstract. The digitalisation of public administration (PA) is essential for the modernisation of public services. Accelerated by the COVID-19 pandemic, it has led to the adoption of new technologies and organisational models, redefining the skills required of public servants. Human capital training is central to supporting digitalisation and enabling process simplification. The reform of the PA labour market, implemented under the NRP, aims to improve the skills of public employees and simplify processes through digital technologies. In addition, several programmes and initiatives promote the digital skills needed by the PA workforce. Despite the measures in place, there are differences between areas due to various factors such as the availability of resources, local initiatives and participation in tenders. The aim of this paper is to examine digital innovation in the public PA labour market, by analysing the strategies adopted to address new skills needs. This study is in continuity with a 2024 analysis that correlated digital innovation of firms and digital skills of workers, profiling regions according to the level of digitalisation of the labour market. This work constitutes a preliminary study for a multidimensional analysis aimed at outlining the digital profile of public institutions at regional level and understanding the role of territories in the digital transition. In terms of methodology, the study will be carried out through desk research, with an analysis of literature and policies implemented. In addition, a descriptive analysis will be carried out on the interventions for updating and retraining digital competences (Sources: ISTAT Census of Public Institutions and ICTPA Surveys). One of the expected results is the classification of the regions in terms of digital skills needs.

1. Introduction

The 21st-century economy, shaped by globalisation and digitalisation, has transformed the labour market, introducing new organisational models and job profiles (Semenza, 2022). Digitalisation has shifted the skills required globally, increasing demand for digital competencies across all sectors, including public administration (PA). The COVID-19 pandemic accelerated this trend, prompting PA to adopt new technologies and redefine service delivery and employee skillsets. As Macri (2022) highlights, training human capital is key to digitalisation and process simplification. Various programmes, aim to improve public sector digital skills and streamline processes through technology. However, territorial disparities persist due to differences in resource access, local initiatives, and participation in tenders.

This paper builds on a 2024 study that examined regional disparities in digital innovation and labour market dynamics (Carta and Straccamore, 2024). The previous research developed three composite indicators to assess technology adoption by firms, workers' digital skills, and skill demand. Building on those findings, the current study serves as a preliminary step toward a broader, multidimensional and integrated analysis of labour market digitalisation across both public and private sectors, beginning with an assessment of digital skill needs.

Specifically, this paper aims to understanding how digitalisation is reshaping strategic choices and skill requirements in the public sector. Furthermore, using data from ISTAT, including the reports of Survey on information and communication technologies in local public administrations (2022)¹ and Permanent Census of Public Institutions (2022)², the study outlines the digital profile of public institutions at the regional level and explores the role of territorial contexts in driving the digital transition. Finally, the research investigates the distribution of digital skills needs within public administration, drawing on simple indices based on selected indicators (ISTAT sources).

This study relies on desk research, combining a comparative analysis of academic literature and policy documents to explore digital innovation in public administration. The literature review examines scholarly works on three key areas: digital innovation, reforms in public sector governance, and the growing need for digital skills. These academic sources offer both theoretical frameworks and empirical evidence that help explain how digital transformation is reshaping the public administration (PA) sector. In parallel, the study analyses policy documents and strategic plans from different levels of government—national, regional, and local. This policy analysis reveals how various territories are addressing digital transition, emphasizing the development of digital competencies and assessing their institutional readiness to manage change. By integrating insights from both academic research and policy practice, the methodology provides a comprehensive understanding of how territorial dynamics and institutional strategies influence the implementation of digital innovation in public administration (sections 2,3,4).

The findings from the desk research contributed to defining the descriptive analysis areas and reformulating the research questions. The descriptive analysis was

¹ The ISTAT survey 'Local Public Administration and ICT – Year 2022' concerns the statistical units made up of local administrations, namely: Regions and Autonomous Provinces; Provinces; Municipalities (of all demographic classes), Metropolitan Cities.

² The Permanent Census of Public Institutions conducted by ISTAT in 2022 has the following statistical units: Central administrations (Ministries, Presidency of the Council, National Agencies); Territorial entities (Regions, Provinces, Municipalities, Metropolitan Cities); Entities of the National Health Service; Non-economic public bodies; State educational institutions; State universities; Constitutional bodies and bodies of constitutional relevance; Armed forces and police; other public entities listed in the Public Institutions Register.

conducted through the identification and analysis of the reference statistical sources (more details in section 5), the construction of a conceptual framework and the development of three simple indices.

2. The Digital Transformation of the Italian Public Administration

Starting with an analysis of the scientific literature on the topic, this session will present the evolution of digital regulations and the implementation of digital services in the process of digitalising public administration. Furthermore, it focuses specifically on the requirement for digital skills and the implementation of strategies and policies to enable effective digitalisation of the public sector.

2.1 *Digital regulations and digital services*

The process of PA digitalisation in Italy, which has been evolving for over two decades, initially manifested more prominently in regulatory frameworks than in the tangible administrative landscape (Zappalà, 2024). The first regulatory foundations can be traced back to the 1990s, with Article 3-bis of Law 241 of 1990 on administrative procedure and the Bassanini Law of 1997, which introduced the principle of using telematic and IT tools to improve efficiency in internal relations, between administrations and with citizens (Zoppoli, 2024). Subsequent regulations, including the Stanca Directive of 2002, encouraged the adoption of digital signatures and online management of payments and communications, representing crucial steps in the digital transformation of the public sector. A major milestone came with Legislative Decree 82/2005, the Digital Administration Code (CAD), which established principles for interoperability and document dematerialisation, consolidating the legal framework for PA digital transformation (Zoppoli, 2024; Astrid, 2016). The 2010s saw acceleration with the creation of the Agency for Digital Italy (AgID) in 2012, tasked with coordinating national digitalisation efforts, and the launch of the Italian Digital Agenda aligned with EU strategies to promote digital infrastructure, e-government, and digital literacy (AgID, 2024). The Digital Growth Strategy (2014-2020) set priorities for digital PA, followed by the Three-Year Plan for IT in PA, regularly updated with the latest edition covering 2024-2026. This plan focuses on services, platforms, data, infrastructure, security, and interoperability, promoting tools like SPID (Public Digital Identity System), PagoPA, Electronic Identity Cards (CIE), and Electronic Health Records (EHR) (Agenda Digitale, 2022; AgID, 2024; Astrid, 2016). From 2021 to 2025, the Three-Year Plan incorporated operational tools, best practices, and checklists, emphasizing artificial intelligence, security, and interoperability. The 2025 Strategy for Technological Innovation and Digitalisation outlines future actions prioritizing accessibility and integration of digital services. Italy leads Europe in AI experiments and projects within PA but

faces challenges in digital skills and specialised training among the population (European Commission, 2024; Faraglia, 2023).

According to DESI 2024 data, Italy's digital public services have improved but remain below the EU average. Digital services availability rose slightly from 67.9% to 68.3% for citizens and from 74.7% to 76.3% for businesses between 2023 and 2024, still under the EU averages of 79.4% and 85.4%, respectively. Usage by citizens declined from 76.26% in 2023 to 68.53% in 2024, below the EU average of 75%. However, the government has advanced digital identity tools, with over 37 million active SPIDs and 39 million CIEs issued in 2023. (European Commission, 2024).

2.2 Civil servants and digital skills

The scientific and institutional literature underscores the critical importance of civil servants' digital competencies in driving the successful digitalisation of public administration. These skills represent a key factor in accelerating digital transformation and improving service quality for citizens and businesses (Macrì, 2022). However, research highlights a widespread shortage of digital skills within the public workforce, stemming from inadequate updating of existing competencies and limited diversification of professional profiles. This persistent "skills gap" significantly hampers the full digital transformation of public administration (Bignotti, 2022; Bontempi, 2022). The development of civil servants' digital skills is closely linked to citizens' digital literacy, as both depend on the quality and effectiveness of public service digitalisation. To address this, national initiatives such as "Digital Republic" aim to reduce the cultural digital divide and foster digital inclusion. Despite recent progress, ISTAT and DESI data show that most Italian civil servants still have only basic digital skills. According to the ISTAT Report on Local Public Administration, in 2022, the utilisation of analogical tools (e.g. stamps, signatures and initials) in document protocol is expected to persist, with 89.1% of institutions still employing such methods. However, it is noteworthy that nearly half of these institutions will limit their use of analogical tools to specific sections of documentation.

Regarding the possession of digital skills, the Digital Decade Report 2025 shows that only 45.8% of Italians, including civil servants, have basic digital skills, which is below the EU average of 55.6%, placing Italy 23rd out of 27 EU countries in this regard. Additionally, pertinent are the findings of studies specifically designed to analyse the competencies of public sector employees. A 2024 Forum PA study highlights that 57% of public sector employees are highly exposed to AI, which could improve efficiency but also risk replacing workers with repetitive tasks. This emphasizes the need for continuous digital skills training to manage this technological shift effectively.

Moreover, the IFEL report (2025) identifies significant gaps between the digital skills required in Italian municipalities and those currently available. The report stresses the growing interconnection between technical and soft skills, noting that sustainable innovation demands strong leadership, strategic vision, and interpersonal abilities. For example, although 62% of respondents (managers and executives) show a strong result orientation, skills like leadership and conflict management are lacking, with nearly 20% of staff operating at entry level.

Expanding training catalogues and imposing more obligations is no longer sufficient. Learning models must evolve into non-linear, flexible, and personalised approaches, tailored to individual aptitudes and organisational contexts. Although the digital transformation of Italy's public administration is underway, significant concerns persist regarding employees' digital competencies and the continued reliance on analogue tools in administrative processes.

2.3 The implementation of strategies and policies

Developing digital skills in Italy's public administration is a strategic priority for the digital transition. A growing gap between required and existing competencies among public employees is widely recognised at national and European levels, prompting policies and significant investment in digital training. The digital divide in public administration is not only technical but also cultural and organisational. As posited by the European Commission (2024), the integration of digital competences within a comprehensive change management framework is imperative to ensure the efficacy and sustainability of digital transformation over time. The "National e-skills strategy" is the all-encompassing reference framework in Italy. This initiative is part of a broader context, coordinating with European initiatives such as the "Digital Skills and Jobs Coalition", which aims to strengthen the digital skills of the workforce in all Member States.

The Italian strategy seeks to systematically overcome digital skill gaps by building a strong foundation for public workers to use digital technologies effectively. It is imperative that there is congruence between national and European strategies to circumvent the issue of fragmentation and to guarantee the uniformity of digital training plans (Van Deursen and Helsper, 2024). Furthermore, synergy between institutional levels speeds up the development of digital skills essential for smart and inclusive public services. The Department of Public Administration created the training platform "Syllabus of Digital Competences for PA," outlining essential digital skills organized by themes and proficiency levels. This instrument delineates a minimum set of fundamental digital competencies, meticulously organised in thematic domains and levels of mastery, that are deemed essential for every civil servant to acquire. Furthermore, the Syllabus provides a national framework for consistent digital training in public administrations.

Recent research highlights the importance of a clear and shared framework for digital skills, showing that common standards facilitate the assessment and customization of training (Carretero *et al.*, 2023). In this context, the Digi.Comp2.2 (Digital Competence Framework for Citizens) elaborated by the European Commission provides an updated, shared model for identifying and evaluating the digital competences needed by citizens.

The NRRP reinforces investment in digital training for public administration, emphasising long-term programmes to ensure transformation through human capital development. OECD (2024) stresses that substantial investment in digital skills is essential to optimise NRRP resources and strengthen institutional resilience. The Strategic Plan for Human Capital (2025) integrates digital, managerial, and organisational skills within a broader framework for workforce enhancement. Scholars confirm that innovation requires a multifaceted skillset, combining technical competencies with problem-solving, leadership, and adaptability (Koh *et al.*, 2024). Training delivery relies on e-learning for flexibility and accessibility, particularly after the health emergency. The goal is to establish a pervasive digital culture that supports technological innovation and continuous improvement of administrative processes. Recent studies highlight that adaptive e-learning and gamification significantly boost engagement and retention of digital skills (Sitzmann *et al.*, 2023), while analytics enable timely, targeted interventions.

3. The descriptive analysis: methodological approach and results

This paper continues the line of study initiated by the 2024 'Territorial Inequalities between Digital Innovation and the Labour Market' (Carta and Straccamore 2025). The 2024 study explored the link between companies' digital innovation and workforce digital skills, identifying regional trends and disparities. The Mazziotta-Pareto index methodology (Mazziotta and Pareto, 2022) was utilised to create three composite indices with the objective of profiling regional digital labour markets. These indices evaluated business adoption of technology, the skills of workers, and skills demand³. The results of the study indicated significant delays

³Each index reflects different dimensions of analysis, and each dimension is measured by different elementary indicators:

The Business's Digitalization Index reflects the state of the digital transformation on the demand side and is measured by 7 indicators of the Istat 2023 survey "The Use of ICT by Businesses", with reference to enterprises with at least 10 employees.

The Labour Force Index measures the level of digital skills on the supply side³ and is measured by 12 indicators (of the Istat 2023 survey "Aspects of Daily Life", with an ad hoc module on the use of digital technologies by citizens, and the Istat 2023 survey on "The Use of ICT by Businesses").

The Digital Skills Prediction Index provides another measure on the demand side, regarding the companies' forecasting needs for digital skills. This index consists of 3 indicators of the 2023 Unioncamere and Anpal survey "Demand Analysis of Digital Skills in Enterprises".

in Southern Italy, with considerable discrepancies between the demand and supply of digital skills in specific regions. Drawing upon the findings of that analysis, this paper presents a preliminary contribution to a broader multidimensional analysis aimed at mapping the digitalisation of the labour market across both public and private sectors. The study focuses on profiling the digital maturity of public institutions at the regional level. The analysis begins with an assessment of digital skill needs within public administration, using available data sources to explore their regional distribution. The skills need analysis constitutes the initial phase of a more in-depth and complex multidimensional analysis.

3.1 Methodological approach

The examination of scientific literature and implemented policies, as described in sections 2, 3 and 4, in conjunction with the study of the available data sources, has led to the identification of three distinct dimensions of analysis. These dimensions are intended to facilitate the interception of the territorial distribution of e-skills needs in PA. The first dimension encompasses the training provided by PA in the domain of e-skills, thereby indicating the necessity for digital skills to be acquired or updated. The second dimension pertains to the utilisation of advanced technologies for data management and service delivery, thus signifying the extent of digitalisation within PA. The third dimension concerns the propensity to innovation, which is indicative of the inclination and tendency towards digital innovation. The initial supposition is that these three dimensions, when considered in relation to each other, can facilitate the identification of both differences and similarities in the digital skills requirements of public institutions at the territorial level. The analytical reading of territorial disparities is significant in order to be able to introduce tailored policies and interventions, adequate to counter and prevent further inequalities and disparities that may be exacerbated if the digital transition process is not adequately governed and if territories and citizens are left behind (OECD, 2023).

For each of the three dimensions identified, a reference index was constructed, consisting of elementary indicators (see Table 2):

- Training provided: the indicators selected are the courses provided by local administrations on ICT-related topics, from the most general to the most specific and/or relevant to the services provided by the administrations or to the performance of specific work activities (Table 2 from 'a' to 'p'). A total number of 16 indicators were identified and the reference source is ISTAT - Survey on information and communication technologies in local public administrations - Year 2022 (see note 1).
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Table 1 – *Indices, Selected Indicators, and Sources.*

Indices	Indicators	Source
Training provided	a) Operating systems	Source: ISTAT - Survey on information and communication technologies in local public administrations - Year 2022
	b) Specific applications and software	
	c) WEB	
	d) ICT security	
	e) Information systems and database management	
	f) Other (ICT courses)	
	g) Digitization of internal flows and processes	
	h) Web services, multimedia, social media	
	i) Cloud computing	
	j) Electronic payments	
	k) Open data	
	l) Electronic invoicing	
	m) Digital identity	
	n) Electronic procurement (eProcurement)	
	o) Privacy, General Data Protection Regulation (GDPR)	
	p) Enabling platforms provided by the ICT Three-Year Plan (PagoPA, ANPR, etc.)	
Use of advanced technologies	q) Cloud computing services	ISTAT, Permanent Census of Public Institutions – Year 2022
	r) Mobile applications	
	s) Internet of Things	
	t) Institutions that used social media	
	u) Institutions that analyzed large amounts of data (big data)	
Propensity for innovation	v) Institutions with interoperable databases and that adhere to the PDND	ISTAT, Permanent Census of Public Institutions – Year 2022
	w) Institutions with interoperable databases or to be made interoperable	

Source: ISTAT

- Use of advanced technologies: the indicators selected are given by the type of technologies used for data management and service delivery (Table 2 - ‘q’ to ‘s’), interaction with users using social media by type of membership (Table 2 - ‘t’) and the analysis of large amounts of information data (big data) from heterogeneous sources for analysis purposes (Table 2 - ‘u’). A total of 5

indicators were selected and the reference source is ISTAT, Permanent Census Public Institutions - Year 2022 (see note 2).

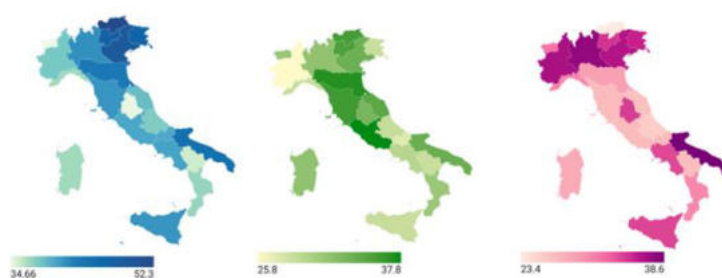
- Propensity for innovation: the selected indicators consist of the possession and use of interoperable databases, adherence to and orientation towards the National Digital Data Platform (PDND), and the ownership and use of databases that have been or could be made interoperable (Table 2 - “v” and “w”). Two indicators were chosen, and the reference source is ISTAT, Permanent Census of Public Institutions – Year 2022.

In this preliminary study phase, the arithmetic mean method was selected for building the indices because it represents the simplest and most used summary indicator to condense a set of quantitative data into a single representative value. The arithmetic mean, calculated as the sum of the values divided by the total number of observations, provides an intuitive and immediate measure of the central tendency of the data distribution, thus facilitating the interpretation and comparison of the indicators. This methodological choice allows for linear aggregation of data, ensuring easy interpretation of the results and guaranteeing that each indicator contributes equally to the formation of the overall index.

3.2 Results and evidence from the descriptive analysis

This section presents the main findings related to the three dimensions investigated. Figure 2 shows three maps of Italy highlighting the territorial distribution of each index, with a color gradient—from darker to lighter shades—indicating the intensity of the index (from higher to lower): the blue map represents “Training provided” (with values ranging from 34.6 to 52.3); the green one shows the “Use of advanced technologies” (from 25.8 to 37.8); and the pink one illustrates the “Propensity for innovation” (from 23.4 to 38.6).

Figure 1 – Territorial distribution of the three indices. Training provided (blue); use of advanced technologies (green); propensity for innovation (pink).



Source: ISTAT 2022

At a glance, looking at all three maps, a polarization between northern and southern regions emerges across all three dimensions, with the north characterized by higher index values and the south by lower ones. Notable exceptions include the regions of Apulia, Piedmont, and Aosta Valley. Apulia stands out for high values across all three indices: training provided (44.4), use of advanced technologies (35.3), and propensity for innovation (38.6). This positioning reflects the Region's commitment to promoting digital training initiatives and adopting innovative technologies in administrative processes, in line with national programs and supported by the NRRP. In contrast, Piedmont and Aosta Valley record the lowest scores among the northern regions. Moreover, Piedmont shows the lowest value in the use of advanced technologies (25.8), and the Autonomous Province of Bolzano presents the lowest value for innovation propensity (23.4). These data suggest that, despite high performance levels in many areas of digitalisation, specific challenges remain in the adoption of advanced technologies and organizational innovation, likely linked to structural or cultural factors (Table 2).

Table 2 – *Training Provided Index, Advanced Digital Technologies Usage Index, Innovation Propensity Index, by Region. Year 2022, Italy.*

REGIONS	Training provided	Use of Digital Advanced Technologies	Propensity Of Innovation
Lombardy	52,3	33,5	37,3
Autonomous Province of Trento	49	36,4	33,9
Apulia	44,4	35,3	38,6
Veneto	46,7	35,2	35,7
Emilia-Romagna	42,8	37,4	31
Tuscany	41,2	36,8	30
Lazio	40,1	37,8	30
Autonomous Province of Bolzano/Bozen	47,4	36,6	23,4
Sicily	41,2	31,2	33,5
Campania	40,4	31,9	33,4
Liguria	41,5	31,2	31,7
Marche	38,8	36	29,1
Umbria	34,8	34,7	33,7
Friuli Venezia Giulia	36,9	31,1	34,7
Calabria	37,2	33,1	31,6
Sardinia	36,9	33,6	30,6
Piedmont	38,1	25,8	36,2
Aosta Valley (or) Valled'Aosta/Vallée d'Aoste	34,7	33,2	32,2
Molise	40	28,7	29,9
Abruzzo	37,9	31,3	27,4

Although the general north-south divide is somewhat confirmed (with Lombardy and the Autonomous Province of Trento at the top of the regional ranking and Abruzzo and Basilicata at the bottom), these data highlight a more nuanced regional picture. Some southern regions (Apulia, Sicily, Campania) and central ones (Lazio and Tuscany) show significant progress in digitalisation and the development of digital skills, while some northern regions, despite overall strong performance, still face specific challenges related to innovation and the adoption of advanced technologies.

4. Conclusion

Italy's PA digitalisation has advanced through regulatory, organisational, and technological reforms, improving efficiency and citizen focus. However, achieving full digitalisation of services remains challenging due to uneven innovation across institutions and territories. The NRRP and national strategies aim to address these gaps (Zappalà, 2024; Astrid, 2016; Faraglia, 2023). Literature agrees that enhancing public employees' digital skills is crucial, requiring structured investment in training, continuous updating, and new professional profiles, alongside citizen digital literacy policies. Current strategies adopt an integrated approach, combining standards, customised training paths, digital learning platforms, and strong financial and strategic support at national and EU levels. These measures are essential to guide PA through digital transformation, making it more efficient, transparent, and citizen oriented. Furthermore, the descriptive analyses reveal persistent territorial disparities, underscoring the need for targeted, region-specific policies to ensure an inclusive and uniform digital transition. Future research should explore the effectiveness of these strategies, the role of adaptive learning technologies, and the interplay between technical and soft skills in fostering sustainable innovation.

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ACCESS TO THE LABOUR MARKET: A COMPARISON BETWEEN FOREIGN AND “NEW ITALIAN” WORKERS¹

Michela C. Pellicani, Monica Carbonara, Roberto A. Palumbo

Abstract. The scientific literature examining the relationship between immigration and the labour market is extensive, with a particular focus on the economic impact of immigration on the host country's welfare system, particularly when addressing the issue of so-called “failed immigrants.”

The theoretical framework for the integration of immigrants into the host country's labour market is based on the international transferability of human capital (Chiswick and Miller, 2009). At the same time, the economic theory of labour market integration suggests that it is primarily influenced by the characteristics of the country of origin, the reason for migration, and the expected duration of migration (Ambrosini and Panichella, 2023).

This study aims to update previous research on foreign workers and the labour market focusing on (still) foreign workers and naturalised ones. We used microdata from the “Labour Force Survey” conducted by Istat.

1. Introduction

The scientific literature examining the relationship between immigration and the labour market is extensive, with a particular focus on the economic impact of immigration on the host country's welfare system. Understanding the connections between migratory dynamics and the labour market characteristics of host societies is therefore essential, especially in terms of the economic and financial costs on welfare, particularly when addressing the issue of so-called “failed immigrants.”

The theoretical framework for the integration of immigrants into the host country's labour market is based on the international transferability of human capital (Chiswick and Miller, 2009). The extent to which this transferability is possible depends on individual skills and the reason for migration (e.g., income maximisation, political situation in the country of origin, ethnic enclaves, etc.). Following these studies economic impact of immigration ultimately depends on the skill composition of the immigrant population.

¹ The paper is the result of the common work of the authors. In particular, the sections are attributed as follows: paragraphs 1 and 4 to M.C. Pellicani, paragraph 2 to M. Carbonara and R.A. Palumbo, paragraphs 3 to the three authors.

Not surprisingly, much of the research in the economics of immigration focuses on examining the evolution of skills in the foreign-born workforce, both in terms of their pre-existing human capital (which depends on the rule that selects the immigrants from the population of the origin countries) and in terms of the rate at which immigrants acquire additional skills in the post-migration period (Borjas, 2014).

Beginning with Chiswick (1978), there has been a great deal of empirical research that attempts to measure the extent of economic assimilation, defined as the rate of wage convergence between immigrants and natives.

At the same time, the economic theory of labour market integration suggests that it is primarily influenced by the characteristics of the country of origin, the reason for migration, and the expected duration of migration (Ambrosini and Panichella, 2023). Some other authors suggest that migration regulates labour markets through processes of social distinction, cultural judgement and the strategic deployment of citizenship (Bauder, 2006). Considering this last aspect, we distinguished two different categories: foreign workers and naturalised ones wishing to highlight what we regard as the most significant reason for interest of our study. Research on those we may term “new Italians” – that are foreigners who have acquired citizenship – remains scarce, largely due to the relative “youth” of the migratory phenomenon in Italy.

Nonetheless, we argue that this population has now reached a sufficient scale to enable reliable statistical and demographic analyses. Such analyses can help shed light on a crucial issue, widely debated also in political arenas: the extent to which the acquisition of citizenship contributes to the integration of migrants into the Italian socio-economic context.

Finally, while numerous studies have focused on countries with a long history of immigration, it is also interesting to examine what happens in European countries with more recent immigration patterns. Among these, Italy stands out as immigration is still considered a relatively “young” phenomenon and is often treated more as an ongoing emergency rather than as a structural reality. This perspective, of course, hinders the development - let alone the implementation - of specific inclusion policies.

2. Methodology and Data

Numerous variables influence the successful integration into the labour market, including age, gender, family structure, level of education, social capital, family background, and the presence or absence of a support network, etc.

For foreign workers, additional factors such as country of origin, length of stay, and language proficiency also play a crucial role. However, data on some of these

key variables are often unavailable, as they are not collected through census or sample surveys.

This study aims to update previous research on foreign workers and the labour market. More precisely, our analysis focuses specifically on a comparison between foreign workers who have acquired Italian citizenship (“new Italians”) and those who have retained exclusively the citizenship of their country of origin.

Consequently, our analysis will be limited to first-generation foreign workers who have acquired Italian citizenship, excluding second-generation foreign workers (born in Italy) due to their still very small numbers, as will be further discussed below.

For our purposes, we draw on microdata of the “Labour Force Survey” conducted on a regular base by ISTAT. As is well known, the Labour Force Survey is an ongoing study that provides estimates of key labour market aggregates (employment status, type of employment, work experience, job search, etc.) based on major sociodemographic characteristics (ISTAT, 2023a).

Methodologically, while such an approach might have been of considerable interest, we ultimately opted against a longitudinal analysis in favour of a cross-sectional one. In our view, a longitudinal analysis would have been unsuitable given the frequent reconfiguration of the sample employed by ISTAT in its “Labour Force Survey”. The households included in the survey sample are interviewed on four occasions over a period of 15 months, after which new households are rotated into the sample².

For the comparison between foreign nationals and new Italians in relation to selected socio-demographic variables, the Chi-squared test was employed. The variables considered are: gender (male and female), nationality (“new Italians”, foreigners), age group (15–34 years, 35–44 years, 45–54 years, 55+ years), education level (up to lower secondary school, upper secondary school diploma, university degree³), macro-region of residence (North, Centre, South), duration of stay (0-9 years, 10-19 years, 20-29 years, 30+ years).

Finally, to analyse the relationship between employment and the aforementioned socio-demographic variables, a multivariable logistic regression was applied to both

² Each household is interviewed for two consecutive quarters, followed by a two-quarter break, and subsequently interviewed again for a further two consecutive quarters.

³ A university degree also includes diplomas from academies (e.g., Fine Arts, National Academy of Dramatic Art, National Academy of Dance); Higher Institute for Artistic Industries; State Conservatory of Music; Recognised Music Institutes; Two/three-year university diplomas; Special-purpose training schools; Para-university schools.

foreign and “new Italian” workers where the employment status⁴ was the dependent variable.

A brief descriptive overview of both foreign and “new Italian” workers concludes our analysis.

3. Some results

By the data of the Labour Force Survey, in 2023 the total labour force was composed by 84.9% Italians by birth, 4.6%⁵ “new Italians” and 10.4% foreigners (Table 1).

Table 1 - *Labour force by country of birth and nationality - Italy, 2023 (values in thousands and percentage composition).*

Italian nationality	Values in thousands (2023)			Percentage composition (2023)			Values in thousands 2014		
	Country of birth			Country of birth			Country of birth		
	Italy	Foreign countries	Total	Italy	Foreign countries	Total	Italy	Foreign countries	Total
Yes	21,680	1,169	22,850	84.9	4.6	89.5	21,977	785	21,762
No	31	2,646	2,677	0.1	10.4	10.5	8	2,838	2,846
Total	21,712	3,815	25,527	85.1	14.9	100.0	21,985	3,623	25,608

Source: own calculations based on Labour Force Survey data, 2023.

⁴ The category of employed persons comprises individuals aged between 15 and 89 years who, during the reference week:

- performed at least one hour of work for pay or profit, including unpaid contributing family workers;
- were temporarily absent from work owing to holidays, flexible working arrangements (such as vertical part-time or recovery of hours), illness, compulsory maternity/paternity leave, or employer-funded vocational training;
- were on parental leave while receiving and/or entitled to income or work-related benefits, irrespective of the duration of the absence;
- were absent as seasonal workers yet continued to regularly perform tasks and duties necessary for the continuation of the activity (excluding the fulfilment of legal or administrative obligations);
- were temporarily absent for other reasons, provided that the expected duration of the absence did not exceed three months.

These conditions apply irrespective of the existence of a formal employment contract. Consequently, estimates of employment derived from the Labour Force Survey also encompass irregular forms of work.

⁵ Among the 1,169,000 Italian workers born abroad, alongside the “new Italians”, there is also a small group of citizens who acquired nationality at birth through *ius sanguinis* as children of at least one Italian parent. Their number, however, is negligible.

Over the past ten years, the total labour force in Italy has slightly decreased (-0.3%), a decline that can be attributed to the reduction in the foreign-born foreign labour force, which more than offset the increase in the Italian labour force (+0.4%). Notably, this increase is entirely due to the substantial rise in the number of Italians born abroad (+48.9%).

Just a brief mention should be made of the sharp increase in the foreign labour force born in Italy (+279.7%), which, however, due to its still limited size, continues to account for only a very marginal share of the overall labour force (0.1% in 2023). This compels us to refrain from any further comment, as such an analysis would risk being highly misleading, if not incorrect.

The labour force born abroad, which in 2023 includes almost one-third Italian citizens born abroad (4.6% compared to 10.4% of foreign nationals born abroad), the decline in the foreign-born foreign labour force (-6.8%), and the 48.9% increase (over the past ten years) in the Italian labour force born abroad all point to the same conclusion regarding the outcomes of the numerous acquisitions of Italian citizenship by foreign nationals, whether born in their country of origin or in the host country.

The transformation of the labour force in terms of its composition by citizenship is clear, and this prompts an interest in the characteristics of each of its components and how these may impact actual employability.

The comparison by gender, age class, educational level, macro-region and duration of stay between foreigner and “new Italian” workers included in the sample⁶ of the Labour Force Survey reveals that there is a statistically significant difference between the two components.

Table 3 shows the parameter estimates with their corresponding standard errors, the test statistics, the p-value and odds ratios⁷, used to test the null hypothesis that the regression coefficient of each individual predictor is equal to zero, given the other explanatory variables of the model.

The conditions that contribute to increase the probability to be employed are being a male foreigner, residing in the North for a duration of stay > 10 years.

The comment on the role of the education level deserves more attention. Having an education level corresponding to upper secondary school helps in improving the probability to be employed. At the same time, paradoxically, a higher level of education – a university degree – becomes a factor that hinders employability. A

⁶ The sample size is 14,726.

⁷ The odds ratio expresses the variation in the dependent variable as a function of changes in the explanatory variable. If the value is greater than 1, an increase in the explanatory variable corresponds to a higher probability of being employed. If the value is less than 1, an increase in the explanatory variable corresponds to a lower probability of being employed.

possible explanation may lie in the characteristics of the Italian labour market, which may not provide a context that adequately values higher-level skills.

Table 2 – *Labour Force by foreigners and new Italians components - Italy, 2023.*

Variables	New Italians		Foreigners		P
	N	%.	N	%	
Gender					
Male	2,349	49.6	5,361	53.7	<0.0001
Female	2,388	50.4	4,628	46.3	
Age class (years)					
15-34	681	14.4	2,453	24.6	<0.0001
35-44	1,103	23.3	3,128	31.3	
45-54	1,644	34.7	2,691	26.9	
55+	1,309	27.6	1,717	17.2	
Educational level					
Up to lower secondary school	1,496	31.6	4,441	44.5	<0.0001
Upper secondary school	2,298	48.5	4,289	42.9	
University degree	943	19.9	1,259	12.6	
Macro-region					
North	2,746	58.0	5,930	59.4	<0.0001
Centre	956	20.2	2,465	24.7	
South	1,035	21.8	1,594	16.0	
Duration of stay (years)					
0-9	121	2.6	2,073	20.8	<0.0001
10-19	919	19.4	4,645	46.5	
20-29	1630	34.4	2,667	26.7	
30+	2,067	43.6	604	6.0	

Source: own calculations based on Labour Force Survey data, 2023

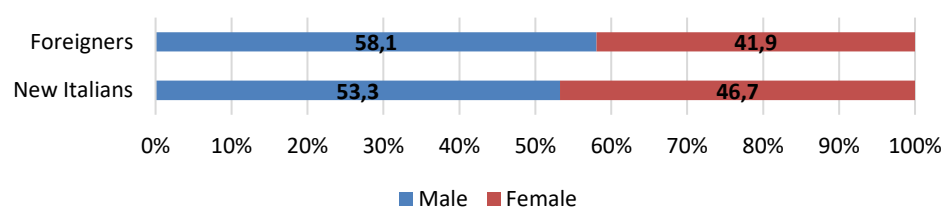
In the descriptive analysis, we consider only the employed, in order to also examine the sectors of economic activity and the occupations.

Starting with the structure by sex and age, we observe that, although still skewed in favour of males, the gender composition of employed “new Italians” appears more balanced (Figure 1).

Table 3 - Logistic Regression: Analysis of Maximum Likelihood Estimates – Labour force by foreigners and new Italians components – Italy, 2023

Variables	B	S.E.	Wald Chi-square	Sig.	Exp(B)
Gender					
Female	-0.2625	0.069	14.4646	0.0001	0.769
Male (<i>baseline</i>)					
Nationality					
Foreigners	0.3531	0.0536	43.1357	<0.0001	1.422
New Italians (<i>baseline</i>)					
Age class (years)					
35-44	-0.0712	0.0763	0.8719	0.3504	0.931
45-54	-0.1233	0.0772	2.5547	0.11	0.884
55+	-0.5592	0.0908	37.9352	<0.0001	0.572
15-34 (<i>baseline</i>)					
Educational level					
Upper secondary school	0.5124	0.0607	71.2215	<0.0001	1.669
University degree	-0.7292	0.0714	104.2099	<0.0001	0.482
Up to lower secondary school (<i>baseline</i>)					
Macro-region					
Centre	-0.1	0.065	2.3653	0.1241	0.905
South	-0.8069	0.0684	139.2759	<0.0001	0.446
North (<i>baseline</i>)					
Duration of stay (years)					
0-9	0.2897	0.0732	15.6785	<0.0001	1.336
10-19	0.3567	0.076	22.0325	<0.0001	1.429
20-29	0.4158	0.1042	15.9379	<0.0001	1.516
30+ (<i>baseline</i>)					

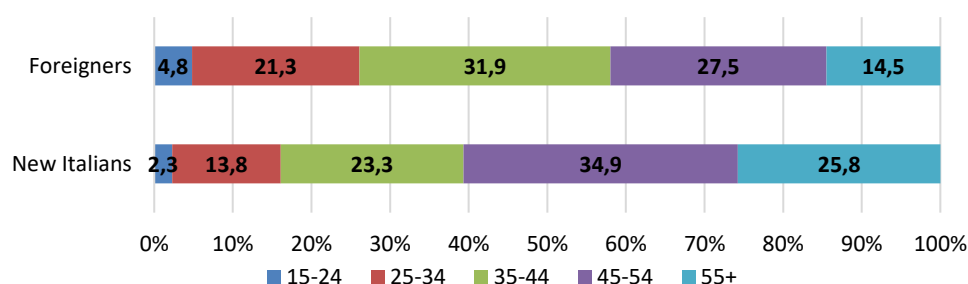
Source: own calculations based on Labour Force Survey data, 2023.

Figure 1 - Foreigners and new Italians employed by gender – Italy, 2023.

Source: own calculations based on Labour Force Survey data, 2023.

Foreign workers are clearly younger than “new Italians”. The average age of the former is 42.3 years, compared to 46.7 years for the latter – a difference of more than four years, which suggests a longer duration of stay in the country (Figure 2).

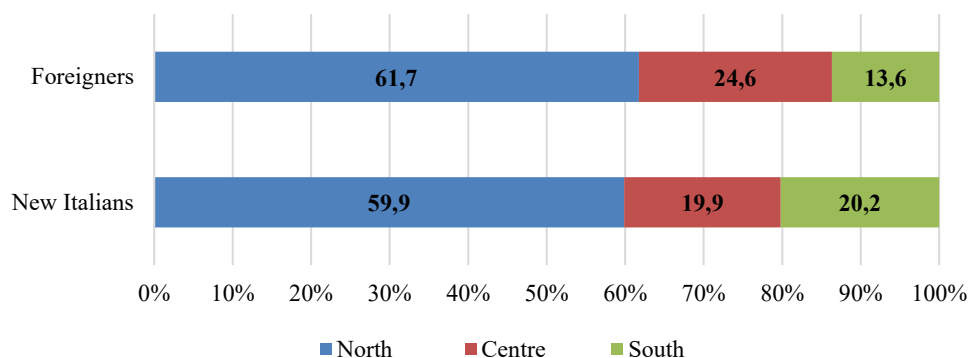
Figure 2 - Foreigners and new Italians employed by age class (years) – Italy, 2023.



Source: own calculations based on Labour Force Survey data, 2023.

More than 60% of naturalised employed individuals are aged 45 or over, compared to just 42.0% of foreign workers. This significant difference could also help explain the lower employability of “new Italians”, unlike that of foreign workers. In terms of territorial distribution, around 60% of workers (both groups) are concentrated in Northern Italy while “new Italians” are equally distributed between the Centre and the South (Figure 3).

Figure 3 – Foreigners and new Italians employed by macro-region – Italy, 2023.

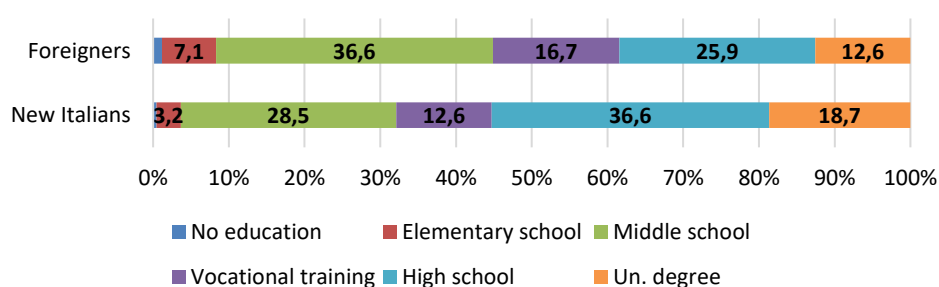


Source: own calculations based on Labour Force Survey data, 2023.

The last three graphs should be observed and interpreted jointly.

Naturalised and foreign workers also differ in their level of education. Foreigners are on average less educated: 44.9% have a middle school diploma at most, compared to 32.1% of naturalised ones (Figure 4).

Figure 4 – *Foreigners and new Italians employed by education level – Italy, 2023.*

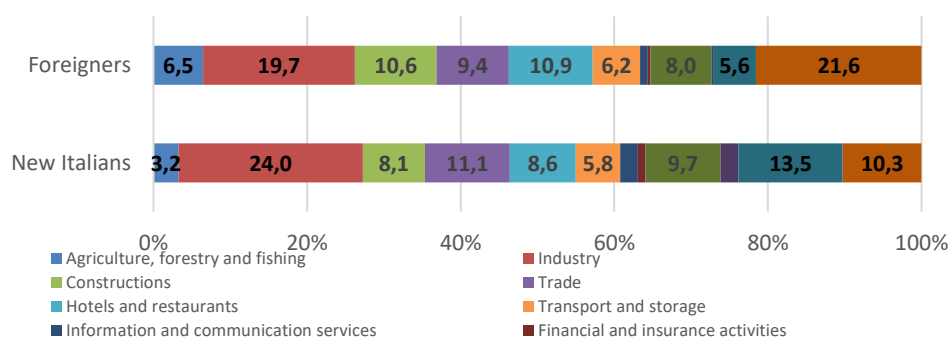


Source: own calculations based on Labour Force Survey data, 2023.

Among “new Italians”, those with no formal education or only primary-level education are extremely rare. Vocational training is also less common among the latter. Conversely, academic qualifications are noticeably more frequent. “New Italians” show the highest share of graduates, 18.7% compared to only 12.6% of foreigners.

The distribution of employed individuals across types of economic activity is highly differentiated in almost all sectors, with particular reference to the primary sector, personal and family services, and services related to education, health, and social care (Figure 5).

Figure 5 – *Foreigners and new Italians employed by sector of economic activity ATECO 2007 – Italy, 2023.*

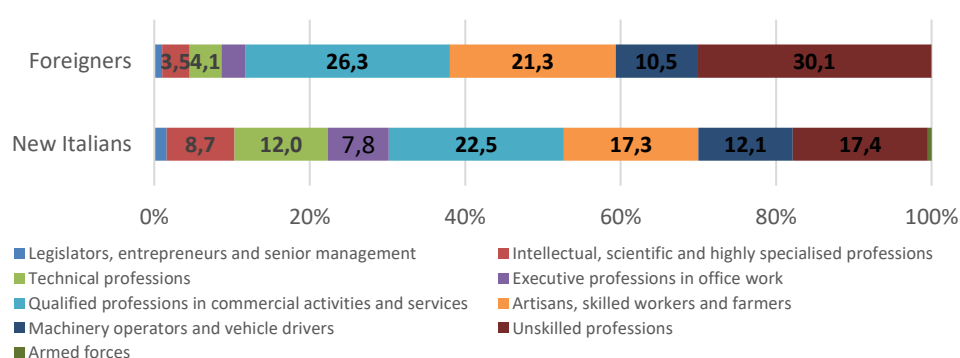


Source: own calculations based on Labour Force Survey data, 2023.

Although still limited in scale, there is a greater presence of naturalised individuals in information and communication services, financial and insurance activities, and in public administration and defence (in the latter case, holding citizenship often becomes decisive, as we will see later in the case of the Armed Forces).

These observations are consistently reflected in the breakdown by type of occupation – once again, across virtually all areas (Figure 6).

Figure 6 – *Foreigners and new Italians employed by classification of occupations – Italy, 2023.*



Source: own calculations based on Labour Force Survey data, 2023.

Jobs requiring higher qualifications are more frequent among “new Italians”, while foreign workers are nearly twice as likely to be employed in occupations that do not require specific qualifications (almost a third of them).

4. Conclusions

Future scenarios concerning employment needs across the various productive sectors will have to contend with the growing difficulty that enterprises report in recruiting personnel, as documented monthly by Unioncamere data.

In Italy, moreover, both labour shortages and skill mismatches take on particularly significant dimensions due to a range of factors – from the country's distinctive demographic situation to well-known shortcomings in the connection between the education system and the labour market (Unioncamere 2023).

In particular, with regard to foreign labour, the main critical issues can be identified as follows: excessively long waiting times due to burdensome bureaucratic procedures that delay labour market entry; complex bureaucracy requiring often redundant documentation and fragmented procedures across multiple authorities; the rigidity of quotas stemming from a system that lacks flexibility in meeting the real

needs of the labour market; and coordination difficulties caused by poor communication among the public bodies involved in these processes (Labartino, Mazzolari and Morleo, 2024).

Specifically concerning educational attainment, it is enough to mention the long-standing issue of recognising qualifications obtained abroad. The recognition rate stands at a particularly low 42% (compared to the EU average of 78%), and the average processing time is excessively long at 240 days (versus 120 in the EU) (CIMEA, 2024). Other issues include the absence of an effective national system for the validation and standardised certification of competences acquired in both formal and informal contexts, as well as the insufficient recognition of previous work experience (non-formal learning) through structured assessment tools (INAPP, 2024).

Moreover, our analysis suggests that the Italian labour market does not adequately value even “new Italians” workers holding university degrees. This is an aspect we intend to explore further in future, alongside a more focused examination of selected countries of origin of both foreign and naturalised workers.

We conclude on a positive note regarding labour market integration. From an economic perspective, foreign-run businesses – which still largely operate in sectors such as trade, construction, catering, and personal services – are gradually expanding into more technological and innovative fields, beginning to dismantle the rigid mechanisms of occupational segregation (Centro Studi e Ricerche IDOS, 2024). This dynamism contributes to GDP growth, increased tax revenues, and the diversification of the productive system.

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THE SILVER ECONOMY: CHALLENGES AND OPPORTUNITIES

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Abstract. Population dynamics is one of the most important global challenges, along with the environmental one. In recent decades, the world population has grown rapidly, people live longer, and inequality between age groups has expanded. With increasing life expectancy and declining birth and fertility rates, societies are facing a growing proportion of older people. This phenomenon has major implications for both the economy and public policy. From a public expenditure perspective, ageing implies a significant increase in resources for social security and health care: spending on pensions and health care already represents a significant proportion of GDP. At the same time, consumption expenditure of the elderly is becoming an increasingly important component of the economy, with growing expenditure on private health care, nursing homes, home services and digital health technologies. Finally, the role of the elderly as a social shock absorber is confirmed, as households with at least one elderly member have a lower incidence of absolute poverty than those without elderly people.

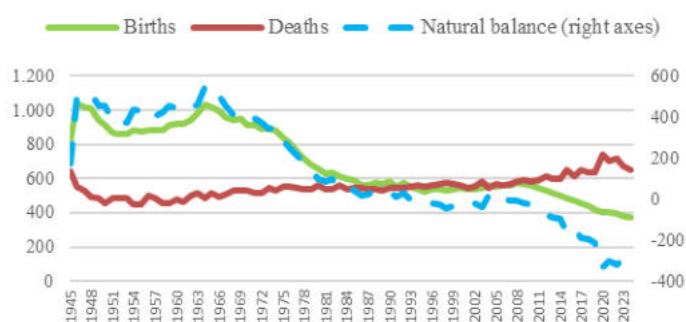
1. The evolution of population

Italy's demographic evolution is characterized by a low birth and fertility rate, coupled with an increasing life expectancy. The current changes have their roots in the social and demographic transformations of the last century: as early as the late 1970s, the average number of children per woman – an indicator of a population's reproductive capacity – had consistently dropped below the replacement level of two children. As a result, new generations are smaller in number than previous ones. At the same time, the increase in life expectancy has led to a continuous growth in the elderly segments of the population. The population is therefore both smaller and older. In Italy, the resident population has long since lost the ability to grow through natural dynamics. Only thanks to the positive impact of immigration, starting in the late 20th century, this trend toward stability was temporarily reversed. In fact, during the early 2000s, the population began to grow significantly again: the 2011 Census counted nearly 60 million residents (an increase of 2.4 million compared to 2001, almost entirely due to foreign nationals), and on January 1, 2014, the historical peak of 60.3 million residents was recorded. Subsequently, starting in 2014, the population began to decline, marking the first decrease in about ninety years and ushering in a phase of demographic decline. To this already fragile dynamic, starting in March 2020, the Covid-19 pandemic was added, producing effects not only on

mortality but also on behaviours and lifestyles, deeply changing them (Blangiardo, 2021). As of January 1, 2025, the resident population in Italy stands at 58.9 million people, a decrease of 37 thousand compared to the previous year, and nearly 1.4 million fewer than ten years earlier. This is a scenario in which, year after year, the population is seeing a reduced capacity to renew itself due to the lack of quantitative contribution from the size of new generations.

Since 1994, the natural population balance has been negative and continues to decline (Figure 1). The increase in population up to 2014 was due exclusively to migration. In recent years, the contribution of the foreign population to demographic growth has also been gradually diminishing, due both to a reduction in migration flows and to a shift in the reasons for immigration, which are increasingly linked to emergencies, such as asylum and humanitarian protection requests. According to the most recent data, 9.2% of the resident population in Italy today holds foreign citizenship (5,4 million).

Figure 1 – Births, deaths, natural balance (right axes), in thousand – Years 1945-2024 (a).



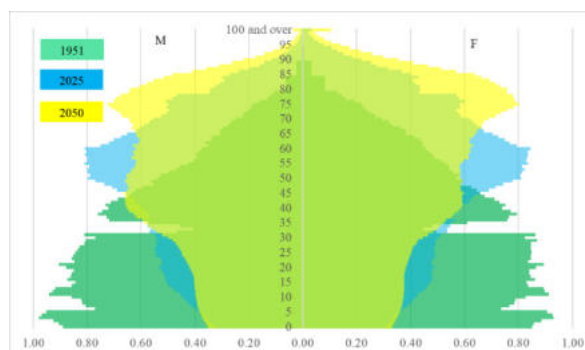
Source: Istat

(a) Data referred to 2024 are preliminary data

An integrated reading of demography in 100 years, made possible through age pyramids (Figure 2), allows us to appreciate the impact of demographic transitions on the population structure. The combined effect of increasing life expectancy and persistently low birth and fertility rates is giving rise to a growing intergenerational imbalance, leading to an inversion of the population pyramid. As of 1 January 2025, the old-age index stands at 207.6 persons aged 65 and over for every 100 individuals under the age of 15. According to current demographic projections, this ratio is expected to exceed 300 by 2050, delineating a future scenario characterised by a markedly ageing population structure. This anticipated situation contrasts sharply with that of the past: in 1951, the relationship was exactly reversed, with three young people for every older person. Such contrasting prospects underscore the magnitude

of the demographic transformation currently unfolding. In Italy, as of 1 January 2025, the estimated median age is 48 years, compared with 28 years in 1951.

Figure 2 – Age Pyramid in Italy– Years 1951-2025 and 2050 (a).



Source: Istat

(a) Data referred to 2025 are preliminary data

This indicates that, within the population age pyramid, approximately twenty cohorts have shifted from the “older” half to the “younger” half of the population over a span of roughly seventy years. Over the next twenty-five years, the median age is projected to increase, approaching 52 years, corresponding to a rejuvenation of the population structure, with approximately four cohorts moving back into the “younger” half of the age distribution.

So, while the population as a whole is aging—with an increasing share in the oldest age groups—individuals are, in a sense, growing younger as they live longer and in better health. What may at first seem like a paradox is actually the starting point for reflecting on the condition of the so-called “elderly” population, in an effort to move beyond a widespread but mistaken interpretation of aging: although the proportion of people over 65 has grown due to increased longevity, those aged 65 and over are today “younger” than in the past in the sense that they remain autonomous for longer, enjoy better health, and participate more fully in social life (Cagiano de Azevedo and Castagnaro, 2013). Ignoring this aspect of demographic and social evolution would mean marginalizing a segment of the population that could otherwise play an active role in society’s development. In this context, defining the threshold between “young” and “old” populations is a complex exercise: the population ages insofar as successive generations reach ever-greater ages, yet at the same time individual members are rejuvenated by living better and longer (Cagiano de Azevedo, Castagnaro and De Wenden, 2011). Conventionally in demography, a person is defined as “elderly” once they reach the age of 65—a threshold that in the past marked exit from the labour market. However, with

increasing longevity, this fixed cut-off now seems increasingly outdated for all cohorts (Istat, 2025). Thanks to improved living conditions, the spread of healthier lifestyles, and advances in medicine and healthcare, today's 65-year-olds can still expect many years of relatively good health, activity, and social participation, while the onset of physical and cognitive decline is pushed further into the future (Bologna, Blangiardo and Castagnaro, 2020). To more accurately measure the size of this "new elderly" population, one can adopt a dynamic approach based on a threshold that varies with remaining life expectancy (for example, life expectancy at age 65), rather than on a conventionally fixed age limit (Egidi, 1992).

In 1952, remaining life expectancy at age 65 was 12.8 years for men and 14.1 years for women. If we define "elderly" today as those whose remaining life expectancy is equal to these 1952 values, then in 2024 the elderly cohort would consist of men aged about 74 and older, and women aged 75 and older.

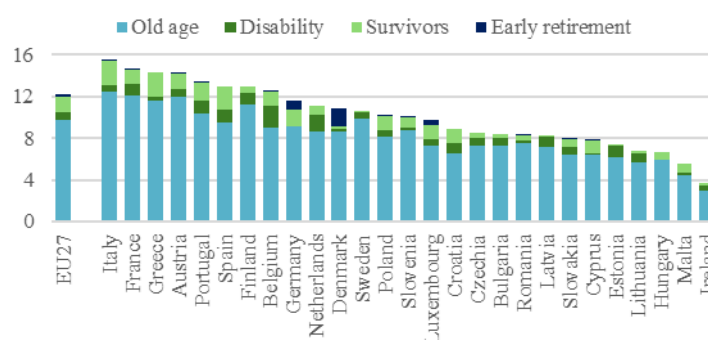
2. Social protection expenditure

Public expenditure related to the old age represents an important component of public budgets. According to the internationally shared classification by functions (COFOG), a high share of Italian public expenditure is allocated to financing social protection interventions (39.2% of the total, €450 billion) and most of this concerns interventions against the risks related to old age. These expenditures are generally aimed at guaranteeing the welfare and social protection of the older adults, of those with low incomes or in need of support to live independently or in specialised facilities. In 2023, Italy's share of public expenditure on old age-related benefits reached 25.4% of the total (€291 billion), compared to an EU27 average of 21.3%. Among the largest EU27 economies, France and Spain also stand out with a relatively high share of expenditure (22.9% and 22.5%, respectively), while in Germany (19.2%) is lower than the European average. In terms of expenditure as a percentage of GDP, Italy (13.6% of GDP) among the EU27 countries is second only to Finland (14.9%); France also stands out with a relatively high percentage of expenditure as a percentage of GDP (13.1%), while Spain, and particularly Germany, with 10.2 and 9.5%, are below the average value (10.2%). According to the European system of integrated social protection statistics (ESSPROS)¹, that includes also private expenditure, Italy's share of social protection expenditure on old age-related benefits reached 50.8% of the total (€303 billion), compared to an EU27 average of

¹ The European System of Integrated Social Protection Statistics (ESSPROS) includes in the field of observation that part of the "welfare" system linked to the activity carried out by all the operators, public and private, in the fields of health, welfare and assistance in order to ensure social coverage for individuals with respect to the occurrence of specific risks, events or needs that are expressly identified and classified, according to their nature, in the following categories or social protection functions: sickness, disability, family, old age, survivors, unemployment, housing, social exclusion.

41.2%. With specific reference to this expenditure, Italy occupies the first position in terms of incidence on GDP. In 2022², 76.1% of the expenditure for the old age function in Italy is absorbed by spending on old age pensions, which accounts for the largest share of total pension expenditure in all EU27 countries (Figure 3).

Figure 3 – Pension expenditure as percentage of GDP in EU27. 2022 (%).



Source: Eurostat (*spr_exp_pens*)

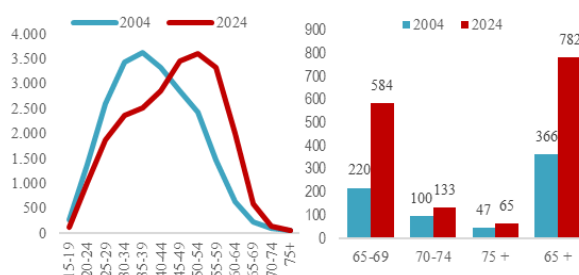
In Italy, 68.3% of pension expenditure is taken up by spending on old age pensions (€211 billion, 10.6% of GDP, against 9.3% in EU27). If anticipated old age pensions are also considered, the share rises to 89.7% and the impact on GDP rises to 12.5% (9.8% in EU27). The share of old age pensions varies between countries also because the relative weight of the older adult's population (aged 65 and over) is different as are the legal retirement age (which, moreover, can be different for men and women) and the rules according to which pensions can be paid before that age. However, if we assume that the threshold of 65 years conventionally defines the entry into old age, it is possible to use this threshold as a proxy for retirement age and to analyse the socio-demographic and income characteristics of pensioners aged 65 and over (henceforth "older adult pensioners"), who account for about 90% of the older adult's population. In 2023, in Italy they were €12.6 million³ and the total of annual pension income received amounts to 296,850 million euros. Men, despite being 46.9% of the total number of pensioners, receive 55.0% of pension income due to the higher average amount of their pension income. Women's often more discontinuous careers and lower paid jobs than men mean that the average per capita income for the over 65s is €27,666 for men and €19,983 for women (almost 8-thousand-euro difference per year on average). The highest average annual amounts are recorded for pensioners aged between 65 and 69 (about €2.7 million, 16.4% of

² 2022 is the last year for which European-wide pension expenditure data is available.

³ All pension types are considered.

the total) for whom the average pension income per capita is 24,489 euros; with 24,047 euros they are followed by pensioners aged between 70 and 74, who with 18.3% (about €3 million) are also the most numerous. It is likely that pensioners aged 75 and over have accrued their pensions in years with shorter or discontinuous working careers and with lower salaries. The ageing trend of the population and the demographic recession of recent years make us reflect on the sustainability of pension expenditure, especially if we take into account that, in 2024, the unemployment rate in Italy is the lowest in the EU27 (62.2%, against 70.8% of the European average and 77.4% in Germany) and that the age distribution of the employed population shows a marked postponement, with a slump below 57 years of age and a recovery that peaks between 50 and 54 years of age. In twenty years, the median age of the employed has increased by almost 7 years, from 39.8 to 46.7 years (Figure 4). There are also many individuals aged 65 and over who, despite being of retirement age, continue to work and thus play an active and participating role in society. In 2024, in Italy the employed in this age group are 782,000 (equal to 5.4% of the resident population aged 65 and over), almost doubled in 20 years.

Figure 4 – *Employees 15-89 by age group (left) and employees 65 years and over by age group (right). 2004, 2024 (thousands).*



Source: Istat, Labour Force Survey

In any case, in 2023, in Italy for every 100 employed there were 67.2 beneficiaries of pension (53.4 if only older adults are considered). If we consider the so-called *grey pressure*, that is, the dependence of the elderly, for every 100 individuals of working age there are 39 older adults, a value that, according to Istat forecasts, will exceed 63% in 2050. These values, which measure the social and economic burden that the elderly population can represent for the working-age population, together with the expenditure data illustrated above, give an account of how much the population aged 65 and over can represent a cost to the community (De Santis, 2025).

3. Consumptions expenditure of households with only members aged 65 and over

The level and composition of household consumption expenditure are significantly influenced by their socio-demographic characteristics, which are, therefore, central elements in reading and understanding these phenomena (Arigoni, 2011). Among them, one of the main socio-demographic keys is undoubtedly represented by the stage of the family life cycle (young, adult, elderly), which is strongly associated with resources and needs and, therefore, with lifestyles and consumption (Freguja, Pannuzi, 2007).

To analyse spending behaviours and habits of households composed only of elderly people (i.e., in which all members are at least 65 years old), the most recent data from the Italian Household Expenditure Survey (HBS)⁴ will be employed in the following. In 2023, in Italy, these households (henceforth “elderly households”) amounted to over 7.6 million, accounting for 29.2% of resident households. They were composed essentially by single persons (60.3%) and childless couples (38.1%); in both cases, these were higher percentages than those observed on total households (36.3% and 21.9%, respectively). They were thus very small households, on average composed of 1.40 members, far below the average size calculated on all resident households, equal to 2.2. Ten years before, in 2014, residing elderly households represented 26.4% of all resident households: thus, in 10 years they have increased by 16.3%. A steadily growing “lonely” population. In 2023, their average monthly consumption expenditure, in equivalent terms⁵, was equal to 2,919 euros, and that is 3.9% more than all resident households (for which, in equivalent terms, it was 2,809 euros per month). In terms of composition⁶, the division Food and non-alcoholic beverages accounted for about one-fifth of the total, in line with the total of resident households, while the remaining 80.5% was spent on non-food goods and services. Among the latter, expenditures with a higher weight for elderly households were those on Housing, water, electricity, gas and other fuels (including major renovations), accounting for 45.1% of their monthly expenditures (compared to

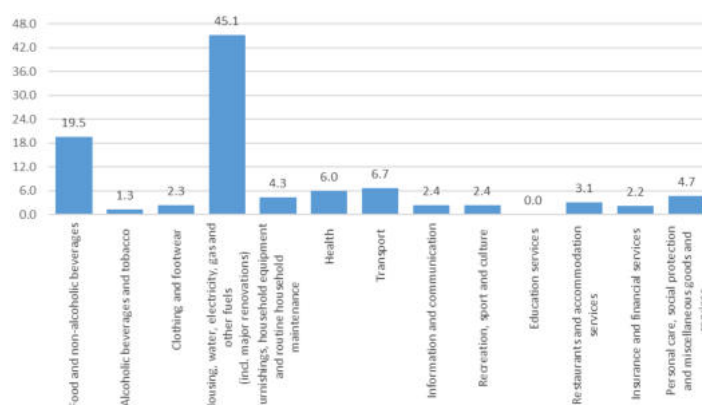
⁴ The HBS focuses on consumption expenditure behaviours of households residing in Italy, according to their main social, economic and spatial characteristics. In agreement with Eurostat, the survey is based on the harmonized international classification of expenditure voices COICOP (Classification of Individual Consumption by Purpose), to ensure international comparability.

⁵ Equivalent household expenditure takes into account the fact that households of different sizes also have different levels and needs for expenditure. Household expenditure is made equivalent by means of appropriate coefficients (equivalence scale) that allow comparisons between the expenditure levels of households of different sizes.

⁶ The objective of COICOP classification is to provide a framework of homogeneous categories of goods and services, which are considered a function or purpose of household consumption expenditure. The COICOP 2018 version has a four-level hierarchical structure: divisions, 2-digit; groups, 3-digit; classes, 4-digit; subclasses, 5-digit. There are 13 expenditure divisions.

36.0% on total households), together with expenditures on Transport (6.7%) and Health, which absorbed 6.0%, above the national figure (4.3%) (Figure 5).

Figure 5 – *Percentage composition of mean monthly consumption expenditure of households composed only of individuals aged 65 and over, according to COICOP 2018 division. Italy, year 2023.*



Source: Istat, Household Budget Survey.

Looking at expenditures incurred by elderly households, from 2014 to 2023, thus over a 10-year period, gross of demographic dynamics, an increase in total expenditure of 29.6% is reported. But if we depart the observed increase in total expenditure from the very strong demographic dynamics affecting this subgroup of households over the time period considered (+16.3%), the increase in total expenditure per single household stands at 11.5%, with the average size of these households remaining essentially the same over the observed decade (in 2014, it was in fact 1.42 members). For this subgroup of households, between 2014 and 2023, more pronounced changes are observed, in terms of levels, in COICOP 2018 divisions related to: Restaurants and accommodation services; Transport; Food and non-alcoholic beverages; Personal care, social protection and miscellaneous goods and services; Health; and Alcoholic beverages and tobacco. Changes described had limited impact on the composition of their consumption expenditure, except for the shares devoted to Food and non-alcoholic beverages, Restaurants and accommodation services and Transport.

Overall, this is a quantitatively increasingly significant subgroup of consumer households, which opens up the possibility for the market to invest and expand (Bieszk-Stolorz, Dmytrów, Frąckiewicz, 2024), prospectively, especially in the sectors of home automation and “smart homes,” nutraceuticals, integrated care, sustainable mobility, personal services and activities related to leisure and tourism,

as already highlighted in the literature (UNECE, 2009; European Commission, 2018). By way of comparison, consider the increase in consumption expenditure incurred by households belonging to the other “extreme” household subgroup, namely those composed exclusively of under-35s (henceforth “young households”). In 2023, these households (amounting to over 1.7 million, 6.8% of all resident households) were composed essentially by single persons (53.7%), followed by childless couples (17.8 per cent) and couples with one child (12.8 per cent) or two children (7.2 per cent). Over the time considered, the demographic dimension of this subgroup of households increased by 1.3%, while the growth in their consumption expenditure was equal to 17.3%: the latter slightly decreases to 15.8% if we look at the change in total expenditure per single household, thus net of demographic dynamics⁷. It should be noted, however, that in contrast to elderly households, the average size of households composed only of individuals aged under 35 somewhat decreased in 10 years, from 2.1 members in 2014 to 1.8 in 2023. The increase highlighted in consumption expenditure for this subgroup of households is higher than for elderly households, but it should not be forgotten that in 2023 young households accounted for just 6.8% of all resident households, lower than in 2014, when they accounted for 7.0 per cent, and compared with 29.2% of elderly households. The decreasing number of young households is therefore already contributing, and will increasingly do so, to the growing shift in consumer demand towards goods and services highly specialised in meeting the needs of the elderly people.

4. Absolute poverty in elderly households

Absolute poverty refers to the concept of basic needs. Households with an average monthly expenditure below a threshold constructed as the monetary value of a basket of goods and services considered essential to avoid serious forms of social exclusion, are classified as absolute poor⁸. Estimates of the incidence of absolute poverty for 2023, show values of 8.4% among households and of 9.7% among individuals. Although in a framework of substantial stability compared to the

⁷ For households composed exclusively of under-35s, the most pronounced changes in expenditure levels between 2014 and 2023 are observed in COICOP 2018 divisions related to: Restaurants and accommodation services; Recreation, sports and culture; Furnishings, household equipment and routine household maintenance; Food and non-alcoholic beverages; Housing, water, electricity, gas and other fuels (including major renovations); and Education. For these households, the composition of consumption expenditure over the same time period undergoes some minor changes, except for the share devoted to Restaurants and accommodation services, which rises from 5.8% to 8.2%, and that on Clothing and footwear, which falls from 5.8% to 4.6%.

⁸ These poverty thresholds are calculated by combining several factors, such as family size and age composition, region of residence and demographic size of the municipality of residence.

previous year, unprecedented values are reached, for a total of 2.2 million of households and 5.7 million of people in absolute poverty (Istat, 2024).

Absolute poverty is a phenomenon that affects households with young reference person more than those with older average members: for the 18-34 age group the individual incidence is 11.8 %, gradually decreasing with age, while individuals aged 65 years and over show an incidence of 6.2%, lower than the national figure (9.4%).

Elderly households in absolute poverty amount to 441 thousand in Italy in 2023. At national level, the incidence for them is 5.7%; it rises to 6.7% in the North, in the South is 5.9%, while the Centre show the lowest value, equal to 3.4%.

Households in this group are mostly single person (62.7%) or couples (34.4%); in terms of incidence, one-component households have higher values (6.0%) than couples (5.2%). 57.3% of individuals in these households is in the 65-79 age group, with a poverty incidence of 4.7%; the remaining 42.7% of individuals, aged 80 and over, experience more severe economic hardship, which result in an absolute poverty incidence of 7.9%. The equivalent average monthly expenditure for elderly households in absolute poverty is 1,170 euros per month. In terms of composition, there are some differences compared to this population as a whole: a higher share of expenditure allocated to Housing, water, electricity, gas and other fuels (67.2%, compared to 45.1% of all elderly households) and lower shares on health (2.7% as against 6.0% for all elderly households), and transport (1.1%, compared to 6.7%). In addition, there are lower shares on Restaurant and accommodation services (0.4%, as against 3.1%) and on Clothing and footwear (0.9% compared to 2.3%).

From 2014 to 2023, elderly households in absolute poverty see a modest growth in incidence (ranging from 5.0% to 5.7%): this moderate dynamic is more appreciated when compared to that of young households in which the incidence, from 2014 to 2023, rises from 10.3% to 11.3%. At individual level⁹, from 2014 to 2023 absolute poverty incidence rises from 6.9% to 9.7% for all resident individuals, whereas the incidence for individuals in elderly households, in the same period, increases from 4.6% to 5.7%. If we break down this group into two, one that includes individuals aged 65-79 and another with those aged 80 and over, it should be noted that, from 2014 to 2023, the incidence of absolute poverty for the first group increases from 4.3% to 5.5%, while for the second group rises from 7.0% to 7.9%, revealing a greater economic distress. From 2014 to 2023, the incidence of absolute poverty for young households increases from 10.3% to 11.3%.

The presence of an elderly member in a household plays a protective role against the condition of poverty (Bugetti M.N., Maino F. 2021): the incidence of absolute poverty for households without elderly members rises in fact from 6.8% in 2014 to

⁹ An individual is classified as absolute poor if he/she is a member of a household in absolute poverty.

9.8% in 2023, while households with at least one elderly see a more moderate growth in the same period, from 5.3% to 6.4%.

Further analyzing these aspects will help to better identify the needs of elderly households, especially those most at risk of economic difficulties.

5. Final remarks

The timing and modalities of the transition from youth to adulthood and from adulthood to older adulthood depend on the one hand on the economic conditions, lifestyles and, more generally, on the human capital of individual, on the other hand, on the institutional and social context in which the members of each generation reinterpret their life course. Therefore, today's elderly population - very different from that of the past - has many opportunities to lead an "active life", improving their lifestyle while making social, economic and cultural contributions to society.

The Silver Economy can become a resource for sustainable development if supported by policies that promote active aging and new models of welfare and healthcare. It is necessary to revise the Italian socio-assistance system by reducing the weight of pension spending and strengthening networks and services for older adults. Investments in technologies and innovative products are also needed to lower costs and make the system more inclusive. The private and non-profit sectors can contribute by meeting the broader needs of the elderly population (housing, mobility, culture, sports, tourism), turning longevity into a driver of development. Abroad, institutions such as the National Institutes on Ageing coordinate initiatives for active and healthy aging in line with UN sustainability goals. In Italy, a step in this direction is the Age-It project funded by the National Recovery and Resilience Plan, which has also led to the creation of the Italian Institute on Ageing.

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DASHBOARD FOR TERRITORIAL DATA ANALYSIS: POTENTIAL, SDMX AND INTEGRATION WITH OTHER SOURCES

Andrea Arru, Paolo Misso

Abstract. Dashboards have become an indispensable tool for the effective and timely representation and analysis of socio-economic phenomena. Organizations that deal with statistics increasingly promote the use of this tool, managing to satisfy the needs and interests of an increasingly wider audience of users. This work presents an effective approach to analyse multi-source territorial data on tourism, using dashboards of the most popular business analytics platforms in order to evaluate their potential. One of the most relevant features of dashboards is the ability to visualize and analyse data up to municipal and monthly levels, offering a temporal and territorial granularity particularly suited for in-depth studies. Furthermore, the platforms allow users to cross-reference tourist information with other territorial variables, such as demographic, economic or infrastructural data, enriching the contextual analysis. The systems are updated both using the ISTAT REST APIs through the SDMX protocol, ensuring dynamic and continuously updated access to official data, and datasets already available previously downloaded and structured.

1. Introduction

Dashboards have become a key tool for data management and analysis, capable of effectively supporting evidence-based decision-making processes. Thanks to their ability to aggregate, summarise and visualize complex information in an intuitive manner, dashboards are widely used across both public and private sectors to monitor phenomena, assess performance, and communicate results to various economic stakeholders (Eurostat, 2021, OECD, 2021).

Beyond their technical and analytical functions, dashboards can also be framed within broader debates on *data governance* and *public sector innovation*. In fact, the capacity to integrate heterogeneous sources and ensure data quality resonates with the literature on data governance frameworks (Khatry & Brown, 2010; Janssen, Charalabidis & Zuiderwijk, 2012). Similarly, the emphasis on openness, transparency and accountability directly connects dashboards to research on open government data and public communication of statistics (Bertot, Jaeger & Grimes, 2010; Meijer, 2015).

An increasingly significant dimension in the development of dashboards is the geographical one, that is, the spatial representation of data—particularly in reference to official statistics produced by public institutions, statistical agencies and governmental bodies (Istat, 2025). The use of thematic maps, Geographic Information Systems (GIS), and spatial visualisations enables the contextualization of information in relation to territory, making local dynamics, territorial disparities, critical issues and latent opportunities immediately visible. This form of representation enhances the accessibility and interpretability of official data for policymakers, citizens and practitioners (Paul A. Longley *et al.*, 2015) and has been successfully applied in geospatial dashboards for monitoring complex urban and territorial systems (Jing *et al.*, 2019, Schaffert *et al.*, 2024), but also aligns with the stream of research on *e-governance dashboards* as instruments for decision support and smart governance in the public sector (Scholl & Scholl, 2014).

A key feature of modern dashboards is their ability to integrate heterogeneous data sources — combining real-time and historical information from censuses, registries, monitoring systems, IoT streams, and more (Stehle & Kitchin, 2019). Interoperability among different sources and formats enables the construction of rich, real-time updateable and highly customisable information frameworks.

The main objective of this work is to develop an effective tool for the preliminary exploration of complex phenomena, characterised by low economic investment, rapid implementation times, ease of deployment, and continuous update capabilities.

A specific focus has been placed on the data ETL process (Extract, Transform, Load), with particular attention to the use of the SDMX format (Statistical Data and Metadata eXchange), which makes it possible to leverage pre-normalised data structures and explicit metadata to streamline the automation of information flows.

2. Data

For the implementation of the multi-source dashboard model, the tourism sector was selected, as it is particularly well suited to showcasing the integration of data from both official and complementary sources. Tourism is, in fact, a complex phenomenon characterised by highly heterogeneous spatial and temporal dynamics, and effective analysis requires the combination of statistical, geographical and economic information.

In developing the dashboard, official data from various Istat information systems (such as IstatData, Demo, Aster, etc.) were integrated. These systems collect multi-source data derived from statistical surveys and administrative records. The datasets cover a wide range of dimensions and are typically available in standard formats such as CSV, SDMX and Excel.

This approach highlights the potential of multi-source dashboards in providing a comprehensive view of tourism-related phenomena, supporting analyses of territorial distribution, seasonality, economic impacts, and accommodation capacity, with dynamic updates and intuitive geospatial visualisations. In this study, multi-decade time series were used, which required a careful preliminary phase of data verification, harmonisation and reconstruction, given that the original datasets were often incomplete or inconsistent.

2.1. Dataset

The datasets used to populate the dashboard are largely derived from census surveys, while a smaller portion originates from Istat's processing of administrative data sources. A selection of these datasets is listed below:

- Annual population movement and calculation of resident population
- Reconstruction of the demographic balance (2001–2018)
- Accommodation capacity of hospitality establishments
- Client movement in hospitality establishments
- ASIA Local Units Register
- Istat processing of open data on tax declarations (MEF – Department of Finance)
- Maritime transport
- Air transport
- Boundaries of administrative units for statistical purposes.

The data were downloaded in the various available formats, primarily CSV and SDMX, in order to compare them in terms of download speed, ease of processing, and update capabilities. CSV is the most widely used format, whereas the IstatData and Aster platforms also provide data in SDMX format. In some cases, Excel format is still available; however, it requires more complex transformation procedures to enable automated integration into the ETL workflow.

2.2. SDMX

SDMX has been analysed in greater depth to better assess its potential and limitations in data downloading and uploading. Data extraction from the IstatData platform was carried out through interaction with the SDMX endpoint of Istat (<https://esploradati.istat.it/SDMXWS/>), implemented by means of scripts in R with the aim of automating access.

The Single Exit Point (SEP) is based on an API that follows the REST architecture and allows the sending of HTTP requests, structured in the form of queries (EUROSTAT 2021, SDMX community 2024). Within the SDMX framework, queries are mainly distinguished into two categories:

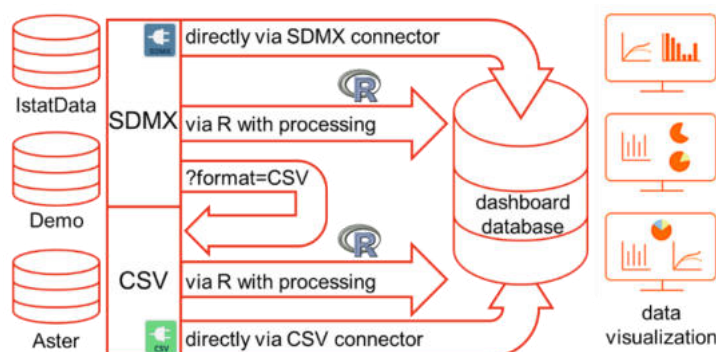
- Structural metadata query:
https://ws-entry-point/**resource**/**agencyID**/**resourceID**/**version**/**itemID**
?queryStringParameters
- Data query:
https://ws-entry-point/**resource**/**flowRef**/**key**/**providerRef**
?queryStringParameters

These queries allow the user to specify, for example, the variable to be analysed, the territorial level, the time range, and other filters. However, a limitation that still remains is the lack of clear and easily understandable documentation: the syntactic rules to be followed are not always explained in detail, which often makes the manual construction of queries a complex and error-prone task. To facilitate the use of the SEP, query builders are provided to guide users in composing the query string, making the tool more accessible even to less experienced users.

With the aim of comparing different access methods, the following three solutions were tested:

- direct use of an HTTP client, such as a browser, which allows simple and immediate access;
- use of R, through the RSDMX library;
- use of connectors, that is, tools enabling direct data integration with visualisation applications such as Power BI, MicroStrategy and Tableau.

From the perspective of integration within an ETL automation process, these methods exhibit very different characteristics. Using a browser is suitable for exploratory purposes or occasional access but cannot be automated efficiently. In contrast, employing R with RSDMX allows for the writing of repeatable, programmable, and schedulable scripts, making it suitable for automated pipelines. Finally, connectors can offer a good level of automation if integrated into tools that support scheduled data refreshes, but they tend to be less flexible during intermediate transformation steps compared to scripting languages such as R or Python.

Figure 1 – Dashboard data feeding scheme via direct connector or processing in R.

The SDMX format includes, alongside the data, a detailed metadata structure organised according to the Data Structure Definition (DSD), which formally describes the dimensions, measures, attributes, and associated value domains. The DSD is essential for understanding how to correctly read and query an SDMX dataset: each dimension corresponds to a statistical variable, while the measures represent the observed values and the attributes specify their context or quality.

To efficiently construct the tables to be loaded into the dashboard, the opportunity was taken to use codelists, that is, sets of valid codes associated with a given dimension or attribute. Since these are often shared across multiple datasets, codelists tend to be broad and generic. The use of tools capable of navigating and filtering the metadata enabled automation of the process, selecting only the combinations that are actually valid between codes and dimensions.

Within the ETL process actually implemented, access to metadata proved to be a crucial step: it allowed the construction of dynamic and automatable queries, the avoidance of interpretation errors, and the efficient application of filters upstream of extraction. However, this phase required the use of tools capable of correctly reading and interpreting the DSD. In particular, specialised R packages such as *rsdmx*, *readsdmx*, and *RJSdmx* were employed.

2.3. Reconstruction of Territorial Time Series

To ensure the temporal consistency of the territorial time series, a data harmonisation procedure was applied to municipal data by aligning them to the current administrative boundaries. This approach helps mitigate the distorting effects arising from territorial changes that occurred during the observation period, such as mergers, splits, creations, cessations, or alterations of municipal boundaries.

The reconstruction is based on a methodology inspired by that used for the creation of the 8milaCensus information system (ISTAT, 2015), although in this work exclusive reference was made to information concerning the creation and cessation of municipalities, without considering minor boundary changes. The temporal assignment of data was carried out through the reconstruction of historical municipal statistical codes, using information obtainable from SITUAS (SITUAS, 2024; ISTAT, 2024).

The historical series of municipal data for the period 2013–2023 was reconstructed using the administrative geography in force as of 1 January 2023 as a reference. In particular, the total number of Italian municipalities decreased from 8,092 in 2013 to 7,901 in 2023, following mergers and the establishment of new entities. Among the latter are the municipalities of Mappano (TO), established in 2017, and Misiliscemi (TP), established in 2021, which do not have complete historical series over the entire considered interval. For these municipalities, data prior to their respective establishment are not directly available and were not subject to disaggregated reconstruction; therefore, their series are partial, starting from the years of their actual creation.

Aligning to the 2023 geography also involved reassigning historical data in correspondence with municipal mergers, according to aggregation criteria consistent with the founding acts and territorial continuity.

3. Dashboard

Among the software solutions for creating analytical dashboards, Tableau, Microsoft Power BI, MicroStrategy, and ArcGIS Dashboards have emerged as the most widely adopted internationally. The choice of Tableau for this project is motivated by specific technical features that make it particularly well-suited to handling and visualising data from multiple sources. In particular, Tableau offers broad compatibility with heterogeneous data sources, enabling rapid integration and updating of datasets, and it incorporates advanced GIS functionalities that allow for the creation of interactive maps, spatial analysis, and thematic overlays without the need for external tools. The platform also stands out for the quality of its visualisations, native interactivity, and the ability to build exploratory analysis pathways through dynamic filters and geographical drill-downs. Tableau is supported by a large user community and proves to be an effective tool for dashboard creation, suitable for both expert users and those with limited technical skills. (Salesforce, 2023).

This section does not present a data analysis, but rather an exploration of the key components of the dashboard dedicated to the tourism sector, with the aim of

illustrating its main features and potential. The data displayed provides information at municipal level, allowing for a detailed exploration of the territory. The intention is to provide an overview of the visual and functional components, highlighting how these can support the identification of patterns, trends, and anomalies during consultation.

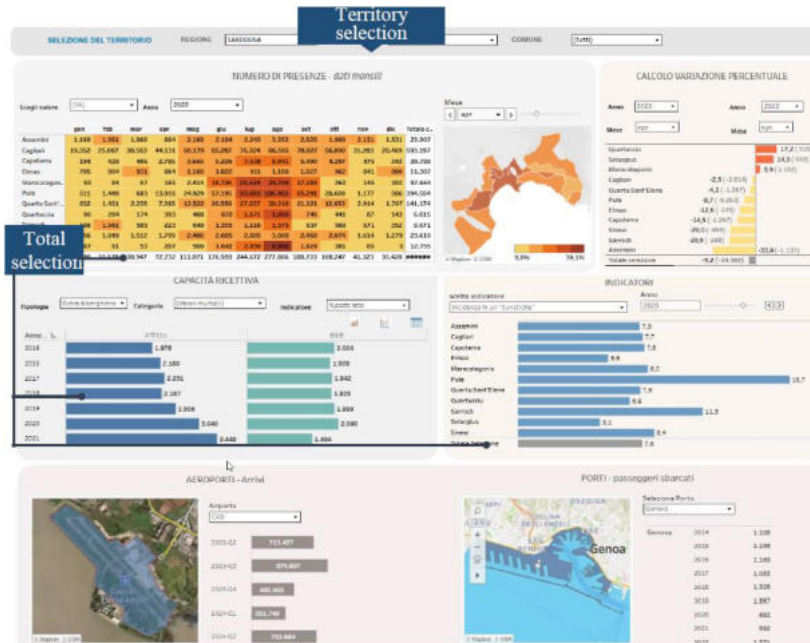
The tool is structured to integrate heterogeneous information sources – including data on tourist flows, accommodation capacity, and other relevant variables – presented through customisable and scalable graphic visualisations. The multi-level territorial filter forms the core element that governs the entire interface: the user can guide the analysis by progressively selecting region, province, and municipality, building flexible exploration paths focused on the area of interest.

The prototype employs a combination of interactive visualizations, including thematic maps for spatial distribution, time-series charts to track historical trends, and comparative dashboards to highlight differences across municipalities. These choices follow established principles in data visualization and statistical communication (Few, 2013; Kelleher & Wagener, 2011; Börner *et al.*, 2019), aiming to make complex administrative and demographic data both accessible and interpretable.

A distinctive feature of the dashboard is the modularity of the spatial component, which allows for contextual geographical selection: users can query data either at a granular level (single municipality) or in aggregate form, assembling customised sets of territories. This configuration enables comparative and cumulative analyses on different geographical aggregates – such as homogeneous areas, functional zones, or sub-regional contexts – even when these do not coincide with administrative boundaries.

Through the functionalities of the dashboard, the spatial, temporal, and structural dimensions that describe the tourism phenomenon can be analysed in detail, allowing users to grasp its complexity and the interrelationships between the variables involved. In particular, for data with a strong temporal component – such as monthly tourist overnight stays – a heatmap has been implemented, enabling users to quickly identify peaks in tourism pressure throughout the year, revealing recurring patterns or seasonal anomalies. This visualisation is integrated with an interactive geographical map that spatially locates the information.

Figure 2 – Overview of the Dashboard.

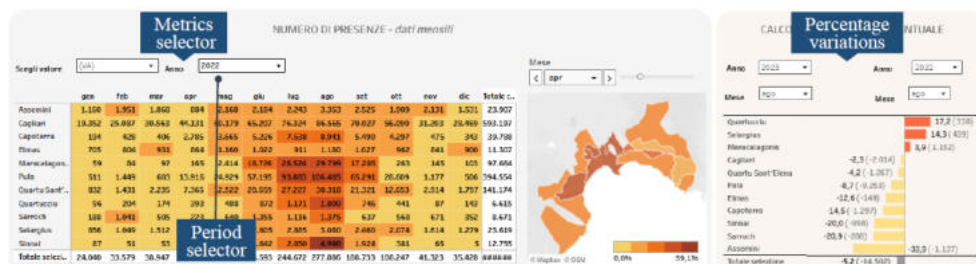


The interface allows for territorial selection through dynamic filters (at regional, provincial, and municipal levels) and displays key indicators for each individual municipality or for the entire selected area.

Thanks to the use of Tableau parameters, the dashboard offers a flexible and customisable configuration of analytical elements. In particular, a function has been integrated to calculate percentage variations, allowing users to compare the same indicator across different periods, based on the selected area. This option proves especially useful for analyses aimed at assessing the temporal evolution of the phenomenon, such as comparing consecutive tourist seasons or evaluating the impact of local policy interventions.

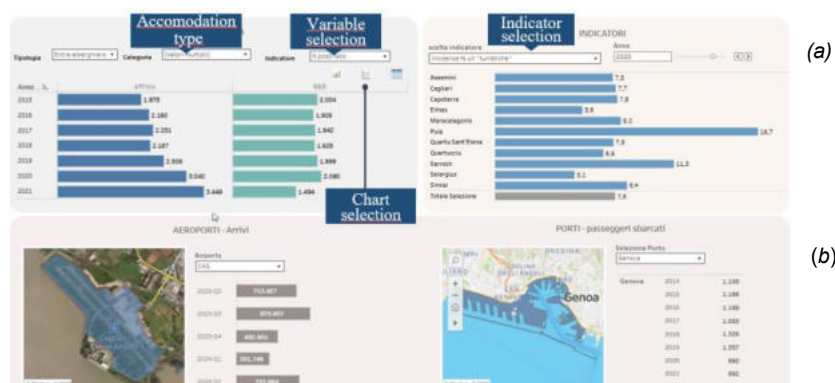
The dashboard allows users to choose the type of metric to be displayed, switching between absolute values, normalised values, or percentage changes, depending on the type of comparison or interpretation intended.

The tool allows the same data to be viewed in different ways, both through charts and tables, in a dynamic manner. The interface enables users to easily switch from a thematic map view to sortable interactive tables, or to bar charts and line charts, while keeping the applied territorial and temporal filters unchanged.

Figure 3 – Top section of the dashboard with territorial selectors.

Monthly data on tourist arrivals are presented in a table and a thematic map. The dashboard enables users to select the metric and the period of analysis, and provides a customisable tool for calculating percentage changes.

An additional filter allows the selection of indicators of interest, enabling the analysis to focus on specific aspects of the tourism phenomenon, such as the incidence of foreign visitors, accommodation capacity by type, or occupancy rates. All these indicators are calculated directly within Tableau.

Figure 4 – Section of the dashboard dedicated to dimensions and indicators (a). Infrastructure data on ports and airports (b).

On the left: modular selection via cascading filters for the type of accommodation facility, and selection buttons to activate the different graphical representations. On the right: selection and display of indicators. On the bottom: example of a query on georeferenced data, integrating official data on passenger traffic at airports and ports

Tableau integrates GIS capabilities that can be easily connected to the data within the dashboard's database, enabling the dynamic display of indicators associated with the selected geographical entities. This approach proves particularly useful, for example, when analysing airport or port infrastructures in relation to tourist access flows.

4. Conclusions

In the present work, an interactive dashboard has been developed in Tableau, which can also be used as a personal tool, with the aim of integrating, enriching, and expanding the functionalities offered by publicly available statistical data warehouses. Although these public querying systems represent a useful resource for accessing official data, they often present limitations in flexible territorial management and in conducting multidimensional analyses. The proposed dashboard, on the other hand, adopts a territorially focused approach, enabling comparative exploration of data across different administrative levels (municipalities, provinces, regions) and facilitating cross-sectional analysis between variables and territories.

Thanks to Tableau's advanced features, users can customise graphical representations, apply dynamic filters, construct composite indicators, and visualise results through thematic maps, interactive charts, and comparative matrices, as well as refresh the dashboard with continuously updated new data.

During the course of the work, the importance of the SDMX format emerged as a standard for building automated ETL procedures, due to its ability to integrate data and metadata within a single structure and the possibility of querying data providers directly through parametric queries. However, some practical drawbacks were also identified, particularly at the initial stage: SDMX files are often 10 to 20 times larger than their CSV counterparts, resulting in longer download times; moreover, reading and interpreting metadata requires specific tools and expertise, at least during the parameterisation phase of the procedures. For these reasons, the CSV format can still represent a valid — and sometimes the only — alternative, especially in cases where providers, as in the case of the Single Exit Point (SEP) of Istat, also allow the automatic export of data already formatted in CSV, thus simplifying integration into ETL workflows.

Tableau offers considerable ease in importing data from various sources; however, it currently lacks a native connector for the SDMX format, which necessitates the development of a custom connector using the appropriate SDK. This represents a limitation that could be overcome in future software versions, hopefully more open to direct support of this standard. Furthermore, although Tableau allows for various data processing and transformation operations, these functionalities are not comparable to the flexibility and power of analytical environments such as R, which remains indispensable for certain advanced transformations.

Finally, a significant aspect of this work concerned the reconstruction of territorial historical series, necessary to ensure data consistency over time in light of frequent changes in administrative geography, particularly at the municipal level. This operation cannot be fully automated due to the heterogeneity of sources and structural variations in historical datasets, which change over time in terms of format,

coverage, and variable structure. In this specific case, the reconstruction was carried out partially, limited to situations manageable with the information available in SITUAS, namely cases of extinction and complete acquisition of municipalities by other entities, which still represent the majority of territorial modifications. Despite its limitations, this intervention significantly improved the longitudinal analysis of phenomena at the municipal scale, providing a firmer basis for consistent temporal and territorial comparisons.

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MULTIVARIATE ANALYSIS FOR EXPLORING SUB-MUNICIPAL DEPRIVATION OF ITALIAN MUNICIPALITIES¹

Samanta Pietropaoli

Abstract. This study presents a multivariate analysis of nine individual indicators representing socio-economic deprivation at the sub-municipal level, based on data from 25 Italian municipalities. The aim is to investigate the internal heterogeneity of urban areas by examining the statistical properties and interrelationships of indicators reflecting different dimensions of local deprivation.

The first phase explores the distributional characteristics of the individual indicators, highlighting asymmetries, heavy tails, and outliers. Particular attention is given to extreme values, which may reveal critical conditions in specific urban zones and influence the robustness of conventional statistical summaries.

Principal Component Analysis is then applied to synthesise the complexity of the information, allowing dimensionality reduction and the identification of latent structures underlying the data. Findings highlight recurring patterns of socio-economic disadvantage common to several urban contexts, as well as context-specific vulnerabilities pointing to shared structural issues.

The ultimate goal is to provide a statistical rationale for selecting the individual indicators used to compute the composite sub-municipal deprivation index. At the same time, the study offers a concise and interpretable representation of spatial disparities, with potential to inform local policy and planning interventions.

1. Introduction

Urban areas are increasingly characterised by pronounced internal disparities in socio-economic conditions, often masked by aggregate municipal-level indicators. Understanding sub-municipal variations is essential for developing targeted policies to address local vulnerabilities and promote inclusive development. Statistical methods capable of capturing and synthesising this complexity are therefore crucial.

This paper investigates the internal heterogeneity of socio-economic deprivation² across 25 Italian municipalities by applying Principal Component Analysis (PCA)

¹ This article exclusively reflects the author's opinions.

² Socio-economic deprivation is defined as a condition in which families and individuals experience difficulties in adequately meeting their basic needs due to a lack of or insufficient economic, employment, educational, and social resources and opportunities. (Carbonetti *et al.*, 2025)

to nine individual indicators. These indicators form the empirical basis for the construction of ISTAT's sub-municipal composite deprivation index, enabling identification of recurrent disadvantage patterns and context-specific phenomena (Carbonetti *et al.*, 2025). The sample includes cities from northern, central, southern, and insular Italy, representing diverse urban and socio-economic contexts. Building on previous PCA applications in deprivation measurement (e.g., Messer *et al.*, 2006; Basu and Das, 2021), this study explores the latent multidimensional structure of deprivation at the sub-municipal level, addressing a methodological gap in the existing literature, which has predominantly focused on broader spatial scales. The contribution of this paper is twofold: first, it critically examines the statistical properties of the indicators—focusing on asymmetry, outliers and heavy-tailed distributions—and second, it employs PCA to explore latent deprivation dimensions, assessing whether one or more underlying dimensions best capture the phenomenon.

This work is part of a broader institutional effort to improve local socio-economic vulnerability measurement through integration of census and administrative data. It aims to support spatially targeted interventions and foster more granular territorial diagnostics. The remainder of the paper is structured as follows: Section 2 reviews the literature on PCA in similar contexts. Section 3 presents the indicators. Section 4 examines their distributional patterns. Section 5 reports and interprets PCA results. Finally, Section 6 concludes.

2. Review of the Literature

PCA (Pearson, 1901) is a multivariate statistical technique widely used in constructing composite indicators, reducing data dimensionality by summarising the variance of correlated variables into a smaller set of uncorrelated components (Ram, 1982). The first component captures the maximum variance, followed by subsequent components explaining decreasing residual variance. PCA has been applied in well-being and deprivation indices, particularly to derive data-driven weighting schemes for the components of a composite indicator. Notable applications include Ram's Physical Quality-of-Life Index, Noorbakhsh's adaptation for the Human Development Index (1998), and contributions by Klasen (2000), McGillivray (2005), as well as OECD and European Commission initiatives (Saisana and Tarantola, 2002; Bandura, 2008). Standard practice often involves using the first principal component's factor loadings as weights for a composite indicator (Greyling and Tregenna, 2016).

However, PCA has well-recognised limitations, it may produce negative weights or yield components that are difficult to interpret when indicator correlations are weak (Saisana and Tarantola, 2002). PCA is primarily an exploratory tool, useful for identifying patterns, detecting redundancy or understanding underlying structures

(Ogwang and Abdou, 2003). Recent studies emphasise its value in revealing multidimensional constructs, where multiple uncorrelated dimensions represent distinct latent phenomena (Terzi *et al.*, 2021). In this sense, PCA is particularly suited to identifying redundant variables and uncovering whether a multidimensional concept—such as a deprivation index—consists of several uncorrelated dimensions, each potentially representing a distinct latent factor. When such distinct dimensions emerge, PCA proves especially valuable in revealing the internal structure of the data. In these cases, multidimensional approaches may be preferable to traditional aggregation methods based on predefined weights. However, as Terzi *et al.* (2021) also warn, PCA may not be ideal for final construction of composite indices, since the orthogonality it imposes among components does not necessarily reflect real-world interdependencies across dimensions.

3. Indicators

The empirical analysis draws on data from 25 Italian municipalities selected to capture a broad spectrum of urban contexts and socio-economic configurations across the country. These municipalities—Turin, Genoa, Milan, Verona, Venice, Padua, Gorizia, Trieste, Parma, Modena, Bologna, Florence, Perugia, Rome, Prato, Carpi, Naples, Bari, Taranto, Reggio Calabria, Palermo, Messina, Catania, Olbia, and Cagliari—are geographically distributed throughout Italy, covering northern, central, southern, and insular regions, and include both large metropolitan areas and medium-sized urban centres. The analysis focuses on enumeration areas³ (EAs), the smallest statistical units, providing high spatial resolution for intra-urban disparities. The analytical framework enhances robustness by filtering only EAs with a stable residential presence and clear urban characteristics—such as buildings, infrastructure, and street networks—while excluding zones⁴ with negligible population or atypical land use (e.g., parks, cemeteries, hospitals).

The number of EAs per municipality ranges from 272 in Gorizia to 11,688 in Rome, with an average of 2,180 and a median of 1,476⁵. All EAs were treated as equally weighted observational units—a one-to-one strategy—to capture the relative

³ According to ISTAT (2015), an enumeration area is the smallest territorial unit used for data collection within a municipality, primarily designed to organise census operations. It generally corresponds to a city block or part of it. These fine-grained spatial units are essential for capturing local socio-economic information and are also used for geocoding processes and delineating functional areas.

⁴ This exclusion was limited to specific zones within the cities of Florence, Bologna, Milan, Rome, and Turin.

⁵ The number of Enumeration Areas (EAs) varies across cities due to differences in city size and population, as well as the selection of EAs meeting completeness criteria. The proportion of EAs included relative to the total number per city varies slightly, but this does not introduce bias in the subsequent analysis.

spatial structure of deprivation rather than to produce population-weighted estimates, which could have overemphasised larger or more densely populated units. Since the indicators were expressed in relative or per-capita terms, differences in population size were already accounted for, ensuring meaningful comparability across units. Indicators were derived from administrative sources and sample surveys—primarily from ISTAT, but also from the National Social Security Institute (INPS), the Ministry of Education (MIM), the Ministry of University and Research (MUR), and the Cadastre Register—using the most recent sub-municipal data available (2020–2021, depending on the source).

These are grouped into three thematic domains: economic hardship, labour market exclusion, and educational disadvantage. Priority was given to indicators capturing observable and measurable conditions rather than potential risk factors, ensuring a tangible and measurable representation of local deprivation. The nine indicators were selected through a collaborative expert-based process, which identified the most appropriate measures based on data availability and conceptual relevance. This study represents an experimental application developed within the methodological framework proposed by Carbonetti et al. (2025), with some adjustments to the indicator set reflecting data constraints and contextual refinements. The formative measurement model (Mazziotta and Pareto, 2019) supports this expert-driven and context-sensitive approach to indicator selection. Particular attention was paid to statistical quality, including relevance, accuracy, and comparability across municipalities. This structured selection process ensured theoretical coherence and empirical robustness, providing a solid foundation for the construction of the composite deprivation index (Carbonetti et al., 2025). Altogether, the selected indicators offer a nuanced depiction of territorial fragility at the sub-municipal level, as summarised in Table 1.

All indicators are oriented so that higher values correspond to greater deprivation, except for DISOCC_1 (employment rate), where higher values indicate better labour integration. Each indicator was computed at the EA level and standardised (z-scores)⁶ prior to analysis.

⁶ Although PCA is sensitive to outliers, z-score standardization was adopted to preserve the relative variability and comparability of indicators across municipalities. Outliers were considered an intrinsic feature of spatial heterogeneity rather than noise. A more robust scaling, such as the Median Absolute Deviation, could have dampened these meaningful territorial contrasts.

Table 1 – List of individual indicators used for the construction of the sub-municipal deprivation index.

Indicator	Description	Prevalent Component	Sources
DISECO_1	% of the population aged 70 and over living alone and without owning a home	Economic	PPHC ⁷ , Cadastre Register
DISECO_2	% of individuals in households where no member is employed or receives a work-related pension	Economic	PPHC, Pensioners' records
DISECO_3	Individuals in households at risk of poverty per 100 residents.	Economic	PPHC, Income Register
DISOCC_1	% of employed individuals aged 25–64 over the total population aged 25–64	Employment	PPHC
DISOCC_2	% of individuals aged 0 to 64 living in households with very low work intensity	Employment	PPHC, Labour Register
DISOCC_3	% of employed individuals (aged 25 to 64) with predominantly precarious employment conditions during the year, over the total number of employed individuals (25–64) in the year	Employment	PPHC, Labour Register
DISEDU_1	% of the population aged 25 to 64 without upper secondary school education	Educational	PPHC
DISEDU_2	% of individuals aged 15–29 who are not employed and not enrolled in any regular education program of the MUR or the MIM	Educational	PPHC, MIM, MUR
DISEDU_3	% of students who drop out or repeat the year (Proxy indicator of potential dropout in secondary school)	Educational	PPHC, Education Register

Sources: ISTAT, INPS, Cadastre, MIM, MUR (2020-2021).

4. Distributional Patterns and Variability of Indicators

As a first step, the distributional characteristics of the nine indicators were analysed, with skewness and kurtosis statistics computed to detect heavy tails and outliers that could distort subsequent multivariate analysis. This exploratory phase revealed substantial heterogeneity in shape and dispersion across the 25 municipalities.

Large urban centres such as Rome, Naples, and Palermo display pronounced asymmetries and extreme values across most DISECO and DISOCC indicators. For instance, DISECO_1 (elderly living alone without home ownership) shows a long right tail, while DISEDU_2 (NEET⁸ rate) exhibits strong positive skewness, indicating spatially concentrated vulnerability and internal segmentation. Outliers are fre-

⁷ PPHC stands for *Permanent Population and Housing Census*.

⁸ NEET (Not in Education, Employment, or Training) refers to young people, typically between the ages of 15 and 29, who are not in education, employment, or training. This means they are neither enrolled in formal education or training programs nor engaged in paid or unpaid work.

quent in these metropolitan areas, with some EAs diverging sharply from the surrounding urban fabric, indicating neighbourhoods where poverty, low employment, or dropout rates reach extreme levels not observed elsewhere in the same city.

In contrast, cities like Parma, Padua, and Modena show more symmetric and compact distributions, with lower dispersion and fewer anomalies. Indicators such as DISOCC_1 (employment rate) and DISEDU_1 (low education) suggest relatively uniform conditions and less spatial concentration of deprivation, supporting the hypothesis of a more homogeneous socio-territorial structure. Some municipalities exhibit irregular or multimodal distributions. For example, DISEDU_3 (students at risk of dropout or repetition) presents a bimodal pattern in Cagliari and Olbia, possibly reflecting contrasts between central and peripheral areas or between resident and seasonal populations. In northern cities such as Trieste and Gorizia, age-related vulnerability (DISECO_1) is particularly evident, with right-skewed distributions highlighting the challenges of ageing populations in housing-insecure settings. At the same time, smaller cities such as Reggio Calabria and Taranto, also show fat-tailed distributions in DISOCC_2 and DISEDU_3, indicating that acute localised disadvantage can emerge even in medium-sized urban contexts. Outliers in these areas often signalling deeply marginalised neighbourhoods. A notable pattern is observed for DISOCC_3 (precarious employment), which exhibits high variability in both central and peripheral zones. In cities like Naples and Rome, this reflects dual labour markets with the coexistence of widespread precariousness and pockets of stable employment. Educational deprivation, particularly DISEDU_2 and DISEDU_3, is unevenly distributed across the country: right-skewed distributions reveal extreme vulnerability in Palermo, Taranto, and Reggio Calabria, whereas northern cities such as Bologna and Milan show tighter and more balanced profiles.

Overall, the presence of skewed and heavy-tailed distributions, combined with significant outliers, confirms the complexity of socio-spatial vulnerability in Italian cities. These findings underscore the importance of developing a composite index at the sub-municipal level, designed to capture localised disparities and distributional patterns that would otherwise be obscured in aggregated analyses.

5. Principal Component Analysis: selected results

Once the dataset was standardised, preliminary checks were conducted to assess the suitability of the indicators for PCA. Two commonly used diagnostic tests were

applied: the Kaiser-Meyer-Olkin (KMO)⁹ measure of sampling adequacy and Bartlett's Test of Sphericity (BTS)¹⁰. All municipalities passed these preliminary tests, with KMO values exceeding the 0.70 threshold, indicating moderate to excellent sampling adequacy. The highest KMO value was observed in Naples (0.88), reflecting excellent adequacy, followed by Palermo (0.85), Cagliari (0.82), and both Rome and Trieste (0.78). Regarding the BTS test, the results confirmed that the data were suitable for the analysis.

The PCA was conducted using the *R* statistical software, specifically the `princomp()` and `PCA()` functions from the *stats* and *FactoMineR* packages. The analysis was based on the correlation matrix of standardised indicators. No rotation was applied, as the aim was to explore the overall structure of the data and identify the principal latent dimensions explaining the maximum variance, rather than to obtain a simpler or more interpretable factor pattern. Negative loadings were interpreted as variables inversely associated with the corresponding component, meaning that higher values of these variables reflect lower scores on that latent dimension. Although PCA is sensitive to sample size, the use of relative and per-capita indicators ensures comparability across cities, maintaining the robustness of the results even in smaller cities with fewer EAs.

The PCA results reveal two dominant components explaining a substantial share of total variance in most municipalities, although in some cases a third component is required to capture socio-economic and educational complexity. This is further illustrated by correlation circles, which visually represent the relationships between indicators and the first two principal components. The direction and length of the arrows indicate the contribution and strength of each indicator in the component space, supporting the interpretation of latent structures and enabling cross-city comparison of dominant dimensions.

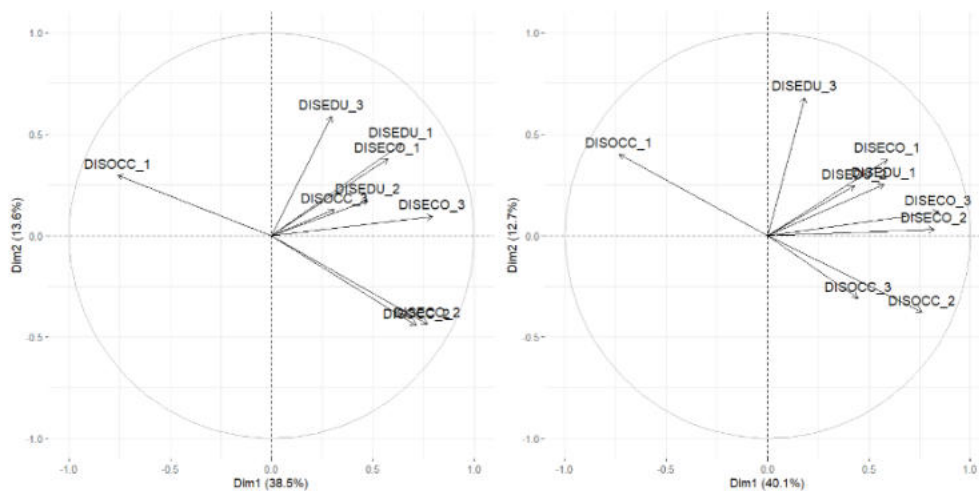
To explore territorial differences more concretely, the results for selected pairs of cities—representative of the North, Centre, South, and Islands—are presented below. These examples highlight how the relative contribution of each indicator to the principal components varies across contexts, revealing both recurring structures and local specificities in patterns of deprivation. Figure 1 shows the PCA correlation circles for Milan and Trieste, where the first two components explain around 52%

⁹ The KMO statistic evaluates the proportion of variance among variables that might be common variance. Its value ranges between 0 and 1, with higher values indicating a greater degree of shared variance and therefore better suitability for factor-based techniques. While a KMO value above 0.6 is generally considered acceptable, values above 0.7 or 0.8 are preferable and indicate good to excellent adequacy (Kaiser, 1974).

¹⁰ The BTS assesses whether the correlation matrix significantly differs from an identity matrix—that is, a matrix in which all diagonal elements are equal to 1 and all off-diagonal elements are 0. If the test is statistically significant ($p < 0.05$), the null hypothesis that the variables are uncorrelated can be rejected, indicating that the data are appropriate for structure detection through PCA (Bartlett, 1951).

and 53% of the variance, respectively. In both cities, PC1 captures structural socio-economic vulnerability, with high positive loadings on DISECO_2 and DISECO_3 (economic hardship) and strong negative loadings on DISOCC_1 (employment rate). Educational exclusion also contributes to PC1, more markedly in Milan through DISEDU_1 and DISEDU_2. PC2 differentiates educational dynamics with DISEDU_3 (youth dropout risk) emerging as a major contributor, especially in Milan, where educational deprivation aligns with both PC1 and PC2. Trieste shows a similar, though less pronounced, pattern.

Figure 1 – Correlation Circles from PCA: Milan (left) vs. Trieste (right): PC1 (Economic and Labour Vulnerability) vs. PC2 (Educational Deprivation).



In Rome and Florence (Figure 2), PC1 explains 38–40% of the variance and reflects economic hardship and labour exclusion, with strong contributions from DISECO_2, DISECO_3, and DISOCC_2, and a negative loading on DISOCC_1. Educational indicators contribute moderately to PC1 in both cities. PC2, explaining around 12–13% of the variance, captures educational exclusion more distinctly in Florence, especially through DISEDU_1 and DISEDU_3. In Rome, PC2 shows weaker or negative correlations with educational indicators, suggesting a less pronounced role. Florence also displays a moderate positive loading of DISECO_1 on PC2, pointing to localised socio-demographic variation.

In Naples and Bari (Figure 3), PC1 dominates the structure, explaining 44–46% of the variance, and reflects structural socio-economic hardship driven by economic dependency (DISECO_2, DISECO_3), low work intensity, and precarious employ-

ment (DISOCC_3). Educational indicators contribute more marginally, with variable patterns across components. These results confirm that deprivation in both cities is primarily shaped by entrenched economic and labour vulnerabilities, with local nuances in the interaction between dimensions.

Figure 2 – Correlation Circles from PCA: Rome (left) vs. Florence (right): PC1 (Economic and Labour Exclusion) vs. PC2 (Educational Exclusion).

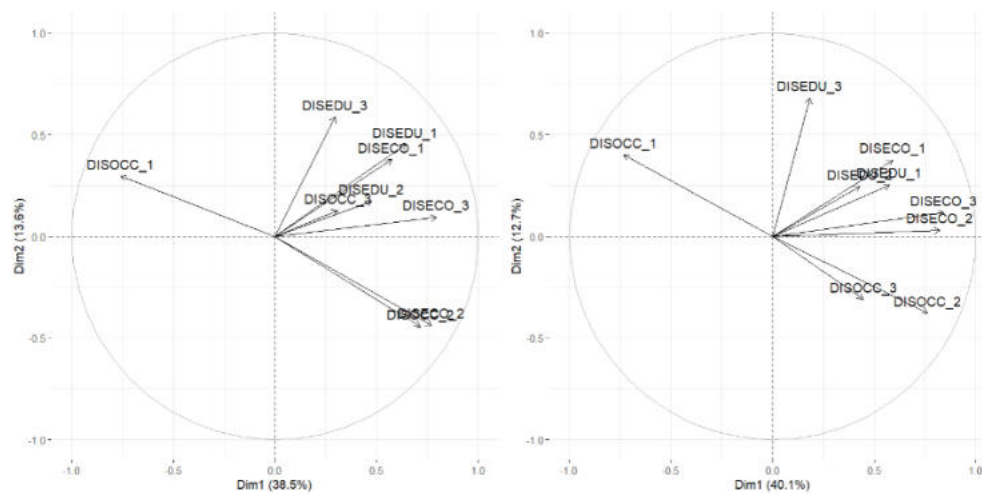


Figure 3 – Correlation Circles from PCA: Naples (left) vs. Bari (right): PC1 (Economic and Labour Vulnerability) vs. PC2 (Marginal Educational Variation).

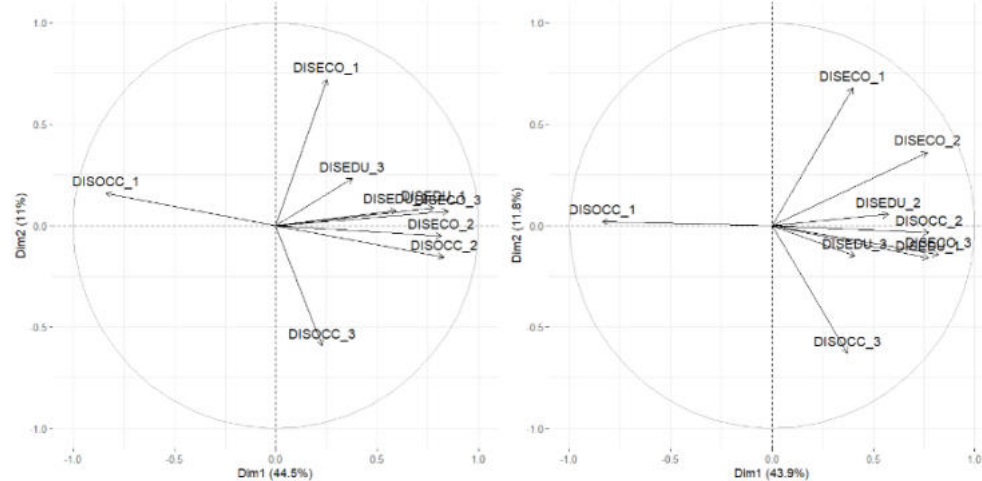
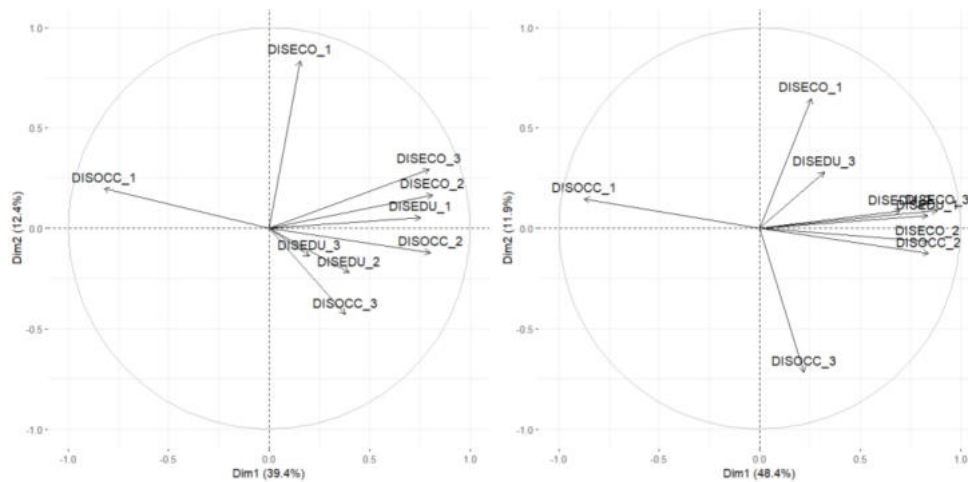


Figure 4 – Correlation Circles from PCA: Palermo (left) vs. Cagliari (right): PC1 (Economic and Educational Deprivation) vs. PC2 (Labour and Context-Specific Dimensions).



6. Conclusions

This study has highlighted the importance of sub-municipal analysis for capturing the internal complexity of socio-economic deprivation in Italian cities. By applying PCA to a set of nine indicators across 25 municipalities, it was possible to identify both recurring patterns of disadvantage and spatially concentrated vulnerabilities that would remain obscured by aggregate measures. The distributional analysis revealed skewed indicators, heavy tails, and outliers—underscoring the limits of aggregate statistics in representing intra-urban disparities and reinforcing the need for disaggregated, multidimensional tools. Rather than using PCA as a weighting mechanism, the study employed it as an exploratory technique to assess the internal coherence of the indicators and to detect latent dimensions of deprivation. This approach highlighted the multidimensionality of the phenomenon—spanning structural socio-economic hardship, labour market exclusion, and educational disengagement—which varies in expression and intensity across different urban contexts. These results underscore that indices constructed at the city level risk overlooking significant intra-urban disparities and therefore call for more flexible frameworks—such as sub-municipal approaches—capable of capturing territorial heterogeneity within municipalities. While certain structural components, particularly economic and labour-related vulnerabilities, appear widely shared, other dimensions like educational deprivation and employment precarity exhibit greater territorial variability, reflecting diverse socio-demographic and economic dynamics. Crucially, PCA also

provided statistical evidence supporting the adequacy of the selected individual indicators used for the construction of the composite deprivation index. While expert knowledge is essential in guiding indicator selection, it is not sufficient on its own; empirical validation through statistical analysis is necessary to ensure the robustness and relevance of the indicators chosen. This reinforces the value of combining theoretical expertise with data-driven evidence in the design of multidimensional measurement tools. Nevertheless, some limitations should be acknowledged. The analysis is cross-sectional and may therefore not capture temporal dynamics or evolving spatial patterns of deprivation. Moreover, PCA assumes linear relationships among variables and may not fully represent complex or non-linear interactions underlying socio-economic phenomena. Finally, although the selected indicators cover key dimensions of deprivation, the omission of other potentially relevant variables could limit the comprehensiveness of the analysis. Overall, the findings contribute to the refinement of the composite deprivation index at the sub-municipal level, enabling more accurate and interpretable representations of territorial vulnerability. Such tools are essential for supporting evidence-based, spatially targeted policies aimed at reducing intra-urban inequalities and promoting inclusive development. Future work could extend this framework to additional cities and incorporate longitudinal data to enhance its utility for territorial diagnostics and policy planning.

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DO ROYALTIES IMPROVE LOCAL SOCIO-ECONOMIC CONDITIONS? EVIDENCE FROM MUNICIPALITIES IN BASILICATA ¹

Agata Maria Madia Carucci, Giovanni Vannella

Abstract. This study aims to analyze the economic impact of royalties on local territories, with particular focus on the shares allocated directly to municipalities where hydrocarbon deposits are located. Following an initial descriptive analysis of the royalties paid by oil companies to local authorities over the period 2008-2024, the study proceeds with non-parametric analyses conducted on a set of municipal-level variables. The objective is to assess whether significant socio-economic differences exist between municipalities that receive royalties and those that do not. The data used originate from the "A misura di Comune" information system – ISTAT's system of municipal indicators – as well as from official statistical sources such as Demographic Balances and the Population Census, and open data provided by the Ministry of Economy and Finance and the Ministry of the Environment and Energy Security.

1. Introduction

Italy exhibits marked socio-economic inequalities, with further differentiation stemming both from the North–South divide and the condition of inner areas, which often require additional financial resources to address such structural imbalances (Istat, 2024; Accetturo, 2022; Fiascinoro, 2024). In some cases, local authorities may benefit from additional funding linked to the presence and exploitation of hydrocarbon deposits within their jurisdiction.

In Italy, as established by Article 826 of the Civil Code, hydrocarbon deposits are considered inalienable property of the State. Although the State does not directly manage hydrocarbon exploration and production activities, it delegates their execution to private companies through a concession-based system. These companies are required to comply with specific obligations, including the submission of work programs, the payment of fees based on the surface area covered by mining titles, and the payment of royalties proportional to the quantity of hydrocarbons extracted.

From 2008 to 2024, oil companies paid a total of nearly 5 billion euros in royalties,

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with the resulting revenues distributed among the State, Regions, and Municipalities located in the areas where the hydrocarbon deposits are found².

Although several studies have examined the impact of these financial flows on local authorities (Pellegrini, 2021; Percoco, 2012; Catullo, 2022), most analyses focus on the regional level. This is due both to the economic relevance of the regional shares and to the difficulty in accessing official statistical data at the municipal level.

However, although municipalities receive only 15% of total royalties (with 30% allocated to the State and 55% to the Regions), the amount of royalties can become economically relevant for many of them, especially considering that a large share of beneficiary municipalities is small or very small in size. The recent availability of municipal-level data has made it possible to study the impact of royalties directly allocated to specific municipalities.

This analysis is relevant given that the beneficiary municipalities, besides their small size, are also targeted by the National Strategy for Inner Areas (SNAI)³, as they are classified as peripheral or ultra-peripheral areas. These municipalities are characterized by limited access to essential services such as education, healthcare, and transportation. The shares allocated to Municipalities, unlike those assigned to Regions or the State, are not earmarked for specific uses. The main legal constraints⁴ are rather general, thereby allowing the use of these funds for current expenditures such as employment and economic development, or for investments in infrastructure, including environmental improvements (Montanari, 2007). Furthermore, these resources are not subject to specific oversight mechanisms, other than the general controls applied to municipal budgets.

This suggests that the management of these funds may lead to either highly positive or disappointing outcomes, depending on the political decisions made, potentially contributing to a reduction in territorial inequalities or, in the worst-case scenario, to the emergence of the well-known resource curse (Van Der Poley, 2019; Svampa, 2015; Poncian, 2019; Pellegrini, 2021). In this framework, the present study aims to apply non-parametric methods to examine whether municipalities receiving royalties experience better socio-economic conditions than non-beneficiary ones.

² The State is entitled to 30% of the royalties from hydrocarbons extracted onshore, while the Regions receive 55% and the Municipalities 15%. However, starting from January 1, 1999, for concessions located within ordinary statute Regions included in Southern Italy (Mezzogiorno), the share allocated to the State is paid directly to the Region, pursuant to Article 20, paragraph 1-bis, of Legislative Decree No. 625/1996.

³ <https://www.agenziacoazione.gov.it/strategia-nazionale-aree-interne/>

⁴ Article 20 of Legislative Decree 625/1996 establishes that "municipalities allocate these resources to the development of employment and economic activities, to industrial growth, and to environmental improvement interventions in the territories where exploration and extraction activities take place."

2. Data

The Ministry of the Environment and Energy Security annually publishes data on hydrocarbons extracted, royalties, and their allocation. The data, provided in open format and released as time series with granular territorial detail, enable timely descriptive analysis of the phenomenon.

Italy in 2024 (the most recent year available) has extracted nearly 3 billion standard cubic meters (scm) of natural gas were extracted, along with over 4,300 million kilograms of crude oil, 79 million kilograms of Lpg, and 8 million kilograms of gasoline.

Extraction activities took place in 11 Italian regions (Abruzzo, Basilicata, Calabria, Emilia-Romagna, Lombardia, Marche, Molise, Puglia, Sicilia, Toscana, and Veneto), with a strong concentration in Basilicata (over one million scm of natural gas, 3,700 million kilograms of crude oil, in addition to the entire Lpg production) (Table 1).

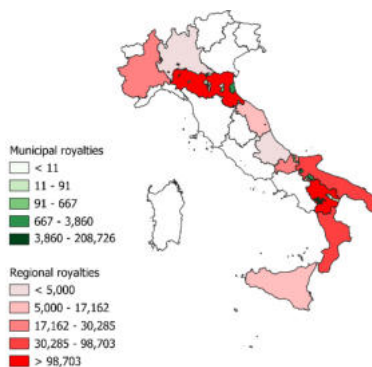
Table 1 – National hydrocarbon production – Year 2024. Distribution of production by regions and marine areas.

Regions	Natural gas production (Scm)	Crude oil production (kg)	Gasoline production (kg)	Lpg production (kg)
Abruzzo	14,164,092			
Basilicata	1,050,746,614	3,703,668,586		79,667,740
Calabria	5,506,436			
Emilia Romagna	117,312,129	14,603,822	511,094	
Lombardia	20,722,042		37,804	
Marche	3,504,213			
Molise	47,500,882	5,677,246	752	
Puglia	29,457,138			
Sicilia	146,230,182	254,159,710	8,060,433	
Toscana	1,339,492			
Veneto	379,180			
TOTAL LAND	1,436,862,400	3,978,109,364	8,610,083	79,667,740
TOTAL SEA	1,444,670,983	388,769,209	141,227	-

Source: Ministry of the Environment and Energy Security

Royalties are determined on the basis of hydrocarbon production, using the average market prices of oil and gas. These payments are then distributed among the State, Regions, and Municipalities in accordance with Articles 20 and 22 of Legislative Decree No. 625/1996. Excluding royalties collected directly by the State, between 2008 and 2024 the regions that received the highest disbursements were Basilicata (1,893,931,944 euros), Emilia-Romagna (106,218,560 euros), and Calabria (96,824,190 euros). Notably, Basilicata (combining both regional and municipal payments) received 86% of the total disbursements, amounting to over 2 billion of euros (Figure 1).

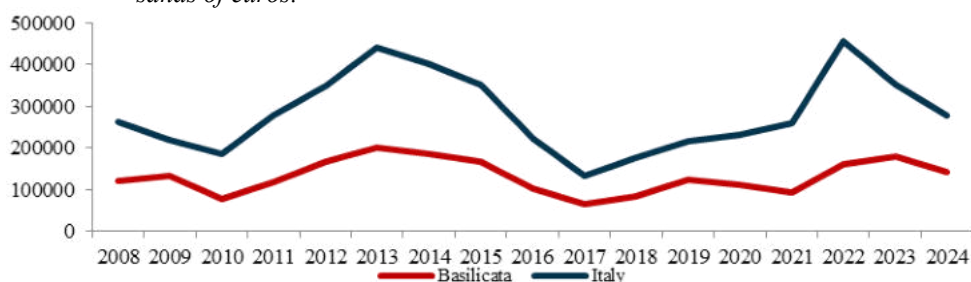
Figure 1 – Distribution of regional and municipal royalties. Years 2008-2024. Values in thousands of euros.



Source: Ministry of the Environment and Energy Security

An analysis of the time series data for the years 2008–2024, at both the Basilicata and national levels (Figure 2), reveals a high degree of temporal irregularity, due to the correlation with the volume of hydrocarbons extracted in the previous year.

Figure 2 – Distribution of royalties in Italy and Basilicata. Years 2008-2024. Values in thousands of euros.



Source: Ministry of the Environment and Energy Security

This variability is likely to pose challenges for multi-year planning by beneficiary territorial authorities, also due to the inherent unpredictability of the phenomenon.

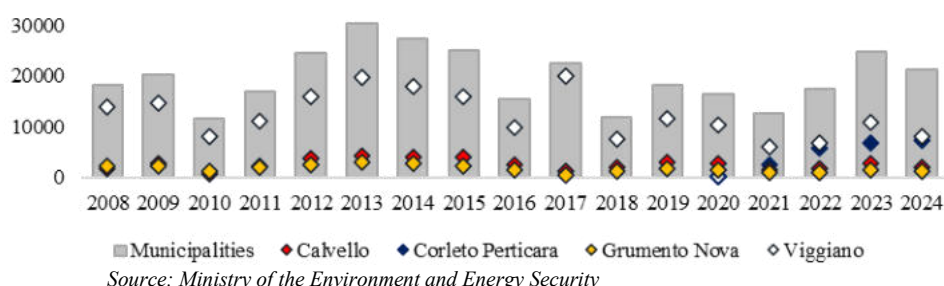
Given the significant weight of Basilicata in this variable, national trends closely mirror those observed in the region. In Basilicata 15% of royalties are paid directly to municipalities, while the remaining 85% is allocated directly to the Region (see Note 2), 12 municipalities received royalty allocations between 2008 and 2024, 60% of which are located in the province of Potenza, accounting for over 99% of the total resources received (Figure 1).

Approximately 90% of total municipal royalties are allocated to just four municipalities (Figure 3 and Table 2). These municipalities are small or very small in size and,

according to the classification of the National Strategy for Inner Areas (SNAI), are categorized as peripheral or ultra-peripheral. They are also characterized by a significant demographic decline, with population decreases ranging from -22.5% to -55.6% between 2023 and 1951. The very small size of the beneficiary municipalities suggests that royalties have a substantial economic impact on municipal budgets. For example, in 2024 the municipality of Viggiano received 8 million euros. Distributed across a population of approximately 3,200 inhabitants, this corresponds to about 2,500 euros per capita per year.

This specific distribution of royalties—despite significant territorial and temporal variability—cannot be considered an outlier, as it reflects a real and structural characteristic of the phenomenon under observation.

Figure 3 - *Distribution of municipal royalties in the main 4 municipalities in Basilicata. Years 2008-2024. Values in thousands of euros.*



3. Methodology

This study sought to explore potential behavioural differences between royalty-receiving and non-receiving municipalities in the province of Potenza.

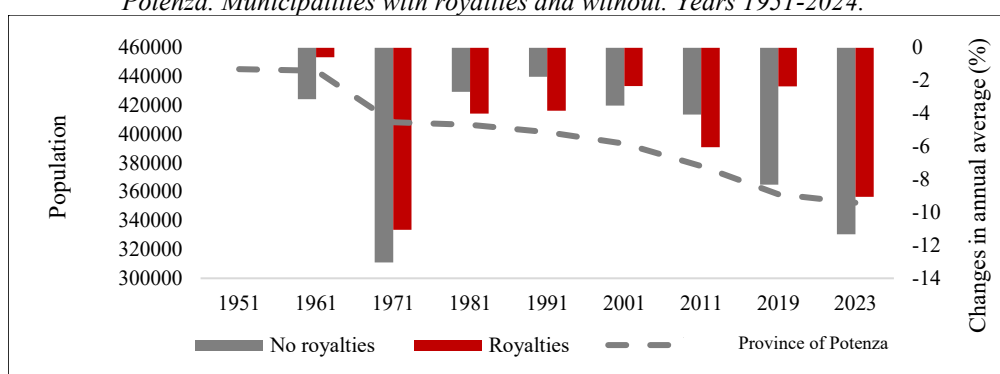
The strong concentration of royalties in a limited number of municipalities (49 at the national level, 12 in Basilicata, and 7 in the province of Potenza alone), the irregular temporal distribution of these resources, and the limited availability of demographic, social, and economic data at the municipal level do not allow for multivariate analyses capable of identifying structured differences between the two groups (royalty beneficiary municipalities vs. non-beneficiary municipalities). Nonetheless, despite being aware of the limitations and acknowledging that the analysis cannot be considered exhaustive, it is still deemed useful to attempt to identify potential demographic and economic differences between the two subpopulations.

Therefore, data on the amount of royalties at the municipal level were cross-referenced with “*A misura di comune*”, a system of municipal indicators developed by Istat and available since 2014. These were supplemented with additional sources of official statistics, such as Demographic Balances, the Population Census (Carucci, 2025; Istat,

2012; Crescenzi, 2020), and open data from the Ministry of Economy and Finance.

Among the various demographic aspects considered, a particularly significant element is the population trend, based on the assumption that municipalities with greater resources to allocate to their residents should experience population growth and improved welfare conditions. Since 1951 Basilicata has experienced a steady and marked decline in its resident population.

Figure 4 - Percentage changes in population and changes in annual average. Province of Potenza. Municipalities with royalties and without. Years 1951-2024.



Source: Authors' elaborations on Istat data.

This phenomenon appears systemic, and the analysed data do not reveal differences attributable to whether a municipality is a beneficiary of royalties or not (Figure 4). The remaining socio-demographic and economic characteristics of the two groups of municipalities (comprising 7 and 92 statistical units, respectively⁵) were examined using non-parametric statistical tests, which are particularly suitable for small sample sizes. Specifically, the Wilcoxon test and the Kruskal-Wallis test are effective tools for comparing two independent groups, especially when the data do not follow a normal distribution or exhibit heterogeneous variances (Siegel, 1957).

These tests are particularly robust (Fay, 2010), as they do not require strict assumptions about the data distribution and are not affected by the presence of outliers. In particular, “indicators derived from official statistical sources do not exhibit data considered to be ‘outliers’; maximum and minimum values are linked to the structure of the indicator and are all considered acceptable”, and they have already undergone processes of compilation, validation, and harmonisation by the producing institutions⁶. Considering also the relatively limited sample size, the risk that potential outliers may significantly influence the results is extremely low. For these reasons, at this exploratory

⁵ The municipality of Potenza was excluded from the analysis due to its socio-economic and demographic characteristics being markedly different from those of the other municipalities in the province.

⁶ <https://www.istat.it/wp-content/uploads/2025/06/Nota-metodologica.pdf>

stage of the study, it is not deemed necessary to implement additional outlier detection analyses, without compromising the methodological soundness of the conclusions.

Therefore, the variables considered, sourced from ISTAT and the Ministry of Finance, can be regarded as robust and methodologically reliable, and as meeting the official statistical data quality criteria set out in the European Statistics Code of Practice⁷: relevance, accuracy, timeliness, punctuality, coherence, and accessibility.

Regarding the two non-parametric tests employed in the analysis, the underlying statistical hypotheses are as follows:

- Null hypothesis (H_0): there are no significant differences between the two groups;
- Alternative hypothesis (H_1): there are significant differences between the two groups.

To determine whether to reject the null hypothesis, the values of the dependent variable are first ranked regardless of group membership. Subsequently, the mean rank for each group is calculated, which serves as the basis for computing the test statistic.

Specifically, the Wilcoxon test compares the mean ranks between the two groups, and two scenarios may arise:

- The mean ranks are similar, providing no evidence of a difference between the groups (leading to acceptance of H_0);
- The mean ranks differ significantly, indicating that one group tends to have higher values than the other (leading to rejection of H_0).

Similarly, the Kruskal-Wallis test assesses differences among multiple groups (typically two or more), also based on ranks, but focuses on medians rather than means. This test is particularly useful when asymmetric distributions or heterogeneous variances are suspected.

4. Results

Based on data availability, a set of socio-economic and structural variables referring to the year 2022 was identified. For each variable, the two non-parametric tests (Wilcoxon and Kruskal-Wallis) were applied to assess the presence of significant differences between the two groups of municipalities (royalty recipients and non-recipients)⁸.

The results reveal statistically significant differences, both in means (Wilcoxon test) and medians (Kruskal-Wallis test), for several key dimensions, notably:

- Labor and enterprises: entrepreneurship rate, employment rate, employee compensation, value added per employee;
- Social expenditure: social spending per capita;
- Demographic mobility: migration rate.

Detailed results are presented in Tables 2 and 3.

⁷ European Statistics Code of Practice — revised edition 2017 - Products Catalogues - Eurostat

⁸ The non-parametric test aims to test the difference in terms of socio-demographic characteristics

Table 2 - Characteristics of Municipalities: Wilcoxon Two-Sample Test. Year 2022.

Variables	Two samples Test of Wilcoxon			Approximation t		Test outcome
	Z	Pr>Z	Pr> Z	Pr > Z	Pr > Z	
Percentage change in population between 2001 and 2022	0.4163	0.3386	0.6772	0.339	0.6781	Non-significant difference
<i>Social services expenditure per inhabitant</i>	<i>2.2319</i>	<i>0.0128</i>	<i>0.0256</i>	<i>0.014</i>	<i>0.0279</i>	<i>Significant difference</i>
Incidence of taxpayers with income less than 10,000 €	0.4982	0.3092	0.6183	0.3097	0.6194	Non-significant difference
Taxable income per taxpayer	1.1125	0.133	0.2659	0.1343	0.2686	Non-significant difference
<i>Entrepreneurship rate</i>	<i>2.7233</i>	<i>0.0032</i>	<i>0.0065</i>	<i>0.0038</i>	<i>0.0077</i>	<i>Significant difference</i>
Density of local units	0.1433	0.443	0.886	0.4432	0.8863	Non-significant difference
<i>Employment rate</i>	<i>2.382</i>	<i>0.0086</i>	<i>0.0172</i>	<i>0.0096</i>	<i>0.0191</i>	<i>Significant difference</i>
Children taken in by social services	1.1711	0.1208	0.2416	0.1222	0.2444	Non-significant difference
Secondary qualification incidence	-0.567	0.2855	0.5711	0.2862	0.5724	Non-significant difference
Tertiary qualification incidence	0.1024	0.4592	0.9185	0.4593	0.9187	Non-significant difference
Old age index	-0.867	0.193	0.386	0.1941	0.3882	Non-significant difference
Birth rate	1.5767	0.0574	0.1149	0.059	0.1181	Non-significant difference
Mortality rate	0.0614	0.4755	0.951	0.4756	0.9511	Non-significant difference
<i>Migration rate</i>	<i>1.9179</i>	<i>0.0276</i>	<i>0.0551</i>	<i>0.029</i>	<i>0.058</i>	<i>Significant difference</i>
<i>Added value per employee</i>	<i>1.903</i>	<i>0.0285</i>	<i>0.057</i>	<i>0.03</i>	<i>0.06</i>	<i>Significant difference</i>
Added value on sales	0.1115	0.4556	0.9112	0.4557	0.9114	Non-significant difference
Purchases on sales	0.8967	0.1849	0.3699	0.1861	0.3721	Non-significant difference
Salary on added value	-0.881	0.1891	0.3783	0.1903	0.3806	Non-significant difference
<i>Wage per employee</i>	<i>1.9011</i>	<i>0.0286</i>	<i>0.0573</i>	<i>0.0302</i>	<i>0.0604</i>	<i>Significant difference</i>

Source: Authors' elaborations on Istat data.

Specifically, the box plots corresponding to the Wilcoxon test scores (Figure 5) provide an effective graphical representation of the differences between the two groups for each variable, visually highlighting the separation between the distributions.

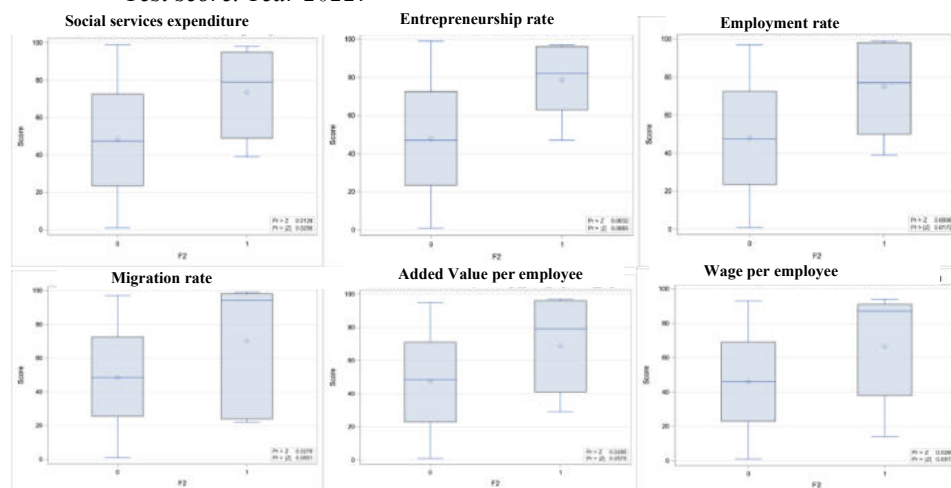
Based on the statistical significance observed for the year 2022, it was appropriate to investigate whether such differences between royalty recipient and non-recipient municipalities were already present in the past, regardless of royalties received, or if an evolution over time occurred that effectively "rewarded" recipient municipalities with relatively better socio-economic performance.

The analysis was repeated considering the average values of municipal rankings, applying the statistical tests once again for a baseline year and an intermediate year, in order to observe any changes in the comparative dynamics between the two groups.

Table 3 - Characteristics of Municipalities: Kruskal - Wallis Test. Year 2022.

Variables	Kruskal-Wallis Test			Test outcome
	X ²	DF	Pr > X ²	
% change in population between 2001 and 2022	0.1791	1	0.6722	Non-significant difference
Social services expenditure per inhabitant	5.0117	1	0.0252	Significant difference
Incidence of taxpayers with income less than 10,000 €	0.2551	1	0.6135	Non-significant difference
Taxable income per taxpayer	1.2529	1	0.2630	Non-significant difference
Entrepreneurship rate	7.4534	1	0.0063	Significant difference
Density of local units	0.0225	1	0.8806	Non-significant difference
Employment rate	5.7065	1	0.0169	Significant difference
Children taken in by social services	1.3928	1	0.2379	Non-significant difference
Secondary qualification incidence	0.3287	1	0.5664	Non-significant difference
Tertiary qualification incidence	0.0119	1	0.9130	Non-significant difference
Old age index	0.7632	1	0.3823	Non-significant difference
Birth rate	2.5075	1	0.1133	Non-significant difference
Mortality rate	0.0047	1	0.9456	Non-significant difference
Migration rate	3.7046	1	0.0543	Significant differences
Added value per employee	3.6480	1	0.0561	Significant difference
Added value on sales	0.0140	1	0.9057	Non-significant difference
Purchases on sales	0.8164	1	0.3662	Non-significant difference
Salary on added value	0.7892	1	0.3744	Non-significant difference
Wage per employee	3.6414	1	0.0564	Significant difference

Source: Authors' elaborations on Istat data.

Figure 5 - Characteristics of Municipalities: Siegel Boxplot of the Wilcoxon Two-Sample Test score. Year 2022.

Source: Authors' elaborations on Istat data.

The baseline year selected was 2001, as it corresponds to the year for which census data at the municipal level are available. The year 2012 was chosen as the intermediate point because, from that period onward, Istat made available a particularly extensive and structured municipal-level information base on enterprises, in addition to data collected during the Population and Housing Census (Table 4).

Table 4 - Characteristics of Municipalities: Wilcoxon Two-Sample Test. Years 2001, 2012 and 2022.

Variables	2001	2012	2022
	Significance		
Percentage change in population between 2022 and 2001	.	.	No
Percentage change in population between 2012 and 2001	.	No	.
Social services expenditure per inhabitant	.	No	Yes
Incidence of taxpayers with income less than 10,000 euros	No	No	No
Taxable income per taxpayer	No	No	No
Entrepreneurship rate ^(b)	.	Yes	Yes
Density of local units ^(b)	.	No	No
Employment rate ^(a)	No	No	Yes
Children taken in by social services	.	No	No
Secondary title incidence ^(a)	No	No	No
Incidence of tertiary qualification ^(a)	No	No	No
Birth rate	No	No	No
Mortality rate	No	No	No
Migration rate	No	No	Yes
Old age index ^(a)	.	No	No
Added value per employee ^(b)	.	Yes	Yes
Added value on sales ^(b)	.	No	No
Purchase on sales ^(b)	.	No	No
Salary on added value ^(b)	.	Yes	No
Salary on employee ^(b)	.	Yes	Yes

Source: Authors' elaborations on Istat data.

(a) For the year 2012, the data are from census sources and therefore relate to the year 2011

(b) For the year 2012, the data are from ASIA - Statistical database of active enterprises and Frame - Statistical database on the economic values of enterprises sources and therefore relate to the year 2014, the first year available

For 2001 the analysis shows no structural differences between the two subpopulations (royalty recipient and non-recipient municipalities) with respect to the variables observed.

It is only from 2012 onwards that initial signs of divergence emerge, limited to business-related variables - such as entrepreneurship rate, value added per employee, compensation on value added, and compensation per employee -with higher average values observed in the recipient municipalities.

5. Conclusion

This study has highlighted a slow and partial improvement in conditions for royalty-recipient municipalities compared to non-recipient ones, at least with reference to the

considered time frame and the socio-economic variables observable at the municipal level.

This improvement is mainly shown in terms of: migration rate; per capita social expenditure by municipalities; employment rate and local economic structure, with reference to business-related variables.

However, most of the analysed variables do not show significant changes, indicating a substantial underlying stability between the two groups with respect to other socio-economic aspects.

It is important to highlight that the differences observed since 2012 might be, at least in part, attributable to the expansion of the available data set: from that year onward, ISTAT made accessible a range of municipal-level data previously unavailable, enabling a more detailed and comprehensive analysis.

The findings also provide valuable insights for further investigation. In particular, the issue of higher social service expenditure in recipient municipalities and the ways in which royalty-derived resources are effectively utilized to address the population's needs merit special attention.

Moreover, the analysis highlighted how the lack of clear regulations regarding the use of royalties by municipalities—combined with the absence of specific monitoring mechanisms—can represent a critical issue.

This situation opens the possibility that resources may not always be allocated towards strategic long-term investments, risking their diversion to current expenditures with limited productivity, thereby generating inefficiencies.

This situation raises the possibility that resources may not always be allocated to long-term strategic investments, with the risk of being diverted toward low-productivity current expenditures, thereby generating inefficiencies.

In the worst-case scenario, this ambiguity could contribute to the emergence of the so-called “resource curse”; however, socio-economic problems predate the oil boom, making any causal claims difficult at this stage.

Finally, the lack of a consolidated literature on the impact of royalties at the municipal level, in contrast to the more widespread analyses at the regional level, calls for further research.

Extending the temporal scope of the analysis, supported by municipal indicators estimable through proxy variables, could enable the adoption of factual/counterfactual approaches aimed at investigating more robustly and systematically the actual influence of royalty revenues on the quality of life and socio-economic development of the local populations involved, also overcoming the limitations associated with non-parametric studies.

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SOCIOECONOMIC POLARISATION AND GREEN VOTE: EVIDENCE FROM ESS

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Abstract. This paper analyses the impact of income inequality on European citizens' attitudes towards the green transition, using data from Round 11 (2023) of the European Social Survey (ESS). Although there is extensive literature on the relationship between inequality and populist political attitudes, the same cannot be said when looking at the “green” orientation of the population. In particular, similar to the Kuznets curve, the relationship studied may take a non-linear form: in a non-polarised context, greater inequality should lead to a strengthening of environmentalist attitudes, while in a polarised context the sign of the relationship should be reversed. From a methodological point of view, the Gini index is calculated to measure inequality, while a binary logistic regression model is estimated to understand the probability of voting for green parties, considering not only polarisation but also individual socio-economic control variables. In addition, a Multilevel Linear Probability Model was used, which also allows for the impact of aggregate factors such as gross domestic product, population density and perceptions of environmental quality to be taken into account. The results show that higher levels of inequality are associated with a lower propensity to vote green. The study contributes to the literature by highlighting how socio-economic polarisation can influence environmental attitudes and support for ecological transition in Europe.

1. Introduction

Environmental degradation undoubtedly represents the most pressing challenge of the 21st century, requiring politicians and society to embark on a path of ecological transition. At the European level, the adoption of the Green Deal marks a fundamental shift towards a sustainable development model, while green parties are now an established presence in the political systems of most Western democracies (O'Neill, 2019; Marquardt, 2024). Their growth is fuelled by increased interest and support for environmental issues (Debus and Tosun, 2021). In particular, environmentalist attitudes reflect a personal commitment to preserving the environment, which can be encompassed in the realm of cooperative behaviours benefiting the collective good (Reese, 2016).

However, citizens also increasingly perceive that they are part of a context marked by strong economic and social inequalities (Qadri *et al.*, 2025). This imbalance can generate disillusionment, leading to support for populist parties (Stoetzer *et al.*, 2023),

on the one hand, and coupling with a decline of social capital (Putnam, 2000), i.e. one of the most common proxies of cooperative behaviour. The scientific literature has extensively studied the relationship between economic inequality and political orientations, showing how contexts characterised by strong social polarisation can fuel distrust of institutions (Lipps and Schraff, 2021) and strengthen support for populist parties (Ivanov, 2023). At the same time, little research has been done on the effect of inequality on environmental attitudes, particularly in terms of the propensity to vote green. Studies offer conflicting evidence. Older studies emphasise that wealthier voters are not necessarily more “green”, as they may not be willing to pay more for better environmental quality through taxes (McAusland, 2003). On the other hand, Huo *et al.*, (2025), highlight how income inequality can inhibit citizens' environmental attitudes by impeding individuals from identifying with their nation. In the authors' view citizens' discontent about the government's inability to guarantee widespread well-being for citizens can lead to a lack of trust in the effectiveness of green policies and therefore to a decreased support for green parties. A possible extension comes from the analogy with the Kuznets environmental curve (EKC), which identifies a non-linear relationship between economic development and environmental quality (Dinda, 2004). Applying this logic to green attitudes, it is plausible to assume that their relationship with inequality follows a similar pattern: in less polarised contexts, moderate levels of inequality can stimulate trust in the system and strengthen willingness to support ecological transition; in highly polarised contexts, however, inequality itself generates mistrust and resentment, weakening support for green policies. In light of these considerations, this study aims to contribute to the literature by analysing the role of economic inequality in the green orientations of European citizens. In particular, three research questions are addressed:

1. To what extent does this inequality affect citizens' propensity to support green parties, controlling for various socio-economic variables?
2. Is the relationship between inequality and green voting linear or does it follow a non-linear pattern, similar to an inverted U-curve?

According to the reviewed literature, we expect inequality to negatively affect green parties' preferences (Hypothesis 1), and we hypothesise that this relationship takes the form of an inverted U-curve, likewise the so-called Environmental Kuznets Curve (Hypothesis 2). The article is organised as follows: in Section 2, we present the dataset and descriptive statistics; in Section 3, we present the methodology; in Section 4, we describe the results obtained from the model estimates; finally, in Section 5, we discuss the results and present our conclusions.

2. Data

This study uses data from Round 11 of the European Social Survey (2023) to investigate inequality in income perceptions and green attitudes of European citizens

in the post-pandemic context. The ESS is a cross-national survey promoted to ensure high standards in the production of reliable and comparable data across countries (Pollak and Grand, 2016). Previous studies have highlighted the importance of ESS questionnaires for analysing attitudes related to the environment (Vaznonis *et al.*, 2024). The dataset includes 31,551 respondents from the 18 EU member countries included in the survey, with a higher percentage of Italians (9%), followed by Greeks (8.7%), Germans (7.6%) and Austrians (7.4%). Concerning political affiliation, respondents identified themselves mostly as centre (46%), followed by centre right (16.4%) and centre left (14.8%). High civic participation is indicated by the fact that 74.4% voted in the last elections. In addition, 24.7% state that they feel fairly close to the political party, while a small group 0.7% do not feel represented. The perception of income emerges as a significant variable: most of the respondents (46%) indicate that they live comfortably and only a small percentage state that they face serious economic difficulties (3.7%). More than half of the sample (63.3%) has a permanent contract, compared to 4.4% who have no employment contract. The analysis was further enriched by adding additional variables, such as educational level, age and outlook on the causes of climate change.

A large proportion of respondents have between 9 and 12 years of education (35.1), followed by a significant proportion of those between 13 and 16 years (32.5%) and a segment with more than 17 years of education (20.2%). A small proportion have a very low education (3.2%). The age range of the sample is wide, with the population tending to be older than 65 (27%). Furthermore, in order to capture the structural and socio-economic conditions of the countries, the ESS microdata were supplemented with additional variables, this time of an aggregate nature from Eurostat, all referring to the year 2023 and relating to the countries included in the analysis. In particular, the following were taken into account: GDP per capita, population density and environmental quality.

3. Methodology

In line with the objective of this study, we examine income inequality among the EU countries included in the data sample. Since the 1980s, Isaac (1982) states that “Economists have lamented the lack of a satisfactory theory of income distribution”, emphasising the need to measure inequality. The theory of income inequality, in fact, developed as a result of the need to make comparisons between or within individual countries and to fill various gaps in our understanding of income distribution. A fundamental contribution was made by the Italian statistician and polymath Carlo Gini through the development of an index measuring how much income distribution differs from perfect equality (Park and Kim, 2021).

Table 1 - Survey socio-demographic characteristics (n and %).

Country	n	%	Gender	n	%
Austria	2354	7,4	Male	14706	46,3
Belgium	1594	5	Female	17077	53,7
Cyprus	685	2,2	Income	n	%
Germany	2420	7,6	Living comfortably on present income	10644	33,5
Spain	1844	5,8	Coping on present income	14614	46
Finland	1563	4,9	Difficult on present income	4991	15,7
France	1771	5,6	Very difficult on present income	1181	3,7
Greece	2757	8,7	Has child	n	%
Hungary	2118	6,7	Yes	11118	35
Ireland	2017	6,3	No	10518	33,1
Italy	2865	9	Employment contract	n	%
Lithuania	1365	4,3	Unlimited	20116	63,3
Netherlands	1695	5,3	Limited	3152	9,9
Poland	1442	4,5	No contract	1385	4,4
Portugal	1373	4,3	Occupation	n	%
Sweden	1230	3,9	Managers	97	0,3
Slovenia	1248	3,9	Professionals	2078	6,5
Slovakia	1442	4,5	Technicians and associate professionals	5652	17,8
Political orientation	n	%	Clerical support workers	3933	12,4
Left	1741	5,5	Service and sales workers	2513	7,9
Centre Left	4697	14,8	Skilled agricultural, forestry and fishery workers	5211	16,4
Centre	14622	46	Craft and related trades workers	875	2,8
Centre Right	5202	16,4	Plant and machine operators and assemblers	3124	9,8
Right	1777	5,6	Elementary occupations	1935	6,1
Party identification	n	%	Armed forces occupations	2678	8,4
Very close	1848	5,8	Age	n	%
Quite close	7866	24,7	under 25	2972	9,5
Not close	2275	7,2	25-35	4262	13,3
Not at all close	227	0,7	36-45	4759	14,9
Born	n	%	46-55	5351	16,9
Born in country	28965	91,1	56-65	5736	17,9
Foreign Born	2799	8,8	over 65	8512	27

Table 1(cont.) - Survey socio-demographic characteristics (n and %).

EU Remain	n	%	Years of education	n	%
Remain member of the European Union	24842	78,2	0-5	998	3,2
Leave the European Union	3484	11	06-08	2506	7,8
			09-12	11157	35,1
			13-16	10237	32,5
			over 17	6412	20,2

Source: own elaboration.

The Gini index is, therefore, a widely used measure of inequality in economics, and its value ranges from 0 to 1, denoting perfect equality and perfect inequality respectively. Its statistical form is given by the following equation:

$$G = \frac{\sum_{i=1}^n \sum_{j=1}^n |x_i - x_j|}{2n^2\mu}$$

In this survey, the Gini index was not calculated on actual income, but rather on the personal assessment of household income provided by ESS respondents. Specifically, we considered the variable *hincfel* (“Feeling about household's income”), which measures the level of satisfaction or economic hardship perceived by participants. The Gini coefficient obtained reflects the effect of inequality experienced by citizens in each country.

The analysis continues with the estimation of a binary logistic regression model, one of the methods commonly used in various research fields. The application of the model makes it possible to answer the next research question, namely to understand how different socio-economic variables, including the inequality calculated above, may influence citizens' propensity to vote for green parties during the last elections. The dependent variable is dichotomous, i.e. it can take value 0 or 1, depending on whether the condition is met or not. In our case, it takes on value 1 when the respondent states that he or she votes for a green party, and value 0 otherwise. The binary logistic regression model is part of the family of generalised linear models (GLM) (Roni and Djajadikerta, 2021). Its main distinguishing feature is the type of dependent variable, which is categorical and has two modes (Harris, 2021). The statistical form of the model is given by the following equation:

$$P(y) = \frac{1}{1 + e^{-(\beta_0 + \beta_1 x_1 + \beta_2 x_2)}}$$

where $P(y)$ represents the probability of belonging to a certain category of the dependent variable, β are the coefficients of the independent variables (or predictors)

and x represents the independent variables. The logistic function ensures that the probability estimate is within the range $[0, 1]$. According to Aliyu *et al.*, (2021), it is possible to rewrite the model in logit form, as shown in the following equation:

$$\text{Logit}(P_i) = \text{Log}\left(\frac{P_i}{1 - P_i}\right) = \beta_0 + \beta_1 X_{1i} + \dots + \beta_k X_{ki}$$

The independent variables include individual factors (gender, age, native/migrant status, contract and sector of employment, years of education, political orientation, party identification and attitude towards the EU) and aggregate factors (Gini index, GDP per capita, population density, environmental quality).

The selection of independent variables takes into account the main demographic, socio-economic and political-value factors that may impact green voting. Native or migrant status allows us to identify potential differences associated with experiences of social integration and perceptions of economic inequality. Employment status, which includes the type of contract and sector of work, is equally relevant as it reflects different degrees of economic stability and material interests that may influence behaviour towards environmental policies. Political position and party affiliation are assessed to consider the importance of ideological preferences and long-term affiliations, which frequently influence electoral decisions. Age structure and educational attainment are also included given the role of these features in shaping political preferences. Attitudes towards the European Union are also considered, as they can be a sign of global openness and trust in supranational institutions, aspects that are usually linked to greater support for environmental policies. Finally, at country level we control for the GDP per capita and the population density.

Reference categories were defined for the dummy variables (female gender, migrants, conservative orientation), while the “occupation” variable was kept unchanged due to its hierarchical nature.

To disentangle the country effect, we then replicate the estimates using a Linear Probability Multilevel Model, which is appropriate for the hierarchical structure of the data, with individuals (level 1) nested within countries (level 2). The associated equation takes the following form:

$$P_{ic} = \beta_1 X_{ic} + \beta_2 Z_c + \mu_c + \epsilon_{ic}$$

where X_{ic} are the individual-level characteristics Z_c are the country-level features, μ_c is the unobserved country effect and ϵ_{ic} is the error term.

4. Results

Table 2 shows the Gini index, which measures the degree of perceived income inequality in most EU countries. There is some heterogeneity in the results obtained,

but overall it is possible to divide them into three categories according to perceived inequality. Ireland, Belgium and Spain record higher levels of economic inequality, which may indicate economic and social polarisation. In contrast, Finland, Lithuania, Slovakia, Greece, Hungary and Poland show a more equal perception of income. In an intermediate position of inequality are most countries.

Table 2 - Gini Index.

Country	Gini Index	Country	Gini Index
Ireland	0.243404	Sweden	0.19937
Belgium	0.241324	Austria	0.1977
Spain	0.233785	Portugal	0.19547
Cyprus	0.228145	Finland	0.18828
Slovenia	0.225852	Lithuania	0.18544
France	0.217502	Slovakia	0.18234
Netherlands	0.210887	Greece	0.16477
Germany	0.210579	Hungary	0.15427
Italy	0.209509	Poland	0.13215

Source: own elaboration.

The estimation of a binary logistic regression model allows us to understand how certain socio-economic factors influence the probability of voting for green parties. The variables were standardised to facilitate comparison of the impact of the different independent variables by placing them on the same scale. Table 3 shows the most relevant results, illustrating only the coefficients of statistically significant variables. The previously calculated Gini index plays a particularly important role, showing an inverse relationship with green voting, suggesting that in contexts characterised by greater inequality, people tend to be less inclined to support green parties (H1 confirmed). Another significant factor is political affiliation: the probability of voting for the Greens is consistent with a progressive orientation, while it is reduced among those who identify with a conservative ideology typical of the right. Education also has a significant influence: as the level of education increases, so does the propensity to vote for green parties. Employment status has a negative and statistically significant effect: individuals employed in less skilled occupations are less likely to vote for green parties. Native-born individuals, on the other hand, show a significantly greater propensity to support green parties than migrants. Finally, a favourable attitude towards remaining in the European Union is positively and significantly associated with voting green, suggesting a consistency between Europeanism and the political agenda of green parties.

Table 3 - Binary Logistic Regression with Standardized Variables.

Variable	Estimate	Std. Error	z	p-value	
(Intercept)	-5.33705	0.216595	-24.6406	0.001	***
Left	2.098513	0.163467	12.83756	0.001	***
Centre left	1.891525	0.156274	12.10392	0.001	***
Centre	1.083785	0.155028	6.990894	0.001	***
Centre right	0.351784	0.167161	2.104465	0.04	*
Born in country	0.530083	0.116026	4.568665	0.001	***
Eu remain	1.257257	0.121027	10.38822	0.001	***
Years of education	0.217961	0.02646	8.237419	0.001	***
Occupation_z	-0.18605	0.029167	-6.37899	0.001	***
Party identification	-0.26882	0.024579	-10.9373	0.001	***
Gini z	-0.35437	0.024412	-14.5159	0.001	***

Source: own elaboration.

Table 4 - Linear Probability Multilevel Model.

Variable	Estimate	Std. Error	z	p-value
Left	.2104562	.0136699	15.40	0.000
Centre right	.0442329	.0117396	3.77	0.000
Centre left	.1753973	.0118988	14.74	0.000
Centre	.0804677	.0109856	7.32	0.000
Male	-.001396	.0050371	-0.28	0.782
Age	-.0002511	.0001745	-1.44	0.150
Has child	.0038872	.0064963	0.60	0.550
Eu remain	.0619436	.0077011	8.04	0.000
Years of education	.0046889	.0007518	6.24	0.000
Occupation	-.0063975	.0011788	-5.43	0.000
Employment contract	.0029312	.004786	0.61	0.540
Party identification	-.010095	.0013113	-7.70	0.000
Gdp_pc_2023	.0002558	.000745	0.34	0.731
Pop_density_2023	.0000721	.0001779	0.41	0.685
Env_problems_2023	.0004096	.004869	0.08	0.933
Gini	-1.685.735	.801532	-2.10	0.035
cntrynum: Identity				
var(_cons)	.0055569	.0019428	.0028005	.0110263
var(Residual)	.0758678	.0009652	.0739995	.0777834

Source: own elaboration.

Table 4 presents the results of the multilevel Linear Probability Model (LPM), with a random intercept at country level, which allows the effect of individual characteristics to be isolated from systematic differences between national contexts. The results confirm that a pro-European orientation and a higher level of education are associated with a greater likelihood of voting for green parties.

Conversely, both employment status, with a lower probability of support for the Greens among those in less skilled jobs, and strong identification with traditional parties show a significant negative effect. At the contextual level, the Gini index confirms that in countries with greater economic inequality, support for green parties tends to be lower. Other factors, such as age, gender, presence of children and aggregate variables (pro capita GDP, population density and perception of environmental problems), do not show statistically significant associations. Furthermore, multilevel analysis shows that a significant variation in support for green parties is due to differences between countries. In particular, approximately 7% is attributable to the national context, while the remainder derives from individual differences within states. LR test $\chi^2(1) = 818.26$; $p < 0.001$ confirms that the inclusion of the “Countries” level significantly improves the explanatory power of the model, despite individual differences being predominant.

Finally, a new binary logistic regression model was estimated that includes the quadratic term of the Gini index. As shown in Table 5, this estimation affected the configuration and interpretation of the model by altering the results obtained in the previous model. In particular, the addition of $Gini^2$ indicates that there is a non-linear connection between the two factors. For low levels of inequality, the support for ecological parties falls, whereas such support rises again above a certain threshold (H2 confirmed).

Table 5 - Binary Logistic Regression with Standardized Variables and $Gini^2$.

Variable	Estimate	Std Error	z	p value
(Intercept)	-4.108	0.231	-17.76	0.000
Left	2.073	0.163	12.7	0.000
Centre left	1.855	0.156	11.9	0.000
Centre	1.05	0.155	6.79	0.000
Centre right	0.324	0.167	1.94	0.052
Born in country	0.546	0.116	4.71	0.000
EU remain	1.261	0.121	10.42	0.000
Years of education_z	0.217	0.026	8.21	0.000
Occupation_z	-0.183	0.029	-6.3	0.000
Party identification z	-0.263	0.025	-10.75	0.000
$Gini^2$	-29.6	2.273	-13.02	0.000

Source: own elaboration.

5. Discussions and conclusion

This study highlights the inverse relationship between perceived income inequality, as measured by the Gini index, and voting for green parties. This suggests that inequality could be a source of discontent that favours populist parties and causes

people to turn away from green parties. However, for a very high level of inequality, this relationship may reverse due to lower voter turnout among low-income citizens, combined with wealthier individuals' greater tolerance of high levels of inequality and their continued participation in elections.

Our results also highlight the influence of other socio-economic factors on the tendency to vote green, which can be understood by analysing the underlying dynamics. The emergence of these new parties is fuelled by a conflict concerning cultural modernisation and globalisation, which reflects the social fractures rooted in today's society, such as those related to economic status or education. Since the 1970s, Kramer (1971) states that economic conditions have always had an impact on the outcome of elections. Specifically, in times of economic growth, green parties tend to achieve more favourable results. This can be explained by the fact that sensitivity to environmental issues increases when people are not beset by urgent material needs (Panarello, 2021). Consequently, as income inequality increases, support for green parties decreases: the focus becomes more on redistributive issues and environmental priorities become less important, perceived as the prerogative of cultural and economic elites (Cassin *et al.*, 2021). Green parties thus behave like what in economics is called the “normal good”: their support grows in contexts where average wealth is higher, on the other hand environmental protection becomes relevant after basic economic needs have been met (Gourley and Khamis, 2023).

However, among the strongest predictors of the green vote is education. Those with a higher level of education are more likely to translate their environmental concerns into consistent political behaviour, such as voting for parties with environmentalist agendas (Papp, 2022). Education is, often, correlated with a higher level of open-mindedness and provides those cognitive and informational tools to assess the importance of the topic (Bleidorn *et al.*, 2025). Infact, Kosse and Piketty (2021) reveal that educated elites tend to vote for left-wing parties (including the Greens), while economic elites move, in some cases, to the right: a sign of misalignment between cultural and economic capital that fuels the polarisation between cosmopolitanism and populism.

Furthermore, our study highlights that those who vote for green parties are generally more favourable towards European integration. Whitley *et al.*, (2023) emphasise that green voters perceive environmental issues as transnational challenges and, for this reason, believe that their country should remain within the EU and collaborate with supranational institutions capable of coordinating and promoting climate policies.

As in any research, the present study has some limitations. Firstly, it is based on cross-sectional data from 2023, which limits the possibility of the evolution of the phenomenon over time or comparisons between different election cycles. It should also be noted that the Gini index is calculated based on subjective perceptions of

household income rather than objective income data. This can lead to perceptual biases or cultural differences in the assessment of personal economic conditions.

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BEYOND HOUSEHOLD INCOME: SOCIAL DETERMINANTS OF CHILD FOOD INSECURITY IN ITALY

Livia Celardo

Abstract. Food insecurity is the inability to acquire or consume adequate or sufficient food, in socially acceptable ways. So, people are food insecure when they lack regular access to enough safe and nutritious food for normal growth and development, and an active and healthy life. Household food security in high-income countries has received increasing attention from policymakers and researchers over the past decades. An emerging body of literature has linked food insecurity to a variety of negative outcomes, particularly for children, confirming the importance of food security as an indicator of well-being and a legitimate target of public concern. In particular, children in food-insecure households may be at risk of poor health, developmental or behavioural problems. Understanding the determinants of food insecurity is crucial for developing child-specific effective national and local policies. While household income level is definitely linked to food insecurity, recent studies have also shown that socio-demographic factors – such as, education level – play a significant role. This study aims to identify, beyond the income-related measures, the social factors that impact on child food insecurity in the Italian context, using data from the European Union Statistics on Income and Living Conditions (EU-SILC, hereafter) national survey. Households with minors have been targeted from the dataset for this study. Through multivariate statistical analysis, the principal social determinants of child food insecurity have been investigated.

1. Introduction

Food security exists when all people, at all times, have physical and economic access to sufficient, safe and nutritious food, that meets their dietary needs and food preferences for an active and healthy life (FAO, 1996). Food security is a broad concept; it includes not only the quality and quantity of food availability, but also physical, social and economic access to food, as well as food preferences.

Food security is a key priority in the international agenda and it is strictly related to the 2030 Agenda for Sustainable Development (Szydło, 2023). SDG 2 aims to end hunger, achieve food security and improved nutrition, and promote sustainable

agriculture. In particular, target 2.1 addresses the universal access by all people, in particular those in vulnerable situations, to safe, sufficient and nutritious food¹.

Monitoring food security requires systematic measurement, which is essential for accurately assessing its current state, identifying vulnerable populations, tracking changes over time, and informing effective policy and intervention strategies (Jones *et al.*, 2013). Over the past half-century, academic and political debates on the definition and measurement of food security have led to the proposal of hundreds of indicators. These range from quantifying food supplies to detailed assessments of food consumption, and include measures of nutritional outcomes, such as growth patterns and nutrient deficiencies (Cafiero *et al.*, 2014). At the global level, the most widely used indicators of food insecurity fall into two main categories: those based on the adequacy of food consumption, and those that define food insecurity through shared behavioral and experiential responses observed across cultures.

Though commonly associated with low-income contexts, food insecurity also affects large portions of the population in wealthy countries (Pollard and Booth, 2019). In Europe, in 2024, 6.8% of the total population have experienced moderate or severe food insecurity² (FAO, 2025), meaning they had not regular access to adequate food. The prevalence reached 10.7% in Northern America.

Recent data show that food insecurity is growing in wealthy nations, as well as in low-income countries (Zaçe *et al.*, 2020). According to Food and Agriculture Organization (FAO), global food insecurity is on the rise starting from mid-2014, with nearly 1 out of 3 people in the world living in this condition (28% in 2024, compared to 21.5% of 2015). In high-income countries, food insecurity has started increasing after COVID-19 pandemic. In Europe, food insecurity has increased of 0.4 percentage points from 2019 to 2024, around 3 p.p. in Northern America. Not only regular access to adequate food has decreased, but also the share of people who can afford a healthy diet. Food prices rose throughout 2022, pushing up the average cost of a healthy diet globally. COVID-19 pandemic and the war in Ukraine contributed to significant increases in international food and energy prices, exacerbating inflationary pressures. At the global level, from 2019 to 2024, the

¹ Nevertheless, food security implicitly affects several SDGs: hunger is an effect of monetary poverty (Goal 1); malnutrition is closely linked to physical and mental health problems (Goal 3); food insecurity affects child educational outcomes (SDG 4); marginalized and vulnerable people are more exposed to food insecurity (Goal 10); climate change worsens food insecurity, especially in vulnerable regions (Goal 13).

² The prevalence of moderate or severe food insecurity (SDG Indicator 2.1.2) measures the percentage of individuals in a population who have experienced difficulties in accessing adequate food during a specified reference period. It is based on the Food Insecurity Experience Scale (FIES), a globally validated, experience-based metric that captures the severity of food insecurity at the individual or household level, through a standardized set of questions addressing food-related behaviours and experiences (Cafiero *et al.*, 2018).

average cost of a healthy diet increased of around 35%, nearly 36% in Europe (FAO, 2025).

Despite international commitments to the right to food³, social policies in wealthy nations often fall short of effectively preventing or alleviating food insecurity. The increasing dependence on food banks and charitable organizations suggests that responsibility is frequently shifted to the third sector, while the root causes remain unaddressed (Spring *et al.*, 2022). One of the main challenges in preventing and addressing food insecurity globally is the persistent lack of reliable data. Many high-income countries – particularly in Europe – do not regularly collect comparable data on food insecurity, making it difficult to design and implement effective and timely policies (Carrillo-Álvarez *et al.*, 2021).

As widely reported in the literature, food insecurity in high-income countries is often associated with economic inequality, poverty, and unemployment. Low-income families, unemployed individuals, and those in precarious employment are particularly at risk (Gundersen and Ziliak, 2015). Income is a fundamental determinant of food insecurity; however, there is not a one-to-one correspondence between income poverty and food insecurity: not all individuals living in poverty are food insecure, and not all food-insecure individuals live in poverty (Rose, 1999). This divergence highlights the limitations of income-based poverty measures in accurately identifying food-insecure households, as research has shown that other socio-demographic factors also play a significant role. In fact, the likelihood of experiencing food insecurity is higher also among households with children, single-parent households, individuals without a university degree and younger adults. Other contributing factors may include disability and household composition (Eicher-Miller *et al.*, 2023). Previous studies have identified a range of socio-economic and demographic factors associated with food insecurity across various countries. However, most of this research has focused on developing countries, where the prevalence of food insecurity tends to be higher. In high-income contexts, seminal studies have been conducted in the United States since the early 1990s (for an extensive review, see Gundersen and Ziliak, 2018).

The emerging interest in food insecurity determinants lie in the fact that food insecurity is closely linked to physical and mental health problems, such as malnutrition, obesity, diabetes and mental health disorders. This applies especially when referring to children (for an extensive review, see Gallegos *et al.*, 2021). Children in food-insecure families are more likely to exhibit physical symptoms

³ The right to food is a universal human right that guarantees every person regular, permanent, and unrestricted access to sufficient, safe, and nutritious food necessary to live in dignity and free from hunger, food insecurity, and malnutrition. This right is enshrined in Article 11 of the International Covenant on Economic, Social and Cultural Rights (ICESCR), which is legally binding on over 170 countries (Mechlem, 2004).

(such as headaches), consume more unhealthy foods, and face a higher risk of overweight and obesity (Zaçe *et al.*, 2020). Investigating food insecurity during childhood is then essential, as it affects not only children's immediate well-being, but also their long-term health, educational achievement, and social integration (Magaña-Lemus *et al.*, 2016).

Building on these introductory considerations, the objective of this study is to identify the socio-demographic determinants of child food insecurity in Italy, going beyond income-based measures. Given that children's access to food is largely determined by the household they live in, the analysis is conducted at the family level, considering all Italian households with at least one minor.

The classification of food-secure household is achieved through the use of eleven questions related to access to food from the 2024 EU-SILC survey, and a nationally representative dataset containing detailed household-level information. Several social dimensions were considered in the analysis (in addition to income- and employment-related measures): educational attainment, nationality, household structure and composition, health-related limitations and informal social support networks. In past research, social support has already been linked to individual access to food, showing that social support – whether emotional or material – can buffer the negative effects of food insecurity, while loneliness and social isolation consistently increase the risk of being food insecure (Burris *et al.*, 2021). However, these studies have mainly focused on adults and the elderly, while the role of social support networks in reducing child food insecurity has not been examined in depth.

To the best of the author's knowledge, the study fills a gap in the literature, as previous research has not analyzed social determinants of child food insecurity at the national level in Italy.

2. Data and methodology

In Italy, relevant food insecurity indicators are collected through the annual EU-SILC survey by the Italian Institute of Statistics (ISTAT). EU-SILC survey is the main source for comparative statistics on income distribution and social inclusion in the European Union. It is a multi-purpose survey, which focuses on income components, at household and individual level, and social exclusion. Particular attention is paid to material and social deprivation, providing information on housing conditions, labour, education and health.

The questionnaire is composed of three parts, which are in turn divided into sections dedicated to specific aspects: the general form, the household questionnaire, and the individual questionnaire. Questions related to household access to food are included in two sections of the household questionnaire: *economic conditions* and

eating habits. The section on economic conditions includes three questions related to access to food⁴. The section on eating habits includes eight questions from FAO Food Insecurity Experience Scale (FIES) module, allowing for the calculation of the SDG indicator (2.1.2) on the prevalence of moderate or severe food insecurity. The FIES module, developed by FAO, consists of 8 yes-or-no questions⁵ designed to capture household access to adequate food over the previous 12 months. The questions are progressively more severe in terms of food insecurity experiences. Following Greece, Italy is the second country in the EU adopting the FIES module into the national statistical system.

In this paper data from the 2024 EU-SILC survey have been used. The dataset includes a sample of more than 30,000 households, providing detailed socio-economic and demographic information. The total sample is statistically representative of the resident population in Italy. In order to investigate child-specific food insecurity, only households with at least one child aged less than 18 have been selected, obtaining a final dataset of 5,413 families.

A Multiple Correspondence Analysis (MCA – Greenacre and Blasius, 2006) has been implemented on targeted variables to detect and represent underlying structures in the dataset. The MCA eigenvalues have been revaluated according to Benzècri method⁶ (Benzècri, 1979). FactoMineR R package was employed for the analysis (Husson *et al.*, 2015).

Twelve active variables have been identified for the analysis (Table 1). As outcome dimension, an index of food insecurity has been constructed, considering eleven questions in EU-SILC survey related to access to food at household level⁷.

⁴ (1) Inability to afford a meal with meat, chicken, fish or vegetarian equivalent every second day; (2) Inability to afford sufficient food to meet household needs; (3) To rely on support from individuals who have donated essential supplies (including food).

⁵ (1) Was there a time when you were worried you would not have enough food to eat? (2) Was there a time when you were unable to eat healthy and nutritious food? (3) Was there a time when you ate only a few kinds of foods? (4) Was there a time when you had to skip a meal? (5) Was there a time when you ate less than you thought you should? (6) Was there a time when your household ran out of food? (7) Was there a time when you were hungry but did not eat? (8) Was there a time when you went without eating for a whole day?

⁶ MCA processes data by transforming each categorical variable into multiple binary columns. This encoding approach introduces artificial dimensions, since a single categorical variable is represented by several columns. As a result, the total inertia of the solution space becomes artificially inflated, which in turn leads to a significant underestimation of the proportion of inertia explained by the first dimension. In fact, it can be demonstrated that any factor with an eigenvalue less than or equal to 1 divided by the number of active variables included in the analysis (K) merely reflects these artificially induced dimensions. The most used correction formula is the one proposed by Benzècri (1979), which excludes those eigenvalues smaller than $1/K$.

⁷ The questions selected are: the three household-related questions on access to food (see note no. 4) and the eight household-related questions of the FIES module (see note no. 5).

The index consists of four levels of food insecurity severity, obtained from the sum of the answers from the original questions (1 was assigned to each answer when there is limited access to food and 0 when there is access to food)⁸.

Table 1 – Active variables selected for MCA.

Variable name	Definition and variable levels []
Food insecurity	Household access to food. [<i>Food security, Mild food insecurity, Moderate food insecurity, Severe food insecurity</i>]
At risk of poverty	Households with a net equivalent income below the 60% of the median of the individual distribution of net equivalent income. In 2024, the poverty threshold is equal to 12.363 euros per year for a household of one adult member. [<i>Yes/No</i>]
Low work intensity	Households where the adults worked a working time equal or less than 20% of their total combined work-time potential during the previous year. [<i>Yes/No</i>]
Income quintiles	Households have been sorted by equivalised income (from the bottom to the top), dividing them in five groups of equal size (quintiles). The first quintile contains the 20% of individuals with the lowest income. [<i>First to Fifth</i>]
Making ends meet	Subjective non-monetary indicator of enforced inability for the household to make ends meet. [<i>With difficulty, With some difficulty, Fairly easily, Easily</i>]
Education attainment	Maximum education level completed by household members. [<i>Up to secondary education, Tertiary education</i>]
Nationality	Nationality of household members. [<i>All-Italian, Mixed, All-foreign</i>]
Reference person age	Age of the person interviewed, who provides information about the household's income and living conditions. [<i>18-34, 35-49, 50-64, 65+</i>]
Limitations	Presence of household members who have limitations in activities people usually do because of health problems (by any on-going physical or mental health problem, illness or disability) for at least the past six months. [<i>Major limitation, Minor limitation, No limitation</i>]
Family type	Household composition. [<i>Couples with children, Single parent with children</i>]
Number of children	Number of children aged less than 18. [<i>One child, Two children, Three or more children</i>]
Social support network	Presence of unpaid persons (e.g., grandparents, relatives, friends, neighbours) who take care of the child/children when not at school or with parent(s). [<i>Yes/No</i>]

As explanatory variables, eleven economic and socio-demographic variables have been selected. In order to control the sampling design effect on the final model, also three sampling design variables have been considered as supplementary

⁸ The four levels have been constructed as follow: [0] The family is food secure; [1] Mild food insecurity; [2 to 4] Moderate food insecurity; [5 to 11] Severe food insecurity. The four level classification of the index is based on both expert judgment and data-driven cut-offs.

variables: sampling strata, municipality and auto-representative municipality (AR)⁹. Sampling weights have also been included in the model, to assign to each household the right significance.

3. Results

In 2024, more than 22% of households residing in Italy has at least one child under the age of 18. Among these families, about 56% has only one child, while nearly 8% has three or more children. More than 81% of households with children is composed entirely of Italian nationals, compared to approximately 11% in which all members are non-nationals. Nearly 60% of households with children has a reference person aged between 35 and 49, while young families (with a reference person under the age of 34) account for almost 11%. More than 23% of households with children reports tertiary education as the highest level attained by family members. More than 5% of household with children has at least one member with a health-related limitation. Around 71% of household with children cannot rely on informal social support network, to take care of the child/children when not at school or with parents/caregivers. Around 60% of households with children reports difficulty or some difficulty making ends meet, while about 7% reports that they do easily. Almost 3% of families with children cannot afford to buy the food they need, while nearly 1 out of 10 household is unable to afford a proper meal (containing meat, fish or a vegetarian equivalent every second day). 17.9% of household with children shows at least one of the eleven signs of food insecurity, used to construct the food insecurity index¹⁰.

The first two dimension extracted of the MCA explain the 82% of the total inertia. At risk of poverty, low work intensity, income quintiles and making ends meet variables, together with food insecurity index, mainly contributed to dimension 1 (50.3% of inertia), while the social dimensions contributed more to the second dimension (31.7% of inertia).

The results of the MCA have been separated into two graphs, for a better understanding of the association between the food insecurity index and the social

⁹ The sample design is based on a two-stages scheme (municipalities and households), where the primary sample units – municipalities – are stratified by population size within each region. A stratified sample of municipalities is selected in the first stage and, in the second stage, a sample of households is randomly selected from the municipalities included in the first stage. The largest municipalities are always included in the sample (therefore they are called auto-representative or AR), while the other ones are selected according to a stratified sample where strata are defined by the administrative regions and the number of inhabitants (non-auto-representative municipalities or NAR).

¹⁰ Following the classification of food security severity here proposed, 13.1% shows mild food insecurity, 3.3% moderate food insecurity and 1.5% severe food insecurity.

and economic dimensions. All the variables have been included in the same model, but the visual representation of the first two axis has been replicated for the economic dimension (Figure 1) and the social dimension (Figure 2).

Figure 1 shows the first two axes of the MCA where the food insecurity index categories and the economic variables categories have been projected. The three categories of food insecurity (mild, moderate and severe) are positioned along the right side of the first axis, while food security category is aligned on the left side. Food insecurity is strongly associated with low work intensity, risk of poverty, the first and the second income quintile and difficulties in making ends meet. These results confirm that, in the Italian context, children living in household with limited economic resources and limited access to the labour market are much more likely to be food insecure.

Figure 1 – Multiple correspondence analysis, economic dimension.

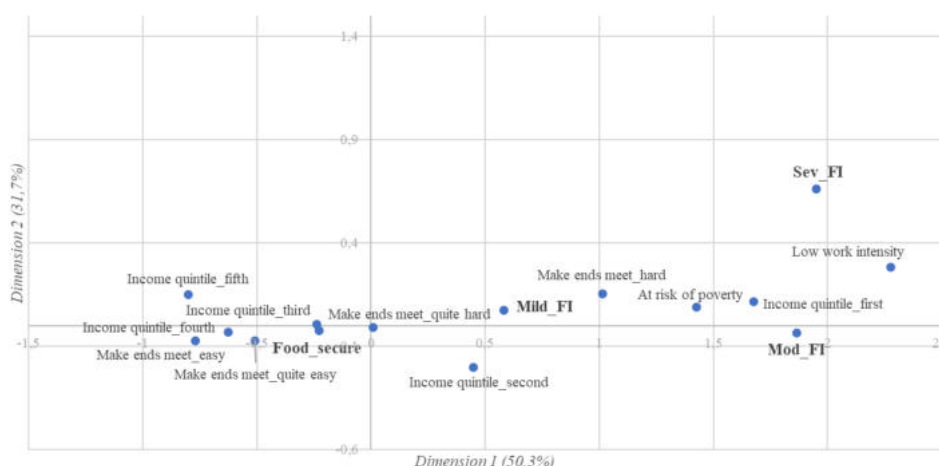
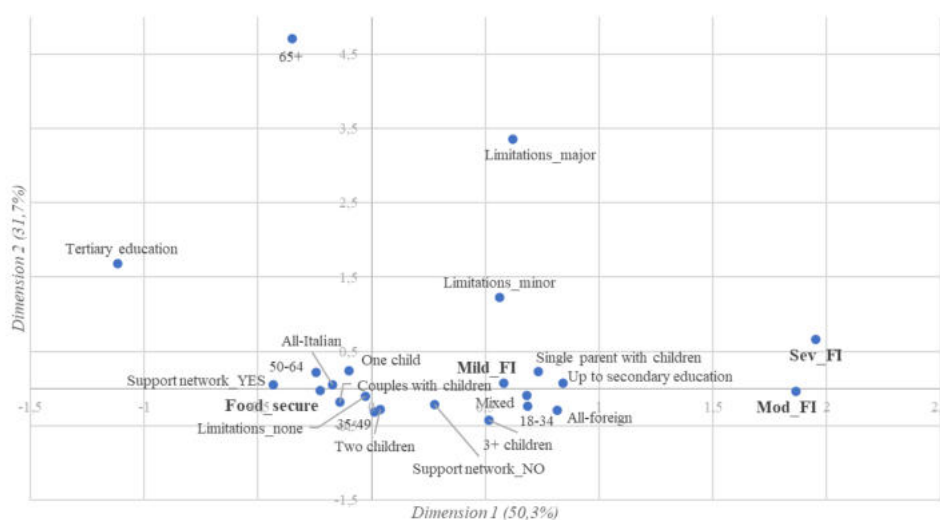


Figure 2 shows the first two axes of the MCA where the food insecurity index categories and the socio-demographic variables categories have been projected. Differently from the previous figure, moderate and severe food insecurity are more isolated, meaning that the social dimension mainly discriminates between food security and mild food insecurity, while moderate and severe food insecurity seem to be more associated with economic constraints. Mild food insecurity is strongly associated with presence of foreign components in the household, a lower education level, a higher number of children, single parent households, a young reference person aged 18-34, the presence of at least one member with minor health-related limitations and the absence of an informal social support network. On the other hand, household composed of national members, with a higher education level, couples with dependent children, relying on informal social support networks, where none

of the household members has health-related limitations, show a lower risk to be food insecure. Moreover, the risk of food insecurity increases as the number of dependent children increase and the age of the reference person decrease.

Figure 2 – Multiple correspondence analysis, social dimension.



4. Conclusions

Nowadays, food insecurity represents a significant challenge, even in high-income countries. Although the prevalence is generally lower than in low- and middle-income countries, millions of people in wealthy nations still face difficulties accessing sufficient, adequate and nutritious food. Food insecurity persists in high-income countries despite overall wealth, primarily because of persistent economic inequality, poverty, and social exclusion.

An emerging body of literature has linked food insecurity to a range of negative outcomes, particularly for children, underscoring the importance of food security as an indicator of well-being and a legitimate focus of public concern.

It is widely recognized that low income is a key determinant of food insecurity. However, not all low-income households experience food insecurity – particularly in high-income countries – suggesting that social factors also play a crucial role.

While several studies have examined the relationship between household economic status and food insecurity – particularly in low-income countries where food insecurity is more prevalent – relatively few analyses have considered the social

dimensions of the household and their relationship with access to food, beyond income level alone.

Shifting the focus from income alone to social factors is essential. Policies addressing food poverty in high-income countries have historically concentrated on income-based interventions – such as cash transfers, minimum wage laws, and food subsidies. While these measures remain important, they often fail to address the complex, multidimensional nature of food insecurity. Relying solely on income overlooks other critical factors that influence whether individuals and families can access sufficient, adequate and nutritious food.

The objective of this paper is to identify, beyond the income-related measures, the social factors that impact on child food insecurity in the Italian context. To this end, MCA was implemented on relevant socio-economic variables from the 2024 EU-SILC survey.

The results of the MCA have highlighted some key findings. Firstly, the analyses have confirmed that, also in the Italian context, there is a strong association between low income, economic constraint, low work intensity and food insecurity – across all levels of severity. Secondly, the results showed that the social dimension also plays a crucial role in determining the likelihood of children experiencing food insecurity. Last but not least, while severe food insecurity is primarily determined by income-related factors, mild forms of food insecurity are strongly influenced by social determinants.

Considering the social dimension, the results of the analyses have shown that households with younger heads are more likely to be food insecure than those with older heads. Older household heads may have more stable incomes and better financial management skills, reducing food insecurity risk. Single-parents households face higher risks of food insecurity, likely due to lower earnings and fewer financial resources. Higher education levels significantly reduce the risk of food insecurity. Education helps individuals access better job opportunities and manage resources more effectively. Households that include members with health-related limitations are less likely to be food secure. Caring for disabled family members increases financial strain, contributing to food insecurity. Households with at least one non-national member are more likely to experience food insecurity. Foreign communities often face economic and social disadvantages, including limited access to education and employment opportunities. Larger households with more children are at higher risk of food insecurity. Lastly, household that cannot rely on informal, no-cost social support network are more likely to be food insecure, as informal social cohesion and support often represent the first line of defence against food insecurity, especially when formal assistance is insufficient or unavailable.

This research has uncovered the complexity of child food insecurity, highlighting that it is not solely a function of household low income, but also of social context. Food insecurity in Italy is influenced by multiple factors, including education, household composition, income, ethnicity, and social support. While poverty is a major determinant, the study emphasizes the importance of monitoring the social dimension to develop effective national and local policies, and achieve child food security. A better understanding of social determinants can improve the design of policies against food insecurity, which should focus on vulnerable populations, considering the unique needs of young, single-parent households, large families and ethnic minorities.

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MAPPING THE INVISIBLE: INTERDIMENSIONAL GEOGRAPHIES OF URBAN FOOD INSECURITY

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Abstract. This research proposes an interdimensional framework for analysing urban food insecurity from a spatial and systemic perspective. The study focuses on the Metropolitan City of Rome, a heterogeneous territory of 121 municipalities that combines dense urban centres, peri-urban transition zones, and rural agricultural areas, while displaying significant socioeconomic inequalities and infrastructural disparities. The framework integrates five analytical dimensions—economic food self-sufficiency, physical food self-sufficiency, healthy diet affordability, physical accessibility, and solidarity-based provisioning—drawing on georeferenced, administrative, and socioeconomic data. The multi-scalar analysis identifies “blackened-out food areas”, that is, territories where all dimensions of food access collapse simultaneously, revealing structural vulnerabilities that conventional indicators fail to capture. By shifting attention from emergency responses to systemic territorial diagnostics, the research develops a replicable model for place-based food policies. It also highlights the need for multi-level governance to reduce disparities, strengthen resilience, and rebuild inclusive food environments, where food access is understood not only as nutrition but as a component of people’s substantive freedoms.

1. Introduction

Despite growing food availability in high-income countries, structural food insecurity remains pervasive, particularly in metropolitan areas where poverty, spatial inequality, and infrastructural fragmentation converge. In these contexts, food insecurity is not merely a matter of scarcity or income, but a multidimensional condition shaped by spatial, social, and institutional barriers to access. The Metropolitan City of Rome offers a compelling case study: a socio-territorially diverse region spanning dense urban centres, peri-urban belts, and rural zones, marked by persistent inequalities and uneven development. To analyse these dynamics, this research develops an interdimensional framework that integrates five analytical dimensions—economic food self-sufficiency, physical food self-sufficiency, healthy diet affordability, physical accessibility, and solidarity-based provisioning—drawing on spatial, administrative, and socioeconomic data. The aim is to move beyond static indicators—such as income thresholds or caloric intake—and toward a dynamic understanding of how people’s capabilities to access, choose, and afford healthy food are shaped by place. Designed to be both diagnostic and

operational, the framework identifies localized vulnerabilities and informs equitable, place-based food policies.

By intersecting these dimensions, the analysis reveals what we define as “*blacked-out food areas*”. Borrowing a metaphor from digital cartography, these are territories that remain blank or uncharted on the conventional map of food systems. They are places where all channels of access—productive, economic, spatial, and supportive—collapse simultaneously, producing conditions of compounded vulnerability. In practical terms, residents in these zones may be unable to rely on local production, face prohibitive food prices, encounter significant barriers to physical access, and have limited or no recourse to solidarity-based safety nets.

These areas are not merely disadvantaged; they are structurally disconnected from the circuits of food provision, and thus risk being rendered invisible to policy interventions grounded in aggregated or sectoral indicators. As highlighted in our previous work (Bernaschi *et al.*, 2023, p. 6), they constitute “*areas where people are socially excluded and, therefore, cannot enjoy the same substantive food-related freedoms as people in other areas*”. Their invisibility is politically consequential: by escaping conventional diagnostics, they perpetuate hidden geographies of exclusion, reinforcing the divide between formal recognition and lived deprivation. At a time when cities must move beyond emergency responses to confront the systemic roots of food insecurity, recognising and mapping these *blacked-out food areas* becomes a crucial step. The Roman case not only illustrates the depth of territorial disparities, but also provides a replicable analytical model that contributes to debates on food justice and spatial inequality, while informing policy tools to reduce disparities, strengthen resilience, and guarantee food access as a right.

2. Rethinking Food Insecurity: Capabilities, Food Environments, and Urban Inequalities

The conceptualization of food insecurity has evolved significantly. While early frameworks focused on availability and caloric intake (Sen, 1985), more recent approaches have expanded to include access, agency, sustainability, and equity (HLPE, 2020; Fanzo *et al.*, 2020; von Braun *et al.*, 2021). According to the 1996 World Food Summit, food security exists when all people, at all times, have physical, social, and economic access to sufficient, safe, and nutritious food. This definition has since been enriched by the concepts of *agency*—the capacity to make autonomous food decisions—and *sustainability*, referring to the long-term viability of food systems within environmental and social boundaries (Clapp *et al.*, 2022).

In high-income contexts, food insecurity rarely reflects scarcity. Instead, it emerges from structural exclusions that constrain people’s real ability to access and choose food. This aligns with Sen’s capability approach, which frames food security as a matter of substantive freedoms—the real opportunities individuals have to lead

a life they value (Sen, 1985). In this perspective, food insecurity stems from material, social, and institutional barriers, not merely from income gaps. Central to this understanding is the concept of *food environments*—the physical, economic, policy, and sociocultural contexts that shape food practices (Turner *et al.*, 2018; Downs *et al.*, 2020). Food environments are influenced by infrastructure, mobility, market structures, and social capital. Access depends not only on the presence of food outlets, but also on transport availability, disposable income, time constraints, and support networks. Research on “food deserts”—areas with limited availability of fresh and nutritious foods—and “food swamps”—areas where unhealthy, ultra-processed options dominate—shows how such environments exacerbate inequalities by restricting access to healthy diets (Cummins & Macintyre, 2002).

Italian evidence illustrates how these structural dynamics translate into inequality. In 2022, about 5.6 million individuals and 1.9 million households lived in absolute poverty, with higher incidence in Southern regions and among families with children (ISTAT, 2023). The EU indicator AROPE (At Risk of Poverty or Social Exclusion) shows that nearly one in five Italians is at risk, with disproportionate effects on women, young people, and foreign residents. At the same time, food inflation between 2018 and 2023 raised the average monthly cost of a household diet from €526 to €655, increasing its weight from 20% to 25% of family expenditure, with peaks of 28% in Southern Italy. Essential categories such as fruit (+19%), vegetables (+22%), dairy (+24%) and vegetable oils (+34%) saw the sharpest price increases, further eroding affordability (Marino *et al.*, 2025).

These pressures undermine not only food affordability but also diet quality. Comparative estimates indicate that the diet recommended by the *Guidelines for Healthy Eating* (CREA, 2019) is, on average, less costly than the one actually consumed. Yet cultural, economic, and informational barriers limit its adoption (Bernaschi *et al.*, 2023). This paradox illustrates how structural constraints hinder the exercise of food-related capabilities even in contexts of apparent abundance. Alongside economic measures, experiential indicators offer complementary insights. Since 2022, ISTAT has integrated the Food Insecurity Experience Scale (FIES) into EU-SILC surveys, revealing that about 1.5% of the Italian population—over 800,000 people—experience moderate or severe food insecurity, with higher prevalence in the South and among families with children (FAO *et al.*, 2023; ISTAT, 2023). Local surveys in Rome confirm similar dynamics: in peripheral municipalities, households report reducing food variety, skipping meals, or giving up nutrient-rich foods (Marino, Bernaschi & Felici, 2025). Such inequalities are deeply territorialized. Processes such as gentrification, uneven development, and the withdrawal of public services from peripheral areas reinforce the spatial concentration of vulnerabilities. As Dahrendorf (1989) noted, *life chances* depend not only on personal choices but also on the structural conditions that enable them. In this sense, eating well is not

simply a private act, but a territorial and relational phenomenon shaped by the interplay of markets, infrastructures, and welfare systems.

3. Data and Methodology

This research adopts an interdimensional and spatially explicit approach to examine food insecurity in the Metropolitan City of Rome, comprising 121 municipalities with diverse socio-territorial profiles. The analysis integrates georeferenced, statistical, administrative, and documentary data to build a territorial diagnosis structured around five analytical dimensions: economic food self-sufficiency, physical food self-sufficiency, healthy diet affordability, physical accessibility, and solidarity-based provisioning.

Physical Food Self-Sufficiency Index (PFSSI). The PFSSI assesses whether local agricultural land can meet the dietary needs of the resident population. It is defined as the ratio between the Utilised Agricultural Area (UAA) per capita—measured from the ISTAT Agriculture Census (2020)—and the agricultural land required to satisfy dietary needs under four consumption models (omnivorous, omnivorous without fish, vegetarian, vegan). The methodology follows Stella *et al.* (2019), but replaces CORINE land cover data with UAA to improve statistical accuracy and coherence with national agricultural statistics. Per-capita land requirements were estimated by converting caloric needs into hectares through crop yields and food loss coefficients (Stella *et al.*, 2019), with reference values ranging from 0.47 ha per capita for an omnivorous diet to 0.18 ha per capita for a vegan diet.

Economic Food Self-Sufficiency Index (EFSSI). The EFSSI captures the economic dimension of territorial self-sufficiency by comparing the value of local agricultural production with the monetary value of resident food demand. Agricultural output was estimated by multiplying municipal UAA (ISTAT, 2020) with crop-specific gross sale coefficients provided by CREA (2023) at the provincial level, thereby estimating the potential economic return of land use (limited to the capital fondiario component, excluding livestock, agritourism, and processing). Food demand was calculated from ISTAT household consumption statistics (2024, reference year 2023), which provide detailed expenditure data at the regional and sub-regional level.

Food Affordability Index (FAI). The FAI measures the extent to which household resources are sufficient to sustain a healthy diet. It compares equivalised household income/consumption capacity with the monthly cost of a nutritionally adequate diet. The diet model follows the *Italian Dietary Guidelines* (CREA, 2019) and was operationalised into a basket of 63 essential food items. Prices were collected through multi-channel surveys of supermarkets, discount stores, and open-air markets across municipalities, and were integrated with socio-economic data from ISTAT (2023) at both municipal and district scales.

Physical accessibility was analysed by mapping the distribution of food retail infrastructure, including supermarkets, discount stores, local markets, and solidarity purchasing groups. The main data source was the AIDA – Archivio Italiano delle Imprese (Chamber of Commerce), complemented with field surveys for validation and classification of outlets. A one-kilometre walking distance was adopted as a threshold, in line with established standards in food-access research and urban planning studies (Moreno *et al.*, 2021). Areas lacking food outlets within this range were classified as food deserts.

Solidarity-based provisioning was assessed by mapping 815 food aid initiatives, identified through the SIFEAD – Sistema Informativo degli Enti che Distribuiscono Aiuti Alimentari (2024), the Lazio Region’s Solidarity Fund, and our own field surveys. Indicators such as initiative density and beneficiary ratios were cross-referenced with affordability and vulnerability data to reconstruct the geography of solidarity-based food access across the metropolitan area.

Finally, by intersecting the five axes—PFSSI, EFSSI, FAI, physical accessibility, and solidarity provisioning—the analysis defines “*blacked-out food areas*” as an operational category: territories where all forms of access collapse simultaneously. Their empirical identification and territorial distribution are presented in the results section.

4. Results: Mapping the Intersections of Food Vulnerability in the Metropolitan City of Rome

The spatialisation of food insecurity in the Metropolitan City of Rome reveals uneven distributions of resources and overlapping vulnerabilities across metropolitan, peri-urban, and rural contexts. Rather than a simple rural–urban divide, the analysis exposes layered geographies of exclusion, fragility, and resilience emerging from the five axes introduced above.

4.1 From Productive Capacity to Land Availability: Economic and Physical Dimensions of Food Self-Sufficiency

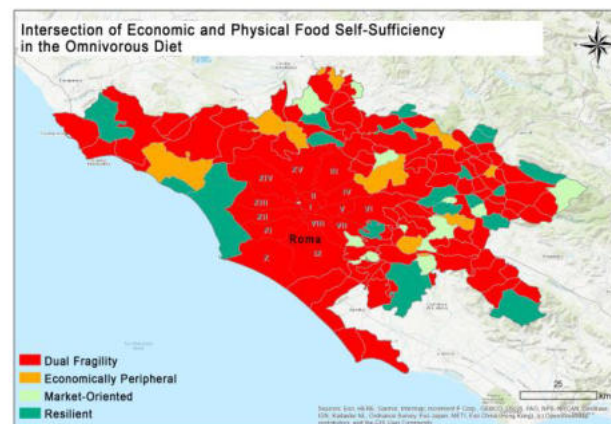
The analysis of food self-sufficiency in the Metropolitan City of Rome highlights a deeply uneven agro-productive landscape shaped by demographic pressure and territorial constraints. The Economic Food Self-Sufficiency Index (EFSSI) shows that 67 out of 121 municipalities—home to about 93% of the population—fall below the sufficiency threshold. Rome itself illustrates this paradox: despite high absolute output, local provisioning remains inadequate due to demographic demand and specialisation in non-essential, high-value crops such as wine grapes and ornamental plants (ISTAT, 2020; CREA, 2023). By contrast, 54 municipalities exceed the threshold, but they are sparsely populated and located in peripheral zones,

accounting for only 7% of residents. This spatial disconnect between productive capacity and demographic distribution raises critical concerns of territorial equity. In some high-performing municipalities, short supply chains and direct sales strengthen economic value and local autonomy, while diversified production systems combining cereals, vegetables, and legumes align more closely with nutritional needs.

The Physical Food Self-Sufficiency Index (PFSSI), based on Utilised Agricultural Area (SAU) and dietary models, reveals even stronger structural limitations. Only 14.8% of municipalities can meet nutritional needs under an omnivorous diet, rising to 34.4% under a vegan diet (Stella *et al.*, 2019; ISTAT, 2020). Most areas remain dependent on external supply chains. The deficit is most acute in urban and peri-urban zones, where SAU is fragmented or reduced by speculative development, while rural municipalities, despite larger land availability, often lack investment, infrastructure, and logistical capacity. Additional challenges include soil degradation, irrigation gaps, and an ageing agricultural workforce. This paradox—where agricultural potential is abundant where demand is low and scarce where demand is high—exposes systemic fragility in the regional food system and underscores issues of territorial equity.

Figure 1 illustrates the intersection of EFSSI and PFSSI under an omnivorous diet, classifying municipalities into four categories: (i) double fragility, with poor performance on both indices; (ii) economically marginal areas, with sufficient land but weak market integration; (iii) market-oriented municipalities, with high economic output despite limited agricultural land; and (iv) resilient territories, combining physical capacity with economic viability. This typology underscores the uneven geography of food resilience, affecting both rural margins and densely populated metropolitan districts. Mapping these interactions provides a nuanced territorial diagnosis essential for the design of equitable, place-based food policies.

Figure 1- *The Intersection of Economic and Physical Food Self-Sufficiency in the Omnivorous Diet.*



Source: Authors' own elaboration based on ISTAT (2020), CREA (2023), and Stella et al. (2019) data

4.2 The Cost of Healthy Eating: Economic Barriers to Food Access

Affordability, understood as the economic dimension of food access, is a key driver of metropolitan food insecurity, shaped by structural poverty, price disparities, and uneven retail provision. The Food Affordability Index (FAI) highlights sharp territorial inequalities: most peripheral and rural municipalities score above 1.28¹, indicating that maintaining a healthy diet often forces households to cut back on other essential expenses such as housing, energy, and transport. By contrast, central and coastal areas display lower values, reflecting higher average incomes, denser retail networks, and a wider presence of discount formats that help ease pressure on household budgets. At the municipal level, disaggregation by retail format shows that discount stores partly mitigate affordability gaps in disadvantaged zones, particularly in the southern and eastern periphery of the metropolitan area. Yet their spatial distribution remains highly uneven. As shown in Figure 3, critical conditions arise when the FAI exceeds 1.28, a situation characterizing 31 out of 121 municipalities (around 25.6% of the metropolitan area). In contrast, when supermarkets and local markets are considered, inaccessibility extends to almost the entire metropolitan territory, underscoring a deeper structural weakness of these retail formats. Nevertheless, some “accessibility niches” remain—mainly in the

¹ Taking 1 as the benchmark threshold for FAI, values above 1.28—corresponding to food costs 28% higher than the average expenditure of urban households in Central Italy—are considered at risk, based on the standard deviation observed across municipalities.

Castelli Romani area and in selected districts within the city of Rome—where the FAI falls below or close to the threshold of 1, suggesting relatively better access conditions. Overall, the evidence points to the compensatory role played by discount stores, which help reduce affordability disparities despite their uneven coverage, while also revealing the persistence of profound territorial inequalities in food access across the metropolitan landscape.

Figure 3 - *Food Affordability Index (FAI) related to discount stores in the Metropolitan City of Rome.*



Source: Authors' elaboration on municipal-level food price data (July 2023); Statistical Bulletin of the Municipality of Rome (2023); household food expenditure and average total consumption data from ISTAT (2023).

4.3 From Food Deserts to Solidarity Gaps: Infrastructures of Access

The analysis of food access through physical and solidarity infrastructures reveals a markedly uneven geography across the Metropolitan City of Rome. Food deserts (Fig. 4)—defined as areas lacking food outlets within 1 km—are concentrated in peripheral and peri-urban municipalities, particularly where transport services are weak. Districts such as Tor Bella Monaca, Corviale, and Ponte di Nona are especially affected, combining high poverty and unemployment with large shares of vulnerable groups, including elderly residents and migrants. Overall, between 20% and 50% of municipal surfaces fall within food deserts, reflecting systemic failures in local provisioning.

Solidarity-based infrastructures (Fig. 5)—including food banks, solidarity emporia, and community kitchens—exceed 800 across the metropolitan area but are disproportionately concentrated in central districts, leaving rural and suburban municipalities underserved. Reliance on these initiatives is substantial, yet cross-

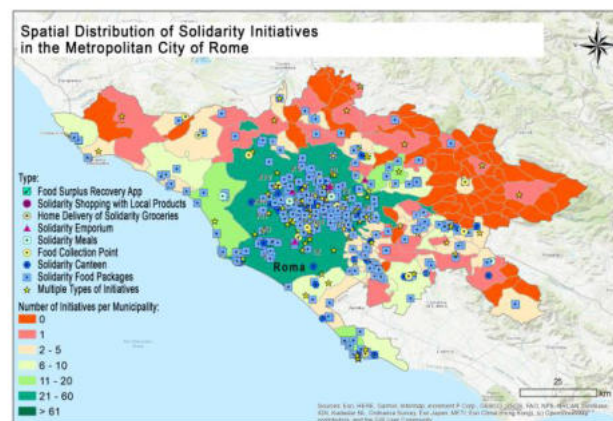
referencing with the Food Affordability Index (FAI) reveals a critical mismatch: precisely the peripheral municipalities—such as IV, V, VI, VII, IX and part of X—and many outer municipalities beyond the GRA, where economic vulnerability is greatest, record the lowest density of initiatives, sometimes fewer than five or none at all. These infrastructures remain fragile, dependent on volunteers, donations, and short-term funding, and are particularly vulnerable to demand surges in times of crisis.

Figure 4 - Food Deserts.



Source: Authors' elaboration on AIDA (2023).

Figure 5 - Spatial Distribution of Solidarity Initiatives in the Metropolitan City of Rome.



Source: Authors' elaboration on SIFEAD (2023) and documentary analysis.

4.4 Blackout Food Areas: When the System Fails

Overlaying the five analytical dimensions—economic and physical food self-sufficiency, healthy diet affordability, physical access, and solidarity-based provisioning—identifies a critical category: *blacked-out food areas*. These zones represent a systemic breakdown, where multiple barriers converge and render food insecurity invisible to conventional diagnostics (Fig. 6). They are not limited to rural margins but also include densely populated districts, where demographic pressure intersects with infrastructural decay, economic marginalisation, and weak social cohesion. In such contexts, food systems are critically undermined: residents cannot produce food, sustain a healthy diet, access retail outlets, or rely on solidarity networks. The result is cumulative and intergenerational vulnerability. Addressing *blackout areas* requires moving beyond emergency aid. More durable responses depend on territorial investment in infrastructure, support for diversified local production, measures to stabilise incomes and prices, and governance arrangements that integrate community-level perspectives. Embedding food access within broader strategies of territorial equity is essential to reconnect these areas to the metropolitan fabric.

Figure 6- *Blacked-Out Food Areas in the Metropolitan City of Rome.*



Source: Authors' elaboration.

5. Concluding Reflections

Blacked-out food areas illustrate how market mechanisms alone are insufficient to secure equitable and resilient food environments. They are territorial manifestations of systemic failure, where infrastructural gaps, economic pressures, and social vulnerabilities converge to restrict people's substantive freedoms to

access healthy diets. Overcoming these structural deficits requires strong institutional intervention. Emergency aid can only mitigate symptoms; durable solutions depend on public investment in infrastructures, redistributive measures that counterbalance spatial disparities, and regulatory frameworks that stabilise prices and incomes. These efforts must be embedded in multi-level governance that coordinates state actors, local administrations, civil society, and market stakeholders. Addressing *blackout areas* is therefore not only a matter of food policy but of economic policy more broadly, aimed at reducing inequalities, strengthening resilience, and ensuring that all territories contribute to and benefit from metropolitan development. Embedding food access in this wider framework allows food systems to become both more resilient and more inclusive, supporting long-term social and economic sustainability.

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TRANSITIONING TOWARDS A MORE SUSTAINABLE DIET: RED AND PROCESSED MEAT CONSUMPTION IN ITALIAN HOUSEHOLDS

Emanuela Furfaro, Giulia Rivellini, Laura Terzera

Abstract. Food-consumption habits are central to both the health and environmental debates. In particular, meat production and consumption are major concerns due to the impact of livestock on global warming and environmental degradation. The Food and Agriculture Organization (FAO) reports that livestock farming accounts for a significant share of anthropogenic greenhouse gas emissions, highlighting the need to shift diets to limit these emissions. Promoting healthier, more sustainable diets is seen as a way to mitigate climate change and global temperature rise, making red and processed meat a key factor. In this contribution, we measure changes in red and processed meat consumption in Italy over the decade 2012-2022 and examine the socio-demographic and household factors associated with these eating behaviours. We use data collected by the Italian National Institute of Statistics through the *Aspects of Daily Life* Multipurpose Survey. We first assess the effects of age and individual propensity on variation in red and processed meat consumption using the Kitagawa decomposition. We then define two indicators to capture the individual environmental sensitivity and explore how these, along with household and other behavioural factors, relate to individual propensity. We identify several significant household-level factors, such as household size, and individual-level characteristics, including environmental sensitivity.

1. Introduction

Food consumption habits are central to the current environmental and health-related debate. In particular, meat production and consumption have become significant concerns due to the impact of livestock on global warming and environmental degradation. The Food and Agriculture Organization (FAO) reported that livestock farming accounts for a significant proportion of anthropogenic greenhouse gas emissions (FAO 2017), highlighting the importance of shifting diets to reduce emissions. The importance of diets is also advocated by the Intergovernmental Panel on Climate Change, which recognises positive effects of diets which are high in coarse grains, pulses, fruits and vegetables, nuts and seeds, and low in energy-intensive animal-sourced foods (IPCC, 2019). Consequently, consumption of meat analogues such as imitation meat from plant

products, cultured meat, and insects is evoked as a means to contribute to the transition to healthier and sustainable diets (ICPP Special report, 2019, chapter 5).

Historically, nutrition played an important role in analysing survival patterns across European countries facing demographic crises (Livi Bacci, 1987). Today, nutrition remains relevant not only in the environmental context but also amid significant socio-demographic changes. The recent shift toward a longevity society is then emphasizing healthy ageing, which can be supported by proper diets (Suresh *et al.*, 2022). The ageing population is reshaping family structures especially in Italy (Vitali *et al.*, 2025) and influencing consumption patterns (Micheli, 2013; Mori and Clacson, 2004; Lagström *et al.*, 2025). At the same time, the growing focus on climate change and sustainability (PNRR - Mission 2, Green Deal, Repower EU) encourages more sustainable food and resource consumption (ISTAT, 2023b). In the Italian context, the Osservatorio Senior has linked food consumption to the concept of "silver ecology," highlighting the role of seniors in sustainable development (Osservatorio Senior, 2021). As a result, meat consumption is increasingly being studied at the intersection of environmental sustainability and demographic trends.

Building on these considerations, several countries, including Italy, monitor food consumption as part of regular multipurpose surveys. The Italian National Institute of Statistics (ISTAT), for instance, has traditionally included nutrition among its indicators related to health risks and lifestyle factors (ISTAT, 2023a). In this contribution, we use Italian data to explore the potential factors associated with the consumption of red and processed meat¹. In particular, we aim to explore the trend in red and processed meat consumption, and break it down into structural vs. behavioural reasons, including environmentally conscious behaviours.

2. Literature Review and Research Hypotheses

The high production of red and processed meat is a function of its high consumption in many developed countries, which is itself highly dependent on population size and age composition. Relations between demographic change, environmental sensitivity, and individuals' prevention have been studied from different perspectives in several countries in the Northern world. However, the literature on the effect of population structure on meat consumption and environmental sensitivity is limited. Some studies have highlighted that individuals

¹Red meat refers to unprocessed mammalian muscle meat—for example, beef, veal, pork, lamb, mutton, horse, or goat meat—including minced or frozen meat; it is usually consumed cooked. Processed meat refers to meat that has been transformed through salting, curing, fermentation, smoking, or other processes to enhance flavour or improve preservation (IARC, 2018).

with greater environmental concern and awareness tend to engage in reduced red meat consumption and are more inclined toward sustainable purchasing choices (Boehm *et al.*, 2019; Coker and van der Linden, 2022). Other studies using varied methods, ranging from 24-hour dietary recalls to cross-sectional surveys, consistently linked measures such as reduced meat consumption or a lower share of red meat spending with higher environmental awareness (Coker and van der Linden, 2022; Bimbo, 2023; Slotnick *et al.*, 2023). These findings indicate that, when measured across diverse populations and methods, environmental consciousness relates quantitatively to lower red meat consumption and increased sustainable food purchasing behaviours.

Di Novi and Marenzi (2022) used Italian survey data from 1997 to 2012 to explore patterns of meat consumption across generations, cohorts and household types. They used an approach that involves age, period, and cohort effects to disentangle the effect of generations on adherence to the Mediterranean diet. In addition, Lo Riso (2021) showed that social networks (as TikTok or Instagram) can be considered a positive driver for combating the global excess of meat consumption, especially for veganism and vegetarianism. Using a 2017 Finnish study, Sares-Jaske *et al.*, (2022) found red and processed meat consumption to be more common in men and in 35–54 year-olds, in those living in rural areas and in those with lower education.

Studies investigating the relationship between families with and without children and red meat consumption have produced contradictory results. Some studies reported that households with children consume less red meat or have more diverse protein sources, while others found that these households are less likely to exclude red meat (Merlino *et al.*, 2017; Gunte *et al.*, 2020).

Moving from the above-cited literature, we contribute by using more recent Italian data to investigate the following hypotheses.

Hypothesis 1: In Italy, the consumption of red and processed meat has decreased over the past years. Changes in individual behaviour drive this decline, while demographic changes have played only a marginal role.

Hypothesis 2: Changes in red and processed meat consumption are also linked to shifts in family structure. We hypothesize that households with children tend to consume more red meat, due to practical considerations, cultural traditions, and the nutritional needs associated with child growth and development.

Hypothesis 3: Individual environmental sensitivity is associated with reduced red meat consumption.

3. Data and Methods

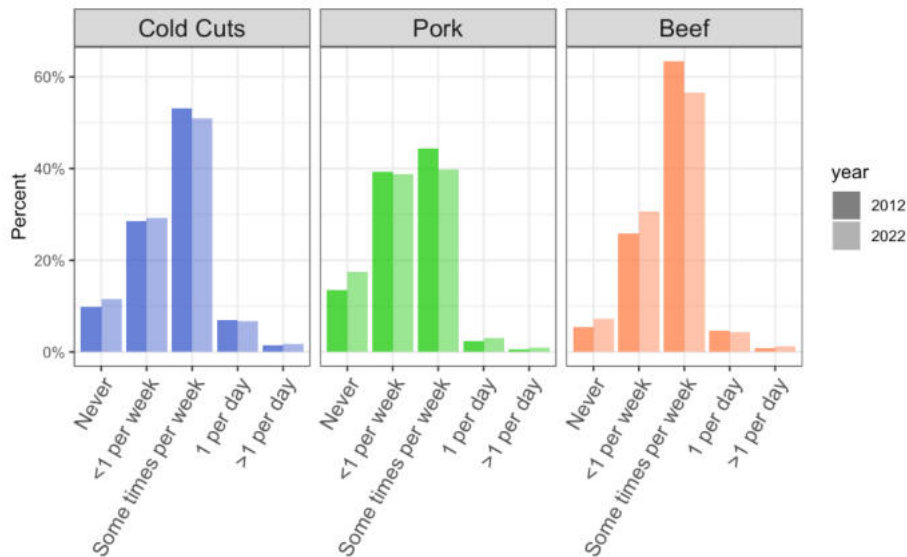
We use data from the annual household survey, *Aspects of Daily Life*, conducted by ISTAT since 1993 as part of its Multipurpose Survey system. Each year, the survey interviews approximately 20,000 households, encompassing around 50,000 individuals. Given that food consumption habits tend to evolve gradually, we focus on two well-separated time points, namely 2012 and 2022, to capture meaningful changes. We consider only people aged 18+ who live in mononuclear households, amounting to a total sample size of 35,916 for 2012 and 38,751 for 2022. The survey includes several items related to dietary habits, and for the purpose of this study, we focus specifically on the consumption of cold cuts, pork and beef. The reduction in their consumption across the two considered years is evident in Figure 1. Starting from this, for each meat type, we construct a variable that takes the value 1 if the respondent reported consuming cold cuts, pork and beef, at least "some time a week" (regular consumption) and 0 otherwise, giving rise to three binary indicators. We note that, although dichotomization entails a loss of information, aggregations of categories are common in this context (Di Novi & Marenzi 2022) and facilitate the interpretability of the results and models.

To disentangle the effects of age structure and individual propensity in eating behaviours, we follow an application of the seminal work of Kitagawa (1955), shown in Rivellini and Clerici (2013).

This decomposition method enables us to break up the amount of overall percentage variation observed in each type of meat consumption between 2012 and 2022 into components which reflect differences in specific rates of consumption of the eight age groups (propensity effect), differences in their age composition (structural effect) and differences in the interaction effects between age structure and propensity to consume (interaction effect).

Since we expect propensity to play a significant role (Hypothesis 1), we will then proceed to explore demographic and non-demographic factors associated with the consumption of cold cuts, pork, and beef using logistic regression models.

More specifically to explore our second hypothesis we consider, among the covariates, the household type (HT), classified as "Couple with no children", "Couple with children", "Single without children" and "Single with children", and the role within a household ("parent" or "kid"). With reference to Hypothesis 3, we proposed two variables representing, respectively, two domains of individual environmental sensitivity: one which refers to behaviour when grocery shopping, named Grocery Environmental Behaviour (GEB), and the other one which measures the behaviour in other everyday activities, named Everyday Environmental Practices (EEP).

Figure 1 - Frequency distribution of cold cuts, pork and beef consumption.

The GEB is a composite indicator with four levels (0, 1, 2, and 3), which is based on answers to the following three questions: (i) how often do you read labels on food products? (ii) How often do you buy organic products? (iii) How often do you buy local products? The value “0” represents no attempt to grocery shop in an environmentally friendly way and it indicates someone who did not answer “Regularly” to all three questions; the value “1” is if they answered “Regularly” to only one of the three questions, the value “2” if the answered “Regularly” to two questions and the value “3” if they answered “Regularly” to all three questions. The EEP is a composite indicator with 5 levels (0, 1, 2, 3, 4) which is based on the answers on the following four questions: (i) how often do you pay attention to saving water?; (ii) how often do you pay attention to saving electricity?; (iii) how often do you use a means of transportation alternative to the car?; (iv) how often do you not use disposable products (plastic bags, paper towels, etc). Similarly to the previous indicator described, 0 represents an individual who does not engage in any of the above on a regular basis, and 4 represents someone who engages in all four activities on a regular basis. We note that the two indicators should remain separate since results on several dependence measures show there is very little dependence between the two.

4. Results

4.1 Kitagawa decomposition

Table 1 shows that the consumption of the three types of red meat varies by age, with older individuals consuming less. Table 1 also shows that, from 2012 to 2022, consumption decreased across all three meat products considered and across all age groups considered. This reduction is particularly noticeable among individuals aged 55 to 64. For the oldest age groups, consumption of red and processed meat remains approximately constant. Beef is the meat product for which we observe the largest decrease, although it was also the highest in both 2012 and 2022.

Table 1 - Incidence of cold cuts, pork and beef by age group in the Italian population aged 18+, 2012 and 2022 (%) (weighted data).

Age class	Cold Cuts		Pork		Beef	
	2012	2022	2012	2022	2012	2022
18-24	72.1	67.8	57.4	50.4	72.8	69.5
25-34	66.4	62.1	51.3	48.8	71.4	64.8
35-44	66.0	61.9	50.2	46.1	72.0	64.7
45-54	64.0	62.0	47.5	44.3	69.7	61.9
55-59	60.7	58.2	43.8	41.5	67.6	57.9
60-64	58.9	55.1	44.3	39.1	64.4	57.4
65-74	55.5	56.2	44.0	42.2	65.4	61.3
75 and more	45.3	52.1	37.7	38.5	63.6	59.4
Total (18 +)	61.5	59.4	47.3	43.8	68.8	62.1

From a demographic perspective, significant disparities in the age structure have emerged over the observed decade, reflecting the combined effects of persistently low fertility and increasing longevity (AISP, 2021, Chapters 1 and 4; AISP, 2025, Chapters 1 and 5). Although meat consumption has declined across all age groups, in 2022, older individuals, who generally consume less red and processed meat, represented a larger share of the population than in 2012. Thus, we use the Kitagawa decomposition to investigate whether the overall reduction in consumption between 2012 and 2022 is primarily due to changes in the population's age structure or to shifts in individuals' propensity to consume these meat products.

The results in Table 2 show that the total variation in cold cuts, pork and beef consumption is almost entirely attributable to the propensity. More specifically, for beef, the overall 6.67% drop is primarily driven by a decrease in consumption propensity (-6.3%), with smaller contributions from demographic changes (-0.39%) and a slight opposing interaction effect (+0.02%). Cold cuts exhibit a 2.08% reduction, primarily due to a decrease in propensity (-1.67%) and demographic changes (-0.73%), offset slightly by the interaction between the two effects (+0.32%). Pork consumption fell by 3.40%, with the decrease attributed mainly to lower propensity (-2.99%) and demographic shifts (-0.55%), partly balanced by a small interaction effect (+0.14%).

Table 2 - Kitagawa decomposition of the overall variation (2012-2022) in cold cuts, pork and beef consumption rates (weighted data).

Type of meat	Total variation (%)	Structural effect (%)	Propensity effect (%)	Interaction effect (%)
Cold cuts	-2.08	-0.73	-1.67	0.32
Pork	-3.4	-0.55	-2.99	0.14
Beef	-6.67	-0.39	-6.3	0.02

4.2 Logistic regression

The lower propensity to consume red meat products raises important questions about the factors associated with this behaviour. To this end, we focus on 2022, as it is the year with the lowest observed meat consumption. We run three logistic models using each of the three meat consumption indicators on regular consumption. We controlled for age, sex, perceived economic status, residential area, perceived health, physical activity, and education.

The main results of the three models are represented in Table 3. Both environmental sensitivity indicators (GEB and EEP) are statistically significant in all three models, with the highest categories being the most significant. However, there seems to be differences between the types of meat, with beef being less subject to environmental sensitivity. In terms of household structure, couples with children tend to consume more red meat products than couples without children. Considering couples without children as the baseline, singles tend to eat less meat, especially less beef, while single parents who live with their children tend to have a meat consumption more similar to that of couples without children. It therefore seems that household composition is a relevant predictor of food habits and may be used to explain the observed decrease throughout time (*Hypothesis 2*). In contrast to this result, the coefficient estimated for an individual's role in the household indicates

that children tend to eat fewer red meat products than their parents. While this result could explain the contrasting findings in the literature, it could also suggest a generational shift.

Among the control variables, Sex appeared crucially interesting and in line with the literature, where women consumed significantly less red and processed meat.

Table 3 - Logistic regression models: coefficient estimates and significance level. (* p -value < 0.05 , ** p -value < 0.01 , *** p -value < 0.001).

Variable		Model 1: Cold cuts	Model 2: Pork	Model 3: Beef
Age (ref: 35-59)				
	20-34	0.221***	0.267***	0.232***
	60+	-0.259***	-0.211***	-0.125***
Sex (ref: M)				
	Female	-0.429***	-0.321***	-0.295***
Perc. Econ. Status (ref: High)				
	Low	0.105	0.02	-0.026
Territorial area (ref: NW)				
	NE	-0.022	0.198***	-0.264***
	Centre	-0.117**	0.406***	0.114**
	South	0.182***	0.583***	0.140***
	Islands	-0.191***	0.358***	0.172***
Perc. Health (ref: Neither good nor bad)				
	Good	-0.022	-0.035	-0.014
	Bad	-0.333***	-0.172**	-0.192**
Physical activity (ref. No)				
	Yes	-0.125***	-0.173***	-0.139***
Education (ref: College or more)				
	High School	0.156***	0.298***	0.129**
	Middle School	0.268***	0.507***	0.246***
	Less than Primary School	0.267***	0.594***	0.363***

Table 3 (cont.)- Logistic regression models: coefficient estimates and significance level. (**p*-value < 0.05, ** *p*-value < 0.01, *** *p*-value < 0.001).

Variable	Model 1: Cold cuts	Model 2: Pork	Model 3: Beef
HT (ref: Couple without kids)			
Couple with kids	0.241***	0.161***	0.122**
Single without kids	-0.081*	-0.115**	-0.214***
Single with kids	0.130*	0.101	-0.083
Role (ref: parent)			
Kid	-0.085	-0.022	-0.043
GEB (ref. Very low)			
1-Low	-0.112**	-0.068*	-0.027
2-High	-0.205***	-0.139**	-0.108*
3-Very High	-0.344***	-0.073	-0.110*
EEP (ref: Very low)			
1-Low	-0.294**	-0.141	-0.157
2-Medium	-0.328**	-0.265**	-0.220*
3-High	-0.425***	-0.335***	-0.260**
4-Very High	-0.635***	-0.526***	-0.470***

5. Discussion

This study contributes to the growing literature on sustainable diets by highlighting the demographic and behavioural drivers of red meat products consumption in Italy. The findings of this study confirm a significant decline in red (beef and pork) and processed meat consumption in Italy between 2012 and 2022, aligning with Hypothesis 1. The Kitagawa decomposition reveals that this reduction is primarily driven by changes in individual consumption propensities rather than shifts in the population's age structure, consistently across all three types of red meat considered. This suggests behavioural changes, possibly influenced by growing environmental awareness, health concerns, and evolving dietary norms.

The logistic regression analysis supports Hypothesis 2, showing, in all types of red meat products considered, that household composition plays a key role in shaping dietary habits. Couples with children are more likely to consume red and

processed meat, possibly due to traditional meal planning practices or nutritional beliefs related to child growth. The fact that children tend to consume less meat than their parents could suggest a generational shift in dietary preferences, and it may also help to explain the conflicting findings in the literature regarding the relationship between household structure and red and processed meat consumption.

With regards to Hypothesis 3, the results show that individuals with higher environmental sensitivity are significantly less likely to consume red and processed meat. This is more evident in cold cuts consumption which is also the least healthy of the three types of red meat considered. Our results reinforce the idea that sustainable consumption patterns are closely tied to broader lifestyle choices and values.

A limitation of this study is the binary construction of the consumption indicators, which may obscure more nuanced dietary behaviours such as vegetarianism or veganism. Additionally, while the environmental sensitivity index is informative, it may not fully capture the complexity of motivations behind food choices. Future research could benefit from a more refined choice of this indicator.

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FROM REGIONAL ATTRACTIVENESS TO DISTANCE LEARNING IN TERTIARY EDUCATION: AN ANALYSIS OF SOME DETERMINANTS BEFORE AND AFTER COVID-19

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Abstract. The Covid-19 pandemic has accelerated the transition to distance education, helping to reduce the spatial, temporal and economic barriers that constrain student mobility. Recent studies have investigated both the trajectories of interregional mobility and the determinants of success of digital educational models. This paper analyzes the evolution of regional university attractiveness and the diffusion of distance education in Italy at two key moments: a.y. 2016/17 (pre-pandemic) and a.y. 2022/23 (post-pandemic), with the aim of assessing the impact of the increase in online educational offerings on interregional student mobility. The analysis is based on an original dataset that integrates institutional sources (ANS, MIUR - Educational Offerings, TEHA Index) and uses OLS regression models, considering the Attractiveness Index (AI) and Distance Learning Enrollment Rate (RDL) as dependent variables. Explanatory variables include indicators related to university policies, type of educational offerings and territorial attractiveness. The results point to significant determinants and suggest a substitution effect between physical and virtual mobility, shaping a possible paradigm shift towards a more flexible, hybrid and territorially accessible university system.

1. Introduction and literature review

Globally, the pandemic of COVID-19 has triggered significant changes and accelerations, especially within the social sciences (Marginson, 2020). Physical distancing measures and restrictions-differently perceived and applied in different international contexts-have transformed how space is used and shared, affecting relational, educational and work dynamics (Aristovnik *et al.*, 2023). In such a scenario, the use of distance education has been an emergency response, but also an opportunity for structural reflection on the future of tertiary education (Panarello, 2022; MIUR, 2023).

The study of territorial attractiveness assumes central importance in the analysis of the role universities play in regional and international development. In particular, interregional student mobility-defined as the temporary movement of individuals from one region to another within the same nation for reasons of university study

(Attanasio *et al.*, 2020)-is one of the main phenomena observed in relation to territorial attractiveness (Muraglia, 2023).

Traditionally, Italian research on this issue has relied on national sources, such as ANS (National Student Registry) data, using indicators of outgoing (from the region of residence) and incoming (into the region of enrollment) mobility (CNVSU, 2011; ANVUR, 2018). These studies have shown that Italian university mobility is predominantly unidirectional, with substantial flows of students moving from the South to the Center-North (Enea and Attanasio, 2019). Northern regions also show the greatest ability to retain graduates (ISTAT, 2010), as evidenced by the fact that many southern students, once they graduate in the North, tend not to return to their region of origin (Dotti *et al.*, 2013; SVIMEZ, 2014; Vecchione, 2017).

According to the literature on internal student mobility (Ordine and Rose, 2007; Dal Bianco *et al.*, 2009; Strozza, 2010), the propensity to study in a region other than one's region of residence is influenced by structural factors in the area of origin, such as the absence of adequate educational offerings (Bruno and Genovese, 2008).

In this context, the mode of educational delivery - and in particular the spread of distance learning- has emerged in recent years as a relevant element in the analysis of academic attractiveness. This mode emerges as a complementary or alternative factor to traditional determinants of interregional mobility, affecting students' choices of university location. The health emergency from COVID-19 has further amplified this phenomenon, giving distance learning a central role in the university system and helping to break down the geographic and temporal barriers that historically conditioned physical mobility (Almalaurea, 2023).

A number of studies have analyzed the effect of distance learning on the university system. For example, Guri-Rosenblit (2005) pointed out that universities that adopt e-learning models can attract students from wider geographic basins, increasing their competitiveness. Similarly, Beine, Noël, and Ragot (2014) point out that distance learning allows access to educational programs without the economic and social costs associated with physical transfer, configuring itself not only as a tool for inclusion but also as an effective solution in emergency contexts.

According to the European Commission's Education and Training Monitor 2024, the number of students enrolled in Italian online universities has increased fivefold in the past decade. This trend is explained by factors such as greater flexibility in time management, the absence of compulsory attendance, and reduced travel and accommodation costs.

In conclusion, if before the pandemic, attractiveness was based on traditional factors such as the quality of infrastructure, academic reputation, and in-presence educational offerings, the lockdown has forced a forced transition to Emergency Remote Education, forcing rectors and policy makers to rapidly rethink strategies to maintain universities' competitiveness in the national and global context.

In light of the context analyzed and the literature consulted, this paper aims to offer an updated interpretative key to the mechanisms that regulate interregional university mobility in Italy, considering the growing incidence of distance education. The research pursues two main objectives:

RO1: analyze, at the regional level, the evolution of universities' Attractiveness Index (AI) and Distance Learning Enrollment Rate (RDL) between the pre-pandemic period (a.y. 2016/17) and the post-pandemic period (a.y. 2022/23), to capture any structural discontinuities related to the health emergency and the expansion of digital offerings.

RO2: to assess the impact of the increase in university courses delivered in distance learning mode on the territorial redistribution of educational demand and the redefinition of the determinants of interregional student mobility, with particular attention to the role of right-to-study policies.

Through these objectives, the research contributes to enriching the debate on the transition to a more hybrid, flexible and territorially equitable university system, highlighting how digital accessibility and university strategies are progressively flanking - and in some cases replacing - traditional structural and geographic factors in the choice of university location.

2. Data and method

This paper is based on an original data set specially constructed for the analysis, integrating variables from different national institutional sources, some of which are derived from unique surveys. The main sources used include: the National Student Registry (ANS), the Ministry of Universities and Research (MUR), the MUR's Educational Offer Data Bank, the MUR-ANS information system on subsidies and investments for the right to study, and the Territorial Human Capital Attractiveness Index (TEHA) developed by The European House - Ambrosetti.

The analysis focuses on two key academic years: 2016/17, considered the pre-pandemic period, and 2022/23, the post-pandemic period. The choice of these two moments allows to assess the structural effects of the health crisis on the organization of university teaching and student mobility dynamics.

In order to measure the attractiveness of Italian universities and the role of distance education, two main dependent variables were constructed:

Attractiveness Index (AI): represents the net difference between incoming and outgoing students from each region, related to the total number of student *movers*. This synthetic indicator makes it possible to assess the ability of regions to attract students from other areas.

$$AI_r = \frac{I_r - O_r}{I_r + O_r}$$

Distance Learning Enrollment Rate (RDL): measures the percentage of students enrolled in degree programs delivered by distance learning (full or partial) as a percentage of total enrollment in each region.

$$R_{DL,r} = \frac{\sum_{i=1}^{n_r} S_{i,DL,r}}{\sum_{i=1}^{n_r} S_{i,Total,r}} \times 100$$

To investigate the determinants of regional attractiveness, the analysis considers a number of independent variables aggregated at the regional level (Table 1).

Table 1 – Description of Independent Variables.

Variable	Source	Description
Part-time Collaborative Activities (CA)	MUR-ANS – Contributions and Investments	Percentage of students involved in paid collaboration activities within universities (e.g., tutoring, administrative support), as part of student support policies.
Allocated Accommodation Places (AP)	MUR-ANS – Contributions and Investments	Ratio between available student housing beds and the number of applications received, indicating the region's capacity to host non-resident students.
Traditional Course (TC)	MUR – Degree Program Database	Degree programs delivered entirely in person, representing the conventional teaching model.
Distance Learning Course (DLC)	MUR – Degree Program Database	Degree programs delivered fully or predominantly online, removing physical presence requirements and increasingly adopted after the pandemic.
Territorial Human Capital Attractiveness Index (TEHA)	The European House – Ambrosetti	Composite index measuring a territory's ability to attract and retain qualified human capital, based on factors such as employment opportunities, quality of life, infrastructure, and innovation.

The empirical analysis was conducted by estimating Ordinary Least Squares (OLS) linear regression models, separate for each academic year considered (2016/17 and 2022/23). The models estimate the marginal effect of a set of independent variables - related to the mode of degree delivery (traditional, blended or distance learning), the policies adopted by universities (activation rate of part-time collaborations and availability of accommodation), and the level of territorial attractiveness for qualified human capital (measured through the TEHA - Territorial Human Capital Attractiveness Index) - on the two dependent variables: the Attractiveness Index (AI) and Distance Learning Enrollment Rate (RDL). The OLS

method makes it possible to estimate the linear relationship between the variables by isolating the effect of each context and policy factor on college students' mobility behavior and educational preferences. The specification of the model adopted is as follows:

$$Y_r = \beta_0 + \beta_1 CA_r + \beta_2 AP_r + \beta_3 TC_r + \beta_4 DCL_r + \beta_5 TEHA_r + \epsilon_r$$

Where:

- Y_r represents, alternatively, the Attractiveness Index (AI) or Distance Learning Enrollment Rate (RDL) in region r ;
- $CA_r, AP_r, TC_r, DCL_r, TEHA_r$, represent the independent variables already described in Table 1;
- ϵ_r is the error term, which collects the unobserved components.

Estimates were made with standard errors robust to heteroscedasticity. To ensure the statistical validity of the results, diagnostic analyses were conducted on the residuals and multicollinearity checks among the explanatory variables by calculating the Variance Inflation Factor (VIF). Alternative model specifications (inclusion/exclusion of selected covariates) were also tested to verify the sensitivity of the results to the specification assumptions. In some cases, a log-linear form of the dependent variables was also explored, but no significant changes in the main results were found.

The adoption of the regional level as the unit of analysis, while not allowing for the capture of the punctual dynamics manifested at the level of individual universities or degree programs, is nevertheless functional to the objective of identifying territorial macro-trends in university mobility. This methodological choice is justified by the fact that many of the policies supporting students - particularly those aimed at ensuring the viability of courses of study, removing economic obstacles to accessing and continuing university studies, and promoting interregional mobility - are the responsibility of the regions (Art. 34 of the Italian Constitution). Within this institutional framework, aggregating data at the regional level is not only consistent with the administrative structure of the policies under analysis, but also allows us to observe more clearly the link between institutional interventions and student mobility behavior.

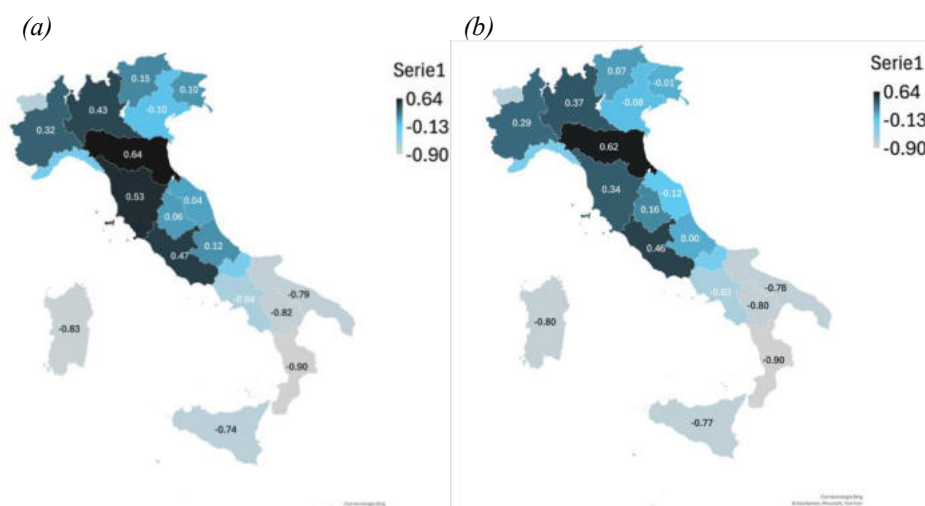
3. Attractiveness Index and diffusion of Distance Learning: a pre and post Covid-19 intra-regional comparison

Figure 1 shows the regional distribution of the Attractiveness Index (AI) of Italian universities in the academic years 2016/17 (Figure 1a) and 2022/23 (Figure 1b), that

is, before and after the Covid-19 pandemic. In 2016/17, the regions with the highest values of the index were Emilia-Romagna (0.64), Tuscany (0.53), and Lazio (0.47), all located in north-central Italy. At the macro-regional level, an average value of 0.43 was observed in the North, 0.48 in the Center, and -0.63 in the South and Islands, where regions such as Calabria, Basilicata, Sicily and Sardinia showed strongly negative values, confirming the established imbalances in outflows.

In 2022/23 (Figure 1b), the index shows a slight decline in historically attractive regions: Emilia-Romagna both drop to 0.62, Tuscany to 0.34, Lazio to 0.46, Lombardy from 0.43 to 0.37, and Piemonte from 0.32 to 0.29. The average value in the North falls slightly to 0.39, while that in the Center stands at 0.44. In the South and the Islands, the index remains negative, but there are slight signs of improvement in some regions: Puglia goes from -0.79 to -0.78, while Campania, Calabria, Sicily and Sardinia maintain stable negative values.

Figure 1 – *The attractiveness Index (AI) of universities in the academic year 2016/17 (Figure 1a - left panel) and in the academic year 2022/23 (Figure 1b- right panel).*



Source: own elaborations based on ANS data.

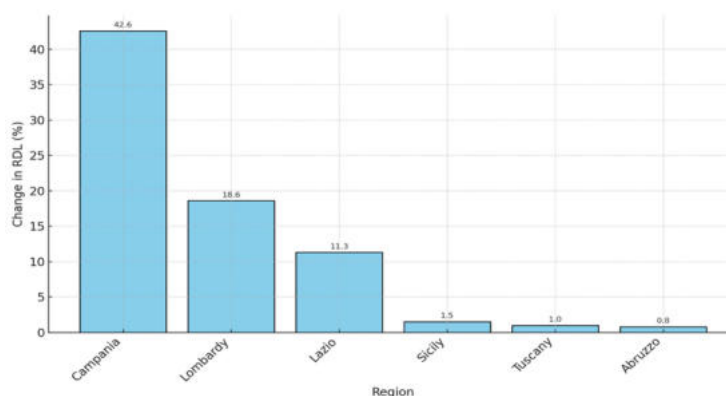
Figure 2¹ highlights regional changes in the rate of enrollment in distance learning (RDL) courses between 2016/17 and 2022/23. The increase is generalized and significant, reflecting a structural transformation of university educational offerings, accelerated by the pandemic. In 2016/17, Lazio was the only region with a high

¹ Figure 2 shows only those regions where the pandemic and the expansion of distance learning produced the most significant changes in enrollment rates, in order to highlight the most relevant shifts.

incidence of enrollment in online courses (47.3%), followed by Campania (12.4%), while in the rest of the country the percentages were almost zero (between 0.2% and 4.6%). In 2022/23, Lazio reaches 58.6%, Campania 55%, and Lombardy rises from 4.6 % to 23.2%. Significant growths are also observed in regions such as Sicily (from 0% to 1.5%), Tuscany (from 0.2% to 1.2%) and Abruzzo (from 0.3% to 1.1%).

This increase in distance learning has important implications for interregional student mobility. On the one hand, remote accessibility to university courses may have reduced the need for physical travel, contributing to the decrease in attractiveness experienced in some North Central regions (Figure 1b). On the other hand, the possibility of attending university remotely may have partially contained student emigration from southern regions, explaining the slight signs of recovery in the attractiveness index in some of them between 2016/17 and 2022/23 (Figures 1a and 1b).

Figure 2 – *Change in Rate of Students Enrolled in Distance Learning (RDL) between period before (a.y. 2016/17) and after Covid-19 (a.y. 2022/23).*



Source: own elaborations based on MUR – Degree Program Database

This change has major implications for the spatial attractiveness of universities and interregional student mobility. On the one hand, the increase in distance-mode courses may have reduced the need to physically travel to university locations, thus contributing to the slight decline in the Attractiveness Index (AI) observed in some traditionally attractive regions in the North-Central region. On the other hand, the ability to access university courses remotely may have mitigated student emigration from southern regions, contributing-at least in part-to the slight improvement in the Attractiveness Index observed in some of them between 2016/17 and 2022/23.

4. Analysis of some determinants of university attractiveness in Italy: the role of distance learning and student support policies before and after Covid-19

The results of the estimated regressions for the academic years 2016/17 and 2022/23 (Figure 3) allow us to analyze the evolution of the determinants of spatial attractiveness of universities and interregional mobility of university students. The increase in distance learning educational offerings, introduced in a massive way following the pandemic, profoundly reconfigures the geography of higher education in Italy.

In the pre-pandemic period, the Attractiveness Index (AI) of university regions is mainly determined by structural and contextual factors. Prominent among these is the TEHA Index, which summarizes the ability of a territory to attract qualified human capital (students, workers, professionals), based on dimensions such as employment opportunities, quality of life, access to services, infrastructure, and economic incentives (Ambrosetti, 2021). The estimated regression coefficient for TEHA in a.y. 2016/17 is high and statistically significant ($\beta = 2.455$; $p < 0.001$), indicating a strong link between university attractiveness and general conditions of territorial competitiveness.

At this stage, universities' own characteristics — such as offering courses in traditional or distance learning modes or activating student support measures — do not show significant effects on the attractiveness index. Interregional mobility follows well-established trajectories, directed toward major academic hubs in the North-Center, and reflects a logic of concentration of educational and professional opportunities (Bonaccorsi *et al.*, 2014; Triventi and Panichella, 2016).

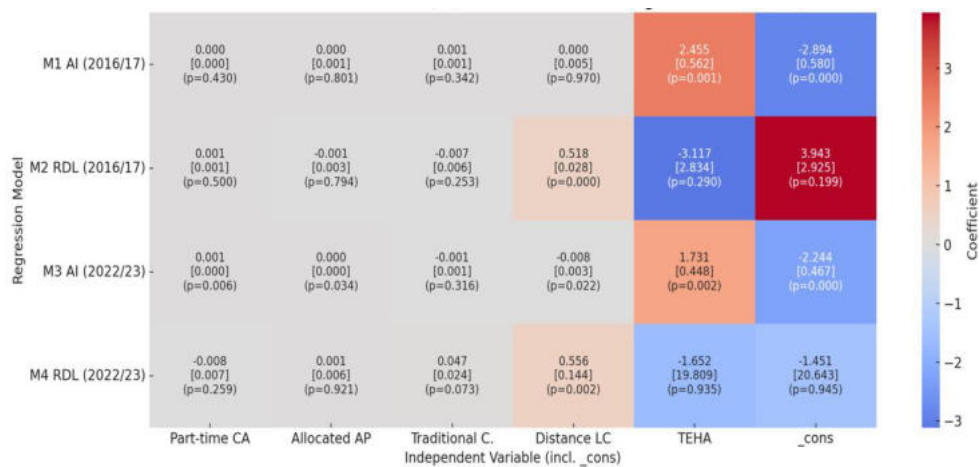
With the Covid-19 pandemic, these dynamics undergo a structural change. The massive and structured introduction of distance learning profoundly changes the behavior of student movers. Data referring to a.y. 2022/23 show a significant increase in enrollment rates in distance education courses, with marked differentials between regions and a direct impact on spatial attractiveness. The post-pandemic regression estimates a negative coefficient for the Distance Learning Course variable on AI ($\beta = -0.008$; $p = 0.022$), signaling that as online offerings increase, the physical attractiveness of regions decreases. This pattern is clearly illustrated in Figure 3, which provides a comparative heatmap of estimated coefficients and their statistical significance across models. A substitution effect of interregional mobility is observed, consistent with international evidence on the anchoring effect of educational digitization (Marginson, 2020).

At the same time, there is a new centrality of university policies on the right to study, particularly part-time collaborative activities ($\beta = 0.001$; $p = 0.006$). These show a significant correlation with attractiveness, suggesting that student mobility becomes more sensitive to the presence of economic instruments for the

sustainability of the university pathway. This shift reflects students' greater attention to the opportunity cost dimension and the possibility of self-financing. In parallel, the rate of enrollment in distance learning courses (RDL) appears to be increasingly influenced by the presence of distance education offerings. The model estimated for 2022/23 (M4) shows a strong positive effect of the Distance Learning Course variable on RDL ($\beta = 0.556$; $p = 0.002$), confirming that the availability of digital education pathways is now the main determinant of virtual university mobility. Conversely, structural variables such as TEHA, which were significant for territorial attractiveness, lose relevance in the context of online education, indicating a growing disconnection between the physical geography of academic offerings and student decision-making.

Overall, these results suggest that the post-pandemic period redefines the logics of university mobility. Physical student mobility declines, partly offset by a growth in virtual mobility (Panarello, 2022). Some regions gain attractiveness due to the increased flexibility and accessibility of online courses, while others—while maintaining a high academic presence—see their attractiveness weaken due to a reduced capacity to adapt to the evolving landscape of higher education delivery.

Figure 3 - Comparative Heatmap of Regression Coefficients and P-values for Attractiveness Index and Distance Learning Enrollment (a.y. 2016/17 and 2022/23)*.



* Each cell reports the regression coefficient and p-value; colors indicate direction and strength of the effect (red = positive, blue = negative). Emphasis is placed on statistically significant variables ($p < 0.05$).

5. Final remarks

This paper offers an updated reading of interregional university mobility processes in Italy, in light of pandemic-induced transformations and the expansion of distance learning. The analysis confirms that the increase in educational offerings in digital mode has introduced new balances in the geography of university attractiveness, reducing the relevance of traditional territorial factors and favoring more flexible access that is less constrained by physical presence (Education and Training Monitor, 2024; MIUR, 2023).

Methodologically, the work is distinguished by the use of an original, purpose-built dataset, which integrates heterogeneous institutional sources (ANS, MUR, educational supply database, GII - Ambrosetti), some of which have so far been poorly explored in the literature on university mobility (ISTAT, 2023). The use of separate OLS models for each academic year makes it possible to capture temporal discontinuities and to estimate the marginal impact of independent variables with high precision.

The results show a substantial change in the determinants of attractiveness: in the pre-pandemic period, the spatial context (as measured by the TEHA Index) is the main driver of mobility, while in the post-pandemic period the substitution effect of distance learning courses and the centrality of study policies, such as part-time collaborations, emerge strongly. This suggests that university attractiveness is progressively shifting from a logic of concentration of spatial opportunities to one based on personalization of supply and affordability and digital accessibility.

In conclusion, the research contributes significantly to the scholarly debate on the transition to hybrid and inclusive university models by providing empirical tools for understanding new student choice strategies. It also lays the groundwork for future reflections on territorial cohesion policies and equity in access to higher education, in a context increasingly marked by virtual mobility and competition among universities on a national and global scale.

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THE EDUCATIONAL PATHWAYS OF YOUNG PEOPLE IN METROPOLITAN CITIES. A MULTIDIMENSIONAL ANALYSIS ACROSS URBAN CONTEXTS¹

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Abstract. An unequal territorial distribution of educational and scholastic supply limits accessibility to a complete educational and education system and the development of specific skills and abilities, exposing young people to a condition of educational and social fragility. In this study we develop an analysis of the educational and schooling pathways of young people aged 0-24 in the 14 Italian metropolitan cities and we verify whether there is a territorial differential, between more urbanised contexts and municipalities distant from the capital city, in the use of the educational and schooling system, in the supply structures and in the levels of education achieved.

1. Young people and educational fragility

In recent decades, profound demographic, socio-economic and cultural transformations have significantly impacted the living conditions and educational pathways of young people, contributing to the emergence of new forms of youth vulnerability. These changes are associated with an increasing exposure to the risk of educational poverty, understood as the deprivation of adequate opportunities for children and young people to learn, experiment and fully develop one's potential (Save the Children, 2014). Educational poverty is a multidimensional phenomenon, resulting from the family, economic and social context in which children and young people live, which is not limited to a lack of material resources but also includes a lack of educational, cultural and relational resources². This condition, now structural in many areas of the country, is closely linked to territorial segmentation and inequalities in access to educational pathways (Battilocchi, 2020).

Increasingly central to scientific and political debate, the issue of educational poverty has become even more relevant following the effects of the Covid-19 pandemic, which has worsened socio-economic conditions and negatively affected

¹ The paper has been jointly written by all the authors but § 1 and 2 can be attributed to D. Tronu, § 3 to V.F. Bellafiore, § 4 to L. Martina, § 5 to D. Cangialosi, § 6 all the authors. Elaborations have been realised by V.F. Bellafiore and L. Martina; maps by V.F. Bellafiore.

² This multidimensional approach goes beyond the anglo-saxon measure of educational poverty, which focuses on the failure to reach educational outcomes, both in terms of school attainment and achievement (Istat, 2024b).

young people's learning and cognitive development (Save the Children, 2021). The difficulty of the school system in guaranteeing truly equal conditions of access to education, personal growth and social participation for young people contributes to the consolidation of educational inequalities linked to the territorial context and the socio-economic background of the families of origin (Save the Children, 2024).

Educational poverty is therefore a particularly form of social exclusion, as it hinders young people's acquisition of essential skills for their personal, civic, and professional development, limiting their future opportunities for skilled employment in the labour market. This phenomenon is recognised as a determining factor in the reproduction of social and territorial inequalities, deeply connected to the segmentation of educational offer and processes of spatial segregation that penalise the most fragile contexts, generating a continuous circle linking low education, job insecurity and social marginalisation (Ballarino *et al.*, 2021).

In complex urban contexts educational and in particular in Italian metropolitan cities, inequalities take on diversified forms, reflecting the social, demographic and economic specificities of the territories. This variability is influenced by an unequal distribution of educational and school services, which is intertwined with structural factors - such as low birth rates, the socio-cultural composition of families and the parents' education- significantly influencing the access, participation and educational attainment and achievement of the new generations. The Italian metropolitan cities, although they represent poles of higher concentration of essential services, present deep internal imbalances in the territorial distribution of educational resources. The capital cities have a greater endowment of early childhood and upper secondary educational services, while the peripheral areas continue to suffer from a structural lag, with levels of educational coverage and per capita public expenditure significantly lower (Istat, 2024a). These imbalances contribute to the spread of educational fragility phenomena, such as an increased number of early school leavers, repeaters and students completing school with inadequate skills (explicit and implicit dropout), leading to low educational attainment levels and difficulties for young people to enter the labour market. These inequalities in urban contexts are increasingly linked to factors of residential and functional segregation, as well as to the limited capacity of local policies to respond equitably to the demand for educational services. The territorial distribution reflects structural mechanisms of social selection and differentiated public investments, which generate cumulative effects on the educational and employment pathways of young people (Burgess and Sievertsen, 2020).

Based on this framework, the study investigates, also using multivariate techniques, how the composition of youth demand and the uneven distribution of educational offer in Italian metropolitan cities contribute to the definition of different territorial patterns of educational and occupational vulnerability. In particular, infra-

urban dynamics are analysed, highlighting the disparities within metropolitan cities and comparing the metropolitan territories of the North and the South, with the aim of bringing out the interactions between structural, social and spatial factors that influence young people's access to and success in education. The aim is to provide evidence to guide targeted policies that reduce territorial inequalities in young people's educational pathways and promote equity in access to education and the labour market, in line with the 2030 Agenda goals³.

2. Data and Methods

This paper presents a descriptive and multivariate analysis of the main socio-demographic characteristics and the educational pathways of young people in Italian urban contexts. This analysis is integrated with several indicators concerning the availability of educational services and school facilities, with the aim of identifying recurring patterns and territorial configurations that highlight the main critical issues related to educational inequalities. The reference area consists of the 14 metropolitan cities⁴, comprising 1,268 municipalities, and their respective territorial subdivisions, defined in accordance with criteria of geographical contiguity starting from the capital municipality, surrounding it are the municipalities belonging to the first and second belts municipalities, as well as the other municipalities within the metropolitan city (Istat, 2020). The descriptive analysis is based on a selection of indicators, referring to the period 2021-2022 and representing the main dimensions of both educational demand and supply, identified according to the availability and accuracy of data at the municipal level⁵.

The study focuses on the population aged 0–24, starting from early childhood – a crucial stage for reducing social and cognitive development gaps and extending to adolescents and young people, through the analysis of school participation and outcomes, using also several proxy indicators as repeater rates, educational attainment levels and young people not in education and not employed⁶ (Istat, 2024 a). Based on the assumption that an unequal geographical distribution of educational and school facilities can limit learning opportunities and hinder the development of specific skills and competences, cluster analysis is used to verify the existence of

³ Goal 4 of the 2030 Agenda aims to ensure quality education and equal opportunities, to reduce educational disparities and to strengthen inclusive education systems.

⁴ Italian metropolitan cities are territorial entities that have replaced provinces in 10 urban areas of ordinary statute regions, to which are added four metropolitan cities of special statute regions.

⁵ Only the mobility indicator refers to 2019, as it was the last year available at the time of drafting the contribution.

⁶ Indicators on students leaving school with inadequate skills (low performers), collected by Invalsi, were not used in the analysis, as it was not possible to calculate data for all territorial subdivisions of the metropolitan cities.

disparities between metropolitan areas with high availability of such facilities and those where access is limited and student mobility to municipalities other than where they live is high. In metropolitan cities, conditions of more educational fragility tend to be concentrated in cities in the South of Italy compared to those in the North and, within urban areas, in municipalities that are geographically further away from the main centres providing essential services, which are generally concentrated in the capital cities (Istat, 2024a). Cluster analysis therefore offers an additional multidimensional interpretation that is useful for a more granular understanding of the relationship between human capital development and school and territorial context, supporting the definition of targeted interventions aimed at ensuring higher levels of education quality, increased school participation and social inclusion of young people in the most critical metropolitan areas.

The indicators come from many Istat and Sistan sources and were calculated by aggregating the data available at the municipal level for the 56 suburban areas of the 14 metropolitan cities, comprising 1,268 municipalities and defined on the basis of municipal geography as of January 1, 2024 (Table 1). Data relating to the supply of early childhood education services (authorised places and expenditure by Municipalities), as well as those on the socio-demographic characteristics of young people (incidence and dynamic of the population aged 0-24, educational attainment levels, population not in education and not employed⁷ and people daily commuting for study purposes within their municipalities of residence), come from Istat sources. Data regarding school resources, full-time enrolled and repeaters in the upper secondary schools are provided by the Ministry of Education and Merit (MIM).

Table 1 - Indicators by total of metropolitan cities.

Dimension	Indicator	Code	Source	Year	Median	Min.	Max.
Socio-demographic characteristics	Change in population 0-24 (1992-2022) (%)	VAR_0-24	Istat	2022	-22,5	-55,6	65,3
	Population 0-24 (% of total)	POP_0-24	Istat	2022	21,9	17,1	28,0
	Population 20-24 with at least upper secondary education level (%)	EDU_20-24	Istat	2022	86,5	71,1	90,5
	Mobility within the municipality for study purposes (%)	MOB	Istat	2019	63,2	45,0	99,4
	Population 15-24 not in education and not employed (%)	NOT_ST_EMPL	Istat	2022	15,9	9,7	26,8
	Employment rate 15-24 years	EMPL_15-24	Istat	2022	18,9	12,1	27,7
School context	Authorised places of early childhood education services (per 100 aged 0-2)	AP_0-2	Istat	2022/2023	27,0	8,0	55,4
	Municipal per capita expenditure on early childhood (values in euro per child aged 0-2)	EXP_0-2	Istat	2022	644	0	4638
	Upper secondary schools (% of total schools)	UPP_SEC_SC	MIM	2021/2022	11,4	0,0	22,6
	Enrolled by school full time in pre-primary school (% of total enrolled)	ENR_FT_PRE	MIM	2021/2022	83,0	16,3	99,8
	Enrolled by school full time in primary school (% of total enrolled)	ENR_FT_PRI	MIM	2021/2022	38,6	1,1	92,8
	Repeaters in upper secondary schools (per 100 enrolled in total)	REP	MIM	2021/2022	6,7	0,2	23,7

⁷The last indicator differs from NEET (Neither in Employment nor in Education and Training) as it uses Istat Census data on professional and non-professional condition and includes 15–24-year-olds actively seeking work or in non-professional status other than studying or receiving pensions from previous work or capital income.

3. Main indicators on educational pathways of young people

This section analyses some of the indicators used in the cluster analysis, to identify the main territorial disparities across the dimensions of the framework.

Young people are the key component for the development of a cohesive, inclusive and sustainable society. In metropolitan cities, people aged 0-24 on 31 December 2022 are 4.8 million (36.8% of total Italian youth) and represent 22.7% of total population. They have decreased significantly over the last 30 years (-19.7%). Southern metropolitan cities have a higher incidence of youth particularly in Naples, Catania and Palermo, but also the sharpest declines up to -44.4% in the metropolitan city of Cagliari (Figure 1). Only Bologna shows an increase in the youth segment (+23%). In the capital cities, the contraction of young people (-27.2%) is greater than in the municipalities of the first two urban belts.

Figure 1 – Population aged 0-24 and change in population in the metropolitan cities (%).

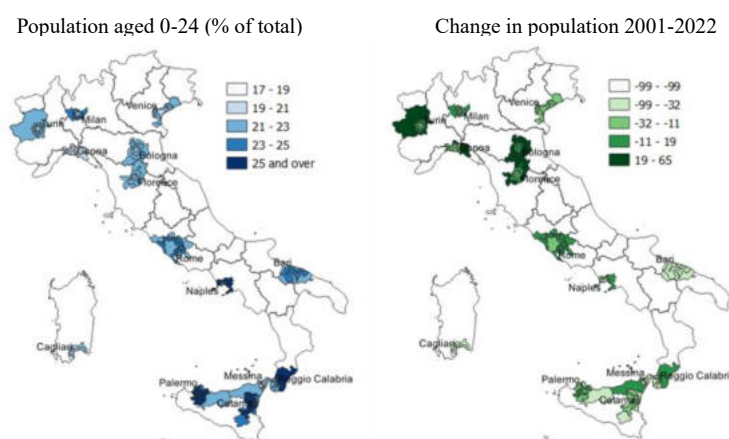


Figure notes: Elaboration on Istat data

The offer of educational and school services is crucial to promote accessibility and participation in the education system and to ensure equal opportunities. Authorized places by Municipalities in public and private early childhood services, in the educational year 2022/2023, are 30.7 places per 100 children under 3 years old and show significant disparities between metropolitan cities in the North-Centre and those in the South (Table 2). The MCs North-Centre exceeds the target of 33.0%, with the exception of Venice and maximum values in Bologna (49.4%) and Florence (45.8%). The most critical values are in the South especially in Naples and Catania, below 13%. Place coverage is highest in the capital cities (38.3%) and lowest in the second belts (22.6%). Full-time school attendance is prevalent in pre-primary (76% of total enrolled) and reaches almost half of total enrolled in primary schools, but with relevant territorial differences. This option is widespread in the metropolitan

cities of the Centre-North, especially in Bologna (pre-primary 97.1%) and Milan (primary 87.8%). The southern metropolitan territories are more disadvantaged in offering this service, mainly in primary school, with Palermo in last place (primary school 5.9%).

Table 2 – Education services, enrolled by school time and repeaters*. Year 2021/2022 (%).

Metropolitan Cities	Authorised places of early childhood education services				Full time pre-primary school				Full time primary school				Repeaters in the upper secondary schools for 100 enrolled in total			
	Capital cities	First belt	Second belt	Total MC	Capital cities	First belt	Second belt	Total MC	Capital cities	First belt	Second belt	Total MC	Capital cities	First belt	Second belt	Total MC
Turin	43.9	38.1	31.8	36.3	80.1	96.0	90.0	88.5	77.7	87.1	71.1	72.5	7.4	6.7	6.9	6.7
Milan	48.0	44.5	37.6	42.4	87.2	85.9	82.3	86.2	82.4	92.8	88.3	87.8	6.4	6.8	6.9	6.6
Venice	39.3	27.0	28.5	30.1	93.8	96.8	99.8	95.7	71.5	38.4	52.5	37.4	7.3	6.4	6.8	6.8
Genoa	40.7	25.6	30.8	38.4	97.2	98.3	95.4	96.2	61.7	38.6	24.0	52.9	8.3	3.1	2.0	8.2
Bologna	51.8	53.3	50.1	49.4	97.3	96.5	99.5	97.1	61.7	70.0	75.3	63.9	6.7	6.6	5.9	7.2
Florence	55.4	42.2	38.8	45.8	91.4	93.3	98.6	93.5	81.0	64.1	68.3	71.4	7.2	7.8	8.8	8.1
Rome	51.2	30.6	21.3	43.0	81.7	64.2	68.8	73.2	75.0	58.9	39.0	68.2	4.8	5.1	7.9	5.2
Naples	15.8	13.4	8.5	12.3	80.0	69.9	70.8	77.6	32.2	13.3	11.3	19.4	7.9	6.0	7.8	6.7
Bari	26.4	16.9	17.9	21.1	45.2	61.2	84.3	75.6	17.8	16.6	13.0	15.7	4.5	6.7	4.4	4.6
Reggio Calabria	20.5	11.2	8.9	15.9	58.4	78.1	54.4	68.9	7.8	8.9	33.9	13.0	4.7	15.1	8.9	8.0
Palermo	12.8	15.3	14.0	13.4	16.9	16.3	22.7	22.2	4.8	1.1	1.4	5.9	8.6	5.7	8.5	8.1
Messina	10.3	24.9	23.3	19.4	44.9	48.9	77.1	67.2	14.1	8.1	39.5	18.6	6.0	-	0.2	5.6
Catania	8.0	8.8	12.8	11.4	25.5	18.8	32.4	30.3	11.0	6.2	8.4	9.0	7.3	3.8	6.4	6.9
Cagliari	42.1	42.1	31.0	40.5	99.4	93.9	98.0	96.5	45.0	26.0	17.9	32.4	10.3	12.9	23.7	11.5
Totale MC	38.3	29.1	22.6	30.7	76.8	73.3	74.5	76.0	57.5	60.7	40.1	49.5	6.7	6.5	6.9	6.6

Table notes: Elaboration on Istat and MIM data. *Authorized places are referring to educational year 2022/2023.

A measure of school outcomes is given by the share of repeaters, which is 6.6% per 100 enrolled in secondary schools. The worst performance is recorded in the MC of Cagliari (11.5%), followed by Genoa (8.2%), Palermo and Florence (8.1%). The best result is recorded in the MC of Bari (4.6 repeaters per 100 enrolled). At infra-territorial level, the incidence of repeaters is slightly higher in the second belts, among which Cagliari stands out (23.7%). There is also a gender difference with a worst result for boys (8.2%) than for girls (4.9%), in all territories.

The educational qualification is essential to enter the labour market. In 2022, 85.4% of 20-24 year olds in metropolitan cities had at least upper secondary education, with the highest values in the MCs of the Centre-North, particularly Rome, Venice and Bologna (Figure 2).

Within the metropolitan territories, the capital cities have lower levels of education than the urban belts, except for Rome and Cagliari. There is also a gender difference showing a higher level of education for girls (88.2%) than for boys (82.8%). The lack of appropriate skills and a high level of education contributes to increasing the number of dissatisfied young people who, by not studying and not working, dissipate their human potential that should instead be put to the benefit of society as a whole. Young people neither studying nor working make up 16.3% of people aged 15–24 in the metropolitan cities, with the highest rates in Palermo, Catania (both 24.2%) and Naples (23%). The metropolitan city of Florence stands out as having the lowest value (10.3%). Considerable differences are found within the metropolitan areas, with worst values in the second belts (17.6%). The phenomenon does not show marked gender differences, 16.6% for females and 16.1% for males.

Figure 2 – Population aged 20-24 with at least upper secondary education and not in education and not employed (%). Year 2022

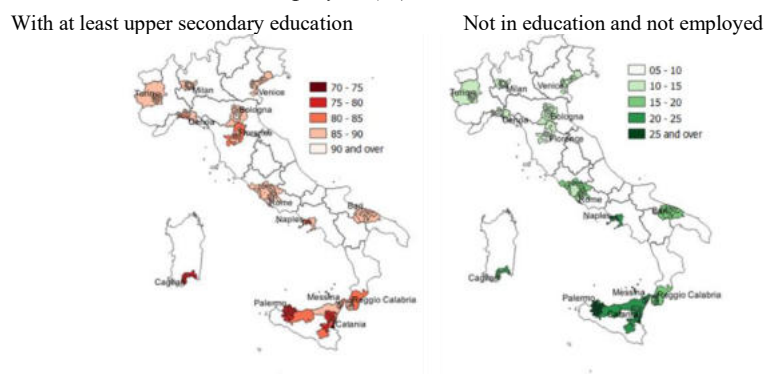


Figure notes: Elaboration on Istat data

4. Cluster analysis

Cluster analysis is applied to the set of twelve indicators and for the 55 territorial levels⁸ of the MCs to identify homogeneous groups of territories. A preliminary correlation analysis shows that the most highly correlated indicators are NOT_ST_EMPL and EMPL_15-24 (–0.88), EXP_0-2 and AP_0-2 (0.84); however, we decided to retain all indicators because they capture distinct theoretically relevant dimensions. Before running cluster analysis, the indicators were scaled using the standardization method (z-score). For cluster analysis, the k-means algorithm (MacQueen, 1967) is used. It is a non-hierarchical clustering tool and its objective is to subdivide a set of units into k clusters based on their similarity, minimizing the total intra-cluster variance and maximizing the inter-cluster variance. The optimal number of clusters into which the data should be divided is not known a priori, which is why the clustering analysis is performed for different values of k, ranging from 2 to 8. To evaluate the clustering method and the choice of the number of groups in this work, the Elbow and the Silhouette (Rousseeuw, 1987) methods are used. The Elbow method is a graph in which the optimum number of clusters is determined by the point forming an “elbow”, indicating that higher numbers of clusters do not significantly reduce the within-group sum of squares. Silhouette method is based on the calculation of intra and inter-cluster distances and is implemented by calculating the silhouette value⁹ for each data point and averaging the result over the entire data

⁸ Only one territory (other municipalities in the metropolitan city of Cagliari) is excluded as it consisted of only one municipality, which led to distorting results in the cluster analysis.

⁹ Silhouette = $(AverageOut - AverageIn) / \max(AverageOut, AverageIn)$, where AverageOut is the minimum average distance between the data point and data within other clusters and AverageIn is the average distance between the data point and other data within the same cluster.

set. The average of the silhouette can vary between -1 and 1: a value close to 1 means that the cluster is well formed, a value close to 0 indicates that the position is unclear and a value close to -1 that the dataset is poorly subdivided. The Elbow method (Figure 3) shows that the optimal number of clusters can be observed at $k=5$, although not very pronounced. Table 3 shows Silhouette and RSQ values, calculated as the number of clusters varies from 4 to 8. The clusters with fewer clusters (2 and 3) are excluded, which are not very explanatory for the purposes of our analysis. The 5-group cluster has the highest silhouette value (0.2682) with a variance explained by the model (RSQ) equal to 0.6263, while the 4 and 6-group clusters show the next best values for the silhouette (0.2550 for both). Therefore, the two combined methods lead us to choose the optimal number for $k=5$.

Figure 3 – Elbow method. WSD by number of clusters.

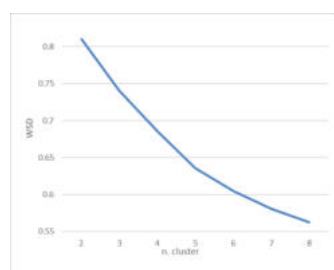


Table 3 – Cluster analysis statistics by number of clusters.

N. cluster	Silhouette	RSQ
4	0.2550	0.5566
5	0.2624	0.6263
6	0.2550	0.6684
7	0.2448	0.7002
8	0.2294	0.7242

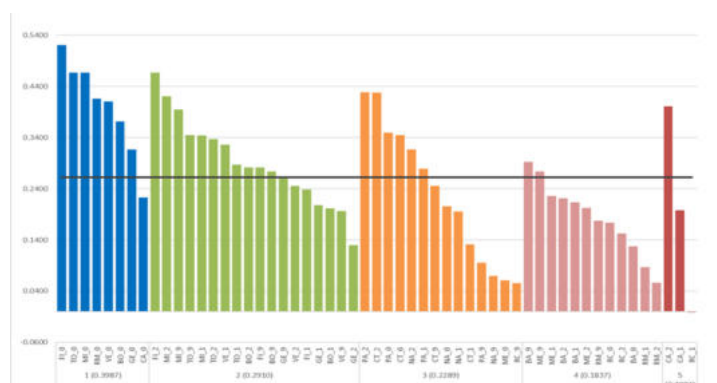
Table and figure notes: WSD=Within cluster standard deviation pooled over clusters and all the variables; RSQ=R square pooled over all the variables

Silhouette average values (Figure 4) in each group for the five-group cluster highlight that in this classification the groups are strong with fairly high values, even though there is a small cluster with only three territories (RC_1, CA 2, CA 1).

The highest value is presented by first group (0.3987), which comprises the eight MCs capital cities of the Centre-North and Cagliari capital city, while the lowest value is presented by the fourth group (0.1837), composed of Southern territories; the only negative value is given by RC_1 in the 5-group of the only three territories.

5. Cluster analysis: results and territorial gaps

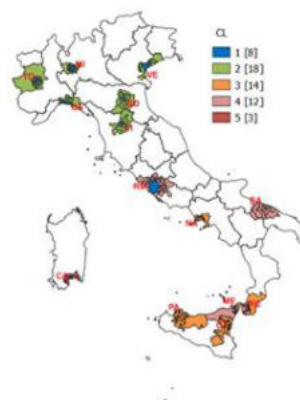
The results of the cluster analysis confirm the existence of a North-South gradient in the educational offer of the territory, which however does not necessarily condition the levels of education achieved also thanks to the good degree of mobility outside the municipality of residence. Instead, there are territorial disadvantages in the level of education and labour market participation. The demographic weight of the youth component is more in favour of the South which has a younger structure and is also confirmed in the formation of the groups.

Figure 4 – Silhouette values by group and territories for the five-group cluster.

The profiles of the five groups (Figure 5) obtained by cluster analysis are shown in Table 5, which presents the average values of the indicators in the groups.

Table 5 – Cluster centres and value Italy by indicators. **Figure 5** - Metropolitan cities by clusters.

	Cluster centres					Overall	Italy
	CL1	CL2	CL3	CL4	CL5		
VAR_0-24	-22.4	3.9	-26.9	-24.5	-39.5	-16.6	-23.2
POIP_0-24	20.1	21.6	25.2	22.3	20.9	22.4	22.3
EDU_20-24	85.2	87.8	80.8	87.6	81.3	85.3	86.0
MOB	94.0	58.2	72.8	67.0	53.7	68.8	70.7
NOT_ST_E	12.5	11.2	23.5	18.0	19.7	16.5	14.7
EMPL_15-2	20.8	25.1	14.2	17.2	15.5	19.5	21.5
AP_0-2	46.5	36.0	12.5	22.2	28.1	28.1	30.0
EXP_0-2	2973.6	1286.9	338.7	574.0	435.0	1088.9	1,116.0
UPP_SEC	17.4	8.2	14.2	10.5	6.1	11.4	12.8
ENR_FT_PI	91.0	93.9	45.8	67.3	89.3	75.2	83.0
ENR_FT_PI	69.5	63.0	11.7	28.4	17.6	40.9	39.2
REP	7.3	6.7	6.8	4.9	17.3	7.0	6.6



The first cluster (CL1) includes the eight capital cities of the MCs of the Centre-North and Cagliari, which present advantageous situations in the offer of services and results. They register excellent performances in the supply of educational services (authorised places for early childhood cover 46.5% of children under 3 years old) and of school facilities, including the use of full time in both pre-primary and primary schools (91.0% and 69.5% of enrolled respectively). Per capita expenditure on early childhood education services (2,974 euro) is the highest compared to the other groups. Levels of education and participation of young people in the labour market are also high, with high mobility within the municipality for study purposes and thus strong self-containment. However, the incidence of young people aged 0-24 is the lowest (20.1%). Nearly 1.4 million young people aged 0-24 (28.8%) reside

in this group, concentrated in the eight capital cities (Table 6). The second cluster (CL2) includes all the urban belts of the six metropolitan cities of the North (18 territories) with advantages in education and employment pathways despite the low supply of upper secondary schools. Levels of education and participation of young people in the labour market are highest (87.8% and 25.1% respectively), but are accompanied by the low incidence of upper secondary schools (8.2%) and commuting within the municipality for study purposes, thus with low self-containment. They achieve good performance in the offer of educational services, with high full-time attendance in pre-primary (93.9%) and primary schools (63.0%). In demographic terms, this cluster is the only one in which there are been an increase in the number of young people over the last thirty years (+3.0%). In this group of 18 urban belts made up of 646 municipalities, 1.2 million young people aged 0-24 live (24.2%), so they are more dispersed across the territory than CL1.

Table 6 – Clusters characteristics.

Cluster	Territories	N. Territories		Population 0-24		N. Municipalities	
		a.v.	%	a.v.	%	a.v.	%
CL1	Total (% on Total groups)	8	14.5	1,400,023	28.8	8	0.6
The capital cities of the Centre-North and Cagliari have an advantage in offering services and outcomes	Capital cities (%on Total CL1)	8	100.0	1,400,023	100.0	8	100.0
	1st Belt (%on Total CL1)						
	2nd Belt (%on Total CL1)						
	Other Mun. MC (%on Total CL1)						
CL2	Total (% on Total of groups)	18	32.7	1,175,246	24.2	646	51.0
The urban belts of the Northern MC's have an advantage in education and employment, despite the lower supply of secondary schools	Capital cities (%on Total CL2)						
	1st Belt (%on Total CL2)	6	33.3	377,965	32.2	79	12.2
	2nd Belt (%on Total CL2)	6	33.3	285,249	24.3	97	15.0
	Other Mun. MC (%on Total CL2)	6	33.3	512,032	43.6	470	72.8
CL3	Total (% on Total of groups)	14	25.5	1,469,571	30.3	310	24.5
The main urban centres in the South with their belts with major issues in offering services and outcomes	Capital cities (%on Total CL3)	4	28.6	504,964	34.4	4	1.3
	1st Belt (%on Total CL3)	3	21.4	232,914	15.8	32	10.3
	2nd Belt (%on Total CL3)	3	21.4	276,028	18.8	54	17.4
	Other Mun. MC (%on Total CL3)	4	28.6	455,645	31.0	220	71.0
CL4	Total (% on Total of groups)	12	21.8	747,038	15.4	276	21.8
Other metropolitan areas in the South, urban belts of Rome with high criticalities in the educational supply and school services	Capital cities (%on Total CL4)	2	16.7	106,202	14.2	2	0.7
	1st Belt (%on Total CL4)	3	25.0	242,687	32.5	46	16.7
	2nd Belt (%on Total CL4)	4	33.3	165,943	22.2	55	19.9
	Other Mun. MC (%on Total CL4)	3	25.0	232,206	31.1	173	62.7
CL5	Total (% on Total of groups)	3	5.5	61,043	1.3	27	2.1
Cagliari belts and first belt of Reggio Calabria with worst issues in school services and educational and labour outcomes	Capital cities (%on Total CL5)						
	1st Belt (%on Total CL5)	2	66.7	49,067	80.4	20	74.1
	2nd Belt (%on Total CL5)	1	33.3	11,976	19.6	7	25.9
	Other Mun. MC (%on Total CL5)						
Total		55	100.0	4,852,921	100.0	1,267	100.0

Table notes: population is referred to 31 December 2022.

The third cluster (CL3) brings together the main urban centres of the South with their belts (14 territories), that present the most critical problems in the supply of services and outcomes. They present the highest presence of young people aged 0-24 (25.2%), even if significantly decreasing over the thirty-year period, accompanied by the lowest values of the supply and expenditure for educational services and of the use of full-time education in pre-primary (45.8%) and primary schools (11.7%).

The values of the level of education and participation in the labour market are also lower. The supply of upper secondary schools is appreciable compared to the other groups (14.2%), with a good degree of self-containment (72.8% mobility within the municipality for study purposes). There are 1.47 million young people aged 0-24 in this group (30.3%).

The fourth cluster (CL4) includes the other metropolitan territories and urban belts of Rome (12 territories) with high criticalities in the supply of educational and school services but with a good level of education. The supply and expenditure for educational services are very low, but they are accompanied by a good supply of full time in pre-primary schools (67.3%). The incidence of upper secondary schools in relation to the total is low (10.5%), which is associated with low self-containment due to considerable mobility outside the municipality for study purposes. Levels of education are high (87.6%), but levels of participation in the labour market and education are low. In this group, there are 747,000 young people 0-24 (15.4%).

Finally, the fifth cluster consists of Cagliari belts and first belt of Reggio Calabria (3 territories) with the most critical issues. It is characterised by the greatest decrease in the population aged 0-24 (-39.5%), the lowest supply of upper secondary schools (6.1%) and the highest incidence of repeaters in upper secondary schools (6.1%). Expenditure on educational services is low, but there is excellent utilisation of full-time in pre-primary schools (89.3%). These areas have low levels of education and labour market participation, with 61,000 young people 0-24 live there (1.3%).

6. Conclusions

The multidimensional analysis of the educational offer and of the educational pathways of young people in the 14 Italian metropolitan cities is carried out on a new subdivision of the selected territorial domain, which allows to capture intra-metropolitan disparities more effectively. Around the metropolitan capitals, first-and second-level urban belts are identified, which, being progressively more distant from the large urban centers, have fewer services and are considered to potentially affect the educational vulnerability of young people. The results of the analysis confirm profound territorial inequalities that influence access, participation and educational outcomes, both within and across metropolitan cities. The MCs of Centre-North generally show better provision of educational services and higher school performance, whereas many Southern areas, especially the peripheral territories, suffer from insufficient provision and greater educational vulnerabilities. Student mobility towards capital cities with better educational provision partially mitigates these imbalances but does not eliminate initial disparities stemming from family, social and territorial background. These findings highlight the need of investment in educational services, school quality and to reduce early school leaving in these fragile areas. For the definition of policy actions, continuous monitoring based on

granular and timely data and a multidimensional approach is required, in order to promptly identify the areas of greatest vulnerability and to implement targeted and differentiated interventions capable of strengthening the educational offer in disadvantaged areas, thereby promoting inclusion and educational equity.

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FLOURISHING AND TIME USE AMONG UNIVERSITY STUDENTS: PRELIMINARY EVIDENCE FROM AD HOC SURVEY DATA

Maria Gabriella Campolo

Abstract. This study examines the relationship between university students' time use and psychological flourishing, focusing on the mediating role of leisure. Using cross-sectional survey data from the University of Messina (spring 2024) analysed with post-stratification weights, a Generalized Structural Equation Model disentangle direct and indirect associations between sociodemographic, attitudinal, and behavioural factors and eudaimonic well-being. Active forms of leisure (volunteering, sport, and general leisure), are positively associated with flourishing, whereas passive media use shows a negative link. Commuting indirectly reduces flourishing by limiting participation in active leisure. Students with more traditional gender-role attitudes report higher flourishing, possibly due to cultural value alignment. The findings underscore the importance of promoting inclusive and meaningful leisure opportunities to foster student well-being in higher education.

1. Introduction

In recent years, the well-being (WB) of university students has attracted growing scholarly and policy attention, reflecting concerns over mental health challenges, academic pressure, and socioeconomic precarity in higher education (Bewick *et al.*, 2010; Stallman, 2010; Busetta *et al.*, 2024). The university experience requires balancing academic demands, social adjustment, and often unstable living arrangements, all of which may affect students' psychological functioning (Bakker and Mostert, 2024). Among the various dimensions of WB, flourishing, a state of eudaimonic WB encompassing meaning, purpose, engagement, self-acceptance, and positive relationships, has gained increasing prominence (Ryff, 1989; Diener *et al.*, 2010; Seligman, 2011). However, most studies focus on adult or occupational populations, leaving limited evidence on the behavioural and contextual antecedents of flourishing among university students. Leisure time (defined as time free from compulsory academic or work obligations) can either support or hinder psychological well-being (PWB) depending on the nature of activities pursued. Active forms of leisure, such as volunteering, sport, and creative engagement, are typically linked to more favourable outcomes, whereas passive activities like television viewing, streaming, or social media use may offer only temporary relief

and sometimes relate negatively to long-term flourishing (Robinson and Godbey, 1997; Kuper *et al.*, 2023).

Drawing on leisure studies, positive psychology, and time use research this study examines how different types of leisure contribute to students' flourishing. Combining a time-use approach with the eudaimonic perspective on WB (Huta and Waterman, 2014), it examines the relationship between time use and psychological flourishing among a sample of students from the University of Messina, using data from an ad hoc online survey conducted in spring 2024. The analysis focuses on four domains of leisure activity: volunteering, sport, general leisure, and mass media use. Flourishing is measured using the validated Flourishing Scale-FS (Diener *et al.*, 2010), and a range of sociodemographic and attitudinal covariates are included, such as gender, age, perceived economic condition, gender-role values, and housing status. Three hypotheses guide the empirical analysis:

H1: Active forms of leisure are positively associated with flourishing, while passive forms are negatively associated (Newman *et al.*, 2014).

H2: Students' sociodemographic and attitudinal factors influence flourishing directly and indirectly through time use. (Diener *et al.*, 2010).

H3: Students who live off-site or commute daily engage differently in leisure activities compared to on-site residents, and these differences partially mediate disparities in flourishing outcomes (Martin and Kilgo, 2015).

The analysis combines weighted Ordinary Least Squares (OLS) regressions and Structural Equation Modelling (SEM) to assess both direct and mediated link between time use and flourishing. This two-step approach offers a comprehensive analytical framework, though the cross-sectional design limits causal inference and the possibility of reverse causality, where flourishing promotes greater leisure engagement, cannot be excluded. By exploring how students spend their time and how these behaviours relate to psychological flourishing, this study contributes to a deeper understanding of the behavioural and structural correlates of WB in higher education. The findings offer insights for the design of student-centred policies and extracurricular initiatives aimed at fostering meaningful and autonomy-supportive engagement. The following sections outline the theoretical framework, data and methods (Section 3), results (Section 4), and discussion with policy implications (Section 5).

2. Theoretical Framework

Flourishing represents an optimal state of human functioning that goes beyond momentary happiness to encompass meaning, growth, and positive engagement. Contemporary models converge on this multidimensional view: Ryff's (1989) six

dimensions of PWB (e.g., self-acceptance, personal growth, purpose in life), Keyes's (2002) tripartite model encompassing emotional, psychological, and social WB, and Seligman's (2011) PERMA framework all emphasise purpose, autonomy, and social connectedness as core component. Empirical research links flourishing to better health, academic success, and civic participation (e.g. Huppert, 2009). In this study, flourishing is measured through the FS (Diener *et al.*, 2010), which captures eudaimonic aspects particularly relevant to university students undergoing identity formation and goal setting.

Time use is a key behavioural channel through which individuals cultivate or compromise WB. For university students, discretionary time outside academic or work responsibilities is especially consequential. Leisure can both reflect and foster psychological health, but its effects vary. Robinson and Godbey (1997) distinguish between active and passive leisure. Active leisure involves intentional, effortful engagement in cognitively, physically, or socially stimulating activities (e.g., sports, volunteering, artistic pursuits), typically linked to intrinsic motivation and the satisfaction of psychological needs for autonomy, mastery, and relatedness. Passive leisure, by contrast, includes low-effort, consumption-oriented behaviours such as watching television or social media use; while relaxing, it often yields short-term gratification with limited long-term benefits (Kuper *et al.*, 2023). Access to leisure is not purely individual choices but is shaped by structural conditions.

In geographically peripheral universities such as Messina, students' living arrangements significantly influence their leisure practices. On-site residents benefit from easier access to university life, while off-site and commuters may face logistical and time-related constraints that limit engagement in restorative or meaningful leisure activities. The University of Messina, located at the northeastern tip of Sicily, provides a particularly relevant case: its student population includes on-site residents, off-site renters, and daily commuters across the Strait, whose living arrangements shape time autonomy, access to leisure, and overall WB. Adopting a bottom-up theoretical perspective on WB (Diener, 1984), the study conceptualises leisure as a potential mediator linking upstream factors, such as gender, socioeconomic status, and living situation, to eudaimonic outcomes. While reciprocal influences are possible, the empirical strategy follows the bottom-up logic of behavioural accumulation.

3. Data and methods

3.1. The data

This study draws on an online survey administered in spring 2024 among students at the University of Messina, a public university in southern Italy. The institutional

EU-Survey platform yielded 869 valid responses, of which a subsample of 548 students enrolled in bachelor's and master's programmes was analysed for the present study. To address potential selection bias due to voluntary participation, post-stratification weights were applied using administrative data on students' gender and field of study. Nonetheless, self-selection may persist, as more engaged or WB-oriented students could have been more likely to respond; therefore, findings should be interpreted as indicative of within-sample relationships rather than representative population estimates. The weighted sample has an average age of 26.6 years, with women representing 59%. Two thirds (66%) are enrolled in undergraduate degree programs, and nearly half (48%) report being in a stable romantic relationship. The mean household size is 3.9 individuals. In terms of housing status, 17% of respondents are on-site residents, 28.5% as off-site renters (living in Messina during term-time but registered elsewhere), and 54.7% commuters (traveling daily, often from Calabria or rural areas in Sicily). These living arrangements are analytically meaningful as they influence time use and access to leisure activities. With respect to economic self-evaluation, 46% describe their situation as satisfactory, 30% as poor, 21% as good, while less than 3% report very poor and 0.6% excellent financial conditions. The distribution across disciplinary macro-areas is as follows: 34% in Humanities, 34% in Life Sciences, 23% in Social Sciences, and 9% in STEM fields. This academic diversity enables the investigation of possible cultural or structural differences in student time use and flourishing.

PWB is assessed using the FS, an eight-item, 7-point Likert instrument (from 1=strongly disagree to 7=strongly agree), assessing purpose in life, engagement, competence, optimism, and social contribution (Diener *et al.*, 2010). The total score ranging from 8 to 56, with higher scores indicating greater flourishing. The scale shows excellent psychometric properties, with high internal consistency (Cronbach's $\alpha = 0.87$) and strong convergent validity. The weighted mean FS score is 43.0 (SE=1.29), indicating generally high levels of flourishing among respondents. Average FS scores vary slightly by housing status: 43.8 for on-site residents, 42.9 for off-site renters, and 42.9 for commuters. Regarding leisure behaviours, Students devote, on average, 81 minutes per day to general leisure, 63 to mass media, 11 to volunteering, and 31 to sport or physical activity (Table 1).

Table 1 – Weighted Average Daily Minutes by Housing Status and Flourishing Score.

Housing Status	Mass Media	Leisure	Volunteering	Sport	FS
Off-site renters	67	84	11	32	42.86
On-site residents	71	84	14	44	43.82
Commuters	59	79	10	26	42.90

Notes: Respondents reported their average daily time spent on several activities using a dropdown menu with predefined intervals (from 0 to 90 minutes in 10-minute steps, then grouped into categories beyond 90 minutes).

3.2. *The model*

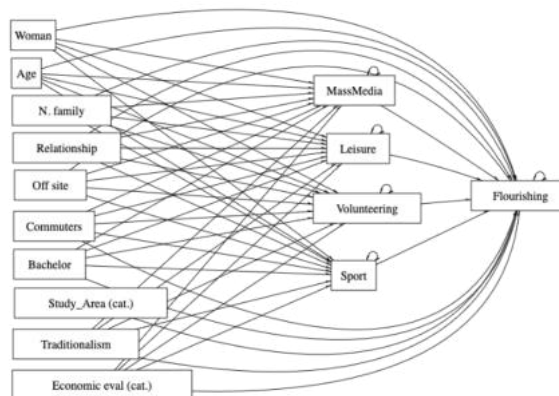
This study adopts a bottom-up theoretical perspective on WB (Diener, 1984), positing that accumulated experiences in specific life domains, such as leisure, contribute to overall flourishing. In this framework, leisure acts as a mediator between sociodemographic and attitudinal factors and eudaimonic outcomes. While reciprocal influences cannot be ruled out, the empirical strategy follows the logic of behavioural accumulation, focusing on how daily time allocation relates to WB rather than assuming causal directionality. To empirically test this framework, two complementary models were estimated. First, a weighted OLS regression of FS on the same set of predictors, including the four time-use variables, was estimated to assess direct associations between daily time use and WB. The model includes both active and passive leisure domains while controlling for gender, age, household size, romantic relationship status, degree cycle, disciplinary area, housing arrangement, perceived economic condition, and gender-role attitudes. Survey post-stratification weights are applied to adjust for sampling imbalance due to self-selection and stratification by gender and disciplinary field. Second, a GSEM extends this specification by jointly estimating the equations for the four observed time-use variables and flourishing. The model is estimated jointly (single likelihood), with correlated residuals among the time-use equations but no feedback from FS to time use. Thus, there is no causal simultaneity; rather, the joint estimation captures residual interdependence across time-use domains and permits a coherent decomposition of indirect effects. Direct effects on FS are comparable to weighted OLS given the identical functional form and Gaussian identity links. While the OLS and GSEM share identical exogenous predictors and yield very similar direct effects, the GSEM provides a more comprehensive representation of behavioural interdependencies. Specifically, it treats the time-use variables as observed endogenous variables that mediate the relationship between structural and attitudinal factors and flourishing, while allowing the residuals of their equations to covary. This specification recognises that unobserved individual characteristic may simultaneously influence several time-use domains. By accounting for these interdependencies, the model better captures how different forms of activity co-occur and jointly shape students' flourishing. Conceptually, time use mediates the effects of sociodemographic and attitudinal factors on flourishing, consistent with bottom-up models of WB that link engagement in meaningful, autonomy-supportive activities to psychological functioning. However, causal interpretations are avoided. Given the cross-sectional nature of the data, results are interpreted as associative rather than causal; reverse causality remains plausible (for instance, higher flourishing may itself encourage greater leisure engagement). Both models include a synthetic index of gender-role traditionalism, derived from seven 5-point Likert-

scale items on family responsibilities and gender equality (e.g., “A preschool child is likely to suffer if the mother works”; “Housework should be equally divided between partners”). Items reflecting egalitarian views were reverse-coded so that higher scores indicate more traditional attitudes. A Principal Component Analysis was applied, and the first component, explaining a substantial share of variance, was used as a synthetic index of gender traditionalism (range ≈ -1.5 more egalitarian to $+6$ more traditionalist). Although internal consistency is moderate ($\alpha=0.69$), this level of reliability is considered acceptable for exploratory research and for attitudinal constructs that are conceptually broad or heterogeneous. As discussed by Nunnally and Bernstein (1994), coefficients around 0.70 are generally adequate in early-stage or theory-building studies, while higher thresholds are required mainly in applied or diagnostic contexts. Similarly, Cortina (1993) emphasises that coefficient alpha depends on the number of items and the heterogeneity of their content and therefore should not be treated as a fixed standard of quality. The use of the first principal component is justified by its clear dominance in the eigenvalue structure and by its conceptual coherence, capturing a single underlying dimension of gender-role traditionalism across items. While further psychometric refinements could be explored in future research, the current specification provides a transparent and theoretically grounded summary indicator suitable for exploratory analysis¹. This index is included in all regression models as a key attitudinal covariate, given the relevance of gender ideology in shaping time use patterns and subjective WB.

All paths in the GSEM are theoretically specified and estimated using Stata 18 with robust standard errors and post-stratification weights. Full Information Maximum Likelihood (FIML) was not used due to the presence of complex survey weights. The combined use of OLS and GSEM offers a rigorous analytical framework to explore how different patterns of time investment relate to students’ WB, while accounting for structural, demographic, and attitudinal heterogeneity.

Figure 1 illustrates the hypothesized relationships in the model. The model includes four time-use variables as mediators between exogenous factors (e.g., commuting status, age, gender,) and the outcome variable, flourishing. Arrows represent hypothesized directional relationships, specified based on theoretical expectations. The model accounts for observed covariates and was estimated using probability weights and robust standard errors.

¹ To assess the robustness of the operationalization, we conducted a supplementary analysis using a simple additive score based on the original items. The structural model was re-estimated using this alternative specification, and the results remained substantively unchanged. This reinforces the validity of the findings and supports the methodological transparency of the study. Full estimation results for the robustness analysis are available upon request.

Figure 1 – Path diagram of the Structural Equation Model.

4. The results

As a preliminary step, weighted OLS regression was estimated to assess the direct associations between time-use patterns and psychological flourishing. The findings reveal that active forms of leisure are positively and significantly associated with higher FS scores, whereas passive media consumption is negatively associated with flourishing. These results align with theoretical expectations from the eudaimonic WB literature and provide initial empirical support for the mediating role of leisure time, as further investigated in the GSEM. The OLS and GSEM estimates are highly consistent in both direction and magnitude, confirming the robustness of the findings across estimation methods (Tab. 2). However, the two approaches differ in their interpretive scope, the GSEM approach offers a more comprehensive analytical framework by simultaneously modelling the mediating role of time-use variables and the interrelations among sociodemographic and attitudinal factors. This allows for the identification of both direct and indirect pathways linking students' characteristics and behaviours to psychological flourishing, providing a richer interpretation of the mechanisms underlying WB outcomes. Gender, age, household composition, and relationship status show expected associations with students' time use and flourishing. Female students engage significantly less in sport ($p \leq 0.001$) but do not differ from men in overall flourishing. Older students report slightly higher flourishing ($p \leq 0.01$) and spend less time on leisure and mass media ($p \leq 0.001$). Larger households are modestly associated with lower flourishing, suggesting reduced autonomy or emotional resources, while being in a stable relationship predicts less volunteering ($p \leq 0.001$).

Table 2 – GSEM and OLS weighted estimation results.

	Generalized Structural Equation Model (GSEM)								OLS weighted	
	Mediators								Outcome	
	MassMedia	Leisure	Volunteering Sport		Outcome Flourishing		Outcome Flourishing			
	coef	p	coef	p	coef	p	coef	p	coef	p
MassMedia							-0.04	***	-0.04	***
Leisure							0.03	***	0.03	***
Volunteering Sport							0.04	***	0.04	***
Housing status (Ref. On site)							0.02	*	0.02	*
Off_site	-0.36		-1.47		-5.85		-13.07	*	0.51	
Commuter	-19.48	*	-7.45		-5.41		-16.23	**	0.04	
Woman	-27.61		6.08		2.08		-18.73	***	0.36	
Age	-1.99	***	-1.85	***	0.75	*	0.11		0.14	
Relationship	-17.18		-13.57		-9.70	***	-7.67		1.67	
N. family	-2.83		-11.40		0.05		-2.38		-1.22	*
Bachelor	-0.23		-8.11		1.09		4.05		-1.22	
Economic Evaluation (Ref. Very Poor)										
Poor	5.78		1.82		-24.63		-30.76	*	3.98	
Satisfactory	-17.37		11.70		-30.31	*	-21.08		5.62	*
Good	-6.88		13.01		-35.63	*	-10.20		9.86	***
Excellent	-15.42		72.76		-36.86	*	55.89		4.91	
Tradisionalism	-9.32		-1.17		0.90		-1.03		1.20	**
Study Area (Ref. = STEM)										
Social Sciences	-11.42		7.26		-2.20		4.30		-0.15	
Life Sciences	-18.66		-7.36		5.74		-6.07		1.04	
Humanities	26.60		18.76		-6.08		-7.80		2.36	
Constant	173.62	***	173.18	***	27.08		86.58	***	35.02	***

Table notes. *** $p \leq 0.001$, ** $p \leq 0.01$, * $p \leq 0.05$

Housing arrangements affect behaviour but not WB directly. Off-site students devote less time to sport ($p \leq 0.05$), while commuters report significantly lower involvement in both sport (and mass media ($p \leq 0.05$)). However, these time-use differences do not translate into significant overall gaps in flourishing. Subjective economic evaluation emerges as a robust predictor of WB: students with “good” financial self-evaluation report significantly higher FS ($p \leq 0.001$). Yet better economic status is also associated with lower participation in sport and volunteering, potentially reflecting different leisure preferences or opportunity costs. Traditional gender-role attitudes are positively related to FS ($p \leq 0.01$), even after controlling for sociodemographic and behavioural factors. This unexpected result may reflect value-behaviour consistency or psychological alignment with dominant cultural norms in more traditional settings. Regarding mediating mechanisms, active forms of leisure are positively and significantly associated with FS, while time spent on

mass media use shows a negative association. These results confirm that active and meaningful engagement contributes more to PWB than passive activities.

Table 3 summarises the direct and indirect associations of housing status with flourishing. Both commuters and off-site students differ from on-site peers mainly through their patterns of time use. For commuters, the total indirect association with flourishing is slightly negative ($b = -0.07$), suggesting that their daily routines modestly counterbalance the small positive direct association ($b = 0.04$). Among specific mediators, time spent on mass media contributes marginally to a positive direction ($b = 0.71$), whereas leisure, volunteering, and sport show negative indirect associations. For off-site students, the total indirect association is stronger and more negative ($b = -0.55$), largely driven by lower participation in volunteering and sport ($b = -0.25$ and -0.27). Although the direct association with flourishing is positive ($b = 0.51$), it does not offset these negative pathways, resulting in a small overall negative total association ($b = -0.03$). Taken together, the results indicate that living away from campus tends to limit engagement in active and social forms of leisure, which indirectly relates to lower levels of flourishing compared to on-site peers.

Table 3 – Indirect, direct, and total associations of housing status with flourishing (GSEM mediation model).

Indirect effect via:	mass media	leisure	volunteering	sport	Total indirect	Direct	Total
Group (ref: <i>on-site students</i>)							
Commuter	0.71	-0.22	-0.23	-0.34	-0.07	0.04	-0.03
Off-site	0.01	-0.04	-0.25	-0.27	-0.55	0.51	-0.03

Table notes. Values are unstandardized path coefficients estimated from the GSEM mediation model. Coefficients for commuter and off-site therefore represent effects relative to on-site students

5. Discussion and conclusion

This study examined the relationship between students' time use and eudaimonic WB, as measured by the FS, using data from a survey conducted at the University of Messina. Consistent with our hypotheses, the results show that engagement in active forms of leisure was positively associated with flourishing, while passive mass media consumption shows a negative association (H1). These findings support a bottom-up perspective of WB, where meaningful and socially enriching activities contribute to psychological functioning. However, we also acknowledge the possibility of reverse or reciprocal effects, as posited by top-down models (Diener *et al.*, 1984). Students with higher WB may be more inclined to participate in active leisure or experience everyday activities more positively. Given the cross-sectional nature of our data, causal direction cannot be established. Supporting H2, the GSEM

indicates that sociodemographic and attitudinal factors influence flourishing both directly and indirectly through time use. Age is positively associated with well-being but negatively with leisure and media time. Women engage less in sport yet report similar flourishing to men. Better economic conditions predict higher well-being but lower participation in volunteering and sport, possibly reflecting opportunity costs or leisure preferences. Consistent with H3, housing status affects flourishing indirectly via time allocation: off-site and commuting students spend less time in sport, volunteering, and leisure, and slightly more in passive media use, generating negative indirect effects—stronger for off-site students and modest for commuters. Overall, living away from campus indirectly reduces flourishing by limiting engagement in active and social leisure. An unexpected but theoretically intriguing finding is the positive association between traditional gender-role attitudes and flourishing. Students endorsing more traditional gender values report higher levels of flourishing, even after controlling for sociodemographic and behavioural factors. Although counterintuitive in a university setting, this may reflect value congruence, whereby alignment between personal beliefs and prevailing cultural norms enhances psychological adjustment (Schwartz and Sortheix, 2018; Inglehart and Baker, 2000). In contexts where traditional norms remain salient, such value coherence may foster a sense of belonging, predictability, and social approval, thereby sustaining PWB. Alternatively, the observed association might reflect adaptive coping or compensatory mechanisms, whereby conformity to prevailing expectations provides a structured framework that reduces uncertainty during transitional life stages such as university years. Future research should explore these dynamics further by incorporating measures of value orientation and cultural context to disentangle normative alignment from individual or situational factors. Importantly, leisure opportunities are shaped by students' structural factors: housing status, economic resources, and gender influence both time availability and types of engagement. For instance, commuter students and women report lower involvement in sport, suggesting unequal access to WB-promoting activities. These results underscore the psychological relevance of time-use patterns in students' WB. While causality remains indeterminate, the results highlight how active and socially engaging forms of leisure contribute to flourishing, whereas passive or isolating behaviours may hinder it. The study thus adds to the literature on student WB by linking structural conditions, personal values, and behavioural choices within a coherent framework of eudaimonic functioning. Nevertheless, these findings should be interpreted with caution due to several limitations. The cross-sectional design prevents causal inference and cannot capture dynamic or reciprocal effects over time. Self-reported data could be affected by social desirability or recall bias. The gender-role attitudes index shows moderate reliability ($\alpha = 0.69$), which is acceptable in exploratory studies using heterogeneous attitudinal items, and robustness checks confirm the

stability of results. Finally, external validity is limited, as data were collected from a single university via an online survey, possibly overrepresenting students with higher digital access or intrinsic interest in WB. Differences in response propensity, may have introduced self-selection bias, which is a key concern in studies of this nature. This could distort the observed estimates in either direction. Future research should adopt multi-site or probabilistic sampling and longitudinal designs to better identify causal mechanisms.

Despite these caveats, the study offers meaningful policy insights. Universities should invest in inclusive and accessible leisure infrastructures, particularly for commuter students and women, to reduce structural barriers to participation. Promoting equitable access to sport, volunteering, and culturally enriching activities can support students' psychological flourishing and foster a more balanced university experience beyond academic achievement.

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NATIONAL TARGETS VS. LOCAL ACTIONS: ANALYZING ITALIAN MUNICIPALITIES' CHILDCARE PROVISION CHOICES WITH A SAMPLE-SELECTION- CORRECTED CLASSIFICATION MODEL¹

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Abstract. In decentralized countries, policies designed at the central level are frequently assigned to local governments for implementation. The central government sets the targets to be achieved and provides the funding, while local governments can decide whether, and to what extent, they participate in these programs. A recently launched program in Italy in the field of childcare follows this general framework. The central government allocated additional grants to municipalities, earmarked for the enhancement of nursery services, consistent with a national target. Individual municipalities utilized these funds to varying extents. This paper aims to investigate the key determinants of the choices made by different municipalities. We employ a sample-corrected model to account for the fact that only a set of municipalities received additional resources. The estimation process shows that demand-side factors and technological factors are the most relevant in explaining the different choices made by municipalities. The results suggest that the program design should be better tailored to the specific characteristics of the local environment to implement a more gradual activation of childcare services.

1. Introduction

In the 2002 at the Barcelona summit (Barcelona, 2002), the European Council set two critical goals for childcare services: ensuring access to early childhood education for at least 33% of children aged 3-36 months and 90% of children aged 3-6 years. These policy objectives aim to achieve two primary outcomes: promoting socio-economic development and fostering cognitive growth in children. From a socio-economic perspective, an extensive body of literature explores the relationship between childcare availability and maternal employment. Recent studies such as Morrissey (2017), and Zimmert (2023), offer compelling analyses of the impact of childcare provision on female employment, consistently demonstrating that expanding access to early childhood services yields substantial benefits, particularly by increasing female labour force participation. On the other hands, numerous studies in the

¹ Author contributions: Alessandro Cremaschini: data analysis, methodology, software, writing and project administration. Marco Mastracci: data analysis, methodology, software, writing, and project administration; Francesco Porcelli: data analysis, methodology, and supervision; Alberto Zanardi: data analysis, methodology, writing, and supervision.

paediatric field emphasize the significant cognitive and psychological advantages for children who attend kindergarten or early childhood programs (Archana V. Hegde and Averett, 2014; Landry et al., 2014, among others).

In federalist-type countries, the implementation of such services often reflects the decentralized nature of governance. Centrally designed policies - the central government sets targets and provides funding - are executed at the local level, allowing local governments to adapt policy design and implementation to their specific contexts (Aiello, *et al.* 2019). This dynamic can manifest either through delegation, where local authorities are mandated to implement centrally designed policies, or through discretion, allowing them to decide whether to participate in national programs via public calls. In the latter scenario, challenges such as low administrative efficiency at the local level or varying fiscal priorities across jurisdictions can undermine the central government's ability to achieve its targets effectively. This interplay between central goals and local execution can influence the effectiveness of public policies, especially for early childhood education initiatives, including their impact on developmental outcomes for children. In this article, we focus on the Italian context, where in 2022 the central government allocated additional grants to municipalities of both Ordinary Statute Regions and Special Status Regions such as Sardinia and Sicily, specifically earmarked for the improvement of nursery services, in line with a centrally established national target. The Italian program facilitates the transfer of funding to municipalities to cover current expenditures for expanding nursery places, while also leveraging the Recovery and Resilience Facility to support infrastructure investments in new nursery schools. It aims to guarantee a minimum level of childcare services both public and private, across the entire country. This is achieved through the establishment of *service objectives*, measured in terms of standard costs. The target requires each municipality to provide enough nursery places to achieve a coverage rate of at least 33% of resident children aged 3-36 months by 2027. To strengthen childcare services, the program targets municipalities where coverage falls below this 33% threshold, focusing on increasing public supply also considering the contributions of private providers. For these local authorities, the program calculates the additional number of nursery places required to close the gap between the current service level and the 33% coverage target. This approach aims to ensure that all territories can meet the established childcare service objectives. The threshold allows for the identification of municipalities that have not met the minimum coverage rate and are thus eligible to access funding as *beneficiaries*. Municipalities that have already reached the 33% target are classified as *non-beneficiaries*. Within the first group, municipalities are further categorized as *active* or *inactive*. *Active* municipalities have either met or surpassed the target, while *inactive* municipalities have failed to achieve the required service level. The binary classification of municipalities as *active* or *inactive* will serve as the target variable in analysing the determinants of the choices influencing the likelihood of achieving the

target and utilizing central government funds. Based on these results, this analysis may provide recommendations on how to revise the design of the measure. The resources allocated for kindergartens will contribute to maintaining the service level of 33% of the target population and covering the current expenditure needed to increase nursery places (in parallel with the Recovery and Resilience Facility for infrastructure investments in new nursery schools). Starting from 2022, increasing resources have been allocated, from € 120 million reaching up to € 1.1 billion by 2027. These funds will bridge the gap between the nursery places available in the reference year (2018) and those required to achieve the final target of a 33% coverage rate by 2027, calculated at the standard cost of €7,670 per new place. Figure 1 provides an overview of the different levels of nursery service coverage in 2018. In general, the coverage was higher in the Northern Italy, in Tuscany, and in the metropolitan area of Rome, while it was very low in Southern Italy averaging roughly to 13%. This evidence highlights a backwardness of the provision of nursery service, which has negative consequences on the social and economic structure of Southern Italy. Although it would be challenging to investigate why, for example, Apulia region had a coverage rate that was on average higher (the regional average is about 24%) than the rest of Southern Italy, the map represents only the starting point—understood as the *status quo*—of our analysis. Instead, we aim to shed light on the current situation, how municipalities have worked to bridge the gap in terms of childcare service coverage, and what factors may have played a role in this public policy activity. To support the most disadvantaged areas, resources allocated for the 2022–2026 period are reserved for municipalities with historical service coverage below 28.88% of the target population. Furthermore, during this period, the allocation of funds considers the presence of unused places in municipal nurseries. This strategy aims to accelerate progress toward the target level in municipalities that already possess the required infrastructure and can promptly begin operations with the additional management funds. Municipalities may use the allocated resources in various ways, such as directly managing public nurseries, forming unions of municipalities, entering agreements with private nurseries, or providing vouchers to families for childcare services. The use of allocated funds is closely monitored: municipalities must report annually to the central government on the additional nursery places provided, ensuring consistency with the assigned targets. Each municipality is required to certify the achievement of its goals by completing the SOGEI² Reporting Questionnaire (SRQ, available on the Open Civitas website³). Municipalities that are not beneficiaries of the service enhancement funds are also required to complete the form for the sections related to monitoring services in their territory.

² SOGEI Spa is an *in-house* company owned by the Italian Ministry of Economics and Finance.

³ www.opencivitas.it

This article is organized as follows: in Section 2 we provide a quantitative analysis of the program along with a regression modeling strategy to infer the likelihood of achieving assigned coverage targets, in Section 3 the results are discussed, Section 4 highlights key discussion points and the conclusion.

Figure 1 - Nursery places coverage in 2018 (%). Lighter to darker shades from 0% to exceeding 33% of coverage in nursery services.

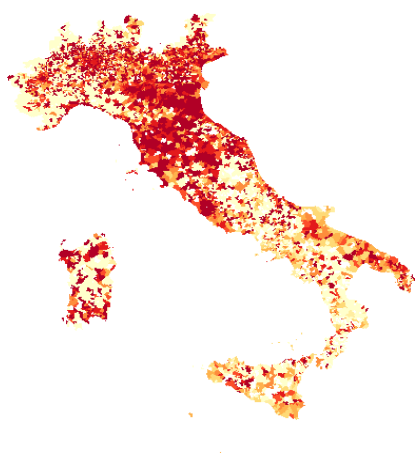


Figure 2 - Beneficiaries and non-beneficiaries of the measure: non-beneficiaries in yellow, the beneficiaries in green.



2. The nursery services measure

According to the measure presented in Section 1, municipalities can be identified as *beneficiaries*, if they did not achieve their own target and entered the program, or *non-beneficiaries* if they had already satisfied the required level of service. A significant number of *non-beneficiaries* are in Northern Italy, as illustrated in Figure 2. The geographical distribution clearly shows that these municipalities are predominantly concentrated around Emilia-Romagna region. This dynamic is undoubtedly shaped by distinct and significant territorial and socio-economic factors. The municipalities that do not benefit from the policy represent 32.2% of the total. For the remaining *beneficiaries*, the ratio between the additional users served (labelled as R28 in the SRQ) and the users assigned by the measure (target coverage, labelled as R27 in the SRQ) was calculated. This allowed for a distinction between *inactive* and *active* municipalities, where the former includes non-responding municipalities that failed to complete the monitoring form, those that failed to meet their target with a target coverage equal to 0%, or those that partially failed to meet their target with a target coverage less than 100%, while the latter includes municipalities that achieved

their target with a target coverage equal to 100% or exceeded their target with a target coverage greater than 100%. Excluding *non-beneficiary* municipalities, the expansion of services was pursued in a highly heterogeneous manner across territories, with responses varying significantly from region to region.

Table 1 - *Beneficiaries vs Non beneficiaries: Statistics on the number of nursery places and assigned resources*⁴.

					Target		Outcome	
			Num ber	%	# nurse ry place s	Assign ed additio nal resourc es	# nurse ry place s	Additio nal resourc es actually used
Non- Benef. municipali ties			2359	32.2 %	0	0.00	0	0.00
Benef. municipali ties	Inactive	Non respond ing	653	8.9 %	1686	12.9	507	1.5
		Failed target	2023	27.6 %	4125	31.7	0	0.00
		Partiall y failed target	247	3.4 %	2169	16.6	888	6.8
	Active	Achieve d target	753	10.3 %	1886	14.5	1886	14.5
		Over achieve d target	1295	17.7 %	5773	44.3	2769 7	44.3
Total			7330	100 %	1563 9	120.0	3097 7	67.0

Table 1 provides details of the framework between *beneficiaries* and *non-beneficiaries*. With specific reference to 2022, the allocation of resources under the regulations (€ 120 million) aimed to increase the total number of daycare centre users by 15.639. The monitoring data relating to the first-year implementation of the measure (2022) gives clear evidence about the variability in the extent to which individual municipalities have used the additional funds: the result is a marked

⁴ Our dataset covers 7330 municipalities, based on the questionnaires of objective service for nursery care: 6562 municipalities for ordinary statute Region (OSRs) and 768 municipalities for Sardinia e Sicily (SSRs).

deviation in the increase of provided nursery places compared to what was centrally planned. However, the partial utilization of these resources (€ 67 million, 55.8% of the total for 2022) resulted in an actual increase of 30.977 additional users. Achieving or exceeding the target would instead appear to have a positive correlation with the demographic size of the entity. The initial service coverage rate, i.e., the *status quo* of the 2018 baseline year, appears to be strongly correlated with the activity or inactivity of municipal authorities. Among the municipalities benefiting from the resources, those with an initial absence or near-absence of nursery services showed no increase. Conversely, higher initial coverage rates were associated with greater municipal activity, as also already highlighted by Figure 1.

1.1. Data modeling

The variables we considered in our modeling strategy represent both the demand and supply-sides of nursery services, in addition to contextual variables that control for the geographical and socio-economic heterogeneity of Italian municipalities. Data sources include the Italian National Institute of Statistics (ISTAT), the Ministry of Economy and Finance (MEF), the National Institute of Social Security (INPS), and SOGEI questionnaires regarding municipalities' standard needs. Exogenous demand-side variables include the *average income* (in thousands of Euros) by municipality, which is expected to positively correlate with higher service demand, thus increasing pressure on local governments to meet service objectives. Additionally, the share of the *foreign population* and *retirees* are considered. On the other hand, the share of *unemployed females* is expected to place less pressure on local governments to fulfill service objectives compared to the aforementioned variables, reflecting the hypothesis that unemployed mothers may refrain from enrolling their children in nursery services to minimize associated costs. Lastly, the percentage of the *unmarried population* (aged 25 to 54) is considered as another factor with comparatively lighter pressure on local governments. On the supply side of service provision, several municipal-level economic and financial covariates were included to capture the health and stability of public finances, such as the *average financial rating index* from 2016 to 2019. This index ranges from 1, indicating a poor financial health status of the municipality, to 5, indicating excellent financial health status. The *average current balance index* from 2016 to 2019 provides insights into the municipality's financial balance, the higher the index, the better the municipality's financial health. *Cash advances* act as a predictor of financial distress, the higher the cash advances, the worse the municipality's cash position. Additionally, two dummy variables account for municipalities' participation in tenders aimed at constructing or renovating nurseries through NRRP (National

Recovery and Resilience Program) funding. A dummy variable capturing a *threshold effect*, i.e., fewer than six infants served in kindergartens, was included to control for the dynamic whereby municipalities with low nursery enrolment levels have less incentive to meet service objectives. Finally, the context variables allow us to control for the effects of morphological and other socio-economic aspects of the municipalities. These context variables are summarized through a clustering procedure that estimates the number of clusters and provides the probabilities of membership (the so-called *a-priori* probabilities) for each identified cluster. One of the aims of this analysis is to evaluate, using a probability measure within a frequentist context, the key determinants that most significantly affect the level of achievement of the service target. To achieve this, we categorized our statistical units (i.e., municipalities) into two groups, *active* or *inactive*, based on the level of service objective achievement as previously defined, and assigned a label of 0 to *inactive* units and 1 to *active* units. The most appropriate model for estimating the probability of belonging to one group or other falls within the class of supervised classification models for binary outcome. Furthermore, since we are dealing with a sub-sample (i.e., the *beneficiaries*), ruling out the municipalities that have not an assigned objective service, our analysis may suffer for a sample-selection bias that would provide inconsistent estimates. Since the work of Heckman (1979), the issue of sample selection bias has been extensively studied in the literature (among others, Wooldridge, 1995, Marra and Wyszynski, 2016, Baltagi *et al.*, 2023, Lim *et al.*, 2024). In our analysis, we adopt a Heckman-type correction, in the fashion of Marra and Radice (2013), which provides for a double simultaneous estimation procedure, the first one to correct for the potential bias, the second one as the model of interest, and a *t*-copula to model the correlation between the two equations, as in equation (1) and (2)

$$\tilde{Y}_1 = Z\gamma + \varepsilon_1, Y_1 = 1 \text{ if } \tilde{Y}_1 > 0 \quad (1)$$

$$\tilde{Y}_2 = X\beta + \varepsilon_2, Y_2 = 1 \text{ if } \tilde{Y}_2 > 0 \quad (2)$$

with $(\varepsilon_1, \varepsilon_2) \sim t_v(\theta)$, where Z and X are the design matrices for the selection and outcome equations, respectively, and γ and β are the corresponding vectors of unknown parameters.

3. Results

The *selection* model allows us to consider a correction for sample-selection bias. It shows good performance in capturing the selection mechanism to be *beneficiary*. At this stage, we guess that the selection process is governed by the *status-quo*, i.e., the percentage level of the service in the 2018, and to inherent characteristics of the

municipalities, such as the *average income* and geographical and context variable. As expected, the *status-quo* has a negative impact on *z-scores* meaning that higher service levels ensure that the municipality already close to the 33% target, making it highly likely that no additional service target will be assigned to it. This result aligns with our initial assumption that the status-quo significantly influences the probability of being a *beneficiary*. Moreover, consistent with expectations, the estimated coefficient associated with the *average income* has a positive sign. This could be due to two main factors: on the one hand, municipalities in wealthier areas might be more likely to have already met the service targets, benefiting from higher and better service levels; on the other hand, there is a strong demand component that makes municipalities more dynamic in fulfilling their tasks, also in terms of accountability and transparency between local governments and residents. Then, we make use of a composite indicator of migration flows defined as,

$$I *_{mf} = I_n * (population_m / population_r)$$

where I_n is the net balance of inter-regional migration, weighted by the ratio between municipal and regional populations. The index assigns a share of regional migration flows to each municipality according to its population within the *j-th* region. In addition, we include the *i-th* municipal population itself to control for the size effect of larger cities on the probability of being beneficiaries, and to properly disentangle the effect of the index from that of population size. The estimated coefficients are consistent with the interpretation that the higher the index, the lower the probability of being a beneficiary. Details on the estimation are reported in Table 2.

Table 2 - *Estimated coefficients of the selection model.*

	Estimate	Std.error	z-value	$\mathbb{P}(> z)$
Intercept	3.9805	.2613	15.23	<.000***
R2201 (<i>status quo</i>)	-.2098	.0077	-27.09	<.000***
Average income	.0539	.0124	4.35	<.000***
Migration flow Index	-.0676	.0322	-2.10	.036**
Municipal Population	.0022	.0004	5.16	<.000***

In the *outcome* equation we consider variables that capture both demand and supply-side factors, along with the a-posteriori probabilities of belonging to a cluster. Focusing on the demand-side explanatory variables, *Average income*, *% Female unemployment*, *birth rate*, and *% aged 25 to 54 unmarried* exhibit statistically significant impacts on the likelihood of being *active*, albeit with differing magnitudes and signs.

The first variable (*Average income*) has a positive impact on the target variable, suggesting that in wealthier areas, local governments tend to be more conscientious in fulfilling their commitments. Moreover, the demand power associated with *Average income* acts as a constraint for local authorities to perform effectively. On the other hand, the latter two variables have negative effects on the likelihood of being active. For *% Female unemployment*, higher unemployment rates among women appear to reduce the demand for nursery services, as mothers outside the labour force may be more inclined to care for their children at home rather than seek external childcare. In the case of *% aged 25 to 54 unmarried*, we hypothesize that individuals in this age group who are not married are less likely to have children, thus reducing the demand for nursery services. The estimated coefficient supports this assumption, as it has a negative sign and a stronger impact on the target variable compared to *% Female unemployment*. Finally, the birth rate plays a key role in explaining the dynamics of the model: its coefficient shows that the share of children in the population is an important driver of municipal policy choices.

Table 3 - *Estimated coefficients of the outcome model (statistically significant).*

	Estimate	Std.Error	z value	Pr(> z)
Intercept	-1.470	.4820	-3.0600	.0022**
<i>Under 6</i> users	-.3690	.0711	-5.1900	.0000***
Average income	.0518	.0086	6.0300	.0000***
% Female unemployment	-.0163	.0048	-3.3900	.0007***
% 25-54 aged nmarried	-.0259	.0096	-2.6900	.0072**
Public funding	.2520	.0508	4.9700	.0000***
Special funding (NGEU-NRRP)	.3270	.0543	6.0300	.0000***
Birth rate	.0776	.0263	2.9600	.0031**

(full output on request)

The variables representing supply-side conditions do not show statistical relevance: the health of local governments have no measurable impact on the likelihood to be *active*. However, a notable effect is observed for the dummy variables indicating participation in NRRP investment programs. This effect is positive and non-negligible in terms of the predicted probability of being a local government that actively pursues its target. NRRP funds, primarily aimed at creating or upgrading infrastructures, play a critical role in addressing infrastructure gaps that significantly hinder municipalities in achieving their goals. The estimated coefficient suggests that access to such funds, which municipalities might not secure through their fiscal capacity alone, makes achieving the nursery service target more feasible.

Finally, the dummy variable representing the number of users in existing facilities (under 6 users) is also significant, with a negative sign. This indicates that municipalities with very low user numbers lack strong incentives to meet the target, potentially redirecting resources to other, more pressing activities. This may reflect a prioritization of limited resources toward areas with higher perceived demand or greater strategic importance. A check on the statistical significance of the correlation parameter is also carried out to corroborate the statistical relevance of the estimates.

4. Conclusion

In this article, we investigated the issue surrounding the provision of nursery services. European legislation has addressed this matter by setting a minimum target, expressed as a percentage, for the availability of nursery places relative to the total resident population aged between 3 and 36 months, which member Countries must guarantee. We discussed the benefits that a progressive increase in this service can provide. On one hand, early childhood education positively impacts cognitive development; on the other hand, nursery services are crucial from a purely economic perspective. Growth in this area has been shown to lead to increased female participation in the workforce. While this is not the place to debate who holds the primary responsibility for infant care, in family dynamics, the lack or scarcity of nursery services often places the burden of childcare primarily on women. In Italy, the provision of nursery services is a pressing issue. In many parts of the country, these services are provided only sparingly and are generally hampered by evident infrastructural and organizational problems. While some regions have managed to meet their obligations, this is far from the case in many areas, with southern Italy being the most prominent example of this disparity. In the article, we presented statistics highlighting the delays and shortcomings in service provision, particularly in meeting the 33% target and intermediate milestones, which are designed to help lagging municipalities catch up. This has led to a divide within Italy, with some municipalities benefiting from funding aimed at achieving these service goals, those that have not yet reached adequate service levels, and others excluded because they have already met the 33% target. Among the *beneficiaries*, a distinction can be made between those municipalities that have acted since 2018 (the *active* ones) and those that, for various reasons, remain stagnant (the *inactive* ones). Our statistical analysis fits within this framework, examining the factors that determine whether a municipality is active or inactive. Beyond territorial dimensions, demand-side factors play a significant role in the likelihood of a municipality being classified as active, although with different magnitude and polarity. Supply-side factors, such as the economic and financial conditions of the entity, do not appear to have a significant impact on achieving service goals, i.e., to be *active*. However, the size of the user base, which in our model is defined as "under 6 users", does influence municipal decision-making, increasing the likelihood of a

municipality not being active in pursuing its assigned target. In general, an increase in demand for nursery services could result in greater compliance from municipalities, compared to the financial background or financial situation of the local government.

From a statistical perspective, we ensured our model was robust against issues of estimate inconsistency through a Heckman-type correction and a convenient simultaneous estimation of the two equations by a *t*-copula.

A significant aspect of the analysis concerns the timing of resource allocation to municipalities. In 2022, under the relevant regulations, funds were transferred only in the latter part of the year. This delay forced some municipalities to hastily initiate public tenders or agreements, creating operational uncertainty. Coupled with a lack of programmatic planning, this led some municipalities to remain *inactive*, failing to meet their objectives. In subsequent years, this issue was addressed by advancing the disbursement of resources to the first part of the year, enabling more effective planning of interventions. A critical factor is the lack of infrastructure capacity, which has limited the utilization of available resources. Investments introduced through the NRRP are expected to play a key role in addressing these structural deficiencies. Another important issue to consider is the paradigm shift resulting from Constitutional Court ruling No. 71 of 2023, implemented through the 2024 Budget Law (Law No. 213/2023). This ruling declared it unconstitutional to reclaim resources allocated for service targets from municipalities that failed to meet their assigned objectives. The decision aimed to avoid harming the rights of citizens residing in the territories of non-compliant entities. The ruling further established that resources designated for service objectives must be transferred to a special fund. Consequently, municipalities were given the opportunity to comply by either detailing the actions they plan to take to meet their objectives or providing justifications for their failure to do so. In cases of continued non-compliance, the entity will face measures, such as being placed under commission or having funds reclaimed.

Our findings could guide policymakers in allocating financial resources aimed at strengthening childcare services. Such interventions must be supported by both central and local authorities, as the latter have extremely limited means to address issues such as female unemployment on their own. These challenges belong to broader policy frameworks that extend well beyond the municipal level. Moreover, infrastructure provision is an area that requires attention — particularly at the European level.

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EXPLICIT AND IMPLICIT SCHOOL LEAVING: HOW TO COMBINE THE TWO MEASURES?

Barbara Baldazzi, Patrizia Falzetti, Paola Giangiacomo

Abstract. Insufficient mastery of fundamental skills hinders entry into the labor market and, more broadly, impedes the attainment of a high quality of life. Early Leavers from Education and Training (ELET), defined by ISTAT as the proportion of 18 to 24-year-olds holding at most a secondary school leaving certificate and not currently enrolled in any educational or training program, serves as the established indicator for early school leaving. This metric is standardized at the European level. The European Community had set a target for Italy to achieve a 10% ELET rate by 2020. In 2020, Italy's ELET rate stood at 14.2%, decreasing to 9.8% in 2024. However, ELET data alone do not fully capture the scope of the early school leaving problem. Students who complete upper secondary education without acquiring the minimum required competencies are not accounted for in this calculation. INVALSI data allows for the observation of this phenomenon, which we term Implicit Leavers from Education and Training (ILET). Implicit school leaving constitutes a problem of equal significance to explicit early school leaving. Quantifying the share of ILET is challenging, but since 2019, INVALSI assessments have provided a representation of this phenomenon. Individuals who, despite graduating, do not achieve at least Level 3 in the Italian language and Mathematics tests, and who fail to reach Level B1 in Reading and Listening in English, possess competence levels aligning with the educational objectives set for eighth-grade students—considerably below the expected proficiency for their educational attainment. The ability to measure the overall phenomenon of school leaving furnishes schools and policymakers with crucial information. This paper aims to estimate the total school leaving rate by statistically matching data from ISTAT (for ELET) and INVALSI (for ILET). A general dispersion estimate will be derived using ISTAT data for ELET and INVALSI data for ILET at the regional level.

1. Introduction

Early school leaving is a social problem that Italy, like other countries, is trying to reduce. In fact, despite a steady decrease over the last 10 years, the share of young people leaving the education and training system early remains high. Young people who interrupt their education at an early age face adult life with insufficient basic skills to enter the job market and, more generally, to live a quality life (ISTAT, 2021b). Dropping out of school is only the tip of the iceberg. The difficulty for some

young people to continue successfully in education and training starts early in school (OECD, 2018; Tarabini *et al.*, 2019). Inadequate competences are perpetuated over the years and influence school choice, learning and, ultimately, the decision to leave the school system.

2. Objective

Early Leavers from Education and Training (ELET), i.e. the share of 18 to 24 year old with at most a secondary school leaving certificate and not attending a school or training course, is the indicator provided by ISTAT¹ that defines early school leaving (ISTAT, 2021a). This measure is agreed at European level and is present in monitoring systems such as the United Nations 2030 Agenda (Baldazzi, 2021), Italy's National Strategy for Sustainable Development, and the ISTAT Equitable and Sustainable Well-being Framework (BES – Equitable and Sustainable Well-being). However, the ELET data cannot give the exact dimension of the problem of early school leaving (Ricci, 2019). Students who graduate from upper secondary school without having reached the minimum skills required for their studies are not included in the calculation INVALSI data make this phenomenon observable, and we call it implicit leavers from education and training (ILET). Establishing the share of ILET is not easy, but since 2019 the INVALSI² tests can give a first representation of the phenomenon.

Is it possible to estimate overall early school leaving using currently available data sources? What are the methodological statistical problems to be overcome? An estimate of the overall dispersion will be obtained using ISTAT data for ELET and INVALSI data for ILET, at regional level. Measuring the overall phenomenon of early school leaving could provide schools and policy makers with essential information to implement policies to improve learning and reduce dropout.

3. Data, methods and problems

Early Leavers from Education and Training (ELET), i.e. the share of 18 to 24 year olds with at most a secondary school leaving certificate (level 2 of ISCED) and not attending a school or training course, is the indicator provided by ISTAT. Data on early leavers are derived from the EU's labour force survey (LFS); the data are calculated as annual averages of quarterly data. This measure is agreed at European

¹ Italian National Statistical Institute

² National Institute for the Evaluation of the Education and Training System

level. The European community had set a target for Italy to reach a 10% share of ELETs by 2020. In 2020, Italy's ELET rate stood at 14.2%, decreasing to 9.8% in 2024. The numerator of the indicator refers to persons aged 18-24 who meet the following two conditions: (a) the highest level of education or training they have completed is ISCED³ levels 0, 1 or 2 and (b) they have not received any education or training (in other words neither formal nor non-formal) in the four weeks preceding the survey. The denominator is the total population of the same age group, excluding respondents who did not answer the questions 'highest level of education or training successfully completed' and 'participation in education and training' (this number is negligible. They do not affect the result.).

Implicit Leavers from Education and Training (ILET) are students that, at the end of upper secondary school, do not reach the minimum competences level expected by their course of study; more in detail is the share of students in grade 13 who reached at most level 2 in Italian and in Mathematics and who did not reach level B1 in English both for reading and listening⁴. So, their achievement level is insufficient in all the subjects examined by INVALSI tests. These students obtain the «diploma» but they don't reach level 3 in Italian language and Mathematics and don't even reach level B1 in English listening and reading; their levels match the learning goals required for low secondary schools students, that is definitely lower than expected. The implicit dispersion indicator, representing the proportion of students who do not achieve the targets set out in the Reference Framework for Italian, Mathematics and English, is undoubtedly a national measure created by INVALSI; nevertheless, this measure can also be reproduced at international level based on the levels considered sufficient by both national and international surveys.

We encountered some problems to combine the two different sources. The first problem concerns the different survey periods: INVALSI data are calculated per school year from 2018/2019 to 2022/2023; LFS data are calculated per calendar year with a continuous survey throughout the year (from year 2018 to year 2023). From this first problem follows the second problem: the students/young people interviewed are from different cohorts. We have made some assumptions on how to harmonise them. We assume that the INVALSI data for 2018/2019, cover students aged 18 in 2018 and aged 19 in 2019. Corresponding to the school year 2018/2019

³ The International Standard Classification of Education (ISCED) belongs to the United Nations International Family of Economic and Social Classifications, which are applied in statistics worldwide with the purpose of assembling, compiling and analysing cross-nationally comparable data (Unesco-UIS, 2012). The levels are: 0 Less than primary education; 1 Primary education; 2 Lower secondary education; 3 Upper secondary education; 4 Post-secondary non-tertiary education; 5 Short-cycle tertiary education; 6 Bachelor's or equivalent level; 7 Master's or equivalent level; 8 Doctoral or equivalent level.

⁴ For the definition of the levels see the National Report Invalsi Tests 2019
https://invalsi-areaprove.cineca.it/docs/2019/Rapporto_prove_INVALSI_2019.pdf

for the LFS data we consider population of 17, 18, 19 years old in 2018 and population of 18, 19, 20 years old in 2019.

The choice of taking two survey waves and 3 population cohorts for each wave also allows for sufficient numerosity for a very limited phenomenon such as ELETs.

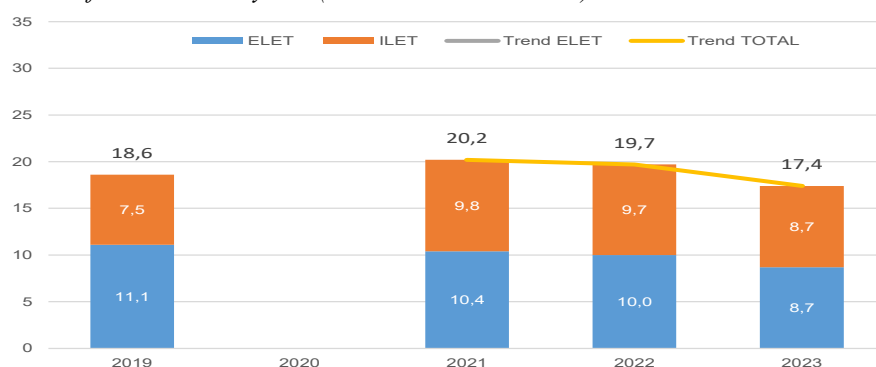
So to harmonise the INVALSI data for 2022/2023, covering students aged 18 in 2022 and aged 19 in 2023, we use the LFS data for the population of 17, 18, 19 years old in 2022 and the population of 18, 19, 20 years old in 2023.

Under the assumption that we manage to capture the same population (students in grade 13 (subset 1) + students who should be in grade 13 in the same school year but who dropped out of school without completing it (subset 2)) and that the two subsets are separate, it is possible to add up the percentage of those who drop out of school and those who do not reach adequate skills: ELET + ILET. The result is a proxy of overall leavers from education and training (OLET).

4. Results

The share of explicit leavers from education and training in scholastic year 2022/2023 in Italy was 2.4 percentage points lower (8.7%) than in 2018/2019 (11.1% - Figure 1). The other way round, share of implicit leavers from education and training in scholastic year 2022/2023 was 1.2 percentage points higher (8.7%) than in 2018/2019 (7.5%).

Figure 1 – Proportion of ELET (people 17-20 years old) and ILET (students in grade 13) in four scholastic years (2018/2019 – 2022/2023) – Source: Istat LFS and Invalsi.

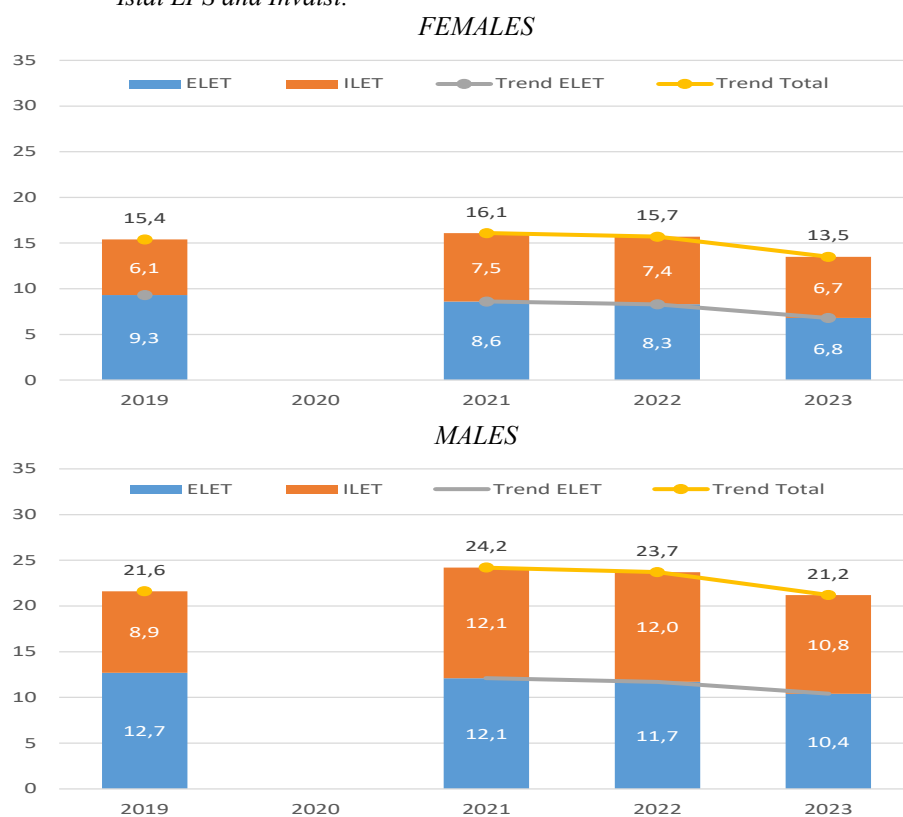


The share of overall school leaving in scholastic year 2022/2023 in Italy was 1.2 percentage points lower (17.4%) than in 2018/2019 (18.6%). This data clearly reflects the dual impact of recent educational shifts: on the one hand, the effects of

distance learning and school closures are discernible within INVALSI assessments (ILET); on the other, the influence of ministerial guidelines on Grade 13 examination procedures (leading to fewer failures) is evident in LFS data (ELET).

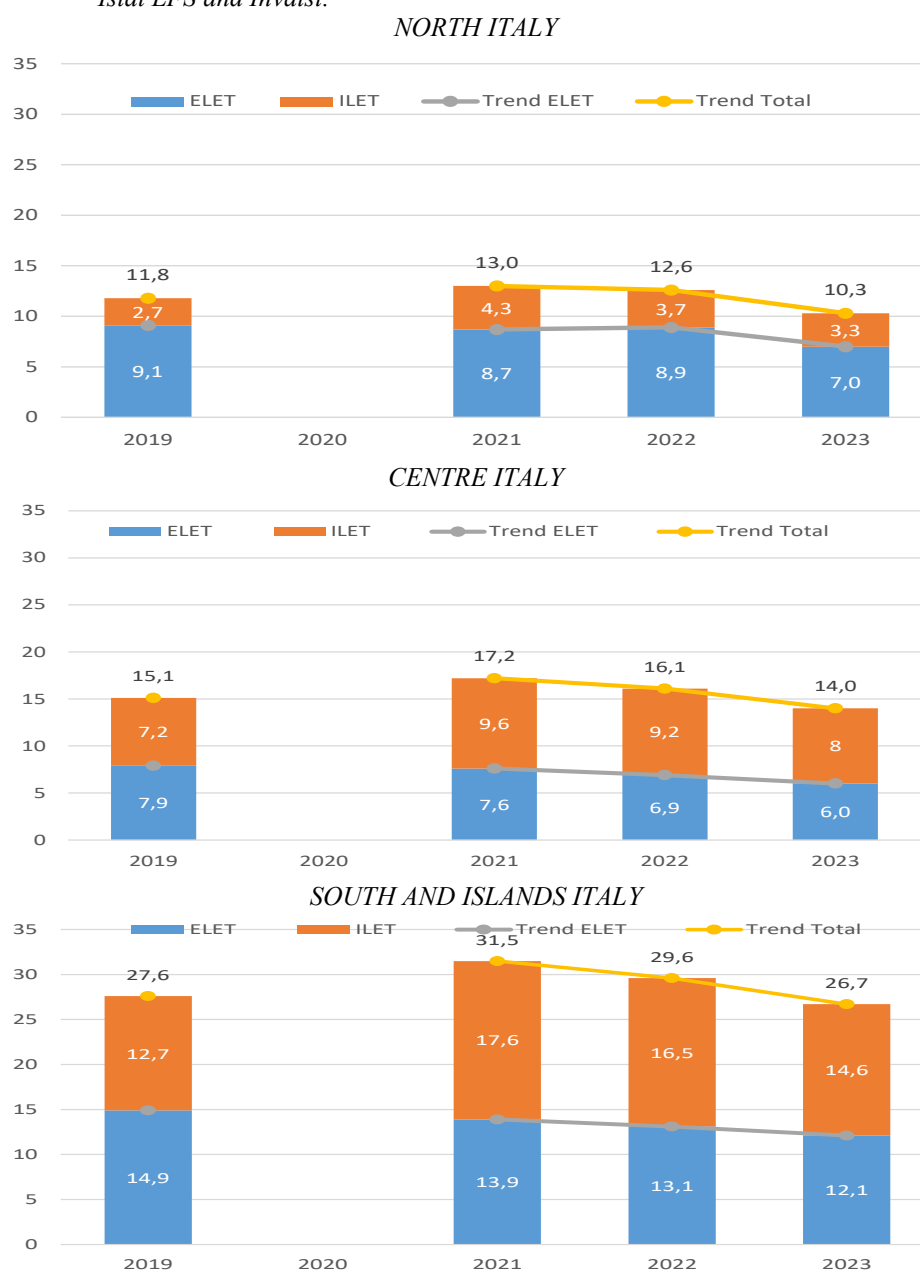
Overall school leaving is higher among males than among females. In scholastic year 2022/2023 one in every five young male people drop out (Figure 2).

Figure 2 – *Proportion of ELET (people 17-20 years old) and ILET (students in grade 13) in two scholastic years for males and females (2018/2019 – 2022/2023) – Source: Istat LFS and Invalsi.*



The overall school dropout rate is decreasing across the country, mainly because the ELET school dropout rate is decreasing. However, the ILET school dropout rate is increasing. The difference between northern, central and southern Italy remains very high (Figure 3). In the north, the ELET school dropout rate remains higher than the ILET rate, while in the centre and south, the ILET school dropout rate is higher than the ELET rate.

Figure 3 – Proportion of ELET (people 17-20 years old) and ILET (students in grade 13) in two scholastic years for geographic areas (2018/2019 – 2022/2023) – Source: Istat LFS and Invalsi.

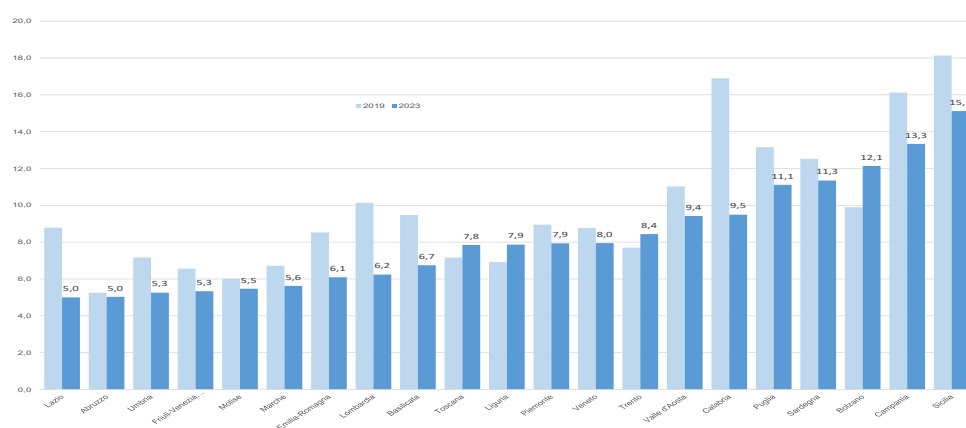


4.1. Regional differences

Both explicit and implicit early school leaving is a phenomenon that mainly concerns students from southern Italy (Figure 4). Despite the continuous improvements in the southern regions, in the school year 2022/2023 the percentage of 17-20 year olds who dropped out of school remains very high (over 10%) in Sicilia (15,1%, they were 18,1% in 2018/2019), Campania (13,3%, they were 16,1% in 2018/2019) and Sardegna (11,3%, they were 12,5% in 2018/2019).

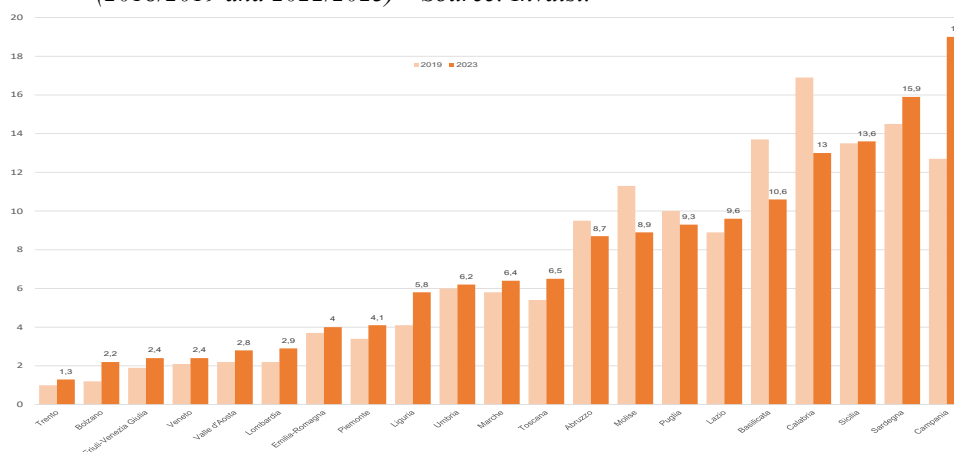
The regions where the phenomenon is less serious are Abruzzo and Lazio (5% in the school year 2022/2023), Umbria and Friuli Venezia Giulia (5,3%).

Figure 4 – Proportion of ELET (people 17-20 years old) in two scholastic years for regions (2018/2019 and 2022/2023) – Source: Istat LFS.



The difference in terms of implicit dispersion (ILET) between regions is very large since, in the 2018-19 school year, it changes from 1% in Province of Trento to 16.9% in Calabria and the gap increases in the 2022-23 school year, changing from 1.3% in Province of Trento to 15.9% in Sardegna maintaining a territorial characteristic over time, that is, stronger in the South and Islands and less in the North (Figure 5).

Figure 5 – *Proportion of ILET (students in grade 13) in two scholastic years for regions (2018/2019 and 2022/2023) – Source: Invalsi.*

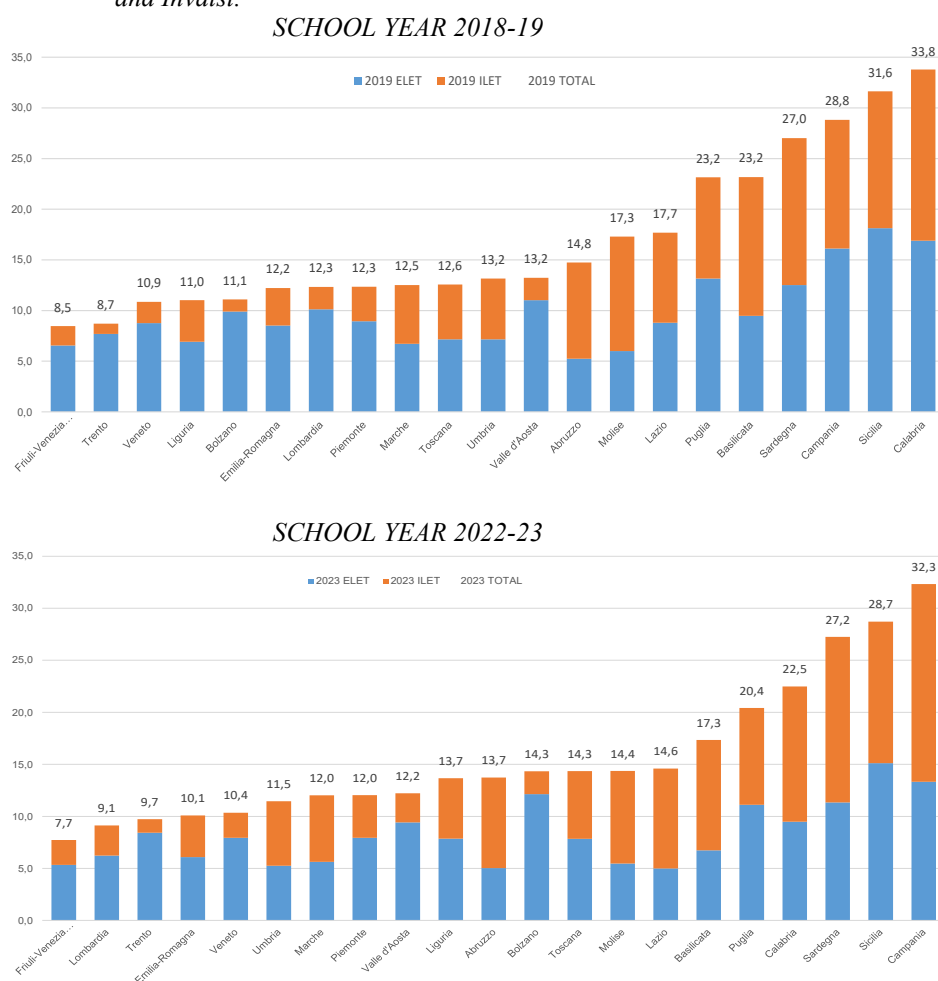


Total dispersion, composed of ELET and ILET added together (Figure 6), goes from the lowest value of 8.5% in Friuli Venezia Giulia and the highest value 33.8% in Calabria in the 2018/2019 school year to 7.7% in Friuli Venezia Giulia and 32.3% in Campania in the 2022/2023 school year.

4.2 Methodological challenges

Even at the macro level, the use of data from different sources presents problems. First of all: are we talking about the same population? The two data sources are constructed with different time frames. Sample population for LFS refers to the calendar year; the survey is continuous (data collection takes place over the entire calendar year) and the age classes are defined. The population surveyed by INVALSI tests is defined by school year. Students responding to the Invalsi test in grade 13 are between 17 and 21 years old.

Figure 6 – Proportion of ELET (people 17-20 years old) and ILET (students in grade 13) in two scholastic years for regions (2018/2019 and 2022/2023) – Source: Istat LFS and Invalsi.



Some students are not surveyed in Invalsi test. In fact, some students do not participate in the Invalsi tests because they are not present at school on the day of test; some students do not participate because they are enrolled in educational courses that do not participate in the tests (IFP courses of vocational training).

Population in LFS is sample-based and therefore the level of territorial disaggregation of results cannot go too deep: estimates are produced down to the level of regions.

Timeliness of the publication of the estimates is different. The Invalsi data for a school year are available in the summer (e.g. for the school year 2022/2023 the data are available in the summer of 2023) whereas LFS data for one year are available in March of the following year (e.g. for the year 2023 the data are available in March 2024).

Comparing data from the 2 sources for different classifications is also difficult: for example, Invalsi's ESCS - Economic Social Cultural Status index is not reproducible with LFS data (a proxy estimate would be possible). Also INVALSI definition of citizenship (native, first generation foreign, second generation) is not reproducible with LFS data (a proxy estimate would be possible).

5. Conclusion

The decline in the ELET indicator can lead to very positive conclusions about academic skills and the education system in general. This makes it necessary to include a component such as implicit dropout (ILET) in the calculation of the school dropout rate. For example, the use of both indicators has highlighted the effects of the pandemic on the education system. Furthermore, their combined use can provide a general indicator of differences between territories and their results over time. However, each of the two indicators must also be analysed individually. In fact, from a policy perspective, the strategies needed to prevent formal school leaving differ substantially from those aimed at addressing skills deficits among graduates.

Being able to measure the overall phenomenon of drop out offers schools and policy makers essential information to envision assistance interventions for students who experience their academic career with difficulty (OECD, 2012). The INVALSI data not only capture the final data on dispersion, but allow it to be diagnosed early, so as to make it possible to carry out an enhancement intervention during the training process (González-Rodríguez, 2019).

On the other hand, LFS data make it possible to monitor early school leaving once it has occurred. Comparing and combining the two data sources can therefore provide useful information for the adoption of implicit and explicit early school leaving prevention measures (Batini *et al.*, 2019).

In this data, it is possible to recognise the impact of distance learning and school closures (on Invalsi data), but also the impact of ministerial guidelines (in LFS data) for the conduct of examinations for Grade 13 (fewer failures).

Prompt action to help, which intervenes on the problem from its onset, can have a greater probability of success and in a few years lead to a significant reduction in this phenomenon in Italian schools.

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THE SOCIO-ECONOMIC GENDER GAP IN ITALY: A TERRITORIAL ANALYSIS

Sara Casacci

Abstract. This paper proposes an experimental analysis of socio-economic gender inequality in Italy using the information potential of integrated administrative archives. There are several international indices to measure gender inequality at the national level, but they are not able to reflect territorial heterogeneity. Thus, a measure of socio-economic gender gap has been created to allow a comparative analysis of the Italian provinces/metropolitan cities. A set of indicators are analysed and a composite index is constructed. The dimension with the best performance in Italy is education; women have better values than men in the individual indicators. The analysis of the individual indicators of work and income confirms the strong disadvantage of women. It also shows a North-South dualism: the gender gap in the work dimension is greater in the Southern provinces, while the gender gap in income is greater in the North, especially in the North-East. The composite index highlights a greater gender gap in some provinces of the South but also in some provinces of Central and Northern Italy.

1. Introduction

The importance of gender equality is enshrined in national and global legal and policy frameworks, such as the Convention on the Elimination of All Forms of Discrimination against Women (CEDAW) and the Sustainable Development Goals (SDGs). In recent decades, there has been much debate about gender inequality and the disadvantaged position of women compared to men. There is a growing interest in understanding the multiple levels at which this inequality affects the lives of men and women in all countries. The need to develop policies that lead to gender equality is increasingly recognized, at national and international level. Many actions have been taken to overcome this problem, although much remains to be done.

Gender equality is “also a driver of sustainable development in all its dimensions, from ending poverty and hunger, promoting prosperity and inclusive growth and building peaceful, just and inclusive societies to securing the protection of the planet and its natural resources” (UN Women, 2018). Access to decent work and regular income for women, for example, contributes to poverty reduction and supports better education, health and nutrition outcomes. Research (Blumberg, 2005; Kabeer and

Natali, 2012) suggests that improvements in gender equality, particularly in education and employment, contribute much more to economic growth than economic growth does to gender equality, especially in terms of health, well-being and rights.

One of the challenges in assessing gender inequality is to quantify it in such a way as to increase the precision of comparisons between different points in time or between different sectors, countries or regions. The construction of a composite indicator that measures the level of overall gender inequality in a given country can be a useful tool to complement different types of statistical information. These indicators have the advantage of focusing the attention of public opinion and decision makers directly to the problem of gender inequality¹ (Beneria and Permanyer, 2010). For this reason, several organisations have produced different indices to measure gender inequality across countries. For instance, the World Economic Forum's 'Global Gender Gap Index' (GGGI), annually measures the current state and evolution of gender parity across four key dimensions (economic participation and opportunity, educational attainment, health and survival, and political empowerment). The United Nations Development Programme's 'Gender Inequality Index' (GII) is a composite measure of gender inequality that encompasses three dimensions: reproductive health, empowerment and labour market (UNPD, 2022). At European level, the EIGE's (European Institute for Gender Equality) 'Gender Equality Indicator' is based on different dimensions that measure equality (employment, time management, economic resources, knowledge, health, power).

In Italy, gender inequality is still a widespread phenomenon (ASVIS, 2023). Data from the World Economic Forum of 2024 places Italy in 87th place in the global ranking (146 countries), far from many other European states (WEF, 2024). As is known, Italy is a country with significant territorial inequalities that cannot be improved if they are only addressed at the national level. The composite indices computed at national level do not highlight territorial differences. There are many data and studies that analyse the gender gap at a regional level (ISTAT, 2024a). This is true especially for some aspects of the gender gap, such as labour market participation and gender pay gap (Filippin, 2019; INPS, 2024). The ISTAT data on BES (Benessere Equo e Sostenibile) allow to identify the areas (generally, the regions) in which the differences between men and women are more pronounced. In fact, most indicators of well-being are disaggregated by sex (Istat, 2024b). Many indicators show a persistent female disadvantage. Focusing on the indicators that highlight a better female condition compared to that of males, the majority of them

¹ Nevertheless, composite indices represent a limited tool to approach issues of gender inequality, particularly in terms of understanding the complexities of gender relations, the significance of the care economy, and their effects on the lives of women and men.

fall into the dimensions of health and education and training. Alaimo and Nanni (2018) created a measure of gender gap that enables a comparative analysis of the Italian Regions.

The aim of this work is to propose a composite index of gender gap that allows a comparative analysis of the Italian Provinces and Metropolitan Cities. In fact, gender inequalities may differ between contexts as well as determinants and causes of such inequalities. This paper deals only with socioeconomic aspects of gender inequality.

The paper is structured as follows. Section 2 presents the theoretical framework, Section 3 describes data and methods, while Section 4 presents the empirical results. Conclusions are drawn in Section 5.

2. Theoretical framework

Gender is one of the fields where inequality is hardest to evaluate, for while there is ample evidence that women are worse off than men in a number of dimensions, it is not easy to determine how to measure gender inequalities.

The literature on inequalities in general and on gender inequalities in particular is vast. A widespread conceptualization assesses that measuring inequality means trying to describe how unequally outcomes are distributed in society. Important issues include what outcomes are considered (i.e. inequalities of what), which groups of people are addressed (i.e. inequalities among whom), the time frame over which outcomes are assessed (i.e. static or dynamic measures), how inequalities relate to deprivations, and whether inequalities are due to circumstances beyond people's control or to their own efforts and initiatives (OECD, 2017).

Gender inequality is a measure of "horizontal" inequality (Stewart, 2009), since it focuses on the gap between population groups defined by specific characteristics, whereas measures of "vertical" inequality look at the unequal distribution of outcomes across all individuals in society.

Following the outcome-based conceptualization, Richardt defined the gender gap as "systematic differences in the outcome of men and women on a variety of issues ranging from economic participation and opportunity, political empowerment, and educational attainment to health and well-being" (Richardt, 2008: 277).

Some of the literature on gender inequalities refers to the capability approach. Sen has claimed that "the question of gender inequality [...] can be understood much better by comparing those things that intrinsically matter (such as functionings and capabilities), rather than just the means [to achieve them] like [...] resources. The issue of gender inequality is ultimately one of disparate freedoms" (Sen, 1992: 125). Resources are only the means to improve people's well-being, while attention should be focused on what matters intrinsically, namely people's functioning and

capabilities. Nevertheless, the focus on capabilities does not deny the important contribution that resources can make to people's well-being. Indeed, inequalities in resources can be significant causes of inequalities in capabilities and therefore need to be studied². Following Ingrid Robeyns (2023, 64) a "complete analysis of gender inequality should not only map the gender inequalities in functionings and capabilities, but also analyse which inequalities in resources cause gender inequalities in capabilities and functionings". This is particularly important for assessing which policies can reduce gender inequalities, because intervening in the distribution of resources will be a crucial (although not the only) way of affecting the distribution of capability well-being.

Some authors (Camilletti, 2024; Nanni, 2023; Gauthier *et al.*, 2018); point out some other important issues. First, the concept of "women" refers to a heterogeneous group, where social and personal circumstances, such as being old or young, being a single mother, or belonging to an ethnic or religious minority, shape the challenges and needs they face in various ways. In particular, some gender inequalities emerge before birth and worsen over time, while others are age-specific. Moreover, gender inequalities can manifest differently across various geographical locations and contexts, and measures may need to be adapted when tested in different realities.

3. Data and method

As is known, constructing a composite indicator is not a straightforward process, because it requires a number of decisions/choices (methodological or not) to be taken. In particular, the main steps to be followed are: (1) Definition of the phenomenon to be measured; (2) Selection of a group of elementary indicators; (3) Exploratory analysis; (4) Normalization of the elementary indicators; (5) Aggregation; (6) Validation of the composite index; (7) Presentation of the results (Salzman, 2003, Mazziotta and Pareto, 2024).

By looking at the nature of the concept (gender gap) and its definition, the measurement model (which refers to the relationship between the latent variable measuring gender inequality and the individual indicators selected for each dimension) is formative. This approach assumes that a concept is a function of a group of indicators, identified in order to define it. This means that changes in formative indicators (Blalock, 1964) determine changes in the value (and meaning) of the latent variable. According to this approach, indicators are not interchangeable

² For example, Bina Agarwal (1994: 1455) has argued that "the gender gap in the ownership and control of property is the single most critical contributor to the gender gap in economic well-being, social status, and empowerment".

(omitting an indicator is omitting part of the construct) and internal consistency is of minimal importance: two uncorrelated indicators can both serve as meaningful indicators of the same construct (Maggino, 2017).

In the literature, the most commonly considered dimensions for the construction of gender gap indices are: economic participation and opportunity, educational attainment, health and survival, and political empowerment. In this paper, the focus is only on socio-economic dimensions. In particular, the considered dimensions are: (1) Education, (2) Income, (3) Work and (4) Politics.

The indicators used in this application come from two data sources. They are:

- a) A collection of microdata produced as part of the ArchIMEDe Project of the Italian National Institute of Statistics to study the socio-economic conditions of individuals and households in Italy at the municipal level (Garofalo, 2014). This microdata collection is based on the integration of several administrative sources and statistical registers. The information derived from administrative sources allows a complete coverage of the reference populations (the universe of individuals and households resident in Italy). Nevertheless, it should be noted that there are some informational gaps and comparability with surveys is not guaranteed.
- b) The “Register of Local and Regional Administrators” of the Ministry of the Interior, which collects data on the register of persons elected to local and regional offices in Italy.

Table 1 provides the list of selected indicators. The selection of indicators is based on a reasoned choice supported by the literature, but limited by the availability of data at a low territorial level. All selected basic indicators (with the exception of percentage of women in municipal councils) represent differences between women and men. Before constructing the composite index of gender gap, an exploratory analysis of the elementary indicators chosen for each dimension was performed. Firstly, the number of the aggregates used to calculate the indicators (population by sex and provinces, by age group, employment status, and educational attainment) was checked for each province. The aim was to ensure that the numbers were high enough to compute all the indicators. The layer with the lowest number counts 591 cases. Secondly, the correlations between the elementary indicators are quite low, with the exception of the correlation between work intensity exceedance and employment rate gap. Nevertheless, the correlations between basic indicators are not very relevant, since a formative model is adopted for the measurement of the gender gap.

Table 1 – *List of indicators*

Indicator	Dimension	Reference population
At least upper secondary education gap	Education	People aged between 25 and 64 years
Tertiary education gap	Education	People aged between 30 and 34 years
Labour income gap	Income	Individuals employed throughout the year aged between 15 and 64 years
Retirement income gap	Income	People over 64 years of age
Work intensity exceedance	Work	People aged between 15 and 64 years
Employment rate gap	Work	People aged between 15 and 64 years
Women in municipal councils (%)	Politics	

The individual indicators were normalized by a Constrained Min-Max transformation (Mazziotta and Pareto, 2022), so that they were directly comparable. In fact, assuming that the individual indicators have the same importance, only normalization methods that eliminate variability should be tested (Mazziotta and Pareto, 2024). Constrained Min-Max normalizes the range of individual indicators, similarly to the Min-Max method, but uses a common reference that allows to “centre” them, without forcing them into a closed range. Given the value x_{ijt} for location i on indicator j at time t , the normalized value is as follows:

$$y_{ijt} = \frac{x_{ijt} - x_{j0}}{\max_{x_j} - \min_{x_j}} \quad (1)$$

where $\min_{x_j}$ and $\max_{x_j}$ are, respectively, a minimum and a maximum that represent the possible range of indicator j for all locations over time (goalposts) and x_{j0} is the reference value or base for indicator j (e.g., the mean at time $t=0$ or a benchmark). This method allows to compare the values of the locations, both in space and time, with respect to a common reference. The value ‘0’ is the reference value for all indicators used in this work, with the exception of percentage of women in municipal councils, for which the reference is ‘50’. This choice allows to obtain normalized indicators that assume a value of 0 in case of equality between the two genders, positive values in case of a gender gap in favour of women and negative values in case of a gender gap in favour of men.

The aggregation function is the arithmetic mean. Four composite indices (one for each dimension) were created and then aggregated into a comprehensive index of Gender Gap (GG). The dimensions are equally weighted. Two dimensions (Work and Income) concerns Economy. This introduces a further element of subjectivity, but this appears manageable as the economy “is a major social arena in which decisions are made in society about the distribution of material resources and through which individuals gain access to positions of authority and power” (Ridgeway, 1992, ix). A compensatory approach was adopted, similar to that used in the World

Economic Forum's GGGI. The GGGI computes four sub-indexes as the weighted average of the underlying individual indicators and a simple average of each subindex score is used to calculate the overall index score. However, the latter calculates weighted averages of non-normalized female-to-male ratios (and assumes a value of 1 in the case of equality between the two genders), whereas this study calculates simple averages of normalized female-to-male differences (and assumes a value of 0 in the case of equality between the two genders). The use of a compensatory approach is justified by the fact that, since we are dealing with "balances", a partially compensatory approach, such as a different power mean, would produce a downward bias (e.g. the geometric mean) or an upward bias (e.g. the quadratic mean).

The robustness of the composite indicators and the underlying policy messages may, however, be contested. For this reason, an Influence Analysis was performed, to assess the robustness of the composite indicator in terms of its ability to produce accurate and stable measures, and its discriminant power. The average shift in the ranking of the provinces, for each removed indicator, was calculated. On average, the provinces move more when the work (13.9 positions) or politics (14 positions) indicators are removed and move less when the education (8.7 positions) indicator is removed.

In order to facilitate the territorial analysis, the results are represented by "quartile maps" of the composite indices for the four dimensions and for the gender gap index, and by a LISA Cluster Map showing the provinces with statistically significant values of the LISA index (Anselin, 1995).

4. Results

4.1. Territorial analysis of the indices of dimensions

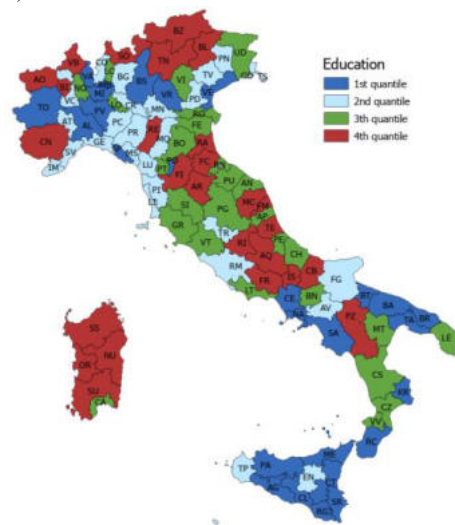
In all dimensions, with the exclusion of education, gaps are in favour of men in all provinces. In Italy, women are more educated than men; in 2023, 68.0% of 25-64 year-olds have at least a diploma or qualification (62.9% for men) and those with a tertiary qualification reach 24.9% (18.3% for men) (ISTAT, 2024a). Gender differences in this dimension are more marked in Italy than in the EU27 average. Figure 1a shows that low gaps in education are present in the provinces of Sicily, Puglia, Campania, and in some provinces of North-West. In the southern provinces, low gaps are associated with the lowest values of the elementary indicators.

Considering the income dimension, the gender pay gap in Italy is lower (5.6% in 2022) than the EU average (12.7%) (ISTAT, 2025). Concerning our data, the largest gaps in the income dimension (Figure 1b) are found in some provinces of the North

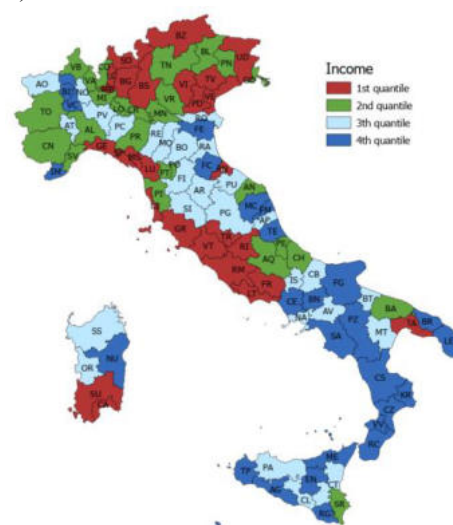
(mainly due to high gender gaps in labour income) and in some coastal provinces from Liguria to Campania, and southern Sardinia.

Figure 1 – Composite indicators for the four dimensions. *Quartile maps.*

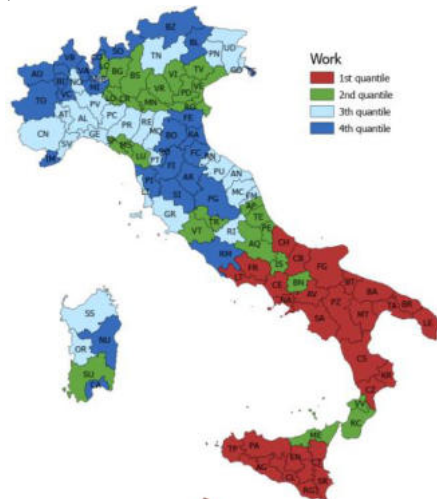
a) Education



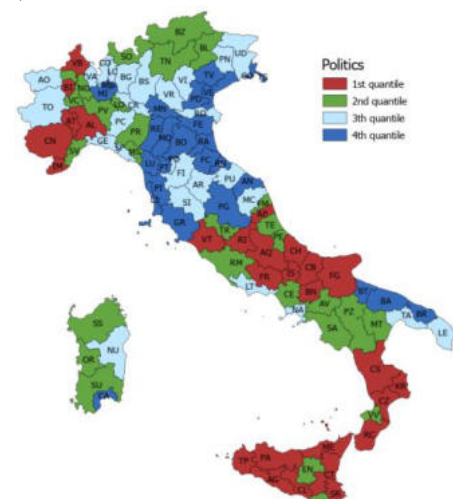
b) Income



c) Work



d) Politics



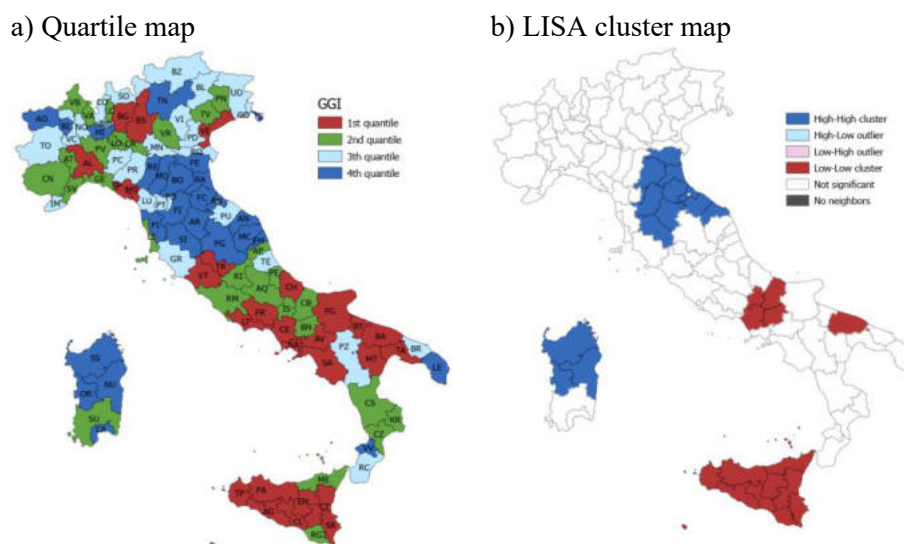
This result is consistent with other studies, which show that the pay gap is in favour of men in almost all regions, even if there are only very small differences in the southern Italian regions (Filippin, 2019; INPS, 2024).

Concerning the work dimension, in Italy, the greater female investment in education does not turn into a job advantage and the indicators that measure returns in the labour market are generally worse for women (ISTAT and CNEL, 2025). The gender gap between employment rates remains on average at 18 percentage points of difference and despite the slight annual decrease in the inactivity rate, to date 64% of inactivity in Italy continues to be female and mainly motivated by family needs (INAPP, 2024). Analyzing the territorial distribution (Figure 1c), almost all the southern provinces belong to the first quartile. The gap is smaller in the northernmost provinces of Italy, in the eastern provinces of Emilia Romagna (including Bologna) and in many provinces of Tuscany, and in Roma, Cagliari and Nuoro.

For politics' dimension, the largest gaps are present in some provinces of the South (especially Sicily, Calabria, Molise and Abruzzo), in some provinces of Lazio and North-west.

4.2. Territorial analysis of GG composite index

No Italian Province has achieved gender equality in any dimension. The composite index highlights a greater gender gap in some provinces of the South but also in some provinces of Central and Northern Italy (Figure 2a). The provinces in the North and Centre where the gap is smaller are Aosta, Trento and Milan, the provinces of Emilia Romagna, the provinces of Tuscany (with the exception of Massa Carrara and Livorno) and Marche. In the South, however, the gap is smaller in the provinces of Sardinia, Lecce, and Vibo Valentia. The composite index shows that there is a larger gender gap in some provinces of Eastern Lombardy (Bergamo and Brescia), in Venice, Alessandria and in the provinces of La Spezia and Massa Carrara. The provinces of Lazio and Southern Italy are mostly in the first quartile of the distribution of the composite index. This also applies to Campania, Puglia and Sicily. The LISA cluster map shows the provinces with statistically significant values of the LISA index (Figure 2b). A discrete spatial interaction is observed, highlighted by the value assumed by the Moran index (equal to 0.48). In Sicily a certain positive autocorrelation is found with seven provinces with low values observed in one province and low values also in its neighbourhood. Two other low-low clusters are present in the South. Eight provinces between Tuscany and Emilia-Romagna form a high-high cluster; two other high-high clusters are present in Sardinia and Marche. Finally, no outliers are identified.

Figure 2 – Composite index of gender gap. *Quartile map and LISA cluster map.*

5. Conclusions

Gender equality is still a long way off. Addressing the multiple dimensions of gender inequality requires action on several fronts, at the individual, interpersonal, household, and structural levels (Camilletti, 2024). The significance of regional disparity, and in particular, the pending effort to be made in terms of gender, is a long work still in progress. Besides, integrated and multi-level policy solutions are needed to achieve positive effects on gender equality. Adequate information is required for the implementation, monitoring, and evaluation of policies at the regional and local level (European Commission, 2010).

This paper presents an experimental analysis of socio-economic gender inequality in Italy at provincial level, by exploiting the potential of integrated administrative archives. The results underline the potential of this kind of data for territorial analysis, even if they are currently limited and not comparable with official data. A composite indicator approach was followed. The composite indicator is an important first step in comparing and monitoring the gender gap in a territorial perspective. The perspectives of analysis point to the possibility of providing useful knowledge to support decision-makers and the implementation of policies for specific areas. Nevertheless, the complexity of the situation shows that further investigation is still needed. Future work should also look at longitudinal analyses,

taking into account the role of external vicissitudes in reducing or increasing differences.

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REGIONAL DISPARITIES AND SOCIAL DEPRIVATION IN SPAIN: A NUTS2-LEVEL ANALYSIS USING THE DP2 METHODOLOGY

Margaret Antonicelli, Enrico Ivaldi

Abstract. Between 2019 and 2023, Spain faced a sequence of major socioeconomic shocks, including the COVID-19 pandemic, the energy crisis, and rising inflationary pressures. These events interacted with pre-existing territorial inequalities, producing persistent and spatially uneven patterns of material and social deprivation. This paper investigates regional disparities in deprivation across Spanish NUTS2 regions over the period 2019–2023 by constructing a multidimensional composite indicator based on the DP2 methodology (Peña, 1977; Somarriba & Peña, 2009). The study pursues three objectives: (i) to operationalize deprivation through a coherent set of harmonized indicators derived from EU-SILC and Eurostat regional statistics; (ii) to compute a DP2-based index that reduces redundancy among correlated indicators through an iterative correction mechanism; and (iii) to identify persistent spatial gradients and crisis-related changes in deprivation levels across regions. The results highlight a stable north–south divide, with southern and insular territories systematically displaying higher deprivation scores and confirm the sensitivity of regional deprivation to external shocks, particularly in regions dependent on vulnerable economic sectors. The findings provide policy-relevant evidence supporting the need for place-based and multidimensional strategies aimed at strengthening territorial cohesion and reducing social vulnerability.

1. Introduction

In recent decades, Spain has often been portrayed as a paradigmatic case of territorial imbalance within the European Union, combining highly competitive regions with territories characterized by persistent structural weaknesses and limited access to opportunities. Despite progress in economic modernization, significant disparities remain between North and South, coastal and inland areas, and metropolitan and rural contexts (European Commission, 2023). Between 2019 and 2023, Spain experienced an exceptional sequence of shocks, including the COVID-19 pandemic, energy crisis, and inflation, which disproportionately affected regions specialized in tourism and low-protection services (Eurostat, 2023). These shocks amplified pre-existing inequalities, particularly in southern and insular territories (Sánchez & Jiménez-Fernández, 2023).

Classical economic indicators, such as regional GDP per capita, only partially represent these dynamics. A region can display high average income while still hosting pockets of severe deprivation related to unemployment, housing insecurity, and limited-service access (Nolan & Whelan, 2011). This has led to a focus on multidimensional deprivation indicators that consider not only income but also factors like housing conditions and energy affordability (Guio, 2009). Composite indicators are increasingly used to synthesize complex phenomena into interpretable metrics for benchmarking and policy evaluation, with careful consideration of methodological choices (Bartram *et al.*, 2024).

This paper uses the DP2 methodology, which reduces redundancy among correlated indicators and allows spatial comparisons of deprivation across regions. By constructing a DP2-based deprivation index for Spanish NUTS2 regions over 2019–2023, the study maps persistent spatial gradients and assesses how crisis-related pressures affected regional deprivation.

The aim of this study is to measure and compare the evolution of material and social deprivation across Spanish NUTS2 regions during 2019–2023. The analysis is guided by three objectives: (i) to define an indicator framework capturing key dimensions of deprivation using harmonized regional data; (ii) to compute a composite deprivation index that accounts for redundancy; and (iii) to identify spatially persistent patterns and temporal shifts associated with economic shocks.

RQ1: Which Spanish NUTS2 regions exhibit higher deprivation levels over 2019–2023?

RQ2: How did deprivation dynamics change during the pandemic and post-pandemic period?

RQ3: Which deprivation-related dimensions contribute most to the composite indicator?

The paper is organized as follows. Section 2 presents the background on territorial deprivation and vulnerability. Section 3 describes data sources and methodology. Section 4 reports results and discusses spatial patterns and temporal dynamics. Section 5 concludes with policy implications.

2. Territorial Patterns and Determinants of Material Deprivation in Spain

Material and social deprivation is increasingly understood as a multidimensional phenomenon that reflects the enforced lack of access to essential goods and services, which individuals or households cannot afford under normal circumstances (Guio, 2009; Nolan & Whelan, 2011). Deprivation can be linked to the inability to achieve a minimum standard of living, where factors such as housing conditions, access to health services, energy affordability, and social participation are crucial. These

dimensions intersect with broader social and economic processes, including labor market segmentation, social exclusion, and regional imbalances, which vary significantly across European territories (European Commission, 2023).

In territorial terms, regional deprivation often manifests in stark spatial patterns, where certain areas—typically peripheral or rural—experience persistent vulnerabilities due to structural weaknesses in economic performance, limited access to public services, and demographic challenges such as aging populations or youth outmigration (Sánchez & Jiménez-Fernández, 2023). This is particularly evident in Spain, where long-standing north-south disparities and differences between urban and rural areas continue to define the landscape of deprivation (Ivaldi & Antonicelli, 2025). Recent economic shocks, such as the COVID-19 pandemic and the subsequent energy and inflation crises, have exacerbated these inequalities, with regions heavily reliant on tourism or low-wage sectors suffering disproportionately from economic disruptions (Eurostat, 2023).

To fully capture these complex and multifaceted phenomena, it is increasingly recognized that traditional economic indicators, such as GDP per capita, fall short in representing the depth of material deprivation. These measures overlook crucial aspects of well-being, such as quality of life, access to essential goods, and housing stability, which are key to understanding social inclusion and cohesion (Nolan & Whelan, 2011). As a result, the use of multidimensional indicators has gained prominence, offering a more comprehensive understanding of regional disparities. These indicators typically combine various dimensions—economic, social, and demographic—into a single composite score, facilitating spatial comparisons and providing valuable insights into regional vulnerabilities (Guio, 2009; Eurostat, 2023).

The construction of composite indicators, however, involves several methodological choices that can significantly affect the interpretability and robustness of results. Key challenges include the selection of relevant indicators, the choice of normalization methods, the determination of indicator weights, and the aggregation approach used to combine different dimensions into a single index (Bartram *et al.*, 2024). A critical decision is the method used to weight the individual indicators. Traditional approaches often rely on arbitrary weighting schemes, whereas newer methods, such as the DP2 methodology, adjust weights based on statistical relationships between variables, reducing redundancy and providing a more accurate representation of regional deprivation (Somarriba & Peña, 2009).

The DP2 approach, developed by Peña (1977), represents a significant advancement in the field of composite indicator construction. Unlike traditional indices, which use ad hoc weighting schemes, DP2 derives weights based on the statistical properties of the data, specifically the variance and co-variance across variables. This ensures that the composite indicator reflects the true

multidimensional nature of deprivation, minimizing the potential for compensatory effects between indicators (Somarriba & Peña, 2009). The DP2 method has been successfully applied in various contexts, including quality of life studies and regional deprivation analyses, offering a transparent and statistically robust alternative to more simplistic aggregation methods (Ivaldi & Antonicelli, 2025).

In the context of Spain, this methodology allows for a more nuanced understanding of territorial disparities by incorporating a wide range of socio-economic indicators and reducing redundancy across correlated variables. The use of DP2 to assess regional deprivation across NUTS2 regions over the period 2019–2023 is expected to provide important insights into how the COVID-19 crisis and other socio-economic shocks have affected material deprivation patterns across the country.

3. Data Sources, Simple Indicators and Research Hypotheses

This study utilizes data from the European Union Statistics on Income and Living Conditions (EU-SILC) and Eurostat regional statistics to construct a comprehensive deprivation indicator for Spanish NUTS2 regions over the period 2019–2023. EU-SILC provides detailed microdata on income, living conditions, and social participation, offering a robust basis for analyzing material deprivation at the household level across different regions of Spain. The dataset includes key variables related to basic living conditions, such as the ability to afford housing, heating, food, and unexpected expenses. These variables are aggregated at the NUTS2 level, ensuring comparability across regions and years.

To capture the multidimensional nature of deprivation, a set of partial indicators is selected from EU-SILC and Eurostat, focusing on key aspects of material and social well-being. These indicators include: (i) the ability to pay rent or utility bills; (ii) the capacity to keep the home adequately warm; (iii) the ability to afford a healthy diet, including meat or protein-equivalent meals; (iv) the capacity to face unexpected financial costs; and (v) access to durable goods such as a washing machine, car, and telephone. These variables are chosen based on their relevance to the concept of material deprivation and their ability to reflect the lived experiences of individuals in different regions (Guio, 2009; Nolan & Whelan, 2011).

In the construction of the composite indicator, the DP2 methodology is employed. The DP2 method is a distance-based approach that constructs a synthetic deprivation index by calculating the distance of each territorial unit from an ideal reference point, which represents the best possible performance across all indicators. Unlike traditional composite indicators, DP2 adjusts for indicator redundancy by calculating the weights for each indicator based on its statistical properties, specifically the

variance and co-variance across the data. This reduces the impact of highly correlated indicators and ensures that the resulting composite score accurately reflects the multidimensional nature of deprivation (Peña, 1977; Somarriba & Peña, 2009).

The reference vector for the DP2 calculation is defined as the best (lowest deprivation) observed performance across all regions and years in the dataset. This approach ensures that the results are comparable across time, as the same reference point is used to compute distances for each year in the study period. The DP2 values are calculated for each region in each year, and the resulting deprivation index provides a clear measure of how far each region is from the optimal deprivation-free state.

Indicator weights are determined endogenously through the DP2 method's iterative procedure. For each indicator, the weight is inversely proportional to its variance and co-variance with other indicators, ensuring that highly redundant variables have a reduced impact on the final index. This method allows for the creation of a non-compensatory indicator, where poor performance in one dimension cannot be offset by better performance in another, thus preserving the integrity of each deprivation dimension (Somarriba & Peña, 2009).

The final composite deprivation index is calculated for each Spanish NUTS2 region for the years 2019 through 2023. The results are then analyzed to identify regional patterns of deprivation, paying particular attention to how deprivation levels have changed over time, especially in response to the economic shocks of the COVID-19 pandemic and subsequent crises. This analysis provides valuable insights into the resilience of regions, the persistence of regional disparities, and the role of specific deprivation dimensions in shaping overall well-being.

4. Methodology

This study makes use of DP2 method based, originally, on Peña (1977), to consider the multiple aspects and dimensions of material deprivation. The DP2 measure is the distance of each territorial unit to an 'ideal' theoretical point located in a multi-dimensional space where the indicators under consideration would reach their best values. In contrast to more simple aggregation approaches, the DP2 accessory criterion considers the co-dependence of the variables and the level of variation in them, so that the composite indicator explains actual differences without overlap (Somarriba, Peña, 2009; Ivaldi, Antonicelli, 2025).

The DP2 index of a region j is calculated mathematically as follows:

$$DP2 = \sqrt{\sum_{i=1}^k \left(\frac{X_{ij} - X_i^{ref}}{s_i} \right)^2} * (1 - R_i^2) \quad (1)$$

where:

- X_{ij} = observed value of variable i in region j ;
- X_i^{ref} = reference (ideal) value for variable i ;
- s_i = standard deviation of variable i across all regions;
- R_i^2 = determination coefficient from the linear regression of variable i on all preceding variables, capturing shared variance and avoiding redundancy.

The $(1 - R_i^2)$ term serves as a penalty and puts less weight on something highly correlated with something included in the index. It ensures that the composite indicator is not compensatory: low performance in one side cannot be compensated by high performance in another side (Peña, 1977; Somarriba, Peña, 2009). The DP2 approach is especially well suited to the analysis of material deprivation as it is: processes several dimensions at a time, thereby accommodating the multifactorial nature of deprivation; reduces redundancy across the correlated measures for analytic clarity; gives a composite index that allows spatial comparisons both between regions and over time; is insensitive to scale and measurements on variables. Using the DP2 methodology, that interesting map is produced being the first data-based and fine-grained map of material deprivation in Spain, revealing latent patterns that single-variable analyses cannot reach. These are important insights for targeted, evidence-informed regional policies aimed at diminishing disparities and enhancing social inclusion (European Commission, 2023; Ivaldi, Antonicelli, 2025).

5. Results

The results of the DP2 analysis for Spanish NUTS2 regions from 2019 to 2023 reveal persistent regional disparities and significant temporal shifts influenced by the socioeconomic shocks of the COVID-19 pandemic and the subsequent energy and inflation crises. The national average DP2 score in 2019 was approximately 0.28, indicating moderate levels of material deprivation across Spain. However, marked regional differences were observed: northern regions, such as Navarre and the Basque Country, exhibited relatively low deprivation scores (around 0.18), while southern and insular regions, including Andalusia, Extremadura, and the Canary Islands, had significantly higher values (over 0.35).

The COVID-19 pandemic had a substantial impact on deprivation levels, particularly in regions highly dependent on tourism and low-wage industries. In 2020, many regions experienced an increase in DP2 scores, with some areas, such as the Canary Islands and Balearic Islands, seeing rises above 0.42. These increases were driven by income losses, housing insecurity, and difficulties in accessing essential services. Although there was some recovery in 2021 and 2022, the DP2 values remained elevated compared to pre-pandemic levels, reflecting the prolonged effects of the crisis. The spatial distribution of material deprivation in Spain is presented in Figures 1 to 5, where regions are color-coded to reflect their DP2 scores. These figures use a gradient scale where darker colors indicate higher levels of deprivation, and the classification is based on quantile categories. For instance, regions in the highest quantile of deprivation are shaded darker, visually emphasizing areas of persistent vulnerability. The DP2 values for each region are listed in Table 1, which presents the exact numerical values for the years 2019–2023. These values in the table correspond to the regional averages and ensure consistency with the figures.

Table 1 – *Material Deprivation Index (DP2) by Spanish Region, 2019–2023.*

Region (NUTS2)	DP2 2019	DP2 2020	DP2 2021	DP2 2022	DP2 2023
Andalucía	0.36	0.38	0.42	0.40	0.38
Aragón	0.24	0.26	0.28	0.26	0.25
Asturias	0.23	0.24	0.26	0.25	0.23
Balearic Islands	0.33	0.38	0.44	0.40	0.35
Canary Islands	0.38	0.42	0.46	0.43	0.42
Cantabria	0.19	0.20	0.22	0.21	0.19
Castilla y León	0.26	0.27	0.29	0.28	0.26
Castilla-La Mancha	0.28	0.30	0.34	0.31	0.30
Catalonia	0.24	0.26	0.28	0.26	0.24
Valencian Community	0.29	0.32	0.35	0.32	0.30
Extremadura	0.37	0.39	0.43	0.41	0.39
Galicia	0.24	0.25	0.28	0.26	0.24
Madrid	0.23	0.26	0.28	0.26	0.24
Murcia	0.30	0.32	0.36	0.33	0.31
Navarre	0.17	0.18	0.20	0.19	0.17
Basque Country	0.15	0.17	0.18	0.17	0.15
La Rioja	0.19	0.20	0.22	0.20	0.19

Table 1 also includes the DP2 values for Ceuta and Melilla, which were previously omitted in the original version for space reasons but are now included for completeness and clarity.

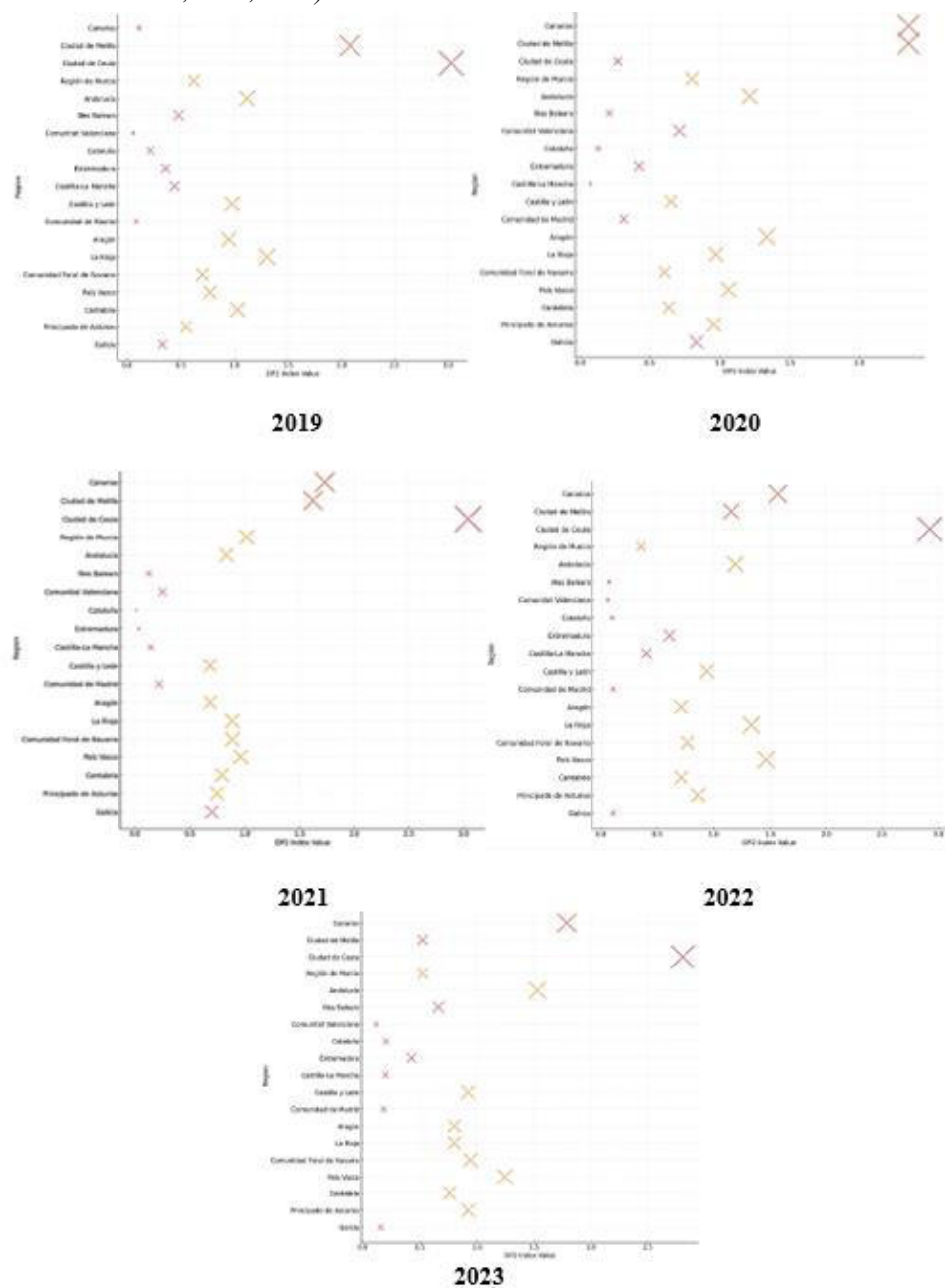
A DP2 score of 0.30 at the national level indicates a moderate level of material deprivation, but the distribution of deprivation was highly uneven across regions. Regions heavily dependent on tourism, such as the Canary Islands and Balearic Islands, saw some of the largest increases in deprivation during this period, with DP2 scores exceeding 0.42 in some areas. The inability to afford unexpected expenses and to keep homes adequately heated were significant challenges during the crisis, highlighting how the economic disruption exacerbated existing vulnerabilities.

By 2021, the effects of the pandemic were still being felt. Although there was some economic recovery, the national DP2 average remained elevated, close to 0.30. Deprivation levels in the most vulnerable regions stabilized but remained well above pre-pandemic levels. Furthermore, urban areas began to show signs of increasing internal polarization. While the overall DP2 scores in regions such as Madrid and Catalonia remained relatively low, certain urban areas experienced rising deprivation, linked to job losses in services and growing housing insecurity.

In 2022, despite some economic recovery, the improvements in material deprivation were modest. The national DP2 index slightly decreased to around 0.28, but this recovery was uneven and insufficient to reverse the damage caused by the pandemic. New sources of stress, particularly the energy price crisis, led to sharp increases in specific deprivation indicators, such as the ability to maintain homes at an adequate temperature. In high deprivation areas, over 25% of households struggled to afford heating, further amplifying regional disparities in deprivation.

By 2023, the national DP2 index decreased to approximately 0.27, indicating a slow recovery toward pre-pandemic conditions. However, the gap between regions remained large. Northern regions saw their deprivation scores improve, with values returning to below 0.18. In contrast, southern and insular regions continued to experience high deprivation, with scores frequently above 0.35. Additionally, intra-urban disparities persisted, suggesting that significant pockets of material deprivation existed even within economically dynamic areas.

Figure 1 – Spatial Distribution of Material Deprivation in Spain (DP2 Index, 2019, 2020, 2021, 2022, 2023).



The spatial-temporal analysis reveals several key trends:

- Persistence of structural disparities: Despite some national-level improvements, long-standing regional divides, particularly between northern and southern Spain, remain entrenched.
- Sensitivity to external shocks: The DP2 index captured sharp increases in deprivation during the pandemic, particularly in regions dependent on vulnerable economic sectors such as tourism.
- Multidimensional nature of deprivation: Beyond income, factors like heating adequacy, the ability to manage unexpected expenses, and access to durable goods played a significant role in regional variations in deprivation across all years.
- Urban polarization: Even regions with relatively modest average DP2 scores exhibited deepening internal inequalities, with specific districts showing heightened deprivation.

These findings underscore the importance of adopting a multidimensional approach to regional development policies that goes beyond traditional economic indicators. The DP2 methodology proves crucial in identifying subtle, yet impactful, spatial and temporal shifts in material deprivation, which can inform targeted local interventions aimed at mitigating inequalities and promoting social cohesion in line with EU policy goals.

6. Conclusion

The analysis of material deprivation across Spanish NUTS2 regions from 2019 to 2023 reveals significant regional disparities and demonstrates the vulnerability of certain territories to external socioeconomic shocks. While the national average DP2 score indicates a moderate level of deprivation, the regional variation is striking. The northern regions, such as Navarre and the Basque Country, consistently exhibit lower levels of deprivation, while southern and insular regions, including Andalusia and the Canary Islands, experience much higher levels of material hardship. The effects of the COVID-19 pandemic and the energy price crisis exacerbated these disparities, with the most vulnerable regions showing sharp increases in deprivation scores during the crisis.

The results underscore the multidimensional nature of deprivation, where factors such as housing, food security, energy affordability, and access to basic services significantly influence the well-being of regional populations. The DP2 methodology proved to be an effective tool in identifying these complex spatial and temporal shifts in deprivation, capturing both longstanding territorial divides and short-term disruptions caused by the pandemic and subsequent crises. The sensitivity

to external shocks is evident, with some regions experiencing deeper and more lasting deprivation due to their reliance on vulnerable economic sectors, such as tourism and low-wage industries.

The analysis also highlighted the emergence of urban polarization, even in economically developed areas like Madrid and Catalonia. Increasing internal disparities within these regions signal a growing divide between affluent districts and areas suffering from housing insecurity, job losses, and social exclusion. These findings emphasize the need for policies that address not only spatial inequalities but also the internal disparities within urban centers.

The findings have important policy implications for regional development strategies. As the analysis reveals, regional disparities are persistent and multifaceted, requiring multidimensional, place-based interventions. Policies aimed at improving regional cohesion should go beyond traditional economic indicators, incorporating factors related to social exclusion, housing, and access to basic services. The DP2 methodology offers a robust framework for detecting and understanding these disparities, allowing policymakers to design more targeted and evidence-based interventions.

In line with the European Union's Cohesion Policy and the Sustainable Development Goals (SDGs), particularly SDG 1 (No Poverty) and SDG 10 (Reduced Inequality), the results of this study underscore the need for inclusive and context-sensitive policies that foster social cohesion and reduce material deprivation in the most vulnerable regions. Future research could expand the analysis by incorporating additional dimensions of well-being, such as cultural, behavioral, and environmental factors, to further deepen our understanding of territorial disparities and inform more comprehensive policy frameworks.

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YOUNG ADULTS RESIDENT IN ITALY: A LOCAL-LEVEL ANALYSIS OF CHARACTERISTICS AND DEMO-SOCIAL WEAKNESS

Mariangela Verrascina

Abstract. Some territories in Italy have experienced a persistent population loss in recent decades. The decline, due to reduced births and emigration, has contributed to population ageing and depopulation in many areas. Italy is experiencing *dejuvenation* (*degiovanimento*) due to the decrease of young people, too. The study focuses on young adults (25-49 years). The aim is to highlight the differences across Italy when the focus is placed on the local level, by a synthetic index to measure the level of ‘demo-social weakness of municipalities (for young adults)’. Five demographic and socio-economic indicators on young adults resident in Italian municipalities are calculated. For each municipality, indicators are compared to the respective national values through the location quotients (LQ). From the combination of the LQ values, criticality profiles are identified and finally summarised in a single measure. The LQs and the synthetic index are represented on maps to allow for visual assessment and highlight territorial disparities. Other geographical peculiarities are included in the analysis to investigate which types of municipalities present more critical elements in the index of demo-social weakness of young adults in Italy. The results show that criticality is not solely linked to belonging to a geographical area or spatial peripherality: despite the presence of services, some municipalities are not immune to criticality, while others, even without essential services, show a positive demographic and social situation, suggesting the influence of factors other than distance from services alone.

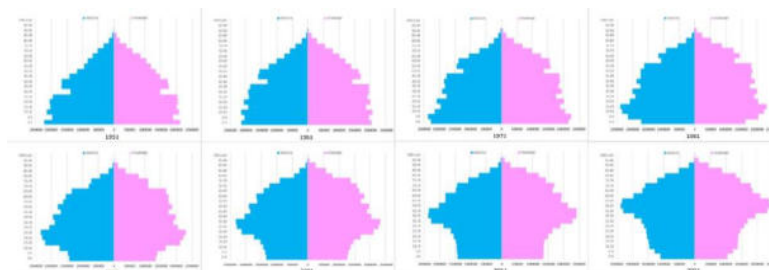
1. Introduction

Demographically, Italy presents differentiated situations with territories that have experienced a persistent population loss in recent decades. The population structure in Italy has changed significantly over the last 70 years as shown by the age-sex pyramids starting from the first post-war census (Figure 1).

In 1951, the resident population stood at 47,515,537, rising to 59,030,133 by 2021. The all-time peak was reached in 2014, with approximately 60,346,000 residents, followed by a gradual and steady decline. An analysis of the population divided into four broad age groups shows that, at the 1951 census, the under-25s were just less than half the population, while at the 2021 census they represent just over one in five; conversely, people aged 65 and over represented less than one in ten in 1951, whereas in 2021 they are approximately one in four inhabitants. There

is also an increasing weight of adults (50-64 years) and a not insignificant decrease of young adults (25-49 years) (Istat, 2023).

Figure 1 - Age-sex pyramids, Censuses from 1951 to 2021.



Source: Istat, General Population Censuses (1951 to 2011) and Permanent Population Census 2021.

The work focuses on individuals aged 25 to 49, referred to as ‘*young adults*’ and presents a proposal to measure the level of ‘demo-social weakness of municipalities (for young adults)’. After an overview of the demographic context of the analysis (Section 2), the data used, the method of analysis and synthesis are illustrated (Section 3), the main results are presented (Section 4) and the conclusions and future prospects are outlined (Section 5).

2. Factors and consequences of demographic change and decline in Italy

Ageing and depopulation are rapidly accelerating phenomena that are set to define global demographics for the rest of the 21st century. The general trend is characterised by an increase in the elderly population and a simultaneous reduction in the working-age labour force (Ljunggren, 2024). Japan is the country with the highest proportion of elderly people globally. However, Europe is projected to become the first continent to experience demographic decline, with significant challenges due to low and decreasing birth rates, limited or negative net migration, rapid ageing and a shrinking workforce. Depopulation occurred mainly in Eastern and Southern Europe in the 2010s, and these areas are expected to experience the sharpest demographic declines between 2023 and 2050 (Majdzińska, 2024; Newsham, Rowe, 2022; Pinkus, Ruer, 2025). Also in Italy, a combination of demographic and migratory dynamics is shaping population trends. One major factor is the shrinking size of new generations, a process called ‘ageing from below’ - a structural shift resulting from fewer births. This led to a broader phenomenon of *dejuvenation*, the gradual reduction in the younger population (Rosina, 2008). Migration flows play a key role, too. Internal migration continues predominantly in a South-to-North direction, especially towards medium to large urban centres that offer better opportunities for education, employment, and overall quality of life. Since the mid-1990s, foreign immigration has helped slow population decline and

ageing in some territories, partially counteracting the negative natural dynamics of the native population. However, these inflows have diminished over the past years and remain concentrated in regions more economically active. Meanwhile, emigration has resumed in recent years; in 2024 the number of individuals leaving the country reached 191,000 people -up 20.5% from the previous year- including over 156,000 Italian citizens (Istat, 2025).

Depopulation and ageing show substantial spatial heterogeneity at the local level. The emigration of young people is a particularly critical factor accelerating depopulation and ageing in rural areas. Depopulation is not limited to rural areas but occurs along the entire rural-urban continuum. Rural and intermediate areas far from large urban centres are proving to be the most vulnerable, with small and medium-sized rural areas being the main driver of accelerating demographic decline in Europe (Newsham, Rowe, 2025). In Italy many areas have given up population to other territories or abroad. Internal and international migration by young adults towards more attractive places has led to the abandonment of municipalities of smaller demographic size, rural, and mountainous areas, intensifying in these territories the processes of *dejuvenation* and population ageing and increasing spatial inequality for those who remain in declining areas. The future perspectives are even worse: if current trends persist, ageing and depopulation will increase especially in marginal zones that will become more and more disadvantaged.

The analysis focuses on young adults, the demographic and economic backbone of society. At that stage of life, they are generally expected to have completed their education, to be active in the labour market, and to have settled in a place chosen as residence. An index is proposed to measure the level of demo-social weakness of municipalities for young adults, i.e. the demo-social weakness with regard to young adults on a municipal basis, obtained as a synthesis of some characteristics of young adults resident in Italian municipalities. The aim is to highlight territorial disparities in Italy by analysing the local level. When considering municipalities separately, peculiarities emerge that might be overlooked when observing broader portions of territory (Quondamstefano, Verrascina, 2024). Five indicators are calculated to describe demographic and socio-economic characteristics of young adults. For each municipality, indicators are compared to the respective national values through the location quotients (LQ). Then, criticality profiles are identified from the combination of the LQ values, and finally summarised in a synthetic index. These steps are explained in detail in the next section.

3. Data, method of analysis and synthesis

3.1. Demographic and socio-economic characteristics of young adults

The data used for the analysis come from the 2021 Permanent Census of Population and Housing, open data available online, which provides annual results

at municipal level, allowing for a detailed understanding of local dynamics. To assess the situation of young adults, five non-redundant indicators are calculated.

- A. *Population aged 25-49 (%)* - ratio of the population aged 25-49 to the total resident population per 100 inhabitants. A low share of this group may signal the onset of demographic fragility.
- B. *Ratio of the population aged 65 and over to the population aged 25-49 (%)* - ratio of the population aged 65 and over to the population aged 25-49 per 100 inhabitants. It reflects the generational balance by indicating how many older individuals exist for every 100 young adults. A high value points to a demographic imbalance and potential dependency issues.
- C. *Population aged 25-49 with high educational level (%)* - ratio of population aged 25-49 with high educational level¹ to population aged 25-49 per 100 inhabitants. It refers to the share of young adults who have attained a tertiary education qualification, reflecting the human capital available in a given area.
- D. *Employment rate of population aged 25-49 (%)* - ratio of employed persons aged 25-49 to the population of the same age group per 100 inhabitants. It measures labour market integration, showing where there are greater employment difficulties for young adults.
- E. *Population aged 25-49 with no income or who are homemakers (%)* - ratio of the population aged 25-49 with no income or who are homemakers to the total population of the same age group per 100 inhabitants. It identifies, among people classified as 'Non-labour force', young adults who do not receive one or more pensions as a result of previous employment or capital income, are homemakers, are not students.

3.2. Method of analysis

A multidimensional phenomenon cannot be investigated through a single descriptive indicator. The synthetic index methodology in statistics is a technique used to summarise information of several variables into a sole indicator. This approach is particularly useful when it is necessary to condense a large amount of data into a more manageable and interpretable form. Synthetic indices are widely used in many disciplines to measure complex because multidimensional phenomena. They can be used as tools to identify more exposed territories, and as an aid to suggest to decision-makers an order of priority for intervention. The construction of a synthetic index requires several steps (Mazziotta, Pareto, 2024). The phenomenon to be measured with the index must be clearly defined and variables that best represent the phenomenon under investigation must be chosen. After identifying the

¹ High educational level: tertiary education (ITS higher technical diploma, tertiary first and second degree and PhD).

variables, data must be normalised to ensure comparability and the polarity (positive or negative), i.e. the sign of the relationship between the indicator and the phenomenon, must be identified. Then the normalised indicators can be aggregated into a single synthetic index. In this study, indicators are normalised through the calculation of location quotients. The location quotient (LQ), a ratio of ratios, is a widely known geographic index. It is used to measure and map relative distributions or relative concentrations of a character in a subarea (in this case municipality) compared to the area as a whole (Italy). The location quotient is an index of local concentration that varies around 1, obtained as the ratio of the indicator value of each municipality to the national value. The LQs allow to identify the spatial units in which a phenomenon is under-represented ($LQ < 1$) or conversely, over-represented ($LQ > 1$) compared to the phenomenon on a national basis (Verrascina et al., 2024; Benassi et al., 2022). When $LQ < 1$ the extent of the phenomenon on a municipal scale is smaller than on a national scale (phenomenon less present in the area); if $LQ = 1$ the extent of the phenomenon on a municipal scale is in line with the national one and when $LQ > 1$ the extent of the phenomenon on a municipal scale is greater than on a national scale (phenomenon more concentrated in the area). The LQ normalises the data with respect to the overall structure and eliminates differences in scale or population, making different territorial areas comparable (a small municipality with a high LQ for an indicator may reveal a significant local concentration of a phenomenon even if the absolute number of cases is low). The method has been applied in several studies when using data for small areas. For instance, LQs are applied to analyse the concentration of different foreign groups in the enumeration areas of an Italian city (Borruso, 2008); to measure the local concentration of foreigners compared to Italians, providing a concise and easily interpretable measure of territorial concentration (Istat, 2024). LQs are also used to measure territorial production specialisation in economic sectors to compare the concentration of employees in a sector in an area vs the national value, helping to identify poles of excellence or areas of production weakness (Istat, 2007).

In order to make the location quotients (LQ) comparable with each other and establish uniform interpretation classes (not distorted by the individual statistical distributions of each indicator), a fixed threshold classification is chosen. This methodological choice is based on a standardised analytical approach that derives consistently from the conceptual nature of the LQ. Thus, the classes are defined with intervals of 0.5 around the reference value ($LQ = 1$, i.e. the national value):

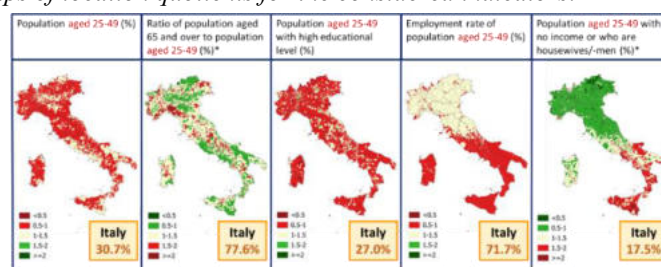
- $LQ < 0.5$: Strong under-representation: municipalities with a situation of severe shortage.
- $0.5 \leq LQ < 1.0$: Moderate under-representation: municipalities that do not reach the national value but with less severity than the previous class.

- $1.0 \leq LQ < 1.5$: Standard representation/slight over-representation: municipalities in line with the national value or with slight over-representation.
- $1.5 \leq LQ < 2.0$: Substantial over-representation: municipalities with a significant concentration.
- $LQ \geq 2.0$: Extreme over-representation: municipalities with an exceptional concentration.

For indicators *Population aged 25-49* and *Employment rate of population aged 25-49*, the LQ values do not exceed the threshold of 1.5, meaning there are no cases of substantial or extreme concentration. For *Population aged 25-49 with high educational level*, more than 3 out of 4 municipalities are in the Moderate under-representation class, corresponding to 57.4% of the resident population. However, there are also a few cases of municipalities showing a concentration of young adults with a high educational level (0.7% of municipalities and 6.0% of the population). *Ratio of the population aged 65 and over to the population aged 25-49* and *Population aged 25-49 with no income or who are homemakers*, conversely, have opposite trends since they are indicators with negative polarity: extreme over-representation ($LQ \geq 2.0$) indicates very critical situations. Although a large number (more than 1,100) of municipalities fall into these high-criticality categories, they correspond to a low proportion of population residing there. In general, the distribution of municipalities is often different from that of the resident population, as many municipalities have a relatively small population.

Location quotients are usually represented visually on maps to allow for a deeper understanding of territorial distributions and disparities and to facilitate their interpretation. By highlighting areas where a phenomenon is either over- or under-represented, the LQ is particularly effective in identifying situations of potential or specific local criticality. By using colour gradients - typically red for areas where the indicator is significantly worse than the national value (signalling a critical condition), and green for areas performing better than the national figure - one can quickly assess where issues are more or less intense (Figure 2).

Figure 2 - Maps of location quotients for the considered indicators.



Source: Istat, Permanent Population Census 2021.

* Indicators with negative polarity.

Compared to the other indicators where criticality occurs when $LQ < 1$, for *Ratio of population aged 65 and over to population aged 25-49* and *Population aged 25-49 with no income or who are homemakers* criticality occurs if $LQ > 1$. Thus, municipalities with a ratio of elderly to young adults and municipalities with an incidence of young adults without income or homemakers higher than the national figure are shown in red.

3.3. Method of synthesis

For each location quotient, based on the value of the LQs themselves, criticality levels are defined, which identify the potential criticality levels for each socio-demographic characteristic of young adults considered. Specifically: Criticality level 0 - no critical elements; Criticality level 1 - LQ value in line with the national value or slightly deviating; Criticality level 2 - significantly divergent LQ value. By counting the frequency with which each Criticality level (0, 1, 2) occurs, combinations of levels are constructed. The combinations identify Criticality profiles then summarised in a synthetic index. The Criticality profiles (i.e. the combinations of Criticality levels) are reclassified for the single index of demographic and social weakness of municipalities (for young adults) and are assigned values between 0 ('no criticality') and 5 ('very high criticality') (Table 1).

Table 1 - Index of demo-social weakness of municipalities (for young adults).

Nr of Criticality level 0	Nr of Criticality level 1	Nr of Criticality level 2	Criticality profiles (Combination of number of Criticality level)	Index		Nr of municipalities
				value	description	
3	2	0	all criticality level 0 or 1 (no criticality level 2)	0	no criticality	154
2	3	0				
1	4	0				
0	5	0	1 criticality level 2 or 4-5 criticality level 1	1	low criticality	1861
3	1	1				
2	2	1				
1	3	1				
0	4	1				
3	0	2	2 criticality level 2 or 4 criticality level 1 & 1 criticality level 2	2	medium-low criticality	2738
2	1	2				
1	2	2				
0	3	2				
2	0	3	3 criticality level 2 or 3 criticality level 1 & 2 criticality level 2	3	medium-high criticality	1478
1	1	3				
0	2	3				
1	0	4	4 criticality level 2 or 2 criticality level 1 & 3 criticality level 2	4	high criticality	899
0	1	4				
0	0	5	5 criticality level 2 or 1 criticality level 1 & 4 criticality level 2	5	very high criticality	774

The synthetic index provides a clear and concise summary of the overall demo-social vulnerability of young adults at municipal level, and also shows how municipalities are distributed across each class.

3.4. Territorial/geographical characteristics of municipalities

When the focus is on the local level, it is useful to include in the analysis some geographical peculiarities that help to better highlight the similarities and differences among Italian municipalities and, in this case, to investigate whether there are types of municipalities that present more critical elements in the index on the level of

demo-social weakness for young adults in Italy. Analysing demographic and socio-economic aspects relating to the population, the disadvantage experienced by some territories due to the lack of citizenship services cannot be ignored. The abandonment of municipalities on the margin (especially by young people) occurs in favour of those with more services or easier access to some services (Carrosio, Faccini, 2020).

The classification of the Italian territory, based on the geography of Inner Areas, assigns municipalities to categories according to the availability and accessibility of specific essential services (namely mobility, education, and health), or the proximity to such services. The remaining municipalities are designated as Inner Areas (Dipartimento per lo sviluppo e la coesione economica, 2014). Thus, Inner Areas are territories in the country that are further away from the centres offering the three types of services. The distance to the supply of essential services is calculated in terms of road travel time; as travel time increases, so does the potential difficulty of accessing services. Municipalities are divided into six groups (types): Pole, Intermunicipal Pole, Belt, Intermediate, Peripheral, Ultraperipheral² (Istat, 2022). For this work, municipalities were grouped into three classes: 'Centre Areas' (Pole, Intermunicipal Pole and Belt municipalities), 'Intermediate Municipalities' and 'Peripheral and Ultraperipheral Municipalities' (the last two groups).

Supplementary geographical characteristics are integrated into the analysis: Altitude zone³, Degree of urbanisation⁴ and Demographic size of municipalities. This allows to identify which types of municipalities demonstrate greater criticality according to Index of demo-social weakness (for young adults).

4. Main results

The situation of Italian municipalities according to the index is shown on maps (Figure 3). Municipalities with no critical issues or with a low level of critical issues are highlighted in dark green. As the intensity of the green colour becomes lighter, the phenomenon increases in intensity, until it turns into to shades of red. The darker the red colour, the higher the criticality level of those municipalities.

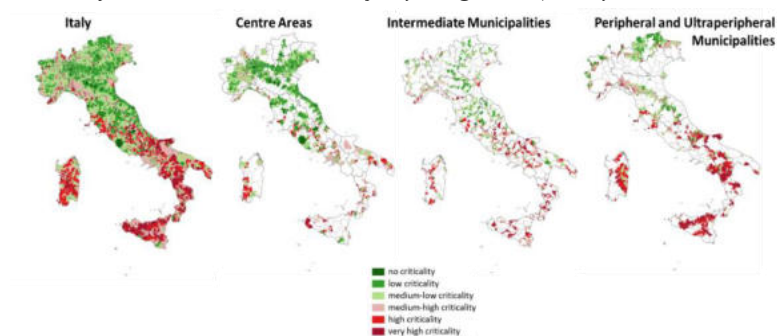
² Centre Areas: 'Pole' and 'Intermunicipal Pole' - all three services present; 'Belt' - distance to the nearest pole less than 27 minutes. Inner Areas (municipalities with higher travel times): 'Intermediate' - between 27 and 41 minutes; 'Peripheral' - between 41 and 67 minutes; 'Ultraperipheral' - over 67 minutes.

³ Altitude zone derives from the division of the national territory into homogeneous zones resulting from the aggregation of contiguous municipalities on the basis of altimetric threshold values. The classification includes: Plain, Coastal Hill, Inland Hill, Coastal Mountain and Inland Mountain (Eurostat, 2019).

⁴ Degree of urbanisation is an international classification that indicates the character of an area. Based on the share of the local population living in urban clusters and urban centres, it classifies Local Administrative Units (LAU or municipalities) into three types of area: Cities (densely populated areas), Towns and suburbs (intermediate density areas), Rural areas (thinly populated areas) (Eurostat, 2019).

An initial analysis of the ‘Italy’ map reveals a predominance of the colour red in the South and the Islands, indicating municipalities with high levels of criticality, highlighting a demo-social weakness for young adults. However, there are areas in the Northern and Central Italy (around Liguria, Tuscany) with red spots, as well as areas in the South (between Apulia and Basilicata) that are greener than the surrounding areas.

Figure 3 - Index of demo-social weakness (for young adults), Italy and Inner Areas.



Source: Istat, Permanent Population Census 2021.

The synthetic index has also been broken down into three maps according to the type of area to which the municipalities belong. Comparing the first and the last, even in the Centre Areas, which have services and should be less penalised, there are red spots, i.e. not all municipalities are completely free of criticality profiles. In contrast, in the more peripheral areas, there are territories in the North where the situation is not bad, even though these municipalities do not have essential services close by. This means that belonging to an Inner Area is not necessarily further penalising; there are other elements that come into play.

The index makes it possible to distinguish, among the Inner Areas, those most at risk, and among the Centre Areas those municipalities that nevertheless present critical profiles. At the same time, the index allows to immediately trace among the municipalities most exposed those that, falling in a peripheral or ultra-peripheral area, present more serious criticalities and require more urgent interventions.

After displaying the index for Inner Areas on maps, the distribution of municipalities and resident population classified according to the values of the synthetic indicator for the geographical/territorial characteristics introduced in the previous section is shown in Table 2. As expected, the most penalised municipalities are those in inland hills and inland mountains, those belonging to rural areas with low population density, and the very small municipalities, which are the majority in Italy (5,533 out of 7,904).

Table 2 - Index for Altitude zone, Degree of urbanisation and Demographic size - number of municipalities and resident population, percentage value.

Altitude zone	Index value	Nr of municipalities								Resident population							
		Total (AV)	Total (N)	no criticality	low criticality	medium-low criticality	medium-high criticality	high criticality	very high criticality	Total (AV)	Total (N)	no criticality	low criticality	medium-low criticality	medium-high criticality	high criticality	very high criticality
Plain		2,099	26.6	10.4	44.4	38.4	13.5	12.2	6.5	29,026,699	49.2	91.4	52.4	41.1	41.2	28.4	17.3
Coastal hill		785	9.9	10.4	7.1	6.4	13.4	16.0	14.7	9,147,809	15.5	3.6	11.1	12.9	31.6	23.0	17.3
Inland hill		2,533	32.0	22.0	28.9	32.9	28.9	17.0	10.9	13,699,210	23.2	11.0	25.6	29.5	16.3	10.0	8.0
Coastal mountain		117	1.5	0.0	0.1	0.7	2.4	2.4	4.9	1,390,452	2.3	0.0	2.2	1.1	2.0	9.0	3.0
Inland mountain		2,370	30.0	16.0	20.5	31.6	36.7	11.7	4.9	5,825,963	9.9	3.8	7.9	14.9	8.0	13.7	16.4
Italy		7,904	100.0	100.0	100.0	100.0	100.0	100.0	100.0	59,030,133	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Degree of urbanisation	Index value	Nr of municipalities								Resident population							
		Total (AV)	Total (N)	no criticality	low criticality	medium-low criticality	medium-high criticality	high criticality	very high criticality	Total (AV)	Total (N)	no criticality	low criticality	medium-low criticality	medium-high criticality	high criticality	very high criticality
Cities (densely populated areas)		256	3.2	18.2	5.1	1.4	3.5	0.8	0.3	20,757,460	35.2	99.8	96.3	11.5	43.3	15.6	13.0
Towns and suburbs (intermediate density areas)		2,608	33.0	70.0	52.8	34.1	25.2	16.6	10.7	28,330,065	47.8	16.3	33.9	63.0	42.3	24.0	17.3
Rural areas (thinly populated areas)		5,040	63.8	11.4	42.3	64.2	68.3	81.7	86.4	10,042,608	17.0	1.6	10.2	27.2	14.1	39.6	69.7
Italy		7,904	100.0	100.0	100.0	100.0	100.0	100.0	100.0	59,030,133	100.0	100.0	100.0	100.0	100.0	100.0	100.0

Demographic size	Index value	Nr of municipalities								Resident population							
		Total (AV)	Total (N)	no criticality	low criticality	medium-low criticality	medium-high criticality	high criticality	very high criticality	Total (AV)	Total (N)	no criticality	low criticality	medium-low criticality	medium-high criticality	high criticality	very high criticality
Up to 5,000		5,533	70.0	31.4	43.8	76.2	71.8	11.8	4.9	9,764,093	16.5	2.0	10.7	25.5	13.0	36.5	69.7
5,001-50,000		2,231	28.2	38.0	43.0	27.4	26.0	15.1	8.9	29,116,580	49.3	21.0	62.5	63.6	48.0	49.0	34.1
50,001-100,000		96	1.2	2.6	2.0	0.8	1.9	0.4	0.3	6,490,006	11.0	4.0	12.5	9.8	15.6	7.5	7.2
100,000 and more		44	0.6	4.5	1.3	0.1	0.3	0.3	0.1	13,659,454	23.1	7.8	24.3	2.7	21.8	6.8	10.0
Italy		7,904	100.0	100.0	100.0	100.0	100.0	100.0	100.0	59,030,133	100.0	100.0	100.0	100.0	100.0	100.0	100.0

5. Conclusions and future perspectives

The analysis carried out reveals a context in Italy for young adults that goes beyond the geographical position of the municipalities in which they reside. Situations of criticality and disadvantage are scattered over the territory: in the North and in the South, in the mountains and in the plains, in rural and in urban areas, in Centre Areas and in Inner Areas. While much discussion revolves around declining birth rates and ageing population, attention should also be paid to the critical age group of young adults, otherwise Italy really risks losing its ‘demographic future’.

The depopulation of the territory, when associated with the ageing of the population living there, represents a major challenge for the society, economy and politics of the future. But public policies and measures should be wide-ranging. It would be necessary to secure those groups of the population able to procreate (before encouraging the birth rate), counter the demographic decline of young people and slow down the *dejuvenation* of the population resident in Italy, both quantitatively and qualitatively, in order to restart development and growth (Rosina, 2023). Furthermore, it would be necessary to invest in training of young people and facilitate their integration into the labour market, find ways to attract and retain young people, both Italians and foreigners (Dalla Zuanna, 2023). Promoting immigration could help achieve some objectives thanks to the arrival of active population with higher fertility levels than those recorded in Italy. If the imbalances between generations increase, already vulnerable territories will become increasingly fragile.

Other actions should be put in place to counter the depopulation and abandonment of some territories. Villages and small towns should be revitalised and revived by providing them with adequate services (schools, social and health services, transport, internet network). Choices to leave or to stay could be linked to these aspects. There are several elements to be considered in order to achieve this objective: attracting people (even from other countries) (Licursi, 2024), reducing the need to leave (those

who leave their place of origin usually go to centres that provide essential services, job opportunities and the possibility of better living conditions and quality of life), encouraging the return of young people who have left to their places of origin, and facilitating the 'restance' (restanza) according to the concept defined by the anthropologist Vito Teti. Sabina Licursi said 'A young person who stays is the prerequisite for another to decide not to leave and perhaps for yet another to arrive' (Elia, 2022). Indeed, there are cases of trend reverse, emerged or accelerated during the period of the pandemic: young people went to or returned to the inland zones, families moved from cities to villages, perceived as places with a higher environmental quality, in search of slower lifestyles.

This work is a preliminary analysis to shed light on young adults. More generally, it is a possible method of contextual analysis of the demographic and socio-economic changes of the resident population in Italy. It will be possible to improve the analysis thanks to the use of the Population and Housing Permanent Census results. With such a fine territorial detail and annual dissemination, they allow to analyse the evolution of phenomena, to identify sub-populations or territories that are particularly vulnerable or in difficulty, and to help policy-makers planning specific local policies and monitoring their progress. It will be possible to calculate the synthetic index both for the pre-pandemic years and in the years to come in order to identify trends and territories that need to be monitored so that policy-makers can implement policies to counter the *dejuvenation* phenomenon.

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LONGITUDINAL DATA ON LABOUR FORCE IN ITALY: NEW METHODS AND RESULTS FROM 2018 - 2024

Alessandra Masi, Cristiano Marini, Alessio Guandalini

Abstract. The Labour Force Survey - the main official source of information about the Italian labour market conducted by the Italian National Institute of Statistics - in addition to produce cross-sectional estimates, provides longitudinal labor market data. These data are obtained matching the members of the households who were interviewed in different periods due to the rotational scheme of the survey: during 15 months, each sampled household is interviewed for 4 quarters and individual records can be matched to produce 12-months longitudinal data (almost 50% of the total sample). The longitudinal data are built matching those of two quarters and the weights used for providing the estimates are obtained solving two calibration problems. In this contribution, we describe the methodology to measure the accuracy of the longitudinal estimates on annual average and examine, considering the sampling error, the movements in the last years of individuals aged 15-64 among labour market employment status during 2018-2024, drawing a detailed picture also due to the availability of household characteristics.

1. Introduction

The study aims to provide a further perspective on the dynamics of the Italian labor market in the pre-COVID period, during the crisis, and in subsequent years, through the use of longitudinal data. These data, compared to the cross-sectional ones, allow us to understand in more detail the recent evolution of the labour market in relation to its inequalities and critical issues.

The Labour Force Survey (LFS) is the main source of information on the Italian labour market, providing official estimates for a relevant number of indicators based on a two-stage sample design with stratification of the first-stage units – municipalities – and a rotation scheme for the second-stage units – households (Istat, 2006). In addition to cross-sectional data, the LFS also provides longitudinal labour market data (Istat 2024, 2025). These are obtained by matching household members interviewed at different time periods, due to the rotational scheme of the survey (Ceccarelli *et al.*, 2002). Specifically, individual records can be matched to generate 12-months and 3-months longitudinal datasets, covering nearly 50% of the total sample. Since December 2015, the Italian National Institute of Statistics (Istat) has

provided 12-months estimates on labour market flows, permanencies and transitions by occupational status (employment, unemployment, inactivity).

In this study, we analyse the 12-month flow data across the four quarters of each year from 2018 to 2024. In particular, we present the methodology used to compute confidence intervals for these main indicators based on annual averages. Furthermore, we illustrate how accuracy measures, such as absolute and relative errors, allow for a more precise analysis of the labour market. The main results on labour market transition are also presented, including the results of logistic regression models used to identify the most important determinants associated with the probability of entering or exiting employment, with a particular focus on different occupations.

The paper is organized as follows: Section 2 provides a brief overview of the longitudinal LFS, discusses the methodological aspects of the weighting procedure, and outlines the proposed methodology for computing sampling errors. The main results are presented in Sections 3 and 4. Finally, Section 5 offers concluding remarks and suggestions for future research.

2. Longitudinal data in the Istat Labor force Survey: methodological aspects

The Italian Labour Force Survey disseminates five main indicators:

- Transition rate

This is calculated as the ratio between the number of individuals who are in a different occupational status at the end of the period compared to the beginning, and the stock of individuals in the initial status. The rate can be interpreted as the probability of transitioning to a different occupational condition between the beginning and the end of the period.

- Permanence rate

This is calculated as the ratio between the number of individuals who remain in the same occupational status throughout the period and the stock of individuals in that status at the beginning of the period.

- Workers' Separation Rate (WSR)

This is calculated, over a given period, as the ratio between the number of individuals entering employment (UE, IE) and the total number of individuals who remain employed (EE), enter employment (UE, IE), or leave employment (EU, EI) during the same period:

$$WSR = \frac{UE + IE}{EE + (UE + IE) + (EU + EI)}$$

- Workers' Hiring Rate (WHR)

This is calculated, over a given period, as the ratio between the number of individuals leaving employment (EU, EI) and the total number of individuals who remain employed (EE), enter (UE, IE), or leave employment (EU, EI) during the same period:

$$WHR = \frac{EU + EI}{EE + (UE + IE) + (EU + EI)}$$

- Reallocation rate

This is the sum of the separation and hiring rates. It provides a measure of labour market dynamism, reflecting its flexibility and mobility.

The indicators are computed using data collected from the same individuals, linked through probabilistic record linkage techniques to better address linkage errors (Ceccarelli *et al.*, 2002). The sampling design of the Labour Force Survey (LFS), and in particular its 2-(2)-2 rotation scheme, allows data to be collected from the same units in repeated interviews conducted after 3, 9, 12, and 15 months (Istat, 2006). In other words, households are interviewed four times over a 15-month period. Each quarter, approximately 50% of households are expected to be re-interviewed after 12 months (see Figure 1).

Figure 1 – Rotating design of LFS and overlapping of a quarterly theoretical sample in two years. Overlapping has been expressed considering the quarter 1 of year 2 as base.

Year	Quarter	Rotation groups																$\sigma^2(\bullet)$ $\sigma^2(\bullet)$
		D	E	F	G	H	I	L	M	N	O	P	Q	R	S	T		
1	4	D4	E3			H2	I1											50%
2	1		E4	F3			I2	L1										---
2	2			F4	G3			L2	M1									50%
2	3				G4	H3			M2	N1								0
2	4					H4	I3			N2	O1							25%
3	1						I4	L3			O2	P1						50%

The indicators listed above are estimated on the linked data using the calibration estimator (Deville and Särndal, 1992). This estimator adjusts the design weights – which reflect the characteristics of the sampling design – to match known population totals, thereby improving the consistency and coherence of the estimates. For a detailed discussion of the calibration system used for longitudinal estimates, see Alaimo *et al.* (2022).

The sampling variance depends on the stratification and the stratification of the sample, the weight adjustment, the correlation among the observation due to the

rotation scheme (Ceccarelli et al., 2017) and the expression of the parameter (Wolter, 2007) and it is computed using the R-package ReGenesees (Zardetto, 2015).

3. Main results: permanencies and transitions in the labour market status from 2018 to 2024

The computation of the sampling error enables evaluation of the accuracy of the longitudinal estimates. Table 1 shows the relative error and confidence interval of main longitudinal indicators for the population aged 15-64, periodically disseminated by Istat, with reference to the last available data; Figures 1-4 refer to the period from 2018 to 2024.

Table 1 – *Permanence and transition rate by occupational status over a 12-month period (estimate, relative error and 95% confidence interval). Population aged 15-64. 2023-2024*

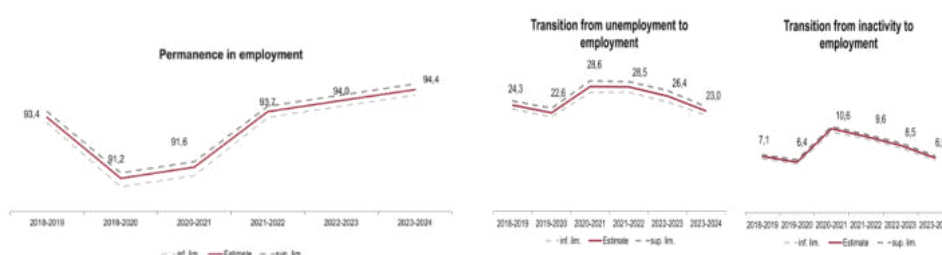
Permanence and transition rate in the professional Condition	Estimate (%)	Relative error (%)	95% confidence interval	
			Lower bound	Upper bound
Permanence in employment	94.4	0.1	94.2	94.6
Transition from employment to unemployment	1.2	4.0	1.0	1.4
Transition from employment to inactivity	4.4	2.1	4.2	4.6
Transition from unemployment to employment	23.0	2.9	21.7	24.3
Transition from inactivity to employment	6.9	2.3	6.6	7.2
Permanence in fixed-term employment	64.3	1.0	63.0	65.6
Transition from fixed-term to permanent	18.0	2.8	17.0	19.0
Transition from fixed-term employment to	4.8	5.8	4.3	5.3
Transition from fixed-term employment to	11.5	3.7	10.7	12.3
Reallocation rate	10.7	1.2	10.4	11.0
Hiring rate	5.4	1.8	5.2	5.6
Separation rate	5.3	1.8	5.1	5.5

Looking at the labour market over the last years, since the period of deepest crisis in 2019-2020, two trends seem to be emerging: the increase in permanent employment and the decrease in entry to employment (Istat, 2025; Istat, 2024; Ciani et al, 2025).

The minimum value of permanent employment, 91.2%, was reached in 2019-2020, and then it steadily grew until reaching 94.4% in 2023-2024. Over time, employment in the longitudinal population has grown due to the positive difference

between hiring and separation rates¹; however, the intensity of this growth has gradually decreased since 2019-2020, following a decline in employment. On the other hand, entry to occupation, after the post-crisis recovery, has decreased in the last three years and the transition from unemployment and inactivity to employment in 2023-2024 is lower than in 2018-2019: respectively 23.0% vs 24.3% and 6.9% vs 7.1%.

Figure 2 – *Permanence employment, transition from unemployment and inactivity to employment. Population aged 15-64. 2018-2019/2023-2024.*



Flow data show an increasing difficulty for fixed-term employees to stabilize their employment status after a year: 18.0% of fixed-term employees in 2023 have a permanent contract in 2024. The value was instead higher respectively by more than 4 percentage points in 2021-2022 (22.2%) and by 6.5 p.p. in 2020-2021 (26.5%). On the contrary, the probability of remaining trapped in precariousness has increased. In 2023, 64.3% of fixed-term employees have the same contract in 2024; this is higher than in previous period (59.5% in 2021-2022 and 51.5% in 2020-2021).

In summary, the Italian labor market shows an increase in the number of permanent workers as a result of their greater permanence in the employment condition, particularly among older workforce, whose exit from the labor market has been delayed over time. The reason is the increase in educational attainment - which has shifted forward entry and exit from employment - as well as the rules that have tightened the requirements for retirement (Istat, 2025). Conversely, entry into employment as a permanent employee is decreasing; in 2024 it concerns less than 30% of new employees. Also the transformation from unstable to stable is decreasing, involves less than 1 in 5 temporary workers in the same year. This leads to a double segmentation between insiders and outsiders, on the one hand, and between standard insiders and unstable insiders on the other, in a context of generalized workforce aging. For the younger generations, which are increasingly reduced in number, it means long periods of non-employment or precarious employment with serious consequences on the

¹ Hiring and separation rates provides a measure of labour market mobility; when the first indicator is greater than the second it means that the longitudinal employed population increases, on the contrary it decreases when the second is greater than the first.

postponement of the transition to adulthood. For older generations, whose demographic weight is increasing, the longer permanence in the labour market could have negative consequences on the new life plans of individuals and on the productivity of the economic system.

Figure 3 – Reallocation rate of entry occupation (hiring rate) and exit from occupation (separation rate). Population aged 15-64. 2018-2019/2023-2024.

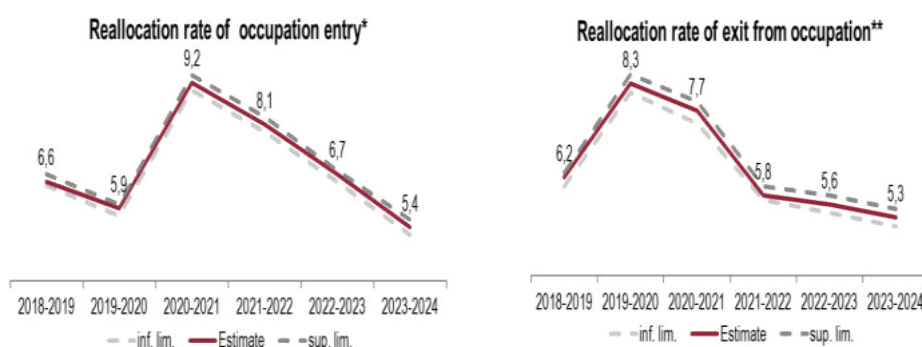
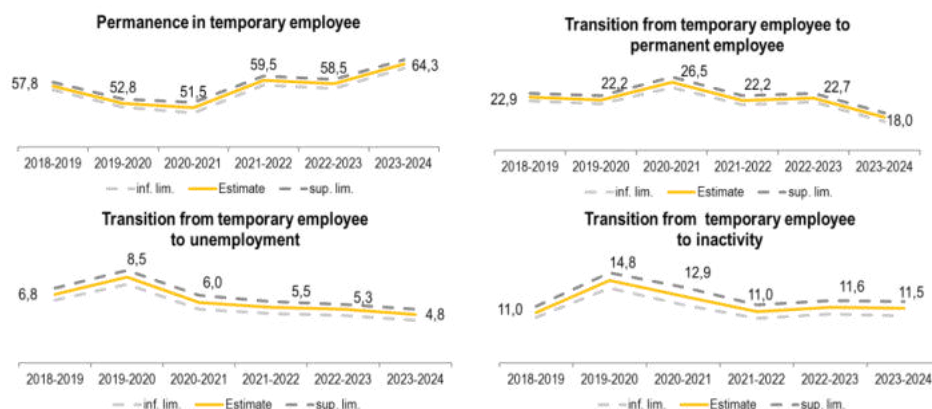


Figure 4 – Permanence and transition in/from fixed-term employment. Population aged 15-64. 2018-2019/2023-2024.



4. Main results: logistic regression

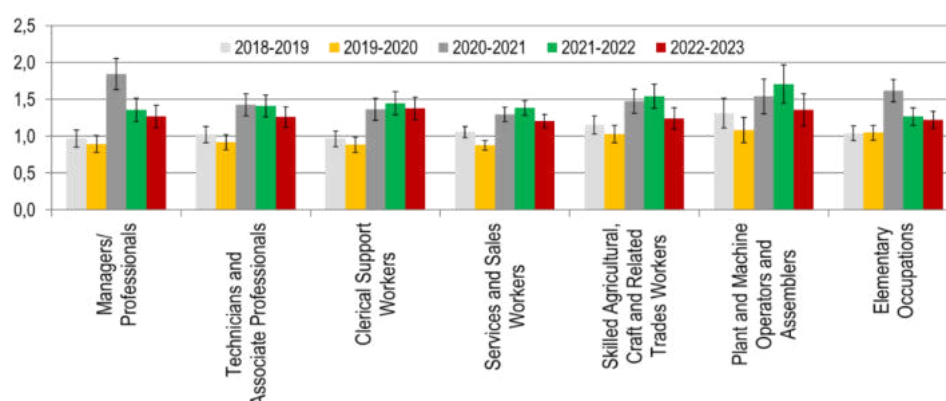
Longitudinal data allow to analyze, in particular, individuals' professional opportunities through their entry into the labour market. This is especially in light of the structural changes in Italy in recent years, which have increased the share of highly skilled employment and that associated with information and communication technologies (Istat, 2025b).

At the same time, analyzing labour market exits completes the study of turnover in Italy by occupation, which represents fundamental elements for corporate and public policies, with particular reference to education and training.

4.1 Probability of entering employment

To identify the main factors associated with the probability of entering employment from 2018 to 2024, a multinomial logistic regression model was applied, taking into account different occupations. Specifically, the analysis focuses on the inactive and unemployed population aged 15–64 at the beginning of each period, excluding members of the armed forces at the end of the period. The outcome variable is the occupational status after 12 months, with employment disaggregated by occupation (ISCO 5-digit). The independent variables are age class, gender, citizenship, educational level, geographical area, non-employment status (inactive or unemployed) at the beginning of the period, and reference period (see Appendix for the results).

Figure 5 – Multinomial logistic regression: odds ratio and confidence interval of entering employment by occupation, 2018-2024 (versus permanence in not-employment). Reference period versus 2023-2024.



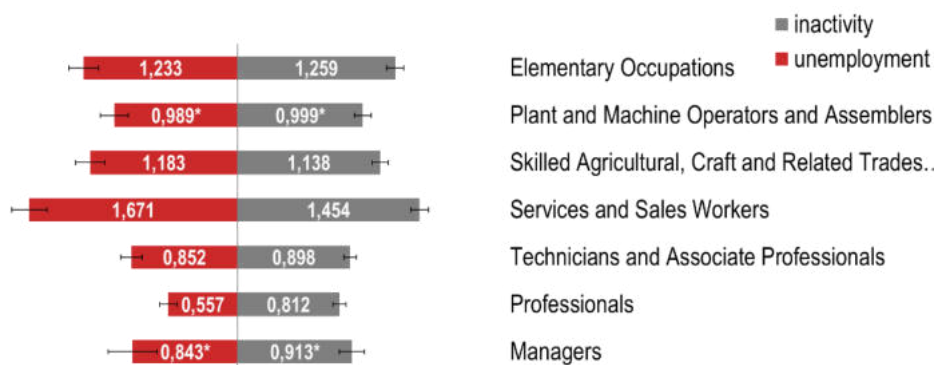
From 2018 to 2021, there was a significant increase in the probability of entering employment for all occupations (see Figure 5). After, a decline was observed for both the most highly qualified occupations (managers and professionals) and elementary occupations - those that had previously experienced the highest growth. From 2021 to 2023, we can observe the highest probabilities of finding employment after 12 months, for each occupation (all odds ratios are significantly above 1). In the last period, the situation was similar to 2018–2020. 2019 is a particular period, because the probability of entering employment after 12 months among service and sales workers reached its lowest point - likely due to the impact of the pandemic.

4.2 Probability of exiting employment

In order to identify the variables associated with the probability of exiting from employment, a multinomial logistic regression model was applied. The population considered includes individuals aged 15–64 who were employed at the beginning of the period (excluding members of the armed forces). The outcome variable is occupational status at the end of the period, classified as employed, unemployed, or inactive. The independent variables include age, sex, citizenship, educational level, geographical area, reference period, and occupation at the beginning of the period (see Appendix for the results).

Service and sales workers have the highest risk of exiting employment: compared to clerical support workers, their risk of becoming inactive is 45% higher, and their risk of becoming unemployed is 67% higher (see Figure 6). Elementary occupations follow, with a risk of exiting employment approximately 25% higher than that of clerical support workers. Professionals have the lowest risk of exiting employment (particularly to become unemployed). Managers follow, whose risk is not significantly different from that of clerical support workers.

Figure 6 – Multinomial logistic regression: odds ratio and confidence interval of exiting employment, 2018-2024 (versus permanence in employment). Occupation versus clerical support workers.



* Not statistically different from 1

5. Conclusion remarks

Longitudinal data have high informational value as they enable a dynamic understanding of labor market trends; it is therefore essential to complement cross-sectional estimates with longitudinal analyses.

The analysis of longitudinal data on labour market has shown that the increase in employment in the last years can only be attributed to the impact of demographic changes on the age composition of the workforce. The increase in permanent workers is primarily a result of their extended tenure in employment, especially among older workers. In the same time, the transition from fixed-term to permanent employment is declining, and the probability of remaining trapped in precariousness increases.

In addition to the reference period, labor market transitions are strongly influenced by occupation; service and sales workers generally have the highest risk of exiting employment, while elementary occupations and the most highly qualified occupations show the most important decline in employment entries from 2020–21 to 2023–24.

In conclusion, the labour force's overall aging encourages contemplation of potential futures, even those that are not too distant, in which making strategic use of the labour force population becomes imperative (Rosina, 2025). Training and employment quality, supply and demand service efficiency, in addition the availability and accessibility of tools for reconciling career paths with life choices, must be a key elements of development policies.

Appendix

Logistic regressions results

Tables A1 and A2 report the results of the multinomial logistic regressions in terms of odds ratio for each category of the independent variables included in the model, according to the order in which they were selected in the stepwise procedure.

Education level is the most important variable for entering employment, followed by occupational status, gender, age, citizenship, and territory (Table A1). The transition from non-employment to qualified occupations is more probably among high education levels, men, Italian young individuals living in central and northern regions. Women have higher probability than men to become clerical support workers or services and sales workers; foreigners, compared to Italians, to be employed in low-qualified occupations. Finally, transitions to employment, for each occupation, are less frequent among individuals living in the South or in the Islands.

The highest risk of exiting employment was observed among term contract and temporary employees, particularly to become unemployed (Table A2). They were followed by young individuals and services and sales workers, during the pandemic

period 2019-2021, women, people living in the South or in the Islands, with low levels of education (especially in relation to becoming inactive) and foreign workers.

Table A1 – Multinomial logistic regression: odds ratio for entering employment (versus permanence in non-employed). Unemployed and inactive persons aged 15-64 at the beginning of the period (excluding armed forces at the end of the period), years 2018-2024.

	Managers/ Profession als	Technician s and Associate Profession als	Clerical Support Workers	Services and Sales Workers	Skilled Agricultur al, Craft and Related	Plant and Machine Operators and	Elementar y Occupatio ns
Education level (vs Low education)							
Medium	6,795	6,484	5,391	2,060	0,912	1,33	1,065
High education	69,589	20,930	9,636	1,106	0,298	0,39	0,439
Occupational condition (vs Inactivity)							
Unemployed	1,548	2,178	3,136	3,393	2,954	3,66	2,762
Gender (vs man)							
Woman	0,774	0,470	1,234	1,185	0,114	0,20	0,509
Age class (vs 15-24)							
25-34	2,306	1,324	1,352	1,375	2,068	1,99	2,638
35-44	1,698	0,986*	1,239	1,050*	2,242	1,59	3,195
45-54	1,250	0,730	0,842	0,782	2,303	1,65	3,102
55-64	0,463	0,260	0,254	0,313	0,885	0,50	1,100*
Citizenship (vs Not Italian)							
Italian	4,477	3,574	3,912	0,824	0,617	0,80	0,369
Geographical area (vs Islands)							
Northwest	1,967	2,752	2,396	1,487	1,193	2,16	1,100
North-East	1,998	2,875	2,634	1,715	1,497	2,78	1,200
Centre	1,674	2,204	2,110	1,561	1,403	1,61	1,079*
South	1,034*	1,207	1,096*	0,972*	1,009*	1,30	0,961*
Reference period (vs 2023-2024)							
2018-2019	0,969*	1,023*	0,966*	1,058*	1,154	1,31	1,039*
2019-2020	0,896*	0,920*	0,885	0,876	1,029*	1,08	1,048*
2020-2021	1,845	1,427	1,367	1,297	1,475	1,54	1,619
2021-2022	1,356	1,410	1,445	1,383	1,544	1,70	1,267
2022-2023	1,271	1,262	1,378	1,209	1,243	1,35	1,221

* Not statistically different from 1

Table A2 – Multinomial logistic regression: odds ratio for exiting employment (versus permanence in employment). Employed aged 15-64 at the beginning of the period (excluding armed forces at the beginning of the period), years 2018-2024.

	Probably of exiting employment to:	
	unemployment	inactivity
Occupational condition (vs Self-employed)		
Permanent employee	1,228	1,020*
Temporary employee	5,840	3,172
Term contract	8,721	6,631
Age class (vs 55-64)		
15-24	2,385	0,769
25-34	1,865	0,439
35-44	1,382	0,315
45-54	1,205	0,289
Occupation (vs Clerical support worker)		
Manager	0,843*	0,913*
Professional	0,557	0,812
Technician and associate professional	0,852	0,898
Services and sales worker	1,671	1,454
Skilled agricultural, craft and related trades worker	1,183	1,138
Plant and machine operator and assembler	0,989*	0,999*
Elementary occupation	1,233	1,259
Reference period (vs 2023-2024)		
2018-2019	1,556	1,089
2019-2020	1,818	1,629
2020-2021	1,657	1,583
2021-2022	1,287	1,116
2022-2023	1,228	1,028*
Gender (vs man)		
Woman	1,139	1,657
Geographical area (vs Northwest)		
North-East	1,152	1,007*
Centre	1,502	1,083
South	1,891	1,495
Islands	1,907	1,380
Education level (vs High education)		
Low education	1,466	1,709
Medium education	1,139	1,310
Citizenship (vs Italian)		
Not italian	1,586	0,894

* Not statistically different from 1

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TOWARDS THE DIGITAL TRANSITION IN DATA COLLECTION: THE CASE OF THE HOUSEHOLD BUDGET SURVEY¹

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Abstract. The Household Budget Survey (HBS) is a key tool for collecting data on Italian households' consumption habits. Traditionally based on a paper "Diary" and CAPI (Computer Assisted Personal Interviewing) interviews, the survey is now undergoing a digital transition. Istat is exploring the adoption of a mobile app with real-time validation and user-friendly features, aiming to reduce respondent fatigue and improve data quality. This study focuses on feedback from the 2023 HBS survey to assess perceptions of burden, preferences for digital tools, and the need for assistance during Diary completion. The analysis explores differences by age, education, and occupational status. Results highlight that older and less educated respondents experience greater difficulties and show lower digital readiness, while younger and more educated individuals are more open to digital modes. These findings support a digital transformation strategy that includes inclusive design and tailored support to bridge technological and socio-cultural gaps.

1. Introduction

The Household Budget Survey (HBS) is a key tool for collecting data on Italian households' consumption habits. Traditionally based on a paper "Diary" and CAPI (Computer Assisted Personal Interviewing) interviews, the survey is now undergoing a digital transition. Istat, the Italian National Institute of Statistics, is exploring the adoption of a mobile app with real-time validation and user-friendly features, aiming to reduce respondent fatigue and improve data quality.

This study explores respondents' experiences during the completion of the Diary in the 2023 wave of this survey, with a focus on perceived burden, digital preferences, and the need for support in recording daily expenditures. While the HBS has traditionally relied on paper-based methods, Istat is currently evaluating a digital alternative through the development of a mobile application.

The analysis aims to identify respondent needs and attitudes across three key socio-demographic variables: age, educational attainment, and occupational status.

¹ This paper is the result of the coordinated work of all the authors. However, paragraph 3 is attributed to Elena Cezza, paragraph 2 to Gabriella D'Ambrosio, paragraphs 1 and 6 to Loredana De Gaetano, and paragraph 4 to Edoardo Raimondi. Finally, paragraph 5 is attributed to all the authors.

These dimensions are particularly relevant for understanding variations in familiarity with digital tools and the degree of autonomy in survey participation.

Although the digital Diary had not yet been implemented at the time of data collection, questions related to respondent preferences provide valuable insights for the design of future digital tools. The analysis was conducted on the total number of families (over 26,300,000) from the 2023 HBS survey edition. Sample weights were used to account for the structure of the reference population, rather than relying solely on the responding sample.

2. Perceived fatigue in the HBS Diary: who finds the survey burdensome?

The analysis concerning the compilation of the Diary of the HBS highlighted some key aspects that influence the perception and experience of filling it in, especially considering the socio-demographic characteristics of the respondents. Indeed, regarding the burden associated with completing the Diary, the results show that filling in the Diary is perceived as a demanding activity.

Overall, the results show that filling in the Diary is perceived as a tiring activity: indeed, 55.9% of the respondents (value obtained by adding the modality “quite tiring” and “very tiring”) stated that they found the entire process of recording expenses wearisome. In relation to age, as shown in Table 1, this perception of fatigue remained largely consistent across all age groups in both years, with similar levels of difficulty reported. However, it is possible to note that 55.7% of people aged 65+ (value obtained by adding the modality “quite tiring” and “very tiring”) stated that filling in the Diary was very demanding compared to people aged 18-34 (52.3%) who reported lower percentages of tiredness, thus emphasizing a generational difference in the perception of the burden and commitment required for the participation in this specific statistical survey.

Table 1 – *Difficulty in filling in the Diary by age of respondents – year 2023 (%)*.

Filling in the Diary has been:	18-34 years	35-64 years	65+ years	Total
Very and quite tiring	52.3	56.5	55.7	55.9
Not very or not at all tiring	47.7	43.5	44.3	44.1

Source: Authors' elaboration on Istat data

Focusing on the educational level of the respondents, the data show similar levels of reported fatigue, with no marked differences between groups. Even though educational background appears to have a limited impact on the perceived difficulty

of compiling the Diary, nevertheless people with advanced education (degree or post-degree) perceive filling in the paper Diary as less burdensome. In detail, 55.2% (value obtained by adding the modality “very tiring” and “quite tiring”) of those with a high educational qualification (degree and post-degree) reported that they did not find the process tiring, compared to 58.1% of those with only an elementary school diploma or no educational qualification (Table 2).

Table 2 – Difficulty in filling in the Diary by educational level of respondents – year 2023 (%)

Filling in the Diary has been:	Elementary school/No educational qualification	Lower secondary school	Upper secondary school	Graduated and post-graduated	Total
Very and quite tiring	58.1	56.9	54.2	55.2	55.9
Not very and not at all tiring	41.9	43.1	45.8	44.8	44.1

Source: Authors' elaboration on Istat data

Lastly, examining the difficulty in filling in the Diary considering the occupational status of respondents, the perceived effort of completing the task is consistent across all occupational categories (Table 3). In detail, manual workers and retired report a slightly above-average sense of fatigue (55.8%), while self-employed individuals and entrepreneurs also show slightly higher levels of fatigue (56.7% and 55.5%, respectively), possibly due to more complex work routines or less free time. Only those seeking employment report a higher level of fatigue (60.0%), which may reflect emotional or motivational challenges related to their job-seeking status.

Table 3 – Difficulty in filling in the Diary by occupational status of respondents – year 2023 (%)

Filling in the Diary has been:	Employee (a)	Manual worker (b)	Entrepreneur (c)	Self-employed (d)	Retired	Seeking employment	Other (e)	Total
Very and quite tiring	55.3	55.8	55.5	56.7	55.8	60.0	55.9	55.9
Not very and not at all tiring	44.7	44.2	44.5	43.3	44.2	40.0	44.1	44.1

(a) Employee: executive, middle manager, and clerical worker

(b) Employee: manual worker and equivalent

(c) Self-employed: entrepreneur and freelance professional

(d) Self-employed: other self-employed

(e) In another condition (e.g. recipients of non-work-related pensions, financially independent individuals not seeking work, or those legally unable to work)

Source: Authors' elaboration on Istat data

3. Need for support in the HBS Diary: who struggles to participate?

The analysis also examined the proportion of respondents who reported having required support from someone outside their household, as an indirect indicator of the difficulty encountered in completing the Diary.

In relation to age, the data show a higher reliance on external support among older respondents: among working-age respondents, 6.6% of those aged 18-34 and 7.1% of those aged 35-64 requested assistance, while this share increases to 17.9% for individuals aged 65 and over (Table 4). These findings suggest a generational gap in terms of autonomy in fulfilling the required task.

Table 4 – *Person responsible for recording expenses in the Diary by age of respondents – year 2023 (%)*.

Who recorded the expenses in the Diary:	18-34 years	35-64 years	65+ years	Total
The only/A single household member	80.4	77.5	66.9	72.8
More household members	8.4	8.6	5.4	7.2
A person external to the household	6.6	7.1	17.9	12.3
Other	4.6	6.8	9.8	7.7

Source: Authors' elaboration on Istat data

The data also reveal a clear inverse relationship between educational attainment and the need for external support in recording household expenses. Among highly educated respondents, only 3.9% reported relying on someone outside the household, compared to 27.0% among those with lower levels of education (Table 5).

Table 5 – *Person responsible for recording expenses in the Diary by educational level of respondents – year 2023 (%)*.

Who recorded the expenses in the Diary:	Elementary school/No educational qualification	Lower secondary school	Upper secondary school	Graduated and post-graduated	Total
The only/A single household member	57.3	73.0	78.2	81.2	72.8
More household members	3.8	7.0	8.3	9.3	7.2
A person external to the household	27.0	11.6	7.1	3.9	12.3
Other	11.9	8.4	6.4	5.6	7.7

Source: Authors' elaboration on Istat data

This pattern indicates that lower educational attainment may represent a vulnerability factor, associated with greater difficulty in independently completing the Diary.

Regarding the employment status, as shown in Table 6, reliance on external support in completing the Diary is highest among retirees (15.7%) and individuals in other non-working conditions (18.4%). Intermediate levels are observed among the unemployed (8.7%) and some self-employed workers (8.5%), while the lowest percentages are reported among managers, professionals, and entrepreneurs (4.8%), as well as clerical staff (4.4%). This pattern may reflect differing levels of confidence or familiarity with administrative and organizational tasks across occupational groups.

Table 6 – Person responsible for recording expenses in the Diary by occupational status of respondents – year 2023 (%).

Who recorded the expenses in the Diary:	Employee (a)	Manual worker (b)	Entrepreneur (c)	Self-employed (d)	Retired	Seeking employment	Other (e)	Total
The only/A single household member	80.3	75.1	79.7	75.5	68.9	80.7	68.4	72.8
More household members	9.9	7.7	9.6	9.2	5.9	5.4	4.4	7.2
A person external to the household	4.4	9.2	4.8	8.5	15.7	8.7	18.4	12.3
Other	5.4	8.0	5.9	6.8	9.5	5.2	8.8	7.7

(a) Employee: executive, middle manager, and clerical worker

(b) Employee: manual worker and equivalent

(c) Self-employed: entrepreneur and freelance professional

(d) Self-employed: other self-employed

(e) In another condition (e.g. recipients of non-work-related pensions, financially independent individuals not seeking work, or those legally unable to work)

Source: Authors' elaboration on Istat data

4. Digital preferences in the HBS Diary: who embraces the shift?

Subsequently, attention was directed to the question “Would you have preferred to complete the Diary online?”, which explicitly investigates the propensity toward a digital mode of completion. The results reveal age-related differences in digital preferences, consistent with the generational patterns identified in earlier sections of this study. Among respondents aged 18-34, 25.0% expressed a preference for online

completion of the Diary. This preference declined markedly with age, dropping to 14.7% among those aged 35-64 and reaching only 5.8% among respondents aged 65 and over (Table 7). This pattern aligns with the earlier finding that older respondents experience greater fatigue and require more external support, suggesting that digital solutions may be particularly beneficial for younger demographics who are already more comfortable with technology.

The low propensity to adopt digital formats among older respondents appears to be partly attributable to access constraints. Indeed, 14.6% of respondents aged 65 and over reported not having an Internet connection, which represents a fundamental barrier to digital participation. This technological divide reveals how access constraints can significantly influence survey methodology preferences across different population segments.

Table 7 – Preference regarding the Diary completion method by age of respondents – year 2023 (%).

Would you have preferred to fill out the diary online?	18-34 years	35-64 years	65+ years	Total
Yes, we would have preferred it	25.0	14.7	5.8	12.1
It would have been the same	27.4	28.0	16.7	23.7
No, because we do not have an Internet connection	3.2	3.9	14.6	7.9
No, for other reasons	44.4	53.4	62.9	56.3

Source: Authors' elaboration on Istat data

Educational attainment represents a second dimension that reinforces the patterns observed throughout this analysis. The preference for online Diary completion was strongly correlated with education level: only 3.4% of respondents with at most a primary school certificate (or no formal qualification) stated they would have preferred to fill in the Diary online, compared to 15.0% among those with a high school diploma and 25.4% among university graduates or postgraduates (Table 8). This finding is particularly relevant given that respondents with lower educational levels were also more likely to require external support for completing the paper version of the Diary, as highlighted above. The convergence of these patterns suggests that digital inequality is closely associated with cultural capital, with higher levels of education corresponding to both greater technological familiarity and increased autonomy in survey completion.

Table 8 – Preference regarding the Diary completion method by educational level of respondents – year 2023 (%).

Would you have preferred to fill out the diary online?	Elementary school/No educational qualification	Lower secondary school	Upper secondary school	Graduated and post-graduated	Total
Yes, we would have preferred it	3.4	6.3	15.0	25.4	12.1
It would have been the same	11.2	21.2	28.1	30.7	23.7
No, because we do not have an Internet connection	20.8	8.4	4.4	1.9	7.9
No, for other reasons	64.6	64.1	52.5	42.0	56.3

Source: Authors' elaboration on Istat data

Professional status also reveals important differences in digital preferences, which again mirror the patterns identified in relation to workload and support needs in the survey. Among employees in executive, managerial or clerical roles, 24.3% indicated that they would prefer to complete the Diary online, compared to only 9.4% of manual and blue-collar workers (Table 9). An even higher percentage was observed among entrepreneurs (23.8%), while the preference dropped to 12.8% among other self-employed workers engaged in less skilled activities.

Table 9 – Preference regarding the Diary completion method by occupational status of respondents – year 2023 (%).

Would you have preferred to fill out the diary online?	Employee (a)	Manual worker (b)	Entrepreneur (c)	Self-employed (d)	Retired	Seeking employment	Other (e)	Total
Yes, we would have preferred it	24.3	9.4	23.8	12.8	6.3	8.4	7.2	12.1
It would have been the same	32.5	24.6	29.8	26.1	17.8	24.2	18.9	23.7
No, because we do not have an Internet connection	1.7	5.3	1.5	3.3	13.3	7.4	12.9	7.9
No, for other reasons	41.5	60.7	44.9	57.8	62.6	60.0	61.0	56.3

(a) Employee: executive, middle manager, and clerical worker

(b) Employee: manual worker and equivalent

(c) Self-employed: entrepreneur and freelance professional

(d) Self-employed: other self-employed

(e) In another condition (e.g. recipients of non-work-related pensions, financially independent individuals not seeking work, or those legally unable to work)

Source: Authors' elaboration on Istat data

It is noteworthy that the preference remained relatively modest among those seeking employment (8.4%) and dropped to 6.3% among retired respondents. Respondents in other working conditions also showed a limited preference for digital completion (7.2%). These findings complement the earlier observation that retirees and individuals in other working conditions were most likely to require external support, suggesting that digital solutions alone may not address the underlying challenges faced by these groups.

Overall, the data confirm the presence of both technological and socio-cultural barriers to the adoption of the digital mode for Diary completion. These findings indicate that any future strategies aimed at digitizing data collection should be accompanied by adequate inclusion measures, designed to mitigate the effects of the so-called “digital divide”.

The consistency of these patterns across different aspects of the survey experience – fatigue, support needs, and digital preferences – indicates that the same demographic factors that make the traditional paper Diary more burdensome also influence attitudes toward digital alternatives. This suggests that while digital tools may offer solutions for some respondent groups, a comprehensive approach addressing both technological access and user support will be necessary to improve the overall survey experience across all demographic segments.

5. Profiling the ideal “digital” respondent

Based on aggregated data from the 2023 HBS, a descriptive analysis was conducted to identify the socio-demographic profile most associated with a preference for digital Diary completion. While no individual-level microdata were available, and no inferential statistical modeling was applied, the group-level percentages reported in the tables of this work allow for cautious analytical interpretation. The data suggest that the ideal “digital” respondent is typically a young adult (aged 18-34), with a university degree or higher, employed in a white-collar or entrepreneurial occupation, with personal Internet access and full autonomy in completing the Diary. Indeed, this group exhibits the highest reported preference for digital mode (up to 25.4%), the lowest reported fatigue, and the least reliance on external support. In contrast, older individuals (aged 65+), those with lower levels of education, and retired respondents show much lower digital preference and a higher need for assistance.

Table 10 summarizes the observed variation in digital preference by age, educational level and occupational status, respectively. These findings, while descriptive, are consistent with established research on digital divides and survey mode effects (Agresti, 2002). In fact, they highlight the importance of designing

inclusive digital data collection instruments that consider not only access to technology, but also digital skills, cognitive autonomy, and familiarity with self-managed administrative tasks. These insights do not support causal claims but offer evidence-based guidance for profiling and targeted support strategies.

Table 10 – *Digital preference by socio-demographic characteristics of respondents – year 2023 (%)*.

Age	Preference for online Diary
18-34 years	25.0
35-64 years	14.7
65+years	5.8
Educational level	
Elementary school/No educational qualification	3.4
Lower secondary school	6.3
Upper secondary school	15.0
Graduated and post-graduated	25.4
Occupational status	
Employee (a)	24.3
Manual worker (b)	9.4
Entrepreneur (c)	23.8
Self-employed (d)	12.8
Retired	6.3
Seeking employment	8.4

(a) Employee: executive, middle manager, and clerical worker
 (b) Employee: manual worker and equivalent
 (c) Self-employed: entrepreneur and freelance professional
 (d) Self-employed: other self-employed

Source: Authors' elaboration on Istat data

Moreover, the framework is still valuable for exploratory purposes. It serves to:

- highlight general trends in digital readiness across demographic profiles;
- inform strategies for inclusive digital transformation;
- guide future data collection design with targeted segmentation in mind.

The trend reported reveal a clear gradient in digital preference across age, educational qualification and occupational groups. While these results are based on aggregate data and do not allow for individual-level inference, they provide consistent evidence that digital readiness is strongly associated with socio-

demographic characteristics. This pattern supports the value of targeted strategies for digital inclusion and survey mode adaptation. Indeed, these results emphasize the importance of inclusive design strategies that accommodate varying levels of digital literacy and autonomy. They also point to the need for flexibility in data collection methods, targeted support for digitally vulnerable groups, and the use of pre-screening tools to guide mode assignment. Ultimately, the success of the digital transformation in official statistics depends not only on the adoption of innovative technologies, but on their capacity to respond to the heterogeneity of respondent experiences and capabilities. Future implementations should therefore align digital solutions with both technical usability and social inclusiveness.

6. Future opportunities and challenges in the digitalization of the HBS Diary

The digitalization of the HBS Diary presents significant opportunities for improving data collection, enhancing data quality, and reducing respondent burden. Its success, however, depends on a user-centered, inclusive, and evidence-based approach. The 2023 results indicate that perceptions of effort, need for assistance, and preferences for digital tools vary according to socio-demographic factors such as age, educational level, and occupational status, reflecting both technological and socio-cultural divides. Younger and more highly educated respondents generally demonstrate greater digital readiness and autonomy, whereas older individuals and those with lower educational attainment face more difficulties.

These findings underline the need for survey strategies tailored to the different capabilities and needs of respondents. A recent study presenting a prototype of the HBS mobile application demonstrates its usability and potential to enhance data accuracy and respondent engagement (D'Ambrosio *et al.*, 2025). Based on this evidence, a digital transition strategy should be built on four key pillars:

- a) a gradual and flexible implementation that retains traditional modes for digitally excluded users;
- b) the development of intuitive, accessible, and adaptive digital interfaces;
- c) the integration of real-time support tools and interactive guidance;
- d) targeted communication and training initiatives, particularly aimed at groups most vulnerable to the digital divide (Duflos and Dyer, 2021).

To further enrich the analysis, a territorial breakdown could be applied for instance by geographical area or urban/rural context, to provide additional insights into potential regional digital divides. This would also help ensure broad

participation, minimize respondent burden (Istat, 2019), and maintain high standards of data quality and reliability.

Overall, these findings have important practical implications: they can improve the respondent experience, reduce item nonresponse, enhance data quality, and guide targeted communication strategies during fieldwork, ultimately supporting a more inclusive and effective digital transition.

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PERCEIVED ACCESSIBILITY OF TRANSPORT SYSTEMS IN ITALY: A STATISTICAL ANALYSIS USING “ASPECT OF DAILY LIFE” SURVEY¹

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Abstract. This study aims at exploring transport accessibility in Italy using data from the Aspect of Daily Life survey conducted by the Italian National Statistical Office (ISTAT). The aim is to identify the main determinants of perceived accessibility, in order to guide targeted policy interventions focused on improving public transport perceptions. The methodological framework is based on Covariance based - Structural Equation Modelling (SEM). The results indicate that confidence towards local and national institutions as well as transport affordability increase the perceived accessibility of public transports. Moreover, the quality of the local viability is negatively related with accessibility perception of public transportation.

1. Introduction

Ensuring access to essential services, including transport, is a cornerstone of social inclusion and sustainable development. Transport accessibility plays a crucial role in enabling individuals to reach opportunities such as employment, education, healthcare, and social participation, thereby influencing quality of life and spatial equity. In particular, Goal 11.2 of the United Nations Sustainable Development Goals (SDG) calls for “access to safe, affordable, accessible and sustainable transport systems for all,” highlighting the need to address the needs of vulnerable groups (United Nations, 2021). According to the European Commission (2021), the European Pillar of Social Rights (EPSR) further strengthens the political relevance of transport accessibility. Principle 20 of the EPSR defines access to essential services—including transport—as a fundamental right for all, with specific emphasis on quality, availability, affordability, and universal coverage, especially for people in precarious conditions or at risk of poverty.

In Italy, disparities in transport infrastructure and service coverage are particularly pronounced. According to ISTAT (2023), while more than 90% of the population in Lombardia can reach a railway station in under 30 minutes by car, the same percentage drops below 40% in Calabria. These sharp regional contrasts reflect

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deeper spatial and social inequalities that call for the development of robust, multidimensional measures of accessibility to support targeted and evidence-based policies.

Ensuring equal access to opportunities requires going beyond infrastructure-based indicators and considering how individuals perceive the accessibility of transport systems in their daily lives. As argued in the literature, accessibility is a key factor in promoting spatial equity and enabling social participation, particularly for disadvantaged groups (Handy and Niemeier, 1997; Delbosc and Currie, 2011; Litman, 2014). A growing body of research highlights the importance of adopting multidimensional, perception-sensitive approaches to capture individuals' actual experiences and constraints (Tahmasbi and Haghshenas, 2019).

In this regard, perceived accessibility has been defined as the subjective evaluation of travel conditions—such as time, comfort, and reliability—filtered through individual preferences and needs (Friman *et al.*, 2020; Jamei *et al.*, 2022). Among existing frameworks, the “modal-focused” approach assesses satisfaction with specific transport modes and is increasingly used to understand user-oriented service quality (Friman *et al.*, 2020; Sundling *et al.*, 2014).

In this context, this study aims at exploring perceived accessibility of transport systems in Italy, using microdata from ISTAT's *Aspects of Daily Life* survey. The objective is to identify the main determinants shaping citizens' perception of transport accessibility and to provide a comprehensive understanding of the phenomenon. Given the interdependent and latent nature of the dimensions involved, a Covariance-Based Structural Equation Modelling (SEM) framework is adopted, thus allowing for simultaneous estimation of direct and indirect relationships between observable indicators and unobservable constructs.

The empirical results reveal that perceptions of accessibility are significantly influenced by a combination of contextual and individual-level factors. Specifically, satisfaction with public transport services, affordability, perceived quality of the surrounding environment (traffic and available parking), and trust in institutions exhibit statistically significant and positive effects on perceived accessibility.

The remainder of the paper is structured as follows. Section 2 outlines the methodological framework, with a focus on the construction and estimation of the SEM and presents the data sources with indicators used. Section 3 discusses the main empirical findings. Finally, Section 4 draws conclusions and outlines key policy implications, offering directions for future research on inclusive and sustainable transport accessibility.

2. Method and data

2.1 Method

This study employs a Covariance-Based Structural Equation Modelling (CB-SEM) approach to assess the relationship between perceived accessibility of public transport and its underlying determinants. CB-SEM was chosen over Partial Least Squares SEM (PLS-SEM) since the goal is to confirm theoretical assumptions rather than predict endogenous variables, following the recommendations of Hair *et al.* (2021). SEM is particularly suitable for models involving latent constructs measured indirectly by multiple indicators, as it accounts for measurement error and estimates both direct and indirect relationships simultaneously.

The model includes four latent constructs: Administration, capturing trust in national, regional, and local institutions (Pagliara *et al.*, 2021; Van de Walle & Bouckaert, 2003); Environment, reflecting perceptions of neighborhood conditions such as traffic and parking (Zhu *et al.*, 2024); Affordability, based on indicators of economic satisfaction; and Perceived Accessibility, the core outcome variable, aimed at evaluating satisfaction with different aspects of public transport, in line with the modal-focused framework by Friman *et al.* (2020) and subsequent studies. From the dataset we extracted valuations for trains, buses, and pullman for several perceived accessibility attributes variables. Subsequently, we created composite indicators for each accessibility attribute.

We followed the reflective-formative (Type II) model structure (Afthanorhan, 2014), in which structural arrows point from independent to dependent latent constructs, and measurement arrows point from latent constructs to their respective observable indicators. Prior to model estimation, we tested the data for multicollinearity using the Variance Inflation Factor (VIF), ensuring all values were below the critical threshold of 5 (Akinwande *et al.*, 2015). Normality was assessed via skewness (<2) and kurtosis (<7), following West *et al.* (1995). Exploratory Factor Analysis (EFA) was conducted to assess indicator correlation (>0.3), and Spearman's rank correlation coefficient was used to evaluate relationships among variables (Habing, 2003; Ritter, 2012). Model estimation was performed using the lavaan package in RStudio, and visualization of the model structure was generated using the Semplot package. Missing values were handled through Full Information Maximum Likelihood (FIML) estimation.

2.2 Capturing Perceptions of Accessibility: Data from the Aspects of Daily Life (ADL)

The empirical analysis is based on microdata for research purposes taken from 2022 edition of the “Aspects of Daily Life” (AVQ) survey, conducted by ISTAT.

The survey is part of the Multipurpose Survey system and provides nationally representative microdata on individual and household well-being. The 2022 wave includes information from approximately 20,000 households and over 45,000 individuals, collected through a two-stage stratified sampling design. In the first stage, municipalities were selected and stratified by region and demographic size; in the second stage, households were randomly drawn from municipal registry lists. Table 1 presents the full list of observed variables, grouped by latent construct, including descriptions and bibliographic sources.

Table 1– *Variables included in the model.*

Latent variable	Variable	Variable description	Source
Administration	TRUST1	Trust for parliament	(Pagliara <i>et al.</i> , 2021; Geert Bouckaert and Van de Walle, 2003; Van de Walle, 2003)
	TRUST2	Trust for regional government	
	TRUST3	Trust for municipality government	
Environment	CONGESTION	Perception of traffic intensity in the district of residence	(Zhu <i>et al.</i> , 2024)
	PARKING	Perception of available parking in the district of residence	
Affordability	AFFORDABILITY1	Perception of economic satisfaction compared to the previous year	
	AFFORDABILITY2	Perception of economic satisfaction	
Perceived Accessibility	TIME	Satisfaction with the time of public transport	(Friman <i>et al.</i> , 2020; Ismael and Duleba, 2021; Jamei <i>et al.</i> , 2022; Mabkhot <i>et al.</i> , 2024; Tanwar <i>et al.</i> , 2024)
	COST	Satisfaction with the cost of public transport	
	PUNCTUALITY	Satisfaction with the punctuality of public transport	
	CLEAN	Satisfaction with the cleanness of public transport	
	WAITING	Satisfaction with the waiting time of public transport	
	SEATS	Satisfaction with the seats of public transport	
	SPEED	Satisfaction with the speed of public transport	
	CONNECTION	Satisfaction with the connection of public transport	

Source: Own elaboration based on ADL data.

To ensure the adequacy of the measurement model, reliability and convergent validity were evaluated. Following the criteria proposed by Fornell and Larcker (1981), Table 2 reports the values of Composite Reliability (CR), and Average Variance Extracted (AVE) for each latent construct. Following the work of Vincókzi *et al.* 2025 the values of Cronbach's alpha were also included. All constructs meet

the recommended thresholds, confirming acceptable levels of internal consistency and convergent validity.

Table 2 - Summary of exploratory factor analysis.

Type of fit	Statistical Index	Test value	Threshold	Source
Administration	Cronbach-alpha	0.883	>0.600	(Vincókzi <i>et al.</i> , 2025)
	Composite reliability (CR)	0.888	>0.600	
	Average Explained Variance (AVE)	0.725	>0.500	
Environment	Cronbach-alpha	0.661	>0.600	
	Composite reliability (CR)	0.661	>0.600	
	Average Explained Variance (AVE)	0.494	>0.500	
Affordability	Cronbach-alpha	0.654	>0.600	
	Composite reliability (CR)	0.660	>0.600	
	Average Explained Variance (AVE)	0.495	>0.500	
Accessibility Perception	Cronbach-alpha	0.899	>0.600	
	Composite reliability (CR)	0.901	>0.600	
	Average Explained Variance (AVE)	0.534	>0.500	

Source: Own elaboration based on ADL data.

All items demonstrated acceptable levels of reliability and validity: item loadings exceeded 0.5, Cronbach's alpha and Composite Reliability (CR) values were above 0.6 for all constructs and Average Variance Extracted (AVE) values were acceptable (>0.5) or (≥ 0.4) if ($CR > 0.6$) (Fornell and Larcker, 1981; Vincókzi *et al.*, 2025). The regression weights for the best version of the model, obtained after testing various different indicators, are presented in Table 4 and Table 5. Bearing in mind the methodological framework and the available data, the specification of the model estimated in this paper is reported in the Appendix (Figure 1).

3. Results

The coefficient of determination (R^2) for the endogenous variable exceeds the 0.1 threshold (Ozili, 2022), confirming the statistical adequacy of the estimated model, which includes four latent constructs and fifteen observed indicators. Model fit was

assessed using a comprehensive set of indices—absolute fit, incremental fit, non-centrality-based, and parsimony indices. As shown in Table 3, all indicators fall within acceptable ranges, supporting the model’s overall goodness of fit (Vincókzi *et al.*, 2025; Newsom, 2025; Rožman *et al.*, 2020).

Table 3 - Measures of model fit.

Type of fit	Statistical Index	Test value	Threshold	Source
Absolute fit	GFI (goodness of fit index)	0.993	>0.800	(Vincókzi <i>et al.</i> , 2025; Newsom, 2025; Rožman <i>et al.</i> , 2020)
	RMSR (root mean square residual)	0.002	<0.08	
	SRMR (standardized root mean square residual index)	0.031	<0.08	
Relative Fit Indices	NFI (Normed fit index)	0.961	>0.900	
	IFI (Incremental Fit Index)	0.962	>0.900	
	TLI (Tucker-Lewis-index)	0.952	>0.900	
Noncentrality-base Indices	RMSEA (root mean square error of approximation)	0.041	<0.100	
	CFI (comparative fit index)	0.962	>0.900	
Parsimony fit Indices	PGFI (parsimony-adjusted goodness of fit index)	0.618	>0.500	
	PCFI (parsimony-adjusted comparative fit index)	0.769	>0.500	
	PNFI (parsimony-adjusted normed fit index)	0.769	>0.500	

Source: Own elaboration based on Questionnaire data.

The measurement model confirms the robustness of the latent constructs. As reported in Table 4, the path loadings for all observed variables are statistically significant ($p < .001$), with estimates exceeding the minimum recommended threshold of 0.5. The items CONNECTION, TIME and CLEAN—both related to satisfaction with public transport—show the highest loading values, suggesting their central role in shaping perceived accessibility.

Table 4 - Results of measurement model.

Observable variable	Latent variable	β (Estimate)	SE	z	p
TRUST1	Administration	0.991	0.006	169.627	<.001
TRUST2	Administration	1.184	0.006	185826	<.001
TRUST3	Administration	1.000	-	-	-
CONGESTION	Environment	1.000	-	-	-
PARKING	Environment	1.037	0.058	17784	<.001
AFFORDABILITY1	Affordability	1.000	-	-	-
AFFORDABILITY2	Affordability	0.827	0.032	25.688	-
TIME	Perceived_accessibility	0.964	0.010	97153	<.001
COST	Perceived_accessibility	0.863	0.011	76630	<.001
PUNCTUALITY	Perceived_accessibility	0.930	0.010	91.809	<.001
CLEAN	Perceived_accessibility	0.992	0.011	91199	<.001
WAITING	Perceived_accessibility	1.000	-	-	-
SEATS	Perceived_accessibility	0.819	0.010	83488	<.001
SPEED	Perceived_accessibility	0.865	0.009	92804	<.001
CONNECTION	Perceived_accessibility	0.959	0.010	92.376	<.001

Source: Own elaboration based on Questionnaire data

The results of the structural model show that the Environment factor has a negative and statistically significant direct effect on the accessibility perception of public transportation services (Table 5). This aligns with the findings of De Vos *et al.* (2025), who asserted that public transit is most attractive to commuters who face less congestion. Moreover, parking availability in Italy has a significant influence on the commuter's perceived accessibility towards the public transport system; Countries where cars are the main transport mode will need more parking slots than nations that have public transport as a dominant mode (Widiyani *et al.*, 2023). Trust in institutions impacts accessibility perception of public transport, in a similar vein to the work of Lim and Moon (2021), where trust in institutions has a direct and positive effect on the behavioral intentions of supporting public transport spending. The results confirm the relationship shown by Pagliara *et al.* (2021), but looking in the opposite direction, from trust to perception. The results are also in line with the

findings of Van de Walle (2003); existing levels of trust in government may also have an impact on perceptions of government performance.

Table 5 - Results of the structural model.

Observable variable	Latent variable	β (Estimate)	SE	z	p
Perceived accessibility	Administration	0.24	0.008	29967	<.001
Perceived accessibility	Environment	0.107	0.009	11708	<.001
Perceived accessibility	Affordability	0.050	0.013	3788	<.001

Source: Own elaboration based on Questionnaire data

The analysis indicates that the *Affordability* factor has a positive and statistically significant direct effect on the accessibility perception of public transport services. This aligns with the findings of Zhu *et al.* (2024), who asserted that transport and housing affordability increases accessibility perception of public bus.

4. Conclusions

This study contributes to the growing body of research on perceived accessibility by exploring how Italian citizens evaluate their access to public transport services, using nationally representative microdata from ISTAT's *Aspects of Daily Life* survey. By employing a CBS-SEM framework, we were able to disentangle the multidimensional nature of transport accessibility and assess the relative influence of contextual and perceptual factors.

Congested areas and limited parking spots may impede the access to public transport in the Italian context. Moreover, restricting parking spaces may not increase the perceived accessibility of public transit. The lower perception of accessibility related to lower economic satisfaction may be determined by the poorer quality of public transportation in the residential areas where people with low economic satisfaction live, but also by the cost itself of public transport. In addition, economically satisfied individuals may have smaller consequences related to public transportation lacks since with greater possibility of obtaining an alternative solution. Concerning trust for the various institutions, interventions in other sectors that increase institutional trust, may improve the perception of accessibility of public transport.

These findings align with European policy priorities, notably Principle 20 of the EPSR, which affirms the right to accessible essential services for all, and the SDG

11.2 target on sustainable transport. Yet, current statistical frameworks often fail to fully capture the perceptual dimension of accessibility, which this study shows to be essential for policy targeting and equity assessments.

Moreover, the results underscore the importance of integrating perception-based indicators into national and EU-level monitoring systems could help better identify local needs, particularly in underserved or vulnerable areas.

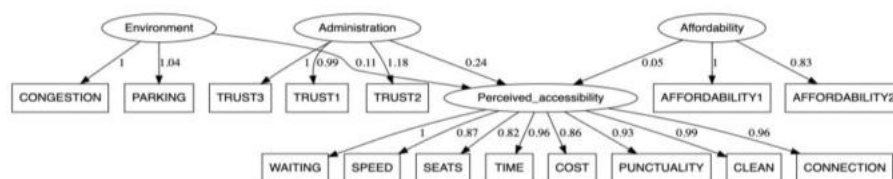
According to Afthanorhan (2014) identification issues usually exist in CB-SEM when the latent construct consists below four indicators. Thus, the researchers may use pooled confirmatory factor analysis CFA, although PLS-SEM is much easier to handle since this method can use a single item for estimation.

Formative or a mixed Formative - Reflective measurement model may be more correct to interpret accessibility perception, due to complex differences among observable indicators inside the same concept. The Formative model in PLS-SEM is easier to handle than CB-SEM, offering the possibility to consider both measurements. Future developments may consider testing the moderating effect and/or mediating effects. Future research should build on this modal-based multidimensional SEM approach by incorporating demographic, ownership and other environmental variables using microdata from ISTAT's Aspects of Daily Life survey and incorporating public transport interventions from other sources of data. Finally, it is important to measure residential characteristics with high granularity in order to understand the factors that influence perception on a local scale. Such efforts are crucial for designing inclusive and sustainable transport policies that respond not only to where people live—but to how they live and move.

Appendix

Code: Filippo955. Repository: Accessibility. [URL](#)

Figure 1 - Path diagram of the model.



Own elaboration based on Questionnaire ADL-Istat data

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TOURISTS' PRESENCE FLASH ESTIMATION BY MNO DATA

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Abstract. The use of big data to anticipate the release of official statistics is attracting growing attention and interest within the scientific community. This paper presents a methodological contribution to flash estimation of overnight stays in Italian municipalities using administrative and mobile network operator (MNO) data. Three forecasting strategies: Simplistic, Quasi-Transfer Learning (QTL), and Augmented Learning (AL) are compared across different models (Linear, Random Forest, and Ensemble). The application focuses on Emilia-Romagna municipalities, evaluating predictive accuracy through repeated cross-validation. Results show that both QTL and AL outperform traditional methods, especially in terms of mean absolute percentage error (MAPE) and confidence interval stability.

1. Introduction

In many problems, such as territorial forecasting, the availability of data is often asynchronous: some observations are reported earlier than others due to administrative and logistic factors. At the same time, highly informative proxy variables are often available, providing valuable signals for anticipating missing information. This motivates the use of forecasting techniques to produce flash estimates.

The asynchronous availability of the response variable and the presence of good proxies create an opportunity to improve standard forecasting approaches. To explore this idea, we evaluate two advanced methodologies - Quasi-Transfer Learning and Augmented Learning - which aim to refine predictions by exploiting structural patterns in the available data. Specifically, we assess their effectiveness in forecasting the number of nights spent by tourists in a given municipality, using statistical register data and mobile network operator (MNO) proxies. We compare these approaches against the traditional forecasting method.

2. Data description

In the field of tourism statistics, a crucial indicator is the total number of nights spent by tourists. In Italy this indicator is provided for each municipality (local administrative unit) on a monthly basis.

Local offices collect the data provided by touristic accommodations and forward them to the National Statistical Institute, typically within two months ($t+2$) from the reference month (t), to ensure no accommodations remain out of the enumeration. However, a certain percentage of municipalities can provide this information earlier, sometimes even within the first ten days of the reference month. It is worth noting that the set of these early response units may vary each month due to several contingency factors.

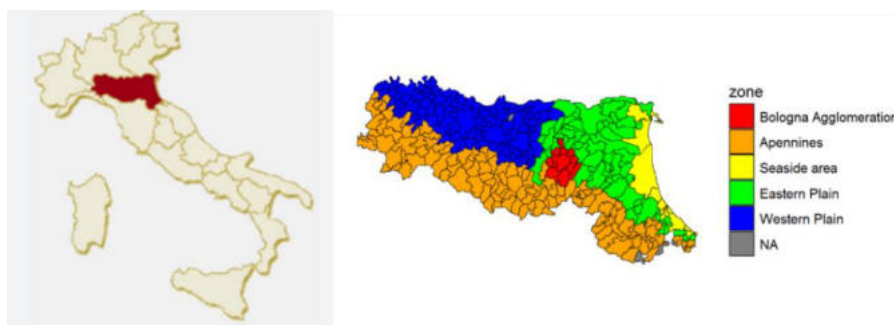
The objective of our study is to investigate whether, by leveraging register data from responding municipalities and the number of overnight stays derived from MNO data, it is possible to provide a flash estimate for municipalities that do not respond promptly.

For this study monthly time series for official overnight stays at municipality level, from October 2023 back to January 2022 are available while MNO data cover the period from August 2022 to October 2023. The data pertain to the Emilia-Romagna which comprises 330 municipalities, grouped in 9 provinces.

The MNO data have been processed according to multi-MNO algorithms; they have also been subject to some adjustments to “reproduce” Istat known totals. The MNO data come from a single operator, and the number of nights is counted based on a simple shared algorithm. Among other aspects, the algorithm includes a rescaling process to account for other operators and factors beyond our control, as well as masking for values at risk of re-identification.

The Emilia Romagna regional territory can be divided into five areas as it is shown in Figure 1: Western Plain, Eastern Plain, Bologna Agglomeration, Apennines and Seaside area.

Figure 1 – Emilia Romagna region with geographic classification zones.



From a tourism perspective, the region is primarily characterized by a high volume of seaside tourism along the coast and urban tourism in the provincial capitals, while nature-based tourism in the Apennines and the Po Delta plays a secondary role, with clear and marked seasonal differences. Table 1 shows the different volumes of tourism in the various geographical zones and the number of municipalities in each zone according to register and MNO data.

Table 1 – *Distribution of municipalities in each geographical zone and percentage of nights spent by tourists, according to Register Data and MNO Data.*

Zone	Municipalities	Register Data (Nights/Month %)	MNO Data (Nights/Month %)
Bologna	12	14.1%	20.8%
Apennines	120	0.5%	1.6%
Seaside Area	14	82.6%	70.4%
Eastern Plain	68	1.3%	3.7%
Western Plain	112	1.4%	3.5%

In addition to data on tourist overnight stays, we also have access to auxiliary administrative data for each municipalities, such as the resident population, the surface area, the geographic classification zones and degree of urbanization.

3. Methodological approaches

3.1. Simplistic approach

Given a dependent response variable y and some features x which become available before the response, forecasting techniques are used to anticipate y based on x . The most straightforward approach to this task is what we will call the Simplistic Model. This consists of training a predictor $\mu(x_j, s_t)$ on a training set s , where both y and x are available, and then applying it to a target set r , where x is available but some values of y are still missing. Formally, we estimate:

$$\hat{y}_j = \mu(x_j, s_t), \forall j \notin s_t$$

where s_t denotes the training set at time t . In our case, the dependent variable represents the number of nights spent by tourists in a given municipality according to register data at time t , while the features are chosen among different possible combinations of MNO data at time t and earlier and register data from some earlier time point.

3.2. Quasi-Transfer Learning

Transfer learning techniques are designed to improve predictive performance by incorporating knowledge from a related source model. In our case, we consider a Quasi-Transfer Learning (QTL) approach, which aims to enhance estimation by leveraging auxiliary models trained on similar but distinct populations.

Let $\mu(x, \beta)$ be a target model with unknown parameters β . Suppose we have access to a related source model, $\mu(x, \hat{\theta})$, estimated separately on a different but similar population. Both models belong to the same family but differ in their parameter values, β and θ . Transfer learning, in this context, aims to enhance the estimation of β by leveraging $\hat{\theta}$. The term Quasi indicates that the method does not directly aim at estimating the target model but rather an approximation that is close to it (Zhang, 2024).

In our framework, we define q_t as:

$$q_t = s_t \cup r_t$$

where s_t represents the set of municipalities that have already provided the value of the response variable y_t , and r_t consists of the remaining units for which the response is not available yet. Given our specific application, we assume that all features (administrative and MNO) are available for r_t .

To account for the unavailability of some responses from the target units in the current period, we introduce an adjusted sample set s_t^* , defined as:

$$s_t^* = s_t \cup r_t^*$$

where r_t^* represents a substitution mechanism in which the missing response values are replaced by the corresponding values from the previous year. In this step, some adjustments may be applied to the replacement values. In our case, to account for a trend effect primarily driven by COVID-19 recovery, we applied a +3% adjustment to the 2022 values.

Furthermore, we denote past observations at a previous time point b as s_b^* , q_b and we define the transfer schema:

$$\begin{array}{ccc} \mu(x, s_t^*) & \xleftarrow{\hat{g}(\cdot)} & \mu(x, s_b^*) \\ \Downarrow & & \\ \mu(x, q_t^*) & \xleftarrow{\hat{g}(\cdot)} & \mu(x, q_b) \end{array}$$

which applies the relationship g between s_t^* and s_b^* to q_t and q_b . In our work, we choose a transfer function $g(\cdot)$ that uses $\mu(x, s_b^*)$ as a feature, modelling the relation to be transferred as:

$$E\{\mu(x, s_t^*)\} = g(x, \mu(x, s_b^*))$$

Where $\mu(x, s_t^*)$ represents the expected value of the response variable given x , and $\mu(x, s_b^*)$ corresponds to the source model. In summary, $\mu(x, s_b^*)$ and $\mu(x, q_b)$ are source models, and $\mu(x, q_t)$ is a target model; all of them share the same functional form but are trained on different data subsets, resulting in distinct parameter values. Alternative substitution mechanisms of unavailable response values, transfer schemes and functions can be considered depending on the specific application. For a detailed discussion, we refer to Zhang (2024).

3.3. Augmented Learning

Augmented learning (AL) techniques are designed to improve predictive performance by enhancing the training set, s , introducing some surrogate units. Given the notation already introduced for transfer learning, the training set is expanded with additional instances, r^* , that, in our case, correspond with the units in the target set r but the values of the dependent target variable $\{y_t \mid j \in r^*\}$ for these units are proxies for the target observations and are taken from some earlier time points. The main objective of this approach is to reduce the bias that arises from learning only from s , thereby improving the results of the baseline Simplistic Model previously described.

In this study, we choose to augment the sample s of fast-response municipalities by using, for the remaining units, the corresponding values from the same months of the previous year. The augmented sample s_t^* has already been described in the Quasi-Transfer Learning paragraph (Section 3.2). We also attempted to replicate the s_t units multiple times in the augmented sample to increase their weight in the training set, but we decided to augment it only once, as no significant improvements were observed.

4. Modeling

We applied AL, QTL, and Simplistic approach to predict the response variable for the months of September and October 2023. All the methodologies are implemented using both a Linear Regression Model (LM) and a Random Forest (RF). For each month we aimed to predict, and for each model, we selected specific variables to achieve the best results. The data available contain both spatial (cross sectional) and temporal information that could be exploited to make forecasting. For simplicity, we refer to the response variable, representing the nights spent as a tourist in a municipality, as y , and its MNO proxy as x . In the Linear Model, the square root transformation of both y and x , used as a feature, was applied to reduce the influence of extreme values and normalize the distribution of the variables. This approach improves the stability and accuracy of the model, especially considering that these variables exhibit a highly skewed distribution.

To find an adequate Linear Model, we started including the proxy x of the current month, and x auto-regressive up to lag 12. We then performed a backward elimination, keeping the most significant variables. Additionally, we included a categorical variable *Zone* as spatial information. The results of these procedures are the following models:

For September

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-3} + \beta_3 y_{t-12} + \beta_4 x_t + \beta_5 x_{t-1} + \beta_6 x_{t-9} + \sum_j \gamma_j \text{Zone}_j + \epsilon$$

For October

$$y_t = \beta_1 y_{t-1} + \beta_2 y_{t-3} + \beta_3 y_{t-6} + \beta_4 y_{t-8} + \beta_5 y_{t-12} + \beta_6 x_t + \beta_7 x_{t-1} + \beta_8 x_{t-2} \\ + \beta_9 x_{t-6} + \beta_{10} x_{t-7} + \beta_{11} x_{t-8} + \beta_{12} x_{t-9} + \sum_j \gamma_j \text{Zone}_j + \epsilon$$

We applied the same procedure for Random Forest, performing backward selection based on feature importance. Since Random Forest is better suited than linear regression to handle a large number of features, we also included some register information. For both September and October, we selected the same set of features:

$$\left\{ \begin{array}{l} y_{t-1}, y_{t-11}, y_{t-12}, x_t, x_{t-1}, x_{t-11}, x_{t-12}, \text{Resident_population}, \\ \text{Costal_municipality}, \text{Altitude_of_center}, \text{Urbanization_degree}, \\ \text{Extension_km2}, \text{Province} \end{array} \right\}$$

For our settings, we used the previous models for $\mu(x)$. For QTL, we obtained $g(x)$ by adding $\hat{\mu}(x)$ to the models and choosing b as the month preceding the one

we wanted to predict. As stated in Section 3.3, for AL, we chose to augment the sample only once.

5. Preliminary Results

We tried to predict September and October 2023 overnight counts, pretending not to observe them from the administrative data, while observing them through MNO data (earlier available). We observed the admin data and MNO referring to previous months, and some characteristics of the municipalities. We applied AL, QTL and a Simplistic models to our data and compared their Mean Absolute Error (MAE), Mean Absolute Percentage Error (MAPE), defined as

$$MAE = \frac{1}{n} \sum_{i=1}^n |y_i - \hat{y}_i| \quad MAPE = \frac{1}{n} \sum_{i=1}^n \frac{|y_i - \hat{y}_i|}{y_i} ,$$

along with the total predicted sum for the entire set of selected municipalities, which can be compared to the actual total. To evaluate the estimates for each available unit in the test set, we performed a 2-fold cross-validation. To reduce the influence of the sampling choice, we repeated this process 50 times. The reported MAPE values were computed as the average of all estimates obtained across these repeated cross-validations.

We decided to evaluate the algorithms on municipalities with a clear touristic vocation, selecting only those with a response value greater than the median, which in our case is 577 overnights. The results are shown in Table 2.

Table 2 – *Model results for September and October 2023.*

Model	MAE (Sep)	MAPE (Sep)	TOT $\hat{y}$ (Sep)	MAE (Oct)	MAPE (Oct)	TOT $\hat{y}$ (Oct)
Linear (Simplistic)	1301.94	19.93	4025369	1486.04	20.94	1766437
Linear (QTL)	1206.17	19.04	4006008	1205.74	20.47	1805782
Linear (AL)	1227.11	19.26	4009297	1238.69	20.35	1807020
Random Forest (Simplistic)	4707.84	27.12	4144826	4625.61	35.31	2389966
Random Forest (QTL)	2356.2	19.73	4104355	1900.56	21.94	1945381
Random Forest (AL)	2224.88	18.98	4092401	1860.68	21.52	1941391
TOT y			4079632			1798189

We also computed 95% Confidence Intervals (CI) and normalized Confidence Intervals, defined for a municipality i as:

$$CI_{normalized,i} = \frac{CI_{upper,i} - CI_{lower,i}}{\hat{y}_i}$$

where $\hat{y}_i$ denotes the mean of the predictions for municipality i across all repetitions. By taking the mean of the $CI_{normalized}$ for each unit across the QTL, AL, and Simplistic models, we obtained the results given in Table 3.

Table 3 – Mean CI Normalized for Simplistic, QTL, and AL Models.

	LINEAR MODEL			RANDOM FOREST		
	Simplistic	QTL	AL	Simplistic	QTL	AL
September 2023	0.222	0.104	0.104	0.346	0.114	0.084
October 2023	0.301	0.097	0.098	0.384	0.087	0.055

In Figure 2, for the month of September, the left panel shows the ratio between the absolute error of the Simplistic model and that of the other two models (Linear Model and Random Forest) for each municipality. The right panel displays the corresponding ratios for the widths of the Confidence Intervals.

In Figure 3, for the month of September, we report the MAPE of the Linear Model for the municipalities where the ratio between the absolute error of the Simplistic model and that of the more advanced methods (AL and QTL) exceeds 1.5. Figure 4 presents the same analysis for the Random Forest model. The aim of these figures is to highlight the municipalities with the lowest MAPE among those where the advanced methods outperform the Simplistic model.

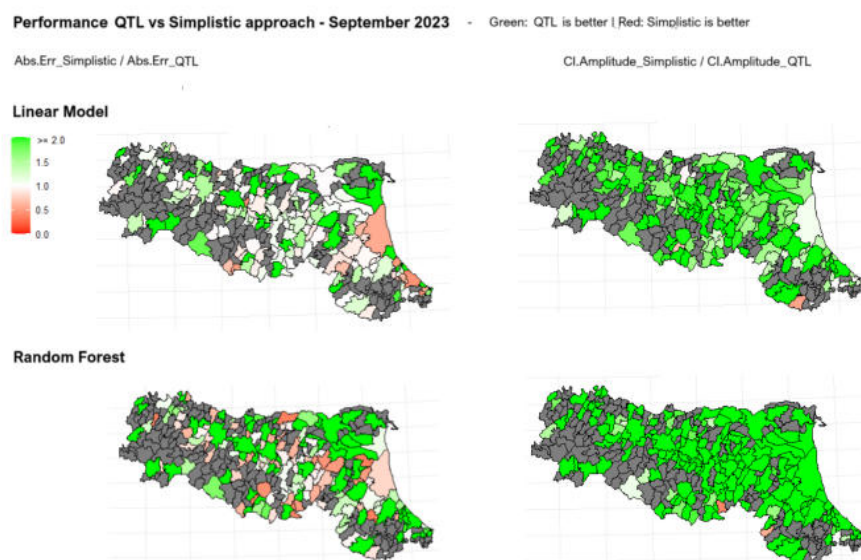
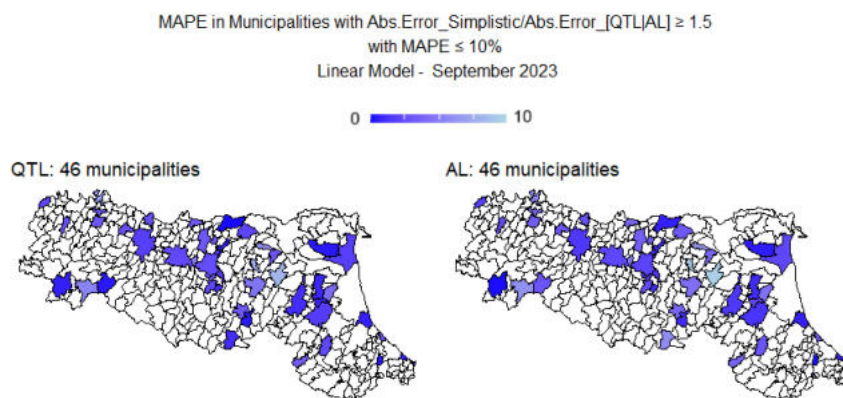
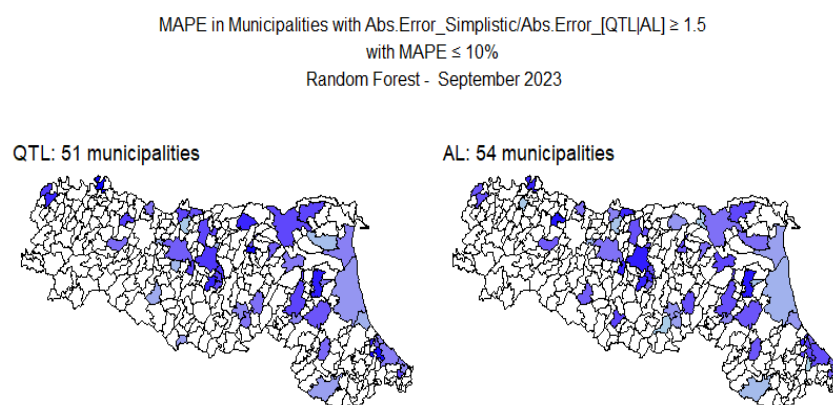
Figure 2 – September 2023 QTL vs Simplistic.**Figure 3 – QTL and AL MAPE - Linear Model.**

Figure 4 – QTL and AL MAPE – Random Forest.

Observing the results, we can state that QTL and AL improve the precision of the estimates. Linear models appear to be more suitable for this prediction task, but Random Forest with QTL and AL achieves significant improvements over the Simplistic approach, reaching or even surpassing the MAPE of its counterpart, which benefits less from these advanced methods. Additionally, as shown in Table 3 and in Figures 3-4 Confidence Interval plots, AL and QTL effectively improve estimates' stability.

6. Models Ensemble

We observed that the Random Forest model performed better in municipalities with low tourism levels (fewer than 5,000 overnight stays per month), while the linear model was more effective for highly sparse data with large, regression-dominating values. Then, we implemented a simple ensemble of the two models: for municipalities where the observed target variable in the previous year exceeded a predefined threshold, we used linear regression for predictions, while Random Forest was employed for all cases below this threshold.

The fixed threshold is 1300; in this application the threshold was chosen empirically to minimise the MAPE. Approximately two-thirds of municipalities were predicted using the linear model, while the remaining third were predicted with Random Forest. The ensemble results are shown in Table 4 and 5.

Table 4 – Ensemble Model results for September 2023.

September 2023			
Model ensemble	MAE	MAPE	TOT_y
Simplistic	1315.20	22.78	4043084
QTL	1198.93	19.19	4014355
AL	1214.54	18.76	4017478
TOT_y			4079632

Table 5 – Ensemble Model results for October 2023.

October 2023			
Model ensemble	MAE	MAPE	TOT_y
Simplistic	1500.68	23.23	1778993
QTL	1194.13	19.15	1810638
AL	1228.30	19.35	1813292
TOT_y			1798189

It is important to note that the global percentage error we obtained (approximately 19%), is not uniformly distributed across the territory. Specifically, for about 40% of municipalities' predictions deviate from the true values by less than 10%.

We need to further investigate municipalities where MNO (Mobile Network Operator) data and administrative data show poor correlation, particularly those with significantly overestimated MNO values compared with administrative records. For instance, Bentivoglio municipality exhibits percentage errors of 143% and 189% in September and October, respectively. This discrepancy may arise because Bentivoglio hosts a major hospital with a high volume of patient admissions, which the MNO data could misinterpret as tourist presence.

7. Concluding Remarks and Future Improvements

Our study highlights several aspects that need to be investigated and developed to improve forecasts.

In our experiments, we observed that the linear model performed better in predicting overnight stays in municipalities with a high number of them, whereas the random forest yielded better results in municipalities with fewer overnight stays. Based on this observation, an ensemble of the two models has been considered. Additionally, a mixed strategy could be explored, selecting among the simplistic, Quasi Transfer Learning, and Augmented Learning approaches, depending on which

method performs best in a given municipality. To implement this, appropriate ensemble criteria and selection methods need to be investigated.

In this work, we tested Quasi Transfer Learning and Augmented Learning with the linear model and random forest, but many other models could be suitable for our forecasting task, such as count models (e.g., negative binomial), neural networks, and ARIMA. Further experiments could also be conducted using additional register data, which may enhance the identification of long-term dependencies while adjusting for short-term variations using MNO data, which are only available for recent periods.

In this study, we adopted the implementation choices that we considered most appropriate for our context, but Zhang and Haug (2024) propose several alternative mechanisms for substituting unavailable response variables, as well as transfer schemes and functions that could be further explored.

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SUB-NATIONAL SPATIAL PRICE INDICES FOR WATER SERVICES IN ITALY: A PRELIMINARY ESTIMATION¹

Cristina Dormi, Barbara Dramis, Agostina Zanoli

Abstract. Italy exhibits pronounced territorial economic disparities, making an accurate measurement of regional price level differences essential for assessing inequalities in real income, household consumption expenditure, and poverty. To this end, the Italian National Institute of Statistics (Istat) is carrying out a project to compute Sub-national Spatial Price Indices (SSPIs) for the 12 Divisions of the ECOICOP (European Classification of Individual Consumption According to Purpose) classification. These indices are crucial for enabling more robust regional comparisons in economic analysis and for supporting evidence-based policymaking. Initial results, based on 2022 data, have been produced for five divisions and reveal substantial differences in price levels across Italian regions. Work is currently underway for Division 04 “Housing, Water, Gas, Electricity and Other Fuels”.

In this paper, we present the first results of SSPI estimation for two Basic Headings (BHs) within Division 4: “Water supply” and “Sewage collection.” The analysis is based on 2023 Consumer Price Index (CPI) data, whose characteristics vary depending on the municipality of observation. To ensure the comparability required for SSPI computation, these data are standardized prior to estimation.

The indices are estimated using a Regional Product Dummy (RPD) model, taking into account differences in consumption levels in accordance with Eurostat methodology. Preliminary findings highlight substantial regional disparities in price levels for the services examined, underscoring the importance of sub-national price measurement for understanding real consumption and household living conditions.

1. Introduction

Differences in price levels across Italian regions are widely acknowledged and stem from substantial economic, social, and geographical disparities. These differences can be measured using Sub-national Spatial Price Indices (SSPIs), also referred to as Regional Purchasing Power Parities (RPPPs), which quantify

¹ Although this document is the result of a collaborative effort by all authors, the contributions were as follows: C. Dormi wrote Section 2, B. Dramis wrote Section 3, and A. Zanoli Section 4. The introduction and conclusion were jointly written by all authors. The views expressed in this article are those of the authors and do not necessarily reflect the views of Istat.

differences in the price levels of a common basket of goods and services across geographical areas at a given point in time. Computing such indices is a particularly complex task, requiring large quantities of locally collected data that must meet specific conditions to ensure valid estimation. In particular, price quotations must satisfy two fundamental requirements: comparability and representativeness.

To ensure comparability, prices must be collected for products or services that are identical or, at least, highly similar across all geographical areas so that observed differences can be attributed solely to price variation rather than to differences in product characteristics. As for representativeness, it is essential to collect prices for products that are relevant for consumers in the surveyed areas. At the international level, purchasing power parities are calculated by the International Comparison Program (ICP), coordinated by the World Bank in collaboration with the OECD, Eurostat, and other organizations (World Bank, 2020).

In recent decades, several experimental studies have been carried out by researchers and national statistical offices (Biggeri et al., 2017; Laureti and Rao, 2018). More recently, the importance of regional (subnational) purchasing power parities or spatial price indices has been formally recognized by the World Bank within the United Nations Statistical Commission. As a result, the ICP has published specific guidelines for the computation of spatial consumer price indices (ICP, 2021).

The Italian National Institute of Statistics (Istat) is among the few national statistical institutes that have officially undertaken experimental calculations of subnational purchasing power parities. The first experiments were conducted in 2008 (Istat, 2008) and 2010 (Istat, 2010) for three and then all expenditure divisions of the ECOICOP, using both CPI data and ad hoc surveys. The introduction of scanner data into the CPI production process in 2018 has further strengthened research efforts in this field (Laureti et al., 2017; Laureti and Polidoro, 2022).

Growing demand for subnational indicators at both the national and European levels has prompted Istat to launch a project to routinely estimate regional spatial consumer price indices. Due to the large volume of data needed, a multi-source approach has been adopted to identify the most suitable information available for each product. The data used in the analyses include scanner data, traditional CPI data, and ad hoc surveys. Results for five expenditure divisions of the ECOICOP classification, referring to the year 2022, have already been published (Istat, 2024). The forthcoming release will update these results and include Division 4, "Housing, Water, Gas, Electricity and Other Fuels," which is characterized by the presence of tariffs and rents.

In this paper, we present the analysis and initial findings of the SSPI estimation for two Basic Headings (BHs) of Division 4: "Water supply" and "Sewage collection." The analysis is based on 2023 CPI data, whose characteristics vary

across municipalities. To ensure the comparability required for SSPI computation, the data are standardized prior to estimation.

The indices are estimated using the Regional Product Dummy (RPD) model, taking into account different consumption levels according to Eurostat methodology. The experimental results are presented and discussed in the rest of this paper: the data source is illustrated in Section 2; Methodological aspects are addressed in Section 3; Section 4 provides an overview of the results. Lastly, concluding remarks are given in Section 5.

2. Collection of Domestic Water Tariffs in the Consumer Price Index Survey

As part of the CPI compilation process (Istat, 2023a), the Istat collects data on domestic water tariffs using a structured and nationally harmonized methodology, in line with European guidelines. These tariffs contribute to the estimation of the Italian Harmonised Index of Consumer Prices (HICP).

Within the CPI basket, water-related services are represented by two product aggregates: water supply and sewerage collection. These services fall under the ECOICOP Division 4, “Housing, water, electricity, gas, and other fuels.”

In 2023, water tariffs were collected in 91 provincial capitals. This survey covers 90% of the provincial population. Full participation is recorded in 10 regions (Piemonte, Valle d’Aosta, Trentino-Alto Adige, Veneto, Friuli-Venezia Giulia, Emilia-Romagna, Toscana, Umbria, Abruzzo and Basilicata), while lower participation levels are observed in other regions, notably Puglia (56.3%), Sardegna (56.6%) and Marche (65.2%) (Istat, 2023b).

Water tariffs are established by local authorities or other entities designated under regional regulations and must be approved by the national regulatory authority, ARERA (Autorità di Regolazione per Energia Reti e Ambiente), based on supporting technical documentation. These tariffs, along with the consumption tiers, can vary significantly across different areas of the country. This territorial variation reflects local conditions, including the cost of service management, water availability, infrastructure characteristics, and environmental priorities specific to each region.

Each household receives a bill consisting of a fixed component, independent of consumption, and a variable component based on the volume of water used (measured in cubic meters). The variable component includes charges for water supply, sewerage, and wastewater treatment.

The water supply charge system is structured based on consumption brackets (or tiers) and the number of individuals in the household. Consumption brackets vary according to household size, with rates increasing as consumption rises. Lower water consumptions corresponds to lower rates and higher consumptions incurs

progressively higher rates. This tiered structure, defined according to household size, was introduced by ARERA through Resolution 665/2017/R/idr with the aim of enhancing the equity of the tariff system. In contrast to water supply charges, sewage and wastewater treatment tariffs are applied uniformly across all consumption volumes.

In addition to consumption-based fees, the bill may include equalization charges, which serve to offset costs incurred for the general benefit of the water system.

Finally, a 10% VAT is applied to the total of both fixed and variable charges.

3. Regional product dummy model

The calculation of SSPIs is carried out using recognized methodological tools employed in numerous studies at international level. The model used for the two BHs considered is the RPD, as recommended by the ICP, which in 2021 published guidelines (ICP, 2021) for the calculation of regional purchasing power parities.

The RPD model is the regional version of the Country Product Dummy (CPD) utilized for international comparisons. The idea behind this method (Rao, 2013; Rao and Hajargasht, 2016) is that the price p_{nr} of an item n ($n=1...N$, where N are the items belonging to the same BH) in an area r ($r=1...R$) is a function of an area-specific factor $SSPI_r$ (parity or general level of prices of the area considered with respect to other areas), of the average price of the item P_n and of a random error u_{nr} :

$$p_{nr} = P_n * SSPI_r * u_{nr} \quad (1)$$

Considering the logarithms, the previous expression can be written as:

$$\ln p_{nr} = \sum_{r=1}^R a_r D_r + \sum_{n=1}^N b_n D_n^* + v_{nr} \quad (2)$$

Where:

D_r is the dummy variable that takes value equal to 1 if the price quotation is from area r and 0 otherwise,

D_n^* is the dummy variable for product n which takes value equal to 1 when item considered is n and 0 otherwise,

a_r and b_n are, the differences in the effects associated with the areas and the product type, respectively,

v_{nr} are random error normally distributed with a zero mean and variance σ^2 .

Parameters of this model can be estimated using ordinary least squares, imposing a restriction, that a coefficient corresponding to a specific area is set equal to zero

($a_1=0$) or equivalently $SSPI_1=1$ thus considering it as a reference area to which the coefficient estimates are referred.

The purchasing power parity between an area r and the reference area is $\widehat{SSPI}_r = \exp(\widehat{a_r})$. The parities thus estimated satisfy the property of transitivity and invariance of the basis.

Having weights in terms of value or quantity for each product, the model can be written as:

$$\sqrt{w_{nr}} \ln p_{nr} = \sum_{r=1}^R a_r \sqrt{w_{nr}} D_r + \sum_{n=1}^N b_n \sqrt{w_{nr}} D_n^* + \sqrt{w_{nr}} v_{nr} \quad (3)$$

where w_{nr} are the weights in terms of value or quantity that reflect the economic importance of the different products consumed in the area.

In this analysis, we use data coming from CPI data collection referred to 2023, taking into account data for a resident family of three members and excluding any social bonuses for households in conditions of economic and social hardship.

In accordance with the definition adopted by ARERA, the standard household is composed of three individuals. For the purposes of the present analysis, the SSPIs are computed using an unweighted RPD model, applied to three consumption levels: 100 m³, 200 m³ and 300 m³. The use of identical consumption levels across all cities ensures adherence to the comparability principle required for SSPIs and aligns with the methodological guidelines established by Eurostat for the construction of international Purchasing Power Parities (PPPs).

Building on ARERA's estimate that a typical Italian household of three members consumed approximately 150 m³ of water in 2023, although with marked geographical variability, the selected consumption levels allow us to assess whether provincial price structures exhibit differential behaviours as demand increases. The unweighted RPD model is therefore implemented twice: first using two consumption levels (100 m³ and 200 m³), following the standard Eurostat approach, and subsequently using all three consumption levels. In both specifications, the consumption levels are treated as distinct products.

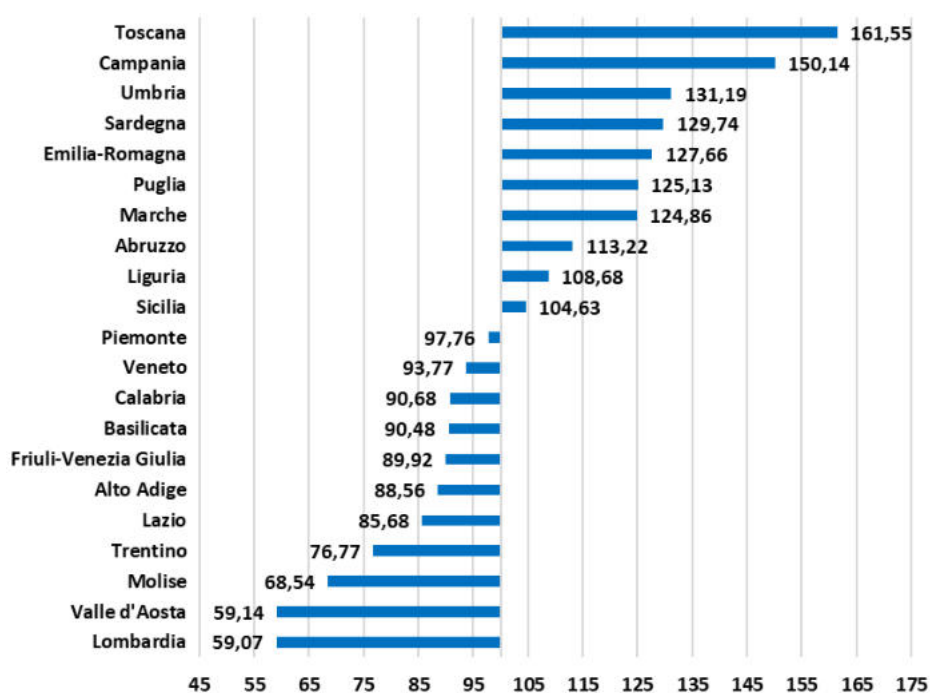
The regional prices per cubic meter employed in the model are computed as a weighted average of provincial tariffs, where the weights correspond to the resident population of each province.

4. Results

The objective of this analysis is to present the SSPIs for each Italian region, estimated relative to the national average, which is conventionally set to 100. A regional price level index above 100 indicates that the region is relatively more

expensive than the national average, and vice versa. Similarly, if the price level index of one region exceeds that of another, the former is relatively more expensive for the product categories considered.

Figure 1 – SSPI for “Water supply” considering two levels of consumption (100 m^3 and 200 m^3) – Year 2023, Italy=100.



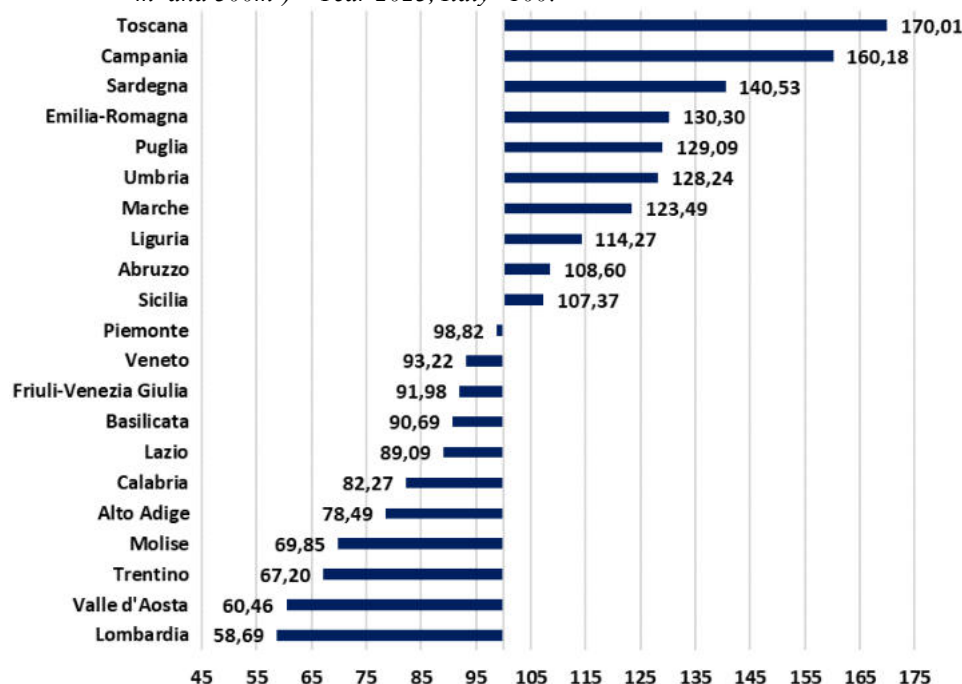
Source: Istat.

The results for the BH “Water supply,” taking into account two consumption levels, reveal substantial regional disparities in the SSPI values (Fig. 1). Toscana emerges as the most expensive region, with a price level more than sixty percent above the national average, whereas Lombardia is the least expensive. Notably, no clear geographical pattern emerges for this Basic Heading: among the most expensive regions, there are areas from the North, Centre, and South of the country. The difference between the most expensive and the least expensive is very large 102.48 percentage points.

The heterogeneity of potable water tariffs across Italian regions is primarily determined by structural and operational disparities within the Integrated Water Service. Key drivers include different infrastructure conditions, particularly network

age and leakage rates, which influence maintenance and investment requirements. Differences in water source characteristics (surface versus groundwater) and the associated treatment needs further contribute to cost variability. Tariffs also reflect the complexity of the organizational model of service provision, which ranges from large-scale single operators to fragmented local utilities. Geographic and hydro-morphological factors, such as elevation and energy requirements for pumping, additionally affect operational expenditures. Finally, region-specific investment plans approved by local regulatory bodies under the national ARERA framework introduce further differentiation. Together, these factors generate significant spatial variability in the cost of providing potable water across the country.

Figure 2 – SSPI for “Water supply” considering three levels of consumption (100 m^3 , 200 m^3 and 300 m^3) – Year 2023, Italy=100.



Source: Istat.

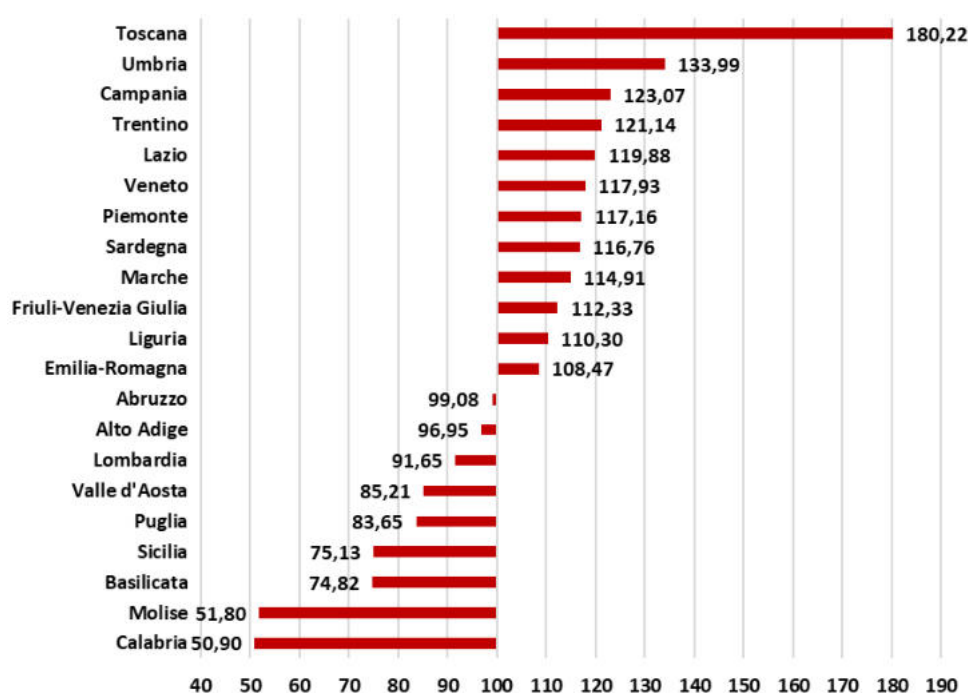
The same analysis, conducted across three consumption levels, yielded similar results regarding the most and least expensive regions (Fig. 2). Toscana and Campania consistently appear among the highest-cost regions, whereas Valle d'Aosta and Lombardia rank among the lowest. However, the gap between the most

and least expensive regions appears substantial, greater than in the previous analysis, amounting to 111.32 percentage points.

The inclusion of a higher consumption level was intended to assess how regions respond when exposed to varying consumption levels, holding all other factors constant. The substantial discrepancies observed across regions suggest the existence of markedly different tariff structures associated with these three consumption levels.

The estimated SSPI for the BH “Sewage collection” considering two levels of consumption shows similar differences as for Water collection for the most expensive regions (Fig.3), but in this case, the dispersion of results is even greater. In this BH, the least expensive regions are located in the South. The rates reflect the complexity of the organizational model as well as the water collection, but also the efficiency of the wastewater collection and treatment systems. Regions with more advanced systems or more stringent environmental standards have higher costs.

Figure 3 – SSPI for “Sewage collection” considering two levels of consumption (100 m³ and 200 m³) – Year 2023, Italy=100.



Source: Istat.

5. Conclusions

As part of the analyses conducted to calculate the SSPIs for the fourth ECOICOP expenditure division, we focused on the BHs “Water supply” and “Sewage collection.” The reprocessing of CPI data for water supply and sewerage services, carried out in accordance with the specific data requirements for SSPIs, enabled the computation of these indices.

The resulting price levels exhibit substantial differences across geographical areas. No clear geographical pattern emerges for Water supply, whereas for Sewage collection the lowest price levels are observed in the southern regions. The analysis could be further refined by examining the role of different water consumption levels across cities and incorporating appropriate weights for these consumption tiers within the model. Additional investigations could also explore the effects of the large number of water management entities operating in Italy, 2.110 in 2022 (Istat, 2025), including the type of management (local public bodies such as municipalities, or dedicated water service companies) and the characteristics of the distribution network.

In the coming years, these scenarios are expected to evolve as a result of the increased investments required in certain areas to modernize infrastructure, comply with regulatory standards, and mitigate the impacts of climate change. Divergent demographic trends will also play a role, potentially disadvantaging regions experiencing depopulation, where the distribution of costs across a shrinking user base may lead to higher tariffs (Utilitaris, 2025).

This preliminary analysis will be complemented by further in-depth studies and the results for the fourth expenditure division will be published together with an update of the indicators for the divisions already reported, with a view to providing ever greater information on the territorial differences in price levels.

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LISTENING TO PILGRIMS: USERS REVIEWS AS A TOOL TO IMPROVE URBAN RECEPTION POLICES DURING THE JUBILEE IN ROME

Sandro Stancampiano

Abstract. The Jubilee 2025 is expected to attract millions of pilgrims to Rome, placing significant pressure on public services and urban infrastructure. This study explores the use of Natural Language Processing (NLP) for the automated analysis of online reviews, with the aim of monitoring the perceived quality of the pilgrims' experience. A corpus of 2,217 user reviews from Google Maps - 1427 related to worship places and 790 to hospitality facilities - was processed through a modular pipeline including text pre-processing, sentiment analysis, and extraction of suggestions and complaints. Results highlight marked differences between the two categories: reviews of worship sites tend to be highly positive and emotionally polarized, while hospitality-related reviews are more nuanced and contain a higher density of constructive feedback. The proposed methodology offers a scalable, low-cost tool for civic listening and urban planning, providing actionable insights that can support public administration in managing complex events such as the Jubilee.

1. Introduction¹

The Jubilee 2025 represents a global event that is expected to draw millions of pilgrims to Rome, generating significant impacts in terms of hospitality, access to services, and urban space management. Public administrations face complex challenges in managing such flows and require innovative tools for monitoring the quality of visitor experience in real time.

In recent years, the automated analysis of online reviews has emerged as a valuable resource for capturing perceptions, needs, and criticisms expressed spontaneously by users. Compared to traditional evaluation methods - such as surveys or post-event institutional reports - digital reviews offer the opportunity to activate continuous, dynamic, and low-cost forms of civic monitoring (Gohil *et al.*, 2018).

¹ The views expressed in this paper are those of the author and do not necessarily reflect the policies of ISTAT.

Platforms like Google Maps collect a large volume of textual content that, when properly processed, can provide empirical insights into both the urban and spiritual experiences of pilgrims. These contents are considered reliable, as they are subject to moderation policies and authenticity checks implemented by Google (Stancampiano, 2023a).

This study contributes to this growing field by exploring the potential of NLP techniques for the automatic analysis of user reviews. The aim is twofold: first, to test a structured and replicable pipeline for thematic and sentiment analysis; second, to provide operational insights for public policies and reception services.

The analysis focuses on two categories of locations that are particularly relevant to the Holy Year: worship places (churches, basilicas, shrines) and hospitality facilities (pilgrims' hospitality centres and religious hostels). The corpus consists of 1,160 reviews in Italian extracted from Google Maps, processed through a three-stage pipeline: linguistic pre-processing, sentiment analysis (using RoBERTa, i.e. a Robustly Optimized BERT Approach; Liu et al., 2019), and rule-based extraction of suggestions and complaints.

Beyond social media and online reviews, a growing body of work in official statistics and urban informatics has explored the use of mobile positioning data to monitor human mobility, define functional urban areas and support COVID-19 policies (Iacus et al., 2021; Iacus et al., 2022; Santamaria et al., 2020). In tourism statistics, national statistical offices are experimenting with mobile phone data to complement traditional surveys and improve the measurement of tourist flows (Cavallo et al., 2022; Grassini and Dugheri, 2021). In this context, user-generated reviews can be seen as a complementary, experience-centred source, focusing less on volumes and more on perceived quality and critical issues along the urban journey.

The final goal is to identify prevailing emotions and perceived strengths and weaknesses, thereby contributing to the construction of an informative map that can support urban governance, and the design of more inclusive services grounded in civic listening (Karami *et al.*, 2020). We also believe that official statistics can be effectively integrated with non-conventional data sources, as has already been demonstrated in the tourism sector (Stancampiano, 2023b).

This article is conceived as an applied case study and technical note rather than as a contribution to state-of-the-art NLP methodology. Our main objective is to document a transparent and reusable workflow that statistical offices and local governments can adopt to turn large volumes of user-generated reviews into simple indicators for civic listening and urban planning. The analysis focuses on two categories of locations that are particularly relevant to the Holy Year: worship places (churches, basilicas, shrines) and hospitality facilities (pilgrims' reception centres and religious hostels). In the current version of the study, the corpus comprises more

than 2,200 Google Maps reviews, of which 1,160 contain non-empty text and are processed through a modular pipeline including linguistic pre-processing, binary sentiment analysis and rule-based extraction of suggestions and complaints. By combining these elements with additional indicators of model confidence and uncertainty, we aim to show how standard NLP tools can be integrated into the toolbox of public administrations for monitoring complex events such as the Jubilee.

2. Methodology

The methodological approach adopted in this study relies on a modular pipeline based on NLP techniques, designed to automatically and reproducibly analyze a corpus of online reviews extracted from Google Maps. Rather than introducing new algorithms, the pipeline deliberately combines well-established NLP components in a way that is easy to reproduce and adapt to different urban contexts, with all steps implemented in modular Python scripts that can be re-run as new reviews become available.

The process is articulated in four main stages, each implemented through reusable Python scripts.

1. Text Pre-processing. The original text is cleaned and normalized through case lowering, removal of special characters and URLs, stopword filtering, tokenization, and lemmatization. The output is a Comma-Separated Values (CSV) file with an additional column containing the cleaned text.

2. Sentiment Analysis. The sentiment classification is performed using the MilaNLProc/feel-it-italian-sentiment model (Bianchi *et al.*, 2021), a RoBERTa-based classifier fine-tuned on Italian texts. The model was trained on a dataset of tweets annotated with four basic emotions: joy, sadness, anger, and fear. For sentiment purposes, these emotions are aggregated into two polarities: positive (joy) and negative (sadness, anger, fear). The model achieves an accuracy of 84% on the SENTIPOLC16 benchmark (Basile *et al.*, 2016) and is available via Hugging Face (Hugging Face, 2021). Unlike other models that include a neutral class, this approach forces binary classification. As a result, each review is assigned to either the positive or negative category, even in cases where the sentiment may be ambiguous or weakly expressed. This choice, while limiting nuance, enhances classification reliability on colloquial, spontaneous Italian language.

3. Suggestion and Complaint Extraction. A rule-based module identifies review segments containing dissatisfaction, needs, or improvement proposals, using regular expressions to detect linguistic patterns. Relevant fragments are extracted into a separate column for further analysis.

4. Synthesis and Visualization. The results are summarized through quantitative tables and graphical outputs. Sentiment distributions and frequencies of suggestion-related phrases are exported in both CSV and visual formats, such as Portable Document Format (PDF) and Portable Network Graphics (PNG), for reporting purposes.

2.1. Sentiment Analysis

The choice of a binary classifier is driven by both linguistic and practical considerations. FEEL-IT is an Italian-specific model trained and evaluated on informal, user-generated texts, with a clear mapping of four basic emotions into two polarities (positive vs. negative). To our knowledge, there is currently no Italian-focused sentiment model that jointly provides a ternary (positive/neutral/negative) taxonomy and robust benchmarks on short, spontaneous texts comparable to those analysed here. In addition, neutral labels in such settings tend to absorb heterogeneous cases - irony, mixed or weakly expressed opinions, and low-information content - making them difficult to interpret in aggregate. For these reasons we adopt a binary scheme, prioritising robustness and clarity of interpretation at the aggregate level over finer-grained distinctions at the level of individual reviews.

2.2. Validation and robustness checks

Although a full manual annotation exercise was beyond the scope of this applied case study, we performed a simple internal robustness check. For each review we compared the predicted polarity with the associated 1–5 star rating on Google Maps. In both worship places and reception centres, the share of reviews classified as positive increases monotonically with the star score, whereas negative classifications concentrate on 1–2 star ratings. This monotonic pattern provides face validity for the FEEL-IT classifier on the specific corpus used in this study, while we explicitly acknowledge that more systematic validation against human-coded labels and alternative models remains an important avenue for future work.

3. Dataset description

The dataset used in this study consists of 2,217 user-generated reviews published on Google Maps and associated with locations of particular interest to pilgrims visiting Rome during the Jubilee 2025. Reviews were retrieved through programmatic queries to the official Google Places Application Programming Interface (API), which provides controlled access to user content linked to geographic Point of interest (POIs).

Two macro-categories of locations were targeted in the analysis: the first includes worship places such as churches, basilicas, shrines and other religious sites; the second comprises reception and charitable facilities, including pilgrim houses, religious hostels, soup kitchens, and assistance centres. An initial list of 100 POIs per category was compiled using Google-friendly naming conventions and then manually validated to ensure thematic relevance. For each POI we collected all available reviews within the reference period and then retained only those with non-empty textual content for the NLP analysis. This procedure yielded 620 text-bearing reviews for worship places and 540 for reception centres (1,160 in total), while still allowing us to keep track of the full population of ratings (1,427 and 790 observations respectively) for descriptive purposes.

Each entry of the final dataset includes the following metadata: review date, rating (1 to 5 stars), full text, and the unique identifier of the reviewed location. The data were saved in CSV format and subsequently processed within a modular Python-based pipeline. The time frame covered by the reviews spans from December 2024 to November 2025.

3.1. Limitations

A key limitation of the present study concerns sampling bias. Google Maps reviews do not constitute a representative sample of all pilgrims, residents or service users in Rome. Participation is voluntary and restricted to individuals who are willing and able to post public feedback on a commercial platform, and locations with a stronger online presence are more likely to be observed. As a result, the indicators we derive should not be interpreted as population-level estimates, but rather as signals emerging from a specific, self-selected group of digitally active users. In the conclusions we therefore emphasise the role of these indicators as complementary to official statistics, in the spirit of “civic listening” and early detection of critical issues, rather than as a substitute for survey-based evidence.

4. Results and Discussion

4.1. Quantitative Comparison

The main quantitative results are summarized in Table 1.

Table 1 – Summary of review metrics by category.

Category	Rating Events	Textual reviews used	Positive (text)	Negative (text)	% with Suggestion (text)	Mean Sentiment Score
Reception Centres	1427	620 (43.4%)	75%	25%	1.8%	1.5%
Worship Places	790	540 (68.4%)	76%	24%	5.9%	1.5%

Source: Own processing based on Google data.

We focus on the subset of reviews that contain a written comment, which form the basis for sentiment and suggestion extraction. However, percentages in Table 1 are normalised by the total number of rating events per category (including star-only ratings), in order to express how frequently users provide positive/negative textual feedback or actionable suggestions in the overall stream of reviews. The mean sentiment score is computed over textual reviews only, with scores 0 for negative and 2 for positive reviews.

For both worship places and reception centres, textual reviews are predominantly positive: around three quarters of comments express a favourable sentiment, and the mean sentiment scores are identical (1.5 vs 1.5 on a 0–2 scale). However, two important differences emerge. First, reception centres generate a higher proportion of textual feedback relative to the total number of rating events (68.4% vs 43.4%), suggesting that users are more inclined to leave written comments when interacting with service facilities than with churches. Second, suggestions and critical remarks are markedly more frequent in reception centres than in worship places (5.9% vs 1.8% of textual reviews), indicating a stronger orientation towards reporting operational issues and improvement needs in the context of service provision.

4.2. Qualitative Examples

The qualitative dimension of the analysis reinforces the quantitative findings. Below are two representative review excerpts, automatically extracted by the rule-based linguistic module.

Reception centre: “Signage for the entrance should be improved—it was unclear and hard to find.”

Worship place: “It would be helpful to provide a reserved access point for disabled visitors, which is currently missing.”

These examples illustrate how automated text analysis can isolate specific user observations that are valuable for planning corrective or improvement actions.

4.3. Confidence and Ambiguity

In addition to the sentiment classification itself, each review was also evaluated using two supplementary indicators.

The first is the confidence score (max score), which corresponds to the probability assigned by the model to the predicted sentiment label. Higher values indicate greater confidence in the model’s decision.

The second is the entropy, a measure of the uncertainty associated with the classification. It is calculated based on the probability distribution across the possible sentiment classes: higher entropy values indicate more ambiguous or mixed inputs.

A summary of these metrics by category is presented in Table 2.

Table 2 – Predictive Confidence and Uncertainty Across Review Categories.

Category	Average Confidence (max score)	Average Entropy
Reception Centres	0.98	0.51
Worship Places	0.98	0.47

Source: Own processing based on model outputs.

These results show that the model was confident in classifying reviews related to worship places, which aligns with the higher polarity of expressions in that context. In contrast, reviews related to reception centres exhibit higher entropy, indicating that the language used was more nuanced and ambiguous. This behaviour reflects the nature of the content: comments on hospitality facilities often combine positive and negative elements, such as: “Overall a good experience, but the bathroom was not very clean and lacked soap.” Such phrasing poses greater challenges for binary classification, as it conveys ambivalence or mixed judgments, which are harder to label unambiguously.

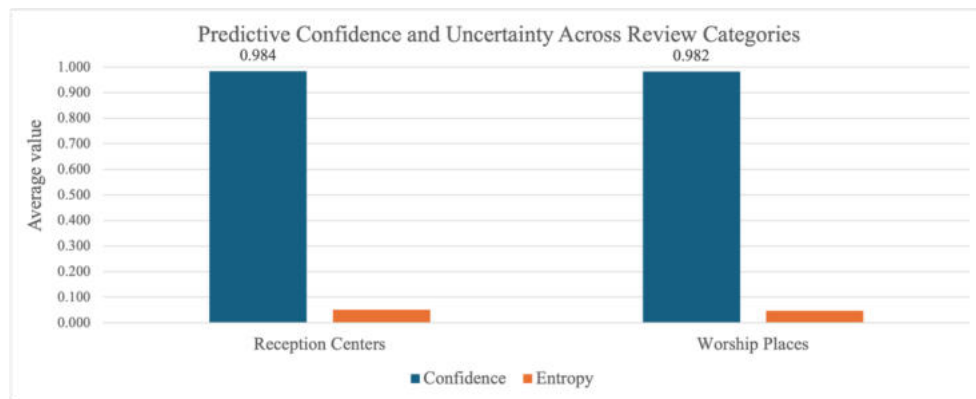
The analysis of predictive confidence and uncertainty indicates that the FEEL-IT model behaves in a very similar way across the two review categories. As shown in Table 2, the average **max score** is extremely high for both reception centres (0.984) and worship places (0.982), while the corresponding **average entropy** values remain

very low (0.051 and 0.047, respectively). This pattern suggests that, in the vast majority of cases, the classifier assigns a clearly dominant probability to one of the two sentiment classes, with limited ambiguity in the underlying probability distribution.

The small differences between the two categories point to a slightly higher degree of uncertainty in reviews about reception centres, where entropy is marginally higher. This is consistent with the intuition that service-related experiences may generate more mixed or nuanced opinions than visits to places of worship. However, the overall level of uncertainty remains low in absolute terms, reinforcing the idea that the binary positive/negative classifier is generally well-calibrated for this type of user-generated content and can be reliably used for aggregate comparisons between categories.

Figure 1 shows the average confidence score (left) and entropy (right) assigned by the sentiment analysis model for each category. Reception services are associated with lower confidence and higher ambiguity, while reviews of worship places show clearer sentiment polarity.

Figure 1 – Comparison of model confidence and ambiguity by category



Source: Own elaboration based on model outputs.

4.4. Policy Implications

The analysis confirms that worship places tend to generate enthusiasm and expressions of gratitude, but relatively few improvement-oriented comments. In contrast, reception facilities emerge as a privileged channel for collecting useful

signals to inform urban governance, particularly in the context of large-scale events such as the Jubilee.

The proposed methodology enables real-time monitoring of user perceptions, while also allowing the detection of recurring themes and emerging issues. By leveraging spontaneously generated content, this approach provides strategic value for public administrations seeking to improve the quality, responsiveness, and inclusivity of urban services.

5. Conclusions and Future Directions

This study explored the effectiveness of an automated text analysis approach for monitoring the perceived quality of services experienced by pilgrims and visitors in Rome during the Jubilee 2025. By applying a NLP pipeline, we analyzed over 2,000 reviews published on Google Maps, focusing on two strategic categories: reception facilities and worship places.

The findings indicate that reviews of worship sites are characterized by strongly positive sentiment, emotionally charged language, and low ambiguity. In contrast, reviews related to hospitality services tend to be more articulated, often containing constructive criticism and explicit suggestions. These differences reflect the symbolic nature of religious sites versus the practical nature of reception services.

From a methodological perspective, the proposed pipeline proved to be effective and replicable. It combines pre-trained language models with simple, rule-based techniques for the extraction of meaningful content. The use of supplementary indicators - such as confidence scores and entropy - provided a more nuanced interpretation of the results.

The use of a binary sentiment classifier, the absence of manual annotations and the reliance on a self-selected sample of Google Maps reviews are important limitations that we explicitly acknowledge; however, they are consistent with the pragmatic objective of this work, which is to test a transparent and easily reusable pipeline for civic monitoring, rather than to push the methodological frontier of sentiment analysis.

Rather than proposing a new NLP technique, the paper demonstrates how a simple and well-documented pipeline based on existing tools can be scaled up to real-world data and embedded into the routine information infrastructure of public administrations, thus complementing official statistics with continuous, low-cost indicators derived from citizens' spontaneous feedback.

6. Strategic relevance for public administrations

The automatic analysis of online reviews represents a high-potential strategic tool for public administration. Unlike traditional survey methods, this approach enables continuous, low-cost, and non-intrusive monitoring of citizens' spontaneous opinions.

The ability to detect emerging issues, recurring topics, and aggregated perceptions in real time provides valuable operational support for improving public services, urban planning, and managing complex events.

When used appropriately, NLP-based tools can enhance institutional intelligence by fostering greater transparency, responsiveness, and accountability in public decision-making processes.

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SMART SPECIALISATION STRATEGY (S3), BUSINESS BEHAVIOURS AND TERRITORIES: A STATISTICAL ANALYSIS OF ENVIRONMENTAL AND DIGITAL CHOICES BASED ON THE ISTAT PERMANENT CENSUS OF ENTERPRISES¹

Annamaria Fiore, Lucia Mongelli, Sergio Salamone

Abstract. The Smart Specialisation Strategy (S3) guides regional policies towards innovation-driven investments aligned with territorial strengths. Despite the widespread adoption of S3, empirical evidence on how the attitudes of firms influence investment choices within regional specialisation domains remains limited. This study addresses this gap by analysing non-linear relationships between firms' environmental awareness, technological modernisation, and investment behaviours. The analysis utilises data from the 2022 ISTAT Permanent Census of Enterprises, which developed a composite index to identify specialised firms by territorial and sectoral criteria.

To assess the relationships between environmental sensitivity and sustainable investments, as well as technological modernisation attitudes and digitalisation investments, Spearman's rank correlations were calculated to determine relationships at both the regional and specialisation-domain levels, as well as cluster analyses.

The findings highlight the potential of differentiated environmental and digital interventions tailored to sector-specific contexts. Future studies might investigate causal dynamics via longitudinal analyses to gain deeper insights into these relationships.

1. Introduction

In 2010, the European Commission urged national and regional governments to formulate Smart Specialisation Strategies (S3) for research and innovation (R&I), aiming to help European regions identify and leverage their competitive advantage (Foray et al., 2009). Since the 2014-2020 programming cycle, the European Commission has established Smart Specialisation as an *ex-ante conditionality* for accessing Structural Funds (European Parliament and the Council, 2013), reinforcing its role in guiding regional development strategies (REG. EU No 1303/2013). This approach was further reaffirmed in the 2021-2027 framework, where the effective governance of S3 was recognised as a *key enabling condition* for

¹ This article is the result of a joint effort by the authors. Section 1 was written by Salamone, Section 2 by Fiore, and Section 3 by Mongelli. Sections 4 and 5 were co-authored by all the authors. The views expressed in this article are those of the authors and do not necessarily reflect the positions of their affiliated institutions.

obtaining European Regional Development Fund (ERDF) resources dedicated to R&I and skills enhancement (EC, 2022).

It is a complex strategy, designed as part of the European Commission's reform of cohesion policy, whose objective is to identify strategic areas of intervention based both on an analysis of the strengths and potential of the economy and on an entrepreneurial discovery process (EDP) with broad involvement of the various institutional stakeholders insisting on the territories. The objective is to identify investment priorities in research, development and innovation that complement the existing tangible and intangible assets in the territories (Fratesi et al., 2021)

This paper moves within the theoretical framework of the Smart Specialisation Strategy. We utilised data from the Italian National Institute of Statistics (ISTAT), which introduced a novel enterprise classification encompassing all dimensions of smart specialisation (Foray et al., 2009). This dataset was used to identify potential S3 enterprises across Italian regions and to support the monitoring and evaluation of regional smart specialisation strategies.

The new S3 classification begins with a conceptualization process, which analyses the main lines of the S3 (five dimensions) and defines a general theoretical model, preserving the multidimensional approach that combines the fundamental dimensions: 1) innovative capacity, 2) R&D, 3) human capital, 4) driving ability to drive the development of the territory, 5) level of economic performance (e.g. added value).

After defining the latent dimensions and sub-dimensions of the S3, the variables that measure the S3 dimensions were researched. The elementary indicators were detected in the 2022 ISTAT Permanent Census of Enterprises, with a specific S3 section of the survey questionnaire.

Once the elementary indicators were selected, various aggregation methodologies were tested for the construction of a synthetic index of potential S3 enterprises. The most convincing methods proved to be the Wroclaw taxonomic method and the Mazziotta–Pareto index (MPI) for summarising a set of individual indicators that are assumed to be not fully substitutable.

The construction process of the synthetic indices (OECD, 2008) was followed: definition of the theoretical framework, selection and normalisation of the elementary indicators, and aggregation into a synthetic index for potential enterprises' S3.

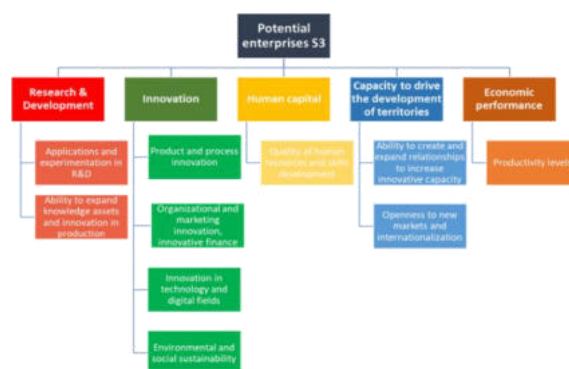
The classification enables the assessment of the specialisation areas selected by each Italian region, highlighting the dimensions in which a region demonstrates relative strengths or weaknesses. This analysis provides valuable guidance for prioritising investments and policy interventions (Iacobucci, 2014).

The data source used for the S3 classification is mainly the 2022 ISTAT Permanent Census of Enterprises, since it has a considerable wealth of information

that allows covering the different dimensions involved in S3. In addition, the classification incorporated data from the Frame-SBS register to account for variables related to productivity and performance, as well as from the ASIA Employment register to capture indicators pertaining to human capital. The five general dimensions, described above, have been decomposed into 11 indicators and more than 30 variables.

The output, obtained using the smart specialisation enterprise classification, consists of a set of statistical tables illustrating the indicators by area of specialisation at the national and regional level² (Figure 1).

Figure 1 – *S3 Dimensions and sub-dimensions.*



2. Correlation analysis

As an initial step in our analysis, we constructed a dataset aligned with our research objectives, drawing on data from the 2022 ISTAT Permanent Census of Enterprises. The objective was to test whether there are relationships between investment propensity and the corresponding sensitivity—both environmental and towards modernisation—and to determine whether these relationships are more pronounced at the territorial level (i.e., individual regions) or within specific territorial domains. One working hypothesis was that stronger relationships between investment propensity and sensitivity would be observed in certain S3 areas, such as a greater sensitivity toward environmental issues in Energy & Environment and Blue Economy specialisation areas. For each Italian region and specialisation area, we report the percentage of potential S3 enterprises with at least one investment for the digitalisation and those with at least one investment in environmental responsibility.

² <https://www.istat.it/it/archivio/273548>

Furthermore, as a proxy for the awareness toward modernisation, we consider the percentage of S3 enterprises undertaking technological modernisation within their area of activity. As a proxy for environmental accountability, we use the percentage of potential S3 enterprises that adopt standards for reporting on economic, social, and environmental sustainability aspects. In the table below, the descriptive statistics of the relevant variables of the analysis are presented (Table 1).

Table 1 – *Summary statistics of quantitative variables.*

Variable	Mean	Std. Dev.	Min	Max
Environmental Investments	67.7	17.1	16.6	94.5
Environmental Accountability (EA)	3.5	2.6	0.0	19.6
Digitalisation Investments	78.8	15.9	23.6	100.0
Technological Awareness (TA)	61.2	12.8	22.1	85.4

Source: Authors' elaboration on ISTAT data. N. observations = 252.

To empirically test these relationships, we employed Spearman's rank correlation coefficient, a non-parametric statistical measure assessing the monotonic association between two ranked variables. This method enables:

- cross-regional comparison of awareness-investment dynamics;
- sector-specific analysis within areas of technological specialisation.

Through this approach, we aim to determine whether heightened awareness effectively translates into increased investment propensity across different economic sectors and/or Italian regions.

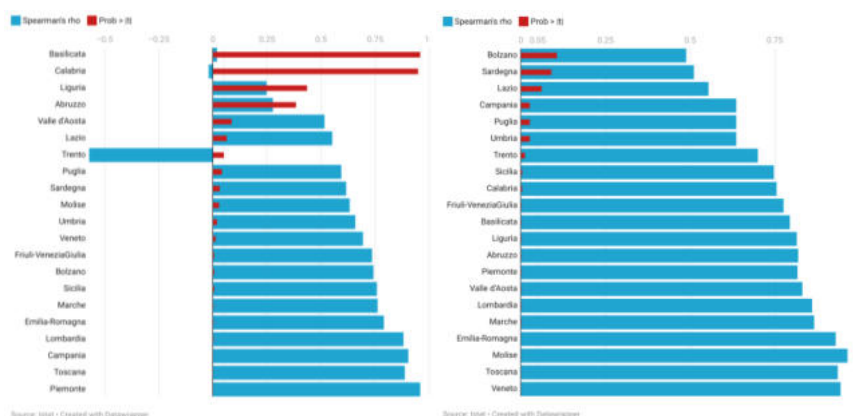
We first performed Spearman's rank coefficient for awareness and investment propensity in the environmental and technological domains across Regions (Figure 2).

In the environmental domain, most regions (14 out of 21) display statistically significant correlations, suggesting consistent patterns across territorial contexts ($p < 0.05$). Some of them have strong positive correlations ($\rho > 0.70$), such as Piemonte, Campania, Toscana, Lombardia, Emilia-Romagna, Marche, Sicilia, Bolzano, Friuli-Venezia Giulia, indicating strong evidence of association. Other regions (7) display high p-values ($p > 0.05$), implying weaker or non-significant correlations, meaning observed patterns may be due to randomness rather than systematic relationships.

In the modernisation domain, several regions show strong positive correlations, such as Molise (0.965), Veneto (0.9441), Toscana (0.9371), and Emilia-Romagna (0.9301), all with highly significant p-values ($p = 0$), suggesting a reliable relationship in these cases. On the other hand, some regions have weaker correlations or lack statistical significance, such as Bolzano (0.4895, $p = 0.1063$) and Sardegna (0.5105, $p = 0.0899$), where the p-values indicate that the correlation may not be meaningful. Interestingly, regions such as Campania, Puglia, Lazio, and Umbria

have moderate correlations with p-values slightly above or below the typical significance threshold of 0.05.

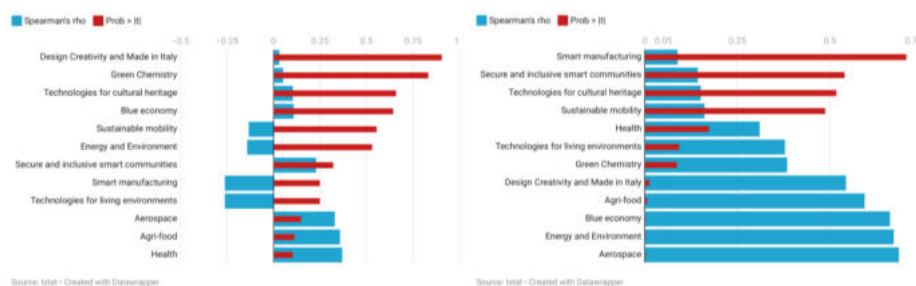
Figure 2 – Spearman's rank coefficient for awareness and investment propensity in the environmental and technological domains across regions. Spearman's correlation coefficient (ρ) and the corresponding p-value.



Source: Authors' elaboration on ISTAT data. Left panel: environmental domain, right panel: modernisation domain.

The same analysis has been replicated across the 12 specialisation areas (Figure 3).

Figure 3 – Spearman's rank coefficient for awareness and investment propensity in the environmental and technological domains across specialisation areas. Spearman's correlation coefficient (ρ) and the corresponding p-value.



Source: Authors' elaboration on ISTAT data. Left panel: environmental domain, right panel: modernisation domain.

Concerning businesses' strategies in the environmental field, all the sectors have high p-values ($p > 0.05$), indicating weak or non-significant correlations, meaning observed trends may not be statistically robust. The closest to significance is Health

($p = 0.1009$), suggesting it may warrant further investigation for potential emerging trends.

Focusing instead on the behaviour of firms in the context of technological awareness, what emerges is that several specialisation areas exhibit statistically significant ($p < 0.05$), and positive correlations ($p > 0.5$), such as Aerospace, Energy & Environment, Blue Economy, Agri-food, and Design Creativity, supporting evidence of association.

In conclusion, the correlation analyses yield the following general findings: correlations at the regional level remain consistently strong across both transitions, underscoring the presence of structured investment behaviours. By contrast, sector-specific correlations appear less pronounced, with statistically significant relationships emerging solely within the domain of the digital transition. These findings underscore the need to address critical gaps through the implementation of targeted innovation policies.

3. Cluster analysis

This section presents the results of a cluster analysis aimed at classifying Italian regions and Smart Specialisation Strategy (S3) domains according to firms' behaviours in the same two strategic dimensions: Environmental Accountability (EA) and Technological Awareness (TA).

The analysis uses data from the 2022 ISTAT Permanent Census of Enterprises, including detailed information on environmental practices (e.g., certifications, energy efficiency, reporting) and digital adoption (e.g., cloud computing, e-commerce, ICT infrastructure).

To ensure comparability across variables, all indicators were standardised (z-scores). Outliers were removed using the interquartile range (IQR) method. Clustering was performed via the k-means algorithm (Lloyd, 1957; MacQueen, 1967), chosen for its scalability and interpretability despite its assumption of spherical and similarly sized clusters, which may not always perfectly capture heterogeneous group structures. The silhouette coefficient (Hennig, 2015; Rousseeuw, 1987) was used to evaluate clustering quality and determine the optimal number of clusters. Values around 0.4 indicate moderate separation, while values above 0.7 suggest well-defined clusters.

The cluster analysis based on the EA z-index ($K = 3$; silhouette = 0.426) yielded three regional profiles (Table 2).

Cluster 0 – *Moderate-Low environmental investment*: Groups Southern and peripheral regions (e.g., Sicilia, Lazio, Liguria, Sardegna, Molise). These areas show low engagement in formalised environmental practices (12% of firms report

sustainability) and limited environmental investments (18%). The mean EA index is 3.0, below the national average.

Cluster 1 – *High-Invest*: Comprises more industrialised and innovation-driven regions (e.g., Lombardia, Emilia-Romagna, Veneto). Around 40% of firms adopt environmental reporting, and 45% invest in environmental practices. The mean index is 3.6, reflecting a more integrated approach.

Cluster 2 – *Benchmark Performer*: Includes only the Autonomous Province of Trento, with 68% of firms engaging in disclosure and an EA index of 8.1, more than twice the national mean, driven by strong governance and innovation ecosystems. Since this cluster contains a single case, it should be interpreted as a peculiar outlier profile rather than a stable cluster.

Table 2 – *Regional clusters by Environmental Accountability (EA): composition and average index.*

Cluster	Profile	Size	Regions
0	Moderate–Low environmental investment	10	Bolzano, Friuli-Venezia Giulia, Lazio, Liguria, Marche, Molise, Sardegna, Sicilia, Toscana, Valle d'Aosta
1	High environmental investment	10	Abruzzo, Basilicata, Calabria, Campania, Emilia-Romagna, Lombardia, Piemonte, Puglia, Umbria, Veneto
2	Very high environmental investment	1	Auton. Province of Trento

The cluster analysis based on the TA z-index ($K = 2$; silhouette = 0.453) identified two regional profiles (Table 3).

Cluster 0 – *Mixed-Advanced Adoption* includes a heterogeneous group of regions, some of which show relatively strong digital infrastructures and widespread use of enabling technologies—such as Lombardia, Emilia-Romagna, Trentino-Alto Adige (Trento, Bolzano) and Friuli-Venezia Giulia. In these areas, over 50% of firms report adoption of cloud services, data analytics, and e-commerce platforms, supported by broadband coverage exceeding 85%. However, the same cluster also comprises regions with less mature digital ecosystems, such as Molise or Sicilia, highlighting intra-cluster heterogeneity.

Cluster 1 – *Lagging Digital Integration* comprises regions like Lazio, Campania, Abruzzo, and Sardegna, where fewer than 20% of firms implement advanced digital tools and broadband penetration is below 60%. Structural weaknesses—such as insufficient infrastructure and skills shortages—continue to hinder their digital transformation.

Table 3 – *Regional clusters by Technological Awareness (TA): composition.*

Cluster	Profile	Size	Regions
0	Mixed-advanced digital adoption	11	Basilicata; Bolzano; Calabria; Emilia-Romagna; Friuli-VG; Lombardia; Marche; Molise; Sicilia; Trento; Veneto
1	Lagging digital integration	9	Abruzzo; Campania; Lazio; Piemonte; Puglia; Sardegna; Toscana; Umbria; Valle d'Aosta

The cluster analysis based on the EA z-index applied to the 12 Smart Specialisation Strategy (S3) domains ($K=3$; silhouette=0.551) identified three distinct sectoral profiles (Table 4).

Table 4 – *Sectoral clusters by Environmental Accountability (EA): composition.*

Cluster	Profile	Size	S3 Specialisation Domains
0	Environmental Front-Runners	2	Design Creativity and Made in Italy; Health
1	Transitioning Domains	9	Aerospace; Blue Economy; Energy & Environment; Green Chemistry; Smart Manufacturing; Sustainable Mobility; Technologies for Cultural Heritage; Technologies for Living Environments; Secure and Inclusive Smart Communities
2	Environmental Laggard	1	Agri-food

Cluster 0 – *Environmental Front-Runners* includes the *Design Creativity and Made in Italy*, and *Health* domains. Over 55% of firms in these sectors adopt environmental certifications or implement energy efficiency solutions. The positive performance reflects a mix of consumer demand for transparency, regulatory alignment, and, in the case of Health, compliance with strict environmental and safety standards. These labels are intended as analytical descriptions of statistical profiles, not normative judgements. In these domains, environmental accountability is perceived not only as a compliance requirement but also as a reputational and competitive lever.

Cluster 1 – *Transitioning Domains* brings together sectors such as *Blue Economy*, *Green Chemistry*, *Smart Manufacturing*, and *Sustainable Mobility*. In this group, around 28% of firms report structured environmental practices. While these domains show engagement with sustainability principles, the level of diffusion is uneven, and performance is highly dependent on the maturity of local ecosystems, access to innovation resources, and sector-specific incentives.

Cluster 2 – *Environmental Laggard* consists solely of the *Agri-food* domain, which records the lowest levels of environmental commitment among all specialisations. Only 10% of firms adopt formal sustainability practices. Despite

significant potential for green innovation, e.g., through precision farming or regenerative practice, sectoral fragmentation, low capitalisation, and regulatory complexity continue to limit systemic progress.

The cluster analysis based on the TA z-index ($K = 2$; silhouette = 0.729) applied to the 12 S3 domains revealed two distinct digital maturity profiles, presented in Table 5.

Cluster 0 – *Digitally Progressive Domains* comprises eight domains, including *Aerospace*, *Smart Manufacturing*, *Sustainable Mobility*, and *Green Chemistr*, where over 52% of firms have adopted at least one advanced digital technology (e.g., cloud platforms, data analytics and automation systems). These sectors benefit from dynamic innovation ecosystems, integration into digital value chains, and public–private partnerships that support technological diffusion. Their maturity reflects both internal capabilities and favourable contextual factors, such as infrastructure, R&D networks, and access to skills.

Cluster 1 – *Digitally Lagging Domains* includes *Design Creativity and Made in Italy*, *Energy & Environment*, and *Health*. In these domains, fewer than 20% of firms report the use of enabling technologies. Despite their strategic relevance, their innovation models remain anchored to traditional processes, and digital integration is hindered by limited internal resources, infrastructure deficits, and low exposure to digital ecosystems. These findings indicate that sectoral digital gaps are structural and require targeted interventions, not only firm-level incentives. These weaknesses restrict their participation in Industry 4.0 trajectories and reduce their competitiveness in high-tech markets.

Table 5 – Sectoral clusters by Technological Awareness (TA): composition.

Cluster	Profile	Size	S3 Specialisation Domains
0	Digitally Progressive Domains	8	Aerospace; Blue Economy; Green Chemistry; Smart Manufacturing; Secure and Inclusive Smart Communities; Sustainable Mobility; Technologies for Cultural Heritage; Technologies for Living Environments
1	Digitally Lagging Domains	3	Design Creativity and Made in Italy; Energy & Environment; Health

4. Discussion of results and policy implications

The analysis reveals a marked territorial divide: Southern regions lag significantly in both environmental accountability and digital adoption, while North-Central areas exhibit a stronger strategic orientation, as reflected in higher EA and TA scores (Barca, McCann & Rodríguez-Pose, 2012; ISTAT, 2022). The Autonomous Province of Trento emerges as a benchmark case, benefiting from

proactive policies—co-financing, incentives, and public–private partnerships—that have fostered the widespread adoption of sustainable and digital practices (Foray, David & Hall, 2009).

At the sectoral level, domains such as “Design and Health” and others characterised by green-digital synergies stand out for their integration of technologies, supported by favourable regulatory environments and collaborative innovation networks (Pisano & Shih, 2012; OECD, 2021). Conversely, domains such as Agri-food show limited penetration of both sustainability and digital solutions, with below 20% of firms using e-commerce or cloud services—signalling the need for targeted capacity-building and incentive schemes (European Commission, 2021).

These findings point to the urgency of place-based policies: fiscal incentives for certifications (e.g., ISO 14001), broadband infrastructure expansion, and digital training programmes—leveraging NextGenerationEU and 2021–2027 EU Cohesion Policy resources (European Commission, 2020). Equally crucial are sectoral interventions for traditional industries—such as agri-food or construction—to stimulate digital uptake and green transitions (Barca et al., 2012).

The robustness of the cluster analysis—ensured through z-score standardisation, IQR-based outlier removal, and silhouette validation—offers a solid empirical foundation to inform Smart Specialisation Strategies and monitor behavioural change across territories and sectors (Rousseeuw, 1987). In addition, the correlation analyses yield two overarching insights: regional-level correlations remain consistently strong across both transitions, suggesting the presence of structured investment behaviours and territorially embedded innovation dynamics. By contrast, sector-specific correlations are comparatively weaker, with statistically significant relationships emerging only in the context of the digital transition. These findings underscore the need to address critical gaps through the implementation of targeted innovation policies, particularly in sectors where green and digital adoption remains limited.

5. Conclusions and future research directions

This study confirms the existence of well-differentiated territorial and sectoral profiles in green and digital investment, enabled by a rigorous correlation and clustering methodology. The North–South divide remains pronounced, with southern regions trailing in both strategic dimensions (ISTAT, 2022), while Trento exemplifies how institutional quality can accelerate convergence. These results strengthen the evidence that regional innovation ecosystems play a decisive role in shaping firms’ environmental accountability and technological awareness (Foray et al., 2009; OECD, 2021). Southern regions demonstrate structural weaknesses related to limited digital infrastructure and reduced access to innovation networks, while

North-Central regions benefit from stronger public–private partnerships and targeted Smart Specialisation policies (European Commission, 2021).

Sectoral insights highlight both frontrunners (e.g., Health, Design) and laggards (e.g., Agri-food), underscoring the need for tailored policies—ranging from ICT grants to sustainability incentives—to close structural gaps and foster ecosystem maturity (Foray et al., 2009; OECD, 2021).

At the policy level, our findings call for place-based strategies tailored to regional strengths and weaknesses. Priority actions should include fiscal incentives for adopting environmental certifications, investments in broadband infrastructure, and capacity-building programmes to strengthen SMEs' integration within innovation ecosystems (European Commission, 2020; Foray et al., 2009).

A promising avenue for future research is longitudinal monitoring of cluster transitions using forthcoming business census waves. This would enable assessment of policy effectiveness and the identification of upward trajectories in green and digital maturity. Integrating predictive modelling techniques with the ISTAT datasets could allow policymakers to identify regions and sectors with the highest potential for transition and optimise the allocation of European funds under the Smart Specialisation Strategy framework (OECD, 2021; ISTAT, 2023).

From a methodological perspective, alternative clustering techniques, such as hierarchical models or latent class analysis, offer the potential to uncover latent subgroup structures that may be overlooked by standard k-means algorithms (Hennig, 2015; Kaufman & Rousseeuw, 1990). Moreover, incorporating explanatory variables such as governance quality, educational attainment, and sector-specific employment dynamics could significantly enrich the analysis by shedding light on the underlying enabling factors.

Finally, the integration of predictive models using machine learning may support forward-looking policymaking, identifying regions or sectors with the highest potential for transition. This would help optimise resource allocation and strengthen the strategic relevance of the Smart Specialisation framework, and support European tools and policies, such as the Multiannual Financial Framework – MFF 2028-2034 currently being defined, to design a balanced relationship between territorial equity and economic competitiveness.

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SMART SURVEYS AND THE DIGITAL DIVIDE IN ITALY: THE INFLUENCE OF SOCIO-DEMOGRAPHIC CHARACTERISTICS ON THE SMART TASKS' PERFORMANCE¹

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Barbara Maria Rosa Lorè, Alessandra Nuccitelli

Abstract. Smart surveys combine data provided by the respondent, either in a traditional way via a web questionnaire or through smart instruments (active mode), with data collected by sensors embedded in smart devices (passive mode). This approach reduces the burden on respondents and improves the quality and timeliness of the results, especially in complex surveys. Within the framework of the European Statistical System, Istat participated in the Smart Surveys Implementation project (2023-2025), in partnership with other national statistical institutes and some European universities. As part of the project, an experimental survey named "New Ways of Measuring" was conducted in Italy, the Netherlands, and Slovenia in a harmonised manner with the aim of assessing the respondents' attitudes towards the new ways of collecting data in smart surveys.

The purpose of this study is to investigate how socio-demographic characteristics influence the performance of smart tasks in the Italian context. The findings provide valuable insights into the relationship between innovations in survey techniques and digital inequality.

1. Introduction

Over the past decade, official statistics have undergone a profound transformation driven by digitalisation and the increasing use of smart devices and mobile technologies. These developments have paved the way for innovative data collection methods that go beyond traditional questionnaire-based surveys. Among these, smart surveys, which integrate self-reported data with sensor-generated information, have emerged as a promising tool. In this approach, respondents may be asked not only to answer questions via web questionnaires (active data), but also to consent to the passive collection of behavioural or contextual information, such as geolocation, physical activity, or purchase transactions recorded through their smartphones or wearable devices (Struminskaya *et al.*, 2020). By leveraging both active and passive data sources, smart surveys aim to reduce the response burden, improve the timeliness of data collection, and enhance its accuracy, particularly in domains where

¹ This work is the result of the joint effort by the authors. However the Sections can be attributed as follows: Sections 1 and 4 to Barbara M.R. Lorè, Section 2 to Monica Perez, Sections 3 and 6 to Alessandra Nuccitelli, Section 5 to Barbara D'Amen.

continuous or real-time measurement is valuable. However, the implementation of smart surveys introduces new methodological and ethical challenges. One of the most pressing issues is the digital divide, a multidimensional concept encompassing disparities not only in the access to technology, but also in skills, usage patterns, and trust in digital environments (Mossberger *et al.*, 2003). In the context of smart surveys, this divide can have a significant impact on the feasibility of data collection and the representativeness of final data. Individuals with lower digital literacy or fewer technological resources may be less likely to engage with smart tasks or grant consent to data sharing.

Research has shown that socio-demographic characteristics – especially age, education, income, and geographical area – are significant predictors of digital competence and device usage (Van Deursen and Van Dijk, 2014). These factors are also associated with varying levels of trust in digital systems – including concerns about data privacy and security – that may further hinder participation in smart data collection (Keusch *et al.*, 2023). Therefore, it is essential to understand how these characteristics affect smart task performance in order to design equitable and effective data collection strategies and to mitigate the non-response bias introduced by the use of the new survey tools.

The present study investigates how socio-demographic characteristics influence respondents' propensity to perform smart tasks using data from an experimental survey named New Ways of Measuring (NWM). This survey was carried out in Italy by the Italian National Statistical Institute (Istat) as part of the Smart Surveys Implementation (SSI) project (2023-2025), funded by Eurostat².

This paper is organised as follows. Section 2 introduces some aspects of the NWM survey, with a focus on the questionnaires and the smart tasks that respondents were asked to complete. Section 3 reports the main findings from a logistic regression model, identifying the factors that mostly affect the propensity to perform these tasks. In Section 4, some descriptive analyses investigate the issues of the digital vulnerability and unequal engagement in smart actions, while in Section 5 a qualitative analysis of the open-ended responses explores the reasons why respondents did not perform the smart tasks. Finally, some conclusions are drawn (Section 6).

² Grant Agreement Project n. 101119594 - SSI; Call topic: SMP-ESS-2022-TrustedSmartSurveys-H7-6257.

2. The New Ways of Measuring survey

Under the European Statistical System (ESS), Istat participated in the SSI project (2023-2025) in partnership with other National Statistical Institutes and some European universities. The project aimed to test and implement smart solutions for the collection of data relating to the Time Use Survey and Household Budget Survey in order to relieve the statistical burden deriving from the requirement for respondents to keep detailed diaries. As part of the project, the NWM survey was conducted in Italy, the Netherlands, and Slovenia in a harmonised manner with the aim of assessing the respondents' attitudes towards the new ways of collecting data in smart surveys (Lunardelli *et al.*, 2024). The Italian survey was carried out in early 2024 on a sample of 3,667 individuals aged 18 or older, randomly selected from the population registers of 131 municipalities. Each person was asked to complete two questionnaires sequentially: first a paper NWM-General questionnaire and then an online NWM-Smart questionnaire (henceforth, NWM-General and NWM-Smart will be abbreviated to NWM-G and NWM-S, respectively).

The NWM-G questionnaire was designed to reach also those who do not have smart devices and/or have limited skills in using them. The aim of this questionnaire was to find out how individuals would like to be invited to participate in a statistical survey, the mode and the device through which they would prefer to participate, their habits regarding the use of smart devices (smartphones or tablets), and their opinions about the use of smart devices for data collection. Individuals were also asked about their hypothetical willingness to perform smart tasks, their concerns regarding the theft or misuse of data provided via smart devices, and the measures they consider essential to guarantee the security of their data.

The NWM-S questionnaire, on the other hand, was designed to explore the respondents' actual willingness to share data via smart devices. This questionnaire required the performance of four smart tasks:

- sharing geolocation
- sharing step count
- taking and sharing photos of shopping receipts
- taking and sharing photos of energy meters.

For the NWM-S questionnaire, individuals were advised to use smartphones/tablets (rather than PCs, notebooks, or laptops), as these devices have built-in features (such as webcams) that allow some of the requested actions to be performed more immediately.

The response rate was 68.9% and 25.3% for the NWM-G and NWM-S questionnaires, respectively.

3. The propensity to perform smart tasks

For the respondents to both the NWM-G and NWM-S questionnaires, a logistic regression model is used to analyse the propensity to perform smart tasks. The aim is to investigate the relationship between two exhaustive, non-overlapping categories – “No smart tasks performed” and “At least one smart task performed” – and a set of explanatory variables, either administrative or collected through the NMW-G questionnaire.

A main-effects model is considered, with “No smart tasks performed” taken as the baseline category of the response variable (Hosmer *et al.*, 2012).

The explanatory variables included in the final model are as follows³:

- *Number of device types* (“0-1”; “2-3”; “> 3”)
- *Household income* per month, in euros (“< 1,900”; “1,900-3,500”; “> 3,500”)
- *Concerns about data security*, i.e., concern that the data collected by Istat through smart devices may be stolen or misused by others than Istat (“No”, “Yes”)
- *Geographical area* (“North”; “Centre, South, and Islands”).

Other characteristics are excluded from the final model as they are not statistically significant ($p\text{-value} > 0.05$). In particular, several variables that have been identified as the most influential on the participation in the NMW-S survey – e.g., *Educational level*, *Age*, *Nationality*, *Household size*, *Number of inhabitants in the municipality of residence* – do not seem to be relevant for performing smart tasks.

Table 1 shows the Wald Chi-Square statistic with the associated p -value by explanatory variable (Columns 2 and 3). The ranking relating to the importance of each explanatory variable, as determined by a classification tree⁴, is also reported (Column 4). According to this ranking, *Number of device types* and *Household income* are the most influential factors among those considered.

Table 1 – *Wald Chi-Square statistics, p -value, and the ranking determined by the classification tree, by explanatory variable.*

Explanatory variable	Wald Chi-Square	p-value	Ranking
Number of device types	30.4	<0.0001	1
Household income	12.1	0.0024	2
Concerns about data security	8.3	0.0039	4
Geographical area	5.0	0.0258	3

Source: Survey on NWM – year 2024.

³ The explanatory variables are categorised on the basis of preliminary analyses of their association with the response variable, while also attempting to adopt a parsimonious model.

⁴ The classification tree is generated by applying the HPSPLIT procedure of the SAS software, using the Entropy criterion to split the observations and the Cost-complexity pruning method to avoid overfitting (Sas Institute Inc., 2015).

Table 2 shows the maximum likelihood point estimates of the ORs and 95% Wald confidence intervals by regressor⁵.

The propensity to perform at least one smart task turns out to increase with both the number of types of devices (OR = 1.68 and 3.19 for “2-3” and “> 3”, respectively) and the household income (OR = 1.55 and 1.92 for “1,900-3,500” and “> 3,500”, respectively). Compared to the NWM-S respondents who did not engage in any of the smart actions, the smart tasks’ performers are much less concerned that the data collected through smart devices might be stolen or misused (OR = 1.83) and are more likely to reside in the North (OR = 1.40).

Table 2 – Estimated ORs and 95% Wald confidence intervals by regressor.

Explanatory variable	Contrast	Estimate	CL
Number of device types	2-3 vs 0-1	1.68	1.17-2.42
	> 3 vs 0-1	3.19	2.11-4.84
Household income	1,900-3,500 vs < 1,900	1.55	1.09-2.20
	> 3,500 vs < 1,900	1.92	1.31-2.80
Concerns about data security	No vs Yes	1.83	1.22-2.77
Geographical area	North vs Centre, South, and Islands	1.40	1.04-1.89

The reference level of each explanatory variable is in italics.

Source: Survey on NWM – year 2024

4. Digital vulnerability and unequal engagement in smart tasks

A digitally vulnerable subgroup of respondents to both the NWM-G and NWM-S questionnaires is identified on the basis of the characteristics found to be most associated with a lower probability of performing a smart task in the logistic regression model. This *digitally vulnerable subpopulation* includes individuals who reported at least one of the following: (i) using only one type of digital device or none at all; (ii) having a household income below €1,900 per month.

The descriptive analysis that follows compares this subgroup with the general population in terms of engagement with the four smart tasks asked in the NWM-S questionnaire. The aim is to understand to what extent digital disadvantage translates into reduced participation in these tasks and to explore which tasks are more affected by the disparities.

Approximately one in three of the respondents to both questionnaires meets the vulnerability criteria (31.1%). Digitally vulnerable respondents perform worse on all indicators of the digital divide: a lower percentage of users for each type of device,

⁵ The maximum likelihood estimates of the model parameters are obtained using the Fisher scoring algorithm.

a lower percentage of frequent users, and a lower level of perceived digital skills (Table 3). Almost two-thirds (63.8%) of vulnerable individuals did not complete any of the four tasks, compared to 52.1% of the total respondents. Only 13.0% of vulnerable individuals completed at least half of the tasks, while this share reaches 17.0% in the general population. These results suggest not only a lower propensity to participate but also a reduced capacity to sustain engagement across multiple tasks within the vulnerable subgroup.

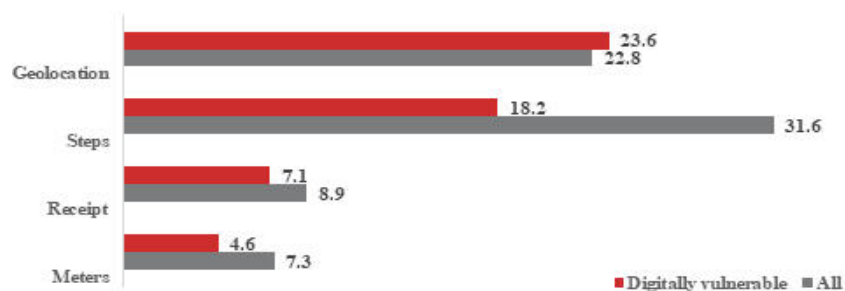
Table 3 – Digital divide indicators – All and digitally vulnerable respondents.

Digital divide indicators	All respondents	Vulnerable respondents
Average n. of devices	2.2	0.9
% of users by device:		
<i>Smartphone</i>	88.3	74.8
<i>Tablet</i>	41.1	4.0
<i>Tracker</i>	13.0	1.1
<i>Watch</i>	23.2	1.9
<i>Speaker</i>	23.9	2.2
<i>Electricity meter</i>	13.0	2.0
<i>Gas meter</i>	11.2	1.1
<i>Water meter</i>	6.0	0.6
<i>Air quality monitor</i>	3.9	0.4
% of smartphone daily users	86.6	76.8
Average skill level (1 to 5)	2.9	2.3
Average n. of tasks performed	0.7	0.5

Source: Survey on NWM – year 2024

The four tasks under consideration differ in terms of the tools and skills required for their completion, as well as the burden they impose on respondents. Consequently, the performance on the four tasks varies in relation to both the specifics of each task and the respondents' characteristics (Figure 1).

Figure 1 – Smart tasks' performance – All and digitally vulnerable respondents (% values).



Source: Survey on NWM – year 2024

Smart tasks also differ from each other depending on the effort required and the mode of interaction. While some rely on passive or background data sharing (*e.g.*, geolocation, step count), others require an active gesture from the respondent (*e.g.*, taking a picture). In the former case, the information is immediately available to the respondent, whereas in the latter an explicit action is required to retrieve it.

Table 4 shows the share of individuals who completed at least one passive and at least one active task, by group of respondents. This makes it possible to assess whether vulnerable individuals are more reluctant to perform one type of task than another. In general, there is a lower propensity for active tasks as a result of a higher burden, regardless of the category to which respondents belong. However, the participation is consistently lower within the vulnerable subgroup, with a more pronounced gap observed for passive tasks (-14.6 percentage points) than for active tasks (-6.8).

Table 4 – *Participation in passive and active tasks – All and digitally vulnerable respondents (% values).*

Task type	All respondents	Vulnerable respondents
≥ 1 passive	49.7	35.1
≥ 1 active	16.0	9.2

Source: Survey on NWM – year 2024

An important insight into digital engagement emerges when comparing respondents' *hypothetical willingness* to perform smart tasks with their *actual behaviour* during the online completion.

Table 5 displays the row percentages of individuals who effectively completed a task out of those who responded to a preliminary question on their hypothetical willingness, by task and group of respondents.

With reference to the general population, the discrepancy between intention and action is substantial across all tasks, with the smallest observed difference⁶ being for geolocation sharing (37.5 percentage points) and the largest for meter reading (85 percentage points).

The discrepancy is wider for the respondents who are digitally vulnerable, with differences ranging from 60.6% for the sharing of step counts to 94.8% for the uploading of receipts. In comparison with the general population, a higher proportion of individuals are unable to perform the tasks, whether due to a lack of tools or skills. This suggests that the process of consenting to and completing a smart task poses a

⁶ The difference is calculated as 100.0 minus the value at *Hypothetical willingness* = "Yes" and *Real performance* = "Shares" in Table 5.

distinct challenge that many vulnerable individuals are unable to overcome, even when they have previously expressed their intent.

Table 5 – *Real performance against hypothetical willingness to perform the smart tasks – All and digitally vulnerable respondents (row percentages).*

Hypothetical willingness	Real performance					
	All respondents			Vulnerable respondents		
	<i>Shares</i>	<i>Is not able to</i>	<i>Does not share</i>	<i>Shares</i>	<i>Is not able to</i>	<i>Does not share</i>
Share geolocation						
<i>Yes</i>	62.5	23.2	14.3	35.4	54.8	9.8
<i>Maybe</i>	38.7	35.5	25.8	54.4	26.7	19.0
<i>No</i>	16.9	62.9	20.2	36.2	31.7	32.1
<i>Does not know</i>	31.8	45.5	22.7	18.9	53.1	28.0
Share step count						
<i>Yes</i>	47.3	42.2	10.5	39.4	52.8	7.8
<i>Maybe</i>	42.3	54.6	3.1	18.2	76.5	5.3
<i>No</i>	19.5	67.9	12.6	8.4	77.7	13.9
<i>Does not know</i>	20.9	67.4	11.6	11.4	86.1	2.5
Share photos of shopping receipts						
<i>Yes</i>	18.1	65.1	16.9	5.2	75.2	19.6
<i>Maybe</i>	17.5	71.4	11.0	10.5	52.6	36.9
<i>No</i>	7.3	56.3	36.5	6.7	43.2	50.1
<i>Does not know</i>	9.4	56.6	34.0	6.8	37.0	56.1
Share photos of energy meters						
<i>Yes</i>	15.0	27.6	57.4	14.8	15.6	69.6
<i>Maybe</i>	4.7	26.9	68.4	0.0	21.0	79.0
<i>No</i>	4.5	15.8	79.8	1.7	9.0	89.3
<i>Does not know</i>	2.1	25.0	72.9	0.0	11.7	88.3

Source: Survey on NWM – year 2024

The combination of motivational readiness and structural constraints (e.g., unfamiliarity with device functions, non-possession of instruments, distrust) appears to generate a wider gap between stated and real participation.

The observed discrepancies between hypothetical and actual performance support the well-known distinction in behavioural research (Ajzen, 1991) between attitude and action. While attitudinal openness toward smart surveys may be relatively widespread, actual engagement might depend on factors that include: technical readiness, task comprehension, privacy and trust concerns, cognitive load and task fatigue.

5. Qualitative data analysis of open-ended responses on the reasons for not performing the smart tasks

The NMW-S questionnaire included four open-ended questions aimed at exploring the reasons why respondents do not perform specific smart tasks. The four open-ended responses, one for each smart task, are analysed using an open coding process (Strauss and Corbin, 1998), a method that allows for the identification and development of concepts and their dimensions directly from the data.

According to this bottom-up approach, codes are generated inductively and grouped into categories based on shared thematic elements. These categories are further aggregated into higher-order or main categories. The initial coding schemes, which include both main categories and emergent subcategories, are thoroughly reviewed in order to ensure a consistent interpretation of the responses' underlying meaning. The final coding schemes are then applied to the full set of responses, providing an evidence-based description of the findings.

As stated in the literature, open-ended questions have much higher non-response rates than other types of survey items (Millar and Dillman, 2012). Table 6 provides the percentage of non-response to the four NWM-S open-ended questions for all respondents and the vulnerable subgroup. As shown in the table, the rates by task are high and quite similar for both groups.

Table 6 – *Non-response rates to open-ended questions of NWM-S – All and digitally vulnerable respondents (% values).*

Smart task	All respondents	Vulnerable respondents
Share geolocation	53	57
Share steps count	98	99
Share photos of shopping receipts	68	66
Share photos of energy meters	48	48

Source: Survey on NWM – year 2024

Since the step count task has a high non-response rate in both groups, only the results related to the other tasks, which have a lower non-response rate, are examined in detail below. The first open-ended question was addressed to respondents who did not share their geolocation. The results indicate that the main reason for not performing this task is a lack of trust and information. This is particularly due to privacy concerns and a lack of clarity about the usefulness of the task. Moreover, these motivations are similarly prevalent in both disadvantaged and general groups (Table 7). Besides, approximately 1% of vulnerable respondents reported being unable to complete the smart task due to technical limitations – such as the lack of a suitable device – or personal difficulties that prevented them from proceeding.

Results related to the reasons for not sharing photos of shopping receipts and energy meters are presented in Tables 8 and 9, respectively.

Table 7 – Reasons for not sharing geolocation – All and digitally vulnerable respondents (% values).

Main category	Category	All respondents	Vulnerable respondents
Lack of trust and information	Privacy issues	36	32
Lack of trust and information	Unclear relevance	2	2
Lack of trust and information	Unclear purpose	2	1
Technical issues	No equipment	0	1
Personal issues	No knowledge	0	1
Miscellaneous	Other	6	6

Source: Survey on NWM – year 2024

Table 8 – Reasons for not taking and sharing photos of shopping receipts – All and digitally vulnerable respondents (% values).

Main category	Category	All respondents	Vulnerable respondents
Lack of trust and information	Privacy issues	19	19
Lack of trust and information	Unclear purpose	1	2
Lack of trust and information	Unclear relevance	2	1
Miscellaneous	Other	10	12

Source: Survey on NWM – year 2024

Table 9 – Reasons for not taking and sharing photos of energy meters – All and digitally vulnerable respondents (% values).

Main category	Category	All respondents	Vulnerable respondents
Lack of trust and information	Privacy issues	28	26
Lack of trust and information	Unclear purpose	2	3
Lack of trust and information	Unclear relevance	3	1
Technical issues	No access	5	5
Technical issues	No equipment	0	1
Personal issues	Too much effort	4	4
Personal issues	No time	2	3
Miscellaneous	Other	6	8
Miscellaneous	Irrelevant	1	1

Source: Survey on NWM – year 2024

As shown in Table 8, the reasons for not sharing a photo of the shopping receipt are primarily related to the main category “Lack of trust and information”, indicating a need for clearer communication on data privacy, purpose, and relevance. In contrast, the reasons for not sharing a photo of the energy meter are more diverse (Table 9). While a lack of trust and information is common to both categories of

respondents, technical issues and personal difficulties – often related to uncertainty about the data collection procedure – emerge specifically in the vulnerable subgroup.

6. Conclusions

This study provides insights for designing equitable and effective data collection strategies, as well as for mitigating the non-response bias introduced by the smart surveys in the Italian context.

The logistic model indicates that the respondents who have access to a wider range of devices and to greater financial resources within their households are more likely to engage in smart tasks, especially if they are not concerned that their data might be stolen or misused. It is worth noting, however, that socio-demographic characteristics affecting the online participation – such as educational level and age – turn out to be weak predictors of the smart tasks' performance.

Descriptive analyses highlight a considerable discrepancy between the stated willingness to engage in smart actions and the actual performance of such actions, particularly among the respondents who are digitally disadvantaged. Considering that the digitally vulnerable subgroup represents 31% of the total population, it is crucial to take the digital inequality into account when designing smart surveys in order to improve the participation of individuals and ensure the representativeness of the final data.

Open-ended responses reveal that a lack of trust and information, along with technical and personal issues, are the main reasons why respondents do not complete smart tasks. As it is challenging to act on the structural factors contributing to the digital divide, the most viable short-term strategy to enhance the implementation of smart surveys appears to be the fostering of trust in digital systems. The first step in achieving this objective is to address privacy and security concerns through a clear communication of the measures in place to protect personal information. Other key elements include transparency about data usage and the implementation of robust security protocols.

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THE REMAINDER AS A TOOL TO INCREASE RESPONSE RATE: THE ITALIAN PERMANENT CENSUSES OF ECONOMIC UNIT

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Abstract. The continuous declining response rate in the surveys conducted by the National Institute of Statistics is countered, in the first instance, with the application of a reminder strategy. But is this really the winning strategy? What is behind the sometimes-frantic rush to send a reminder?

What is the institute doing to optimise this path?

What other elements can interact to support the improvement of the response rate?

The aim of the paper is precisely to answer these questions by comparing the experiences of the major business surveys, i.e. the Permanent Censuses of Economic Units.

1. Introduction

The declining response rates in surveys conducted by the Italian National Institute of Statistics (Istat) is faced initially through the implementation of a reminder strategy. However, is this really the most effective approach? What underlies the urgency - at times bordering on haste - to send reminders? What measures is the Institute undertaking to optimise this process?

Which additional factors may interact to support the enhancement of response rates?

This work is part of a broader analytical initiative led by the Data Collection Directorate, aimed to identify the most effective levers to increase participation in the Institute's surveys.

We are fully aware that broadening the criteria for sanctionability or building a more active and targeted system for engaging enterprises during the data collection period is not sufficient to stimulate their participation. Our intention is firstly to analyse and address the challenges within our Directorate and subsequently extend the resulting initiatives to other structures within the Institute.

The objective of this paper is to explore these matters by comparing the operational experiences of the principal surveys on businesses, namely Permanent Censuses of Economic Units. To this end, it is important to consider the international context, in particular the tools used to increase response rate in business surveys. Section 2 briefly presents the international context.

Section 3 describes the methodological and operational characteristics of the 2022 Permanent Census of Economic Units (CPUE2022). Section 4 outlines several innovative features introduced in the implementation of CPUE2022. Section 5 examines the role of reminders in the survey process. Section 6 explains the main results of the proposed statistical model, while Section 7 summarises the key conclusions.

2. The international context

The progressive decrease in surveys participation doesn't concern exclusively the Italian context but represents an international issue.

Scheme 1 – *Tools used in the main National Statistical Institutes (NSI) context to increase participation in business surveys¹.*

NSI	Obligation to respond (business surveys)	Reminders use/ suggestion	Enforcement (sanctions/actions)	Transparency Response rates
K ONS	Yes, required by law for all the surveys conducted under the Statistics of Trade Act 1947	Sequence of planned reminders; online platforms	Enforcement conducted by Enforcement Unit in case of non-response	High: publishes monthly response rates dataset for MBS (production & services) and historical for ABS
S Census Bureau	Depending on federal and state laws	Sequence of reminders; e-mail; responsive follow-up, calls	Administrative Enforcement	High in technical documents and scientific articles: outcomes of contact experiments/reminders and performance reports
Canada Statistics Canada	Yes, required by law for most surveys	E-mail, SMS, calls; channels reported in the Frequently asked questions page and in Information for survey participants page	Compliance with legal requirements	Medium: public information about contact procedures and burden; publication of rates

¹ For further analysis refer to the following links:

<https://www.ons.gov.uk/surveys/informationforbusinesses/businesssurveys/annualbusinesssurvey>
<https://www.ons.gov.uk/economy/economicoutputandproductivity/output/datasets/currentsurveyresponse rates>

<https://www.statcan.gc.ca/en/survey/faq>

https://unece.org/sites/default/files/2023-07/DC2023_S1_Australia_Dsouza_et_al_Paper.pdf

<https://www.abs.gov.au/participate-survey/business-survey/quarterly-business-indicators-survey>

<https://www.abs.gov.au/participate-survey/business-reporting/quarterly-business-indicators-survey-abs-business-reporting>

<https://www.stats.govt.nz/help-with-surveys/>

<https://www.stats.govt.nz/help-with-surveys/business-survey-information/>

Scheme 1 (cont.) –Tools used in the main National Statistical Institutes (NSI) context to increase participation in business survey.

NSI	Obligation to respond (business surveys)	Reminders use/ suggestion	Enforcement (sanctions/actions)	Transparency Response rates
Australia ABS	Yes	Sequence of reminders: SMS; reminders, calls	Obligation.	Medium/high: FAQ pages and notes about the reminders; UNECE documents report the survey's results
New Zealand Stats NZ	Yes, required by law for most surveys	E-mail/letters and follow-up depending on response rate; multi-channel support	Obligation with compliance procedures; support channels	Medium: "Help with surveys" pages and "Business survey information" reporting general rules
Norway SSB	Yes, required by law for most business surveys	Internet Portal Altinn; e-mail/letters	Enforcement fines in compliance with the Statistics Act. regulations)	Medium: public informative report on obligations, deadlines and enforcement
Italy Istat	Yes: required by law for all the surveys conducted under Articles 7 and 11 of the legislative decree n. 322/1989	Certified Electronic Mail (PEC)/e-mail, letters; calls (outbound 1510) and standardised reminders, web page for respondents	Sanction procedures required by law, in compliance with the General Censuses Plan and related Acts	High: internal guidelines and manuals on quality/compliance; public documents on the General Censuses Plan

Note: The Scheme, produced by the authors, summarizing the information derived from the NSI websites listed in note1.

The figure highlights a shared model grounded in mandatory participation, multi-channel reminder systems, and enforcement actions, with countries differing mainly in how transparent they are and how they manage respondent contact. The UK and Italy distinguish themselves through more structured data systems and broader dissemination practices, whereas the US and Canada place stronger emphasis on supporting respondents throughout the process.

3. Permanent Censuses of Economic Units.

Istat has launched a strategic project for the transition from a decennial census framework to a triennial cycle, with the objective of collecting, producing, and disseminating up-to-date information on the structural and behavioural characteristics of Italian enterprises (Bellini, Filiberti, 2024). This shift, initiated with the first edition of the Permanent Census of Economic Units (CPUE) in 2018

and continued with the 2022 edition, responds to the growing need for comprehensive, detailed, and timely data in an economic context marked by rapid and unforeseen changes. The project aligns with the objectives set out in the General Census Plan (PGC), the planning document adopted by Istat to regulate the organisation of the Permanent Census of Economic Units².

The new General Census Plan (PGC) introduces innovative elements based on a close complementarity between the core business registers (such as the ASIA Register), satellite registers, and direct sample surveys. This approach aims to significantly reduce both the time required and the burden on respondents. Specifically, the Permanent Census seeks to:

- provide a statistical information framework on the structure of the economic system with high territorial granularity;
- deepen the knowledge of specific aspects of the production system through targeted information sets;
- expand, update, and improve the quality of statistical business registers through the integration of administrative data;
- promote innovation in data collection methods and the exchange of statistical information.

The survey, conducted every three years on a probabilistic sample drawn from the ASIA Register, is structured into two survey modules: the “long form” questionnaire for enterprises with 10 or more employees, and the “short form” for enterprises with fewer than 10 employees. This design choice was adopted to accommodate the diversity of business realities and to reduce the statistical burden, particularly for those survey units that may not possess all the requested information due to their structure.

From a contextual standpoint, the design of the 2022 questionnaire was heavily influenced by the shock of the pandemic, the geopolitical conflict in Ukraine, and the resulting energy crisis. These circumstances led to the development of a qualitative questionnaire for enterprises that took into account emerging information needs and the potential obsolescence of certain questions.

4. Innovative Aspects Introduced in the Implementation of CPUE2022

Given the internal organisational changes that occurred within the Institute on the eve of the census, the project was guided by the principle of activating agile and flexible organisational processes to ensure more effective and efficient management of human resources—always with the overarching goal of producing clear, comprehensive, and high-quality information on the entire Italian business system.

² In addition to the Census of Economic Units, the General Census Plan (PGC) also governs all other permanent censuses on population, non-profit institutions, and agriculture.

In CPUE 2022, the sampling design adopted was a one-stage stratified simple random sample. Stratification was based on economic activity, enterprise size in terms of number of employees, and geographic location at provincial level. The sample size consisted of 287,348 units, determined through a one-stage stratified simple random sampling design, with strata defined by combinations of structural variables used to identify the domains of interest: economic activity, average number of employees, and location of the enterprise (ISTAT, 2023).

The data collection phase was characterised by innovative solutions aimed to increase efficiency, reduce the duration of fieldwork, and minimise the burden on enterprises. These efforts were shaped by the redefined role of the territorial support network, which was significantly downsized in terms of dedicated personnel (from 150 to 15 coordinators compared to the previous edition). This led to a more agile and specialised structure, focused on resolving more complex thematic issues.

Passive (inbound) technical and non-specialist support—i.e., enterprises assistance requests — and active (outbound) support—i.e., follow-ups with non-responding enterprises — were both managed by the centralised Contact Centre.

The core of the organisational innovation lies in the structure of the official communication sent to enterprises to request their participation in the census: the information letter signed by the President of Istat³ that is the element that formally and legally involves the respondent—whether a citizen, enterprise, or institution—in the statistical survey. It is the act that transfers responsibility and the burden of response to the respondent; therefore, it must be clear, comprehensive, and not induce concern, as the ultimate goal is to encourage participation in the survey.

This is the focal point of the entire process, particularly for surveys in which respondents are liable to sanctions. In this regard, significant simplifications were introduced in the communication language and structure—the various components of the message were clearly and comprehensively highlighted— in order to achieve the primary objective: encouraging respondent participation.

To this end, the sample was segmented into seven groups based on enterprise size (number of employees), registration on the Statistical Business Portal due to previous participation in Istat surveys, questionnaire type (long form/short form), and, indirectly, sanctionability (derived from employees number). Furthermore, through the sample segmentation it has been possible to target the follow-up actions to specific subsamples, allowing for more effective identification of categories with

³ Given the response obligation and the application of sanctions for non-respondents—which, of course, applies only to enterprises with more than 20 employees—the information letter constitutes the first legal act supporting the sanctioning framework in the event of non-compliance. Through this letter, the President of Istat formally establishes that the enterprise is part of the survey and, therefore, subject to potential sanctioning procedures should it fail to respond, specifically for enterprise with 20 or more employees.

lower response propensity and prioritising reminder efforts accordingly. Moreover, this process enabled the Institute to optimise the information letter sending.

The information letters initiating the data collection were delivered via Certified Electronic Mail (PEC) as the primary channel, followed by registered mail with return receipt for enterprises without PEC but with at least 10 employees, and ordinary mail for the remaining enterprises (those with fewer than 10 employees)⁴.

The centralised Contact Centre supported enterprises through a dedicated toll-free number, a specific email inbox, and—for the first time—a dedicated certified email (PEC) address for those enterprises choosing to use a certified communication channel. The service was structured on two levels: the first level (Contact Centre operators) handled simple and standardised requests (e.g., system access, usability), supported by an extensive set of FAQs with predefined responses; the second level (Istat thematic experts) managed more complex or specific requests, particularly those related to the thematic content of the survey.

5. The reminders

For the first time in a business census, Istat chose an adaptive strategy to recover total non-response, integrating standard mass reminders with targeted follow-up actions⁵. This strategy is based on the awareness that the success of statistical surveys—in terms of participation—depends on the behaviour of the statistical units involved, and that non-response, if not uniformly distributed across estimation domains, can introduce bias into the final estimates⁶. The objective is to minimise such distortion—which cannot be measured even retrospectively—by aiming to ensure that all units reach a comparable response propensity.

During CPUE2022, four key phases can be identified that highlight the importance of reminders and how they influenced the progress of data collection.

As shown in Figure 1, the launch of the survey is, naturally, marked by the delivery of the information letters to enterprises. These letters not only inform them

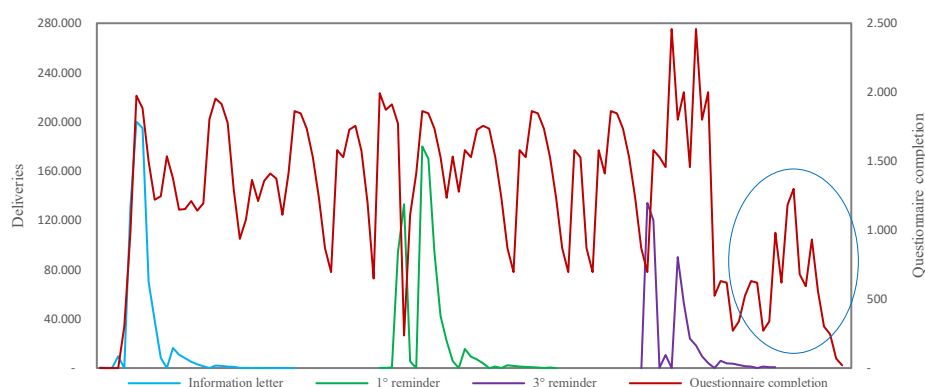
⁴ For enterprises with fewer than 10 employees that fall within the group of non-sanctionable units, it was not necessary to send the information letter via certified email (PEC) or registered mail with return receipt.

⁵ The adaptive strategy is closely linked to the concept of Total Survey Error (TSE), whereby the quality of information is the result of multiple sources of error, including nonresponse. The adoption of adaptive strategies is viewed as a methodological response to mitigate non-sampling error and improve the representativeness of estimates (Ceccarelli *et al.* 2021). In essence, targeted actions are directed at non-respondents based on pre-observed characteristics that define specific behavioural profiles with respect to total nonresponse (Bellini *et al.* 2019).

⁶ The lack of representativeness of the collected sample within the planned domains is one of the most critical issues.

of their inclusion in CPUE2022 but also provide the necessary credentials and instructions for accessing the portal and filling out the questionnaire⁷.

Figure 1 – *Trend in questionnaire completion as a function of the distribution of the information letter and reminders⁸.*



The questionnaire completion curve clearly shows—particularly in the final portion highlighted by the oval in the graph—the effect of the fourth reminder. Unlike the previous reminders, this one was not sent via mail (PEC and/or ordinary mail, depending on the segment), but was instead carried out through direct phone calls from the Contact Centre to a selected group of enterprises—specifically, the largest ones in terms of number of employees—that had not yet responded⁹.

6. The model and the empirical outcomes

To complete the analysis of response propensities and to identify the factors influencing the behaviour of statistical units in deciding whether or not to participate in the survey, we employed a logistic regression model to highlight the variables that improve the response rate—commonly used as a crude indicator of data collection quality and effectiveness.

⁷ The CPUE2022 was conducted entirely using the CAWI (Computer-Assisted Web Interviewing) mode.

⁸ To enhance the readability of the chart, the information related to the second reminder was intentionally omitted. However, such information has been included in the model presented below.

⁹ The calculation was performed by considering, overall, the peak in questionnaire completion during the reminder sending period and the minimum, which coincides with the completion rate immediately prior to the launch of the reminders themselves.

The model considers, individually, the main variables—appropriately grouped—that defined the seven segments into which the sample was divided, along with the variable indicating whether a reminder was sent. Specifically, we included as dichotomous explanatory variables: territorial distribution, whether the enterprise is subject to penalties for non-response, the type of questionnaire, enterprise size in terms of number of employees, the three economic activity sectors, and indicator variables for the four reminders.

The selected model is specified without an intercept. Table 1 reports the corresponding test statistics, which demonstrate the good fit achieved with the data.

Table 1 – *Goodness of fit parameters.*

Global null hypothesis test: BETA=0			
Test	Chi-squared	DF	Pr > Chi-squared
Likelihood ratio test	349029,218	13	<.0001
Score	248923,492	13	<.0001
Wald	35428,732	13	<.0001

Table 2 reports the odds ratios for the categories of the dichotomized variables (one for each category of the original variable) relative to the reference categories, which were excluded from the model. The reference profile is defined as follows:

- ⇒ Sanction = No,
- ⇒ Questionnaire type = Short form,
- ⇒ Territorial area = Islands,
- ⇒ Enterprise size = Up to 9 employees,
- ⇒ Economic activity = Services,
- ⇒ Reminder = First.

For each category of every variable, the odds ratio was calculated with respect to its corresponding reference category. A particularly noteworthy result observed during the CPUE2002 survey is that enterprises receiving a telephone reminder had a response probability three times higher than those who received only the first reminder. The odds ratios for the second and third reminders, also relative to the first, indicate a response probability approximately one and a half times greater.

From an operational standpoint, these findings highlight the effectiveness of a targeted reminder strategy compared to a blanket reminder approach.

The odds ratios also reveal interesting patterns regarding enterprise size in terms of employees number. Specifically, the odds ratios increase with enterprise size, with the largest firms showing a response probability nearly six times higher than the smallest ones. This likely reflects differences in organisational capacity and familiarity with responding to Istat surveys.

A separate consideration is warranted for the variable indicating whether an enterprise is subject to sanctions. Usually, large enterprises that have previously participated in other Istat surveys are aware in advance of potential penalties for non-response

Table 2 – Odds Ratio.

Variabile	Comparison between categories	ODS RATIO
Sanction	Yes vs No	1.21
Questionnaire type	Long form vs Short form	0.63
Geographical area	North West vs Islands	1.01
	Nord East vs Islands	1.12
	Centre vs Islands	1.43
	South vs Islands	1.37
Enterprise size	10 to 49 / Up to 9	3.51
	50 to 249 / Up to 9	4.25
	250 and more / Up to 9	5.83
Economic activity	Industry vs Services	2.98
	Constructions vs Services	3.23
Reminder	Second vs First	1.49
	Third vs First	1.48
	Fourth vs First	3.08

The label “subject to sanction,” in addition to verifying elements of objectivity, is often unknown to the enterprise, which may decide whether to respond without considering the risk of incurring penalties. In fact, the probability of response among enterprises that meet the criteria for sanctionability is approximately 1.2 times higher than that of enterprises not subject to sanctions in the event of non-response. These results suggest that the sanction serves to encourage enterprises to respond, but it plays only the role assigned to it by the National Statistical Plan: the sanction reinforces the obligation to respond that applies to every citizen, enterprise, or institution required to participate in statistical surveys included in the plan.

Table 3 shows the probability of responding to the questionnaire as a function of the characteristics of the enterprises participating in the census, always taking the baseline profile described in the previous paragraph as a reference.

There are important insights that emerge from the analysis of this table. Being merely subject to sanction, in addition to the baseline profile, increases the probability of response only marginally. Enterprises that received a phone call from the Contact Centre as a fourth reminder, in fact, show a response probability of 0.9084.

The second and third reminders play a crucial role, raising the probability of response to approximately $p = 0.75$.

Table 3 - Response probability resulting from the combination of enterprise features.

<i>Parameter</i>	<i>$P(X/\beta_i)^{10}$</i>
Sanction → No	
Questionnaire type → Short form	
Geographical area → Islands	
Employees number → Up to 9	0.5000
Economic activity → Services	
Reminder → First	
Sanction → Yes	0.5485
Type of questionnaire → Long form	0.3665
Geographical area → North West	0.5592
Geographical area → North East	0.6151
Geographical area → Centre	0.6635
Geographical area → South	0.6331
Employees number → 10 to 49	0.7781
Employees number → 50 to 249	0.8095
Employees number → 250 and more	0.8892
Economic Activity → Industry	0.7484
Economic Activity → Constructions	0.7633
Reminder → Second	0.7466
Reminder → Third	0.7414
Reminder → Fourth	0.9084

Enterprises required to complete a long-form questionnaire are understandably not encouraged by the additional workload involved in completing the entire survey; the probability of response decreases significantly ($p=0.3663$). As already highlighted in the odds ratio analysis, a very long questionnaire can act as a deterrent, especially for enterprises that access the portal and, upon seeing the questionnaire's length, decide to abandon it rather than continue (Binci *et al*, 2025). However, in this case, the analysis cannot be conducted simply by including one parameter at a time, because - due to the survey design - a small enterprise will never be required to complete a long-form questionnaire. For enterprises with more than 250 employees, which are required to respond using the long-form questionnaire, the probability of response is $p=0.82227$. If these enterprises receive the fourth reminder by phone by the Contact Centre, reserved only for larger enterprises, the probability of response rises to $p=0.9787$, making response almost certain. Only those who have firmly

¹⁰ A response probability of 0.5 results from the combination of variables that define the baseline profile: Sanction = No; Questionnaire type = Short; Geographical area = Islands; Employees number = up to 9; Economic activity = Services; Reminder = First.

decided not to respond—regardless of any consequences, including the risk of a sanction—ultimately fail to do so.

7. Conclusion

As part of a series of studies conducted by Data Collection Directorate over the years, the approach presented in this work aims to identify key factors that can enhance the probability of survey response. Working with and analysing the outcomes of a large and demanding survey such as the Permanent Census of Economic Units provides us with the statistical power necessary to conduct consistent and robust analyses. This, in turn, allows us to apply the empirical findings to other business surveys as well.

With regard to the analysis, we observed that the effectiveness of reminders is also confirmed by the logistic model. However, it is the fourth reminder - addressed to a limited group of enterprises economically significant and still hesitant to participate, that proves to be particularly impactful.

The factors that emerged are clear and provide both the scale and direction of the actions needed to achieve higher participation rates. The issue must be addressed from multiple angles:

- **Communication.** Effective and timely communication is essential to inform, engage, and motivate enterprises to participate, for this reason it should be tailored to the target audience. The purpose and the importance of the survey should be clearly explained to reduce uncertainty or perceived burden.
- **Burden reduction.** This involves simplifying and shortening questionnaires through greater harmonisation between the definitions used in European Regulations and those adopted nationally for administrative purposes.
- **Use of administrative data.** Leveraging administrative data as a partial or even full substitute for specific questionnaire items - or, in some cases, for entire surveys - can significantly reduce response burden and improve efficiency.
- **Returning useful information to enterprises.** Providing enterprises with feedback and insights that are relevant to their specific economic sector can enhance engagement and reinforce the value of participation in statistical surveys. Let us not forget that enterprises operate for profit, not out of charity. Providing them with data derived from multiple sources - not only from the specific survey editions in which they are asked to participate - is a practical, low-cost, and effective way to directly convey the importance of their contribution to statistical information, which constitutes a public good for the entire country.

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MONITORING PROCESS AND NON-SAMPLING ERRORS CONTROL IN THE IT-LFS SAMPLE SURVEY¹

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Abstract. This study presents strategies to minimise non-sampling errors in the IT Labour Force Survey. Emphasis is placed on the rigorous monitoring of interviews and processing data to ensure the reliability and accuracy of the collected information. Ongoing data analysis is conducted to promptly identify and address inconsistencies or biases, thereby enhancing data quality. In the context of the LFS, this takes on a very high value due to the complexity of the defining framework and the breadth of the concepts involved.

Several strategies are developed to ensure these objectives: i) instructional notes and ad hoc training sessions are systematically implemented to enhance the proficiency of interviewers and ensure standardised data collection procedures; ii) real-time remote monitoring of CATI interviews: listening to the conversation between the interviewer and respondent, as well as viewing the interviewer's screen in real-time, through remote tools; iii) on-site monitoring: ISTAT staff periodically visit the interview sites to observe interviews, ensuring adherence to quality standards directly; iv) post-interview monitoring and data analysis to evaluate the logical flow of the questionnaire as well as the consistency of the collected information with the data time series.

To assess the impact of interviewers on the quality of survey results, a synthetic indicator was developed to highlight areas significantly influenced by interviewer effects (as measured by the intraclass correlation coefficient), support corrective measures through evaluations at the individual-interviewer level, and plan targeted training activities.

These strategies help identify and correct potential sources of non-sampling error in relevant process parameters and ensure a thorough evaluation of both methodological and content-related aspects of the interviews, enabling timely interventions when necessary.

1. Monitoring process and non-sampling error control in the IT-LFS sample survey

The work presents strategies adopted to identify and minimise non-sampling errors in the IT Labour Force Survey during and following the transition to the new

¹ For research articles with several authors, a short sentence specifying their individual contributions can be provided here. The affiliations and contacts of the authors should NOT be reported here, but at the bottom of the last page.

companies conducting field interviews using CAPI and CATI techniques. The outsourcing of CAPI and CATI interview services to new providers was conducted through a public procurement process, in accordance with the Public Contracts Code, which governs the awarding and management of public tenders in Italy. The change involved implementing an electronic questionnaire, establishing new procedures and training interviewers.

Non-sampling errors encompass all sources of error that are independent of the sampling process. They can occur at any stage of the survey process and are primarily associated with data collection and processing. They arise from multiple factors (inaccurate respondent-reported data and missing observations mainly due to misleading definitions and concepts, inadequate frames, unsatisfactory questionnaires, defective data collection methods, tabulation and coding, incomplete coverage of sample units, etc.). Non-sampling errors can be categorised into two distinct types: random errors and systematic errors. The former are stochastic variations whose aggregate effects tend to neutralise when the sample size is sufficiently large. Systematic errors are directionally consistent, accumulate across the dataset and introduce bias into the results. They represent the primary challenge in ensuring the quality of survey data. Non-sampling errors can be further divided into errors of observation and errors of non-observation. The first category encompasses measurement inaccuracies stemming from various sources, including the method of data collection, interviewer influences, deficiencies in the measurement instrument (i.e., questionnaire deficiencies), respondent-related factors, post-survey data processing, and alteration of reported data. These errors introduce potential bias into the collected data and require methodological controls to mitigate their impact, as they involve differences between reported/recorded values and the “true” or underlying value. Errors of non-observation include coverage and nonresponse errors.

Some conditions remained unchanged when responsibility for field data collection was transferred to new companies. Therefore, our analysis has focused on specific types of error (Table 1). For example, we know that errors could not be found in misleading definitions and concepts, unsatisfactory questionnaires, tabulation, and coding, since these aspects remained stable and were, in some cases, governed by automatic procedures that were under the control of ISTAT. Also, the questionnaire includes internal consistency checks, and the collected data are verified for consistency and coherence. The strategies adopted to minimise non-sampling errors in the IT-LFS only address some error types.

Concerning observation errors, we did not consider specification errors, which occur “when the concept implied by the survey question differs from the concept that should be measured in the survey”. This is because there has been no change to the conceptual and technical framework with the new companies. At the same time,

we did not account for processing errors that occur after data collection and during processing, as the way data are recorded, coded, stored, or analysed remains unchanged. We consider the situation stable compared to the past (e.g., software bugs in data processing, mistakes in data transformation or aggregation, etc.).

Table 1 - *Types of non-sampling errors identified and monitored, and actions taken.*

Types	Sub-types	Error occurrence	Monitoring carried out	Action
Coverage errors: omissions (undercoverage), erroneous inclusions and duplications (overcoverage), and misclassifications of units in the survey frame		NO	-	-
Measurement error: difference between measured values and true values caused by inefficiencies in the questionnaire, interviewer, respondent or survey process	Poor questionnaire design: misleading or confusing questions	NO/Unchanged	-	-
	Interviewer bias: inexperienced or poorly trained interviewer or displaying incorrect or inappropriate behaviour	YES	YES	Remote and on-site listening, data analysis
	Respondent error: providing incorrect answers, having faulty recollections, exaggerating or downplaying events, and giving socially acceptable answers	NO/Unchanged	-	-
	Survey process problems: proxy responses, lack of control over survey procedures	YES	PARTIALLY	Data analysis
Non-response error: difference between the estimates that would have been obtained in the absence of non-response and those that are observed (or imputed)	Total nonresponse error: data for a sampling unit are missing (respondent was unavailable, temporarily absent, unable to participate, or refused to participate in the survey)	YES	YES	Remote and on-site listening, data analysis
	Partial nonresponse error: respondents provide incomplete information (the questions are difficult to understand or because they refuse or forget to answer a question)	Not relevant, mandatory answers	-	-

Table 1 (cont.) - *Types of non-sampling errors identified and monitored, and actions taken.*

Types	Sub-types	Error occurrence	Monitoring carried out	Action
Processing error: errors in the capture, coding, editing and tabulation of data, and in the assignment of survey weights	Coding errors: the same answer is coded differently by different coders due to poor training, incomplete instructions, variance in coder performance, data entry errors, or machine malfunction	YES	YES	Remote and on-site listening
	Data capture errors: data are not entered as they appear in the questionnaire	No/Unchanged + automated data capture method	-	-
	Errors in editing and imputation: poor quality of the original data or by its complex structure	No/Unchanges	-	-

Source: Our elaboration based on Statistics Canada, <https://www150.statcan.gc.ca/n1/edu/power-pouvoir/ch6/nse-enda/5214806-eng.htm>.

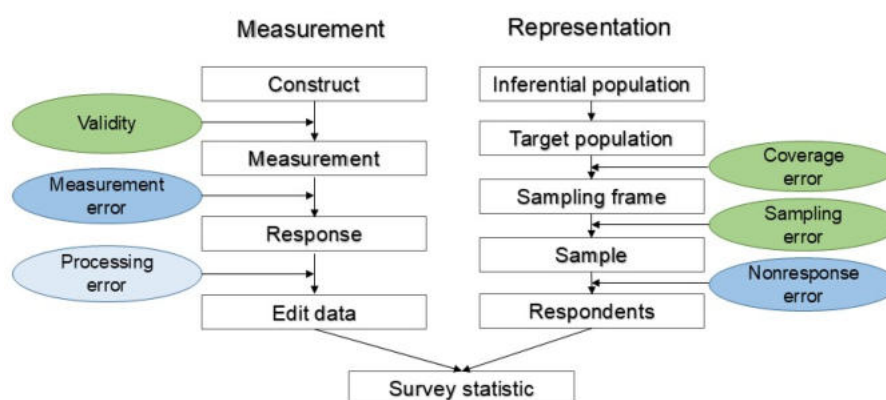
Instead, consistent efforts were made to analyse measurement error, the deviation between observed and true values. This occurs when data are inaccurately solicited, reported, received, or recorded, and is strictly influenced by the interviewer's behaviours. In this context, we also investigated the use of proxy interviews, given the interviewer's tendency to use proxies, which introduces additional uncertainty and classification errors.

We also checked for nonresponse errors, which occur when discrepancies arise between the survey statistics and the frame population. We focused on total nonresponse error (unit nonresponse) in particular, as it systematically affects all survey-based estimates. This is one of the most critical sources of error, as it can bias population estimates across subgroups.

The diagram in Figure 1 illustrates the key sources of error in statistical surveys, classified into *measurement errors* (e.g., response and validity issues, processing errors) and *representation errors* (e.g., coverage, sampling, and nonresponse errors). These errors can significantly affect the accuracy of survey estimates. To ensure reliable results, the aim is to minimise them through targeted methodologies and quality control measures. The strategies implemented involve a combination of methodological approaches and control tools. The primary focus is on measurement errors, followed by nonresponse errors, and to a lesser extent, processing errors

related to coding (Figure 1). These strategies have been developed and are continuously applied to prevent, identify, and address these challenges.

Figure 1 - Total survey error components linked to steps in the measurement and representational process.



Source: Groves et al., 2004.

On the controlling side, the following are carried out:

1. Real-time remote monitoring of CATI interviews: listening to the interviewer and respondent's conversation and viewing the interviewer's screen in real-time through remote tools. The activities are carried out in compliance with the relevant regulations on personal data protection (EU Regulation 2016/679, Legislative Decree 196/2003, and subsequent amendments).

2. On-site monitoring: ISTAT staff periodically visit the interview sites to observe interviews, ensuring adherence to quality standards directly.

3. Post-interview monitoring and data analysis involve evaluating the logical flow of the questionnaire and the consistency of the collected information with the available historical data.

4. To identify the interviewer effect on the quality of the survey results, a synthetic estimate has been developed to highlight issues affected by a significant interviewer effect (intraclass correlation coefficient), and to make corrections to the process, an evaluation at the level of the individual interviewer (the rate of interviewers with an estimate significantly different from 0).

To counter and resolve anomalies or misconduct, instructional notes, ad hoc training sessions, and debriefings are systematically implemented to enhance interviewers' proficiency and ensure standardised data collection procedures.

2. Quality monitoring strategies in interview conducting

To minimise non-sampling errors in the conduct of interviews for the IT-LFS, continuous quality monitoring is carried out regarding the administration of interviews and the management of contacts with sampled households to identify potential weaknesses and needs for targeted training feedback. The following operational strategies are implemented:

- a. Real-time remote monitoring of CATI interviews.
- b. On-site monitoring of CATI interviews at the interviewers' workplace.
- c. Interviews and contacts were monitored ex-post through quality indicator analysis related to interview conduction.

The monitoring activities allow verification of interview administration methods and contact management (e.g., question comprehension, interaction difficulties with respondents, proper questionnaire administration, appointment scheduling, household substitutions), with the goal of timely intervention in case of problems, including targeted training initiatives and, at the same time, to monitor and verify the occurrence of proxy interviews.

a. *Real-time remote monitoring of CATI*: Interviews is conducted to assess the quality of telephone interviews using tools that enable real-time listening and viewing of CATI-mode interviews via a VPN connection to the interviewers' operational headquarters. The activities include:

- live listening of the conversation between the interviewer and respondent, with prior notification to the interviewer;
- real-time screen viewing of the application used by the interviewer.

The activities aim to follow interviewers to detect erroneous behaviours (e.g., suggesting or anticipating answers, misleading response categories). A weekly monitoring plan is structured in a matrix organised by days and time slots to ensure a fair distribution of listening activities among ISTAT colleagues, daily monitoring of interviews, observing the same interviewer at different times, and accounting for variations in interview style throughout the day and the entire week.

The listening session includes descriptive evaluation, addressing aspects such as question reading, coding correctness, refusal management, empathy, etc., and synthetic evaluation, rated on a scale from "insufficient" to "excellent". Evaluations are stored in an interviewer assessment registry to track individual performance over time. The platform enables interviewer selection and focused monitoring of specific questionnaire sections, allowing targeted checks based on emerging needs, such as active/inactive interviewers, interview duration with significant deviations from the average/standard, below-average qualitative performance, and anomalies in quality indicators. These listening sessions help assess question comprehension, identify

difficulties with wording or question structure, and address them through appropriate training feedback.

The remote monitoring platform is technically reliable, easy to use independently, secure in data and communication protection with the authentication into the switchboard dashboard, and compliant with privacy regulations. It has been implemented on laptops used for remote monitoring.

b. *On-site monitoring of CATI Interviews*: ISTAT periodically conducts control activities at interviewers' workplaces, including direct listening via dual headsets and remote verification of ongoing interviews (audio and video) via dedicated CATI stations. These controls comply with privacy regulations and provide detailed insight into interview quality and interviewer behaviour.

c. *Ex-post monitoring of contact and Interview conduct assessment*: Some paradata are also collected and monitored to improve data quality. Quality indicators and evaluations are used to assess the entire data collection process. Provisional and final contact outcomes are analysed, and specific indicators are generated:

- response rate, base family response rate, refusal rate, unavailability rate, average number of contacts required to complete household interviews;
- incorrect telephone contact rate;
- newly acquired telephone contact rate;
- interview distribution by survey day, time slot, and interviewer;
- average interview duration.

In this context, the checks also concern total nonresponse error in the case: 1) not-at-homes: prospective respondents who may not be at home when enumerators visit their households, controlling first/last interviews and request for differentiating time scheduling contacts, 2) refusals, respondents who refuse to give information for whatever reasons, monitoring data and possible increase.

3. Analysis of collected individual interview data

Frequency distributions, contingency tables, and indicators are developed based on key LFS variables. The post-interview monitoring and data analysis focused on:

- The respondent's response style, particularly the tendency to provide the same answer to a set of questions on a specific topic (response set on work satisfaction and working hours).
- The percentage of questions confirming the information provided in previous interviews, especially for specific questions or categories of respondents (for

example, 16-24-year-olds who confirm their educational qualification from the earlier interview).

- The consistency of specific key aggregates: percentage of persons employed, percentage of persons neither seeking nor available for work, and unpaid family workers. And, in general, significant percentage changes in key variables (reason for not seeking a job, differences in hours worked during the week compared to contractual working hours) and in questionnaire flow, shortening the pathway questions.

All results are observed and compared with the time series, assuming that in the past we obtained a “true value” (or better) of the characteristic under study for every unit in the population.

Survey data analysis proceeds in conjunction with remote listening, and the joint results are used during training to remedy interviewer shortcomings.

4. Evaluation of the interviewer’s effect

A hierarchical structure is evident in the LFS data: respondents are nested within interviewers, and in both CAPI and CATI modes, we find clusters of households (and individuals) interviewed by a particular interviewer. An appropriate class of models for analysing this type of data is the multilevel modelling approach, which accounts for variance due to differences between interviewers. In this paper, we cannot investigate in depth how interviewer characteristics may affect respondents’ answers and interviewer-respondent interactions, as additional information on interviewers is unavailable due to privacy issues. On the other hand, we are interested in providing a consistent measure of the “total” interviewer effect, which should be consistently monitored during data collection, and in what can be done to reduce this source of bias.

We have started applying it during the IT LFS data collection phase to identify and estimate the interviewer’s effect on survey quality. Moreover, only in the CATI mode is the random allocation of interviews to interviewers. CAPI interviewers collect data in a specific area, which often has a particular influence on the data. With the new data collection framework, we have unique interviewer codes for both techniques. We conducted this analysis only on the CATI subsample to obtain a reliable estimate of the interviewer effect, which was not confounded by territorial heterogeneity.

The response variables considered in our analysis are mainly dichotomous (activation of critical items or questionnaire filters, new items in the questionnaire, “Don’t Know- No Answer” responses to specific items, Proxy interviewing). For

these kinds of variables, the model we have chosen is the logit-based model described by:

$$y_{ij}|u_j \sim B(1, \pi_{ij}) \quad (1)$$

$$g(\pi_{ij}) = \mu + u_j \text{ with } u_j \sim N(0, \sigma_u^2) \quad (2)$$

$$\pi_{ij} = \frac{\exp(\mu + u_j)}{1 + \exp(\mu + u_j)} \quad (3)$$

$$\rho = \frac{\sigma_u^2}{(\frac{\pi^2}{3} + \sigma_u^2)} \quad (4)$$

π_{ij} denotes the probability of having the outcome 1 for the response variable y_{ij} and the j -th interviewer, and u_j , which are assumed to be independent identically distributed (IID) random variables $N(0, \sigma_u^2)$, are supposed to represent the variability due to the interviewer's effect. The intra-class correlation coefficient (ICC) is estimated as the ratio of group variance to total variance. It measures the degree of homogeneity within units in the same cluster and, in our context, represents the interviewer effect. We use a random intercept model to obtain a reliable estimate of the interviewer effect, as the introduction of additional explanatory variables makes the variance composition in (4) less precise. To monitor the data collection process, a synthetic estimate can highlight the topics affected by a significant interviewer effect. Still, we also need some "interviewer-level" evaluation to correct the process. For this reason, once a suitable model has been fitted, it is possible to estimate an interviewer-level effect using empirical Bayes prediction. Prediction procedures provide $(\hat{u}_j)$ estimates for each interviewer with their relative confidence intervals, which allow us to analyse the interviewers' performance ranking and identify those with a predicted estimate significantly different from zero.

The interviewer effect has been tested across many aspects of the data, using the last four quarters for which the new operator is contracted to manage the interviews (Table 2). For most of the aspects investigated, the effect is not significant, indicating that the interviews are of average quality. The first important result is that, considering the respondent's gender as a target variable, a significant interviewer effect does not emerge, consistent with the literature.

Table 2 - Intraclass correlation (interviewer's effect) for specific variables in the IT-LFS questionnaire. Year 2024-2025.

Target Variable	2024		2025	
	<i>Q2</i>	<i>Q3</i>	<i>Q4</i>	<i>Q1</i>
Respondent's gender	0.00	0.00	0.00	0.00
Filter to the previous work exp section	0.00	0.01	0.03	0.02
Lifelong learning indicator	0.07	0.18	0.18	0.06
Response set - work satisfaction	0.18	0.33	0.46	0.25
Confirm on educational level	0.00	0.04	0.06	0.03
Response set - working hours	0.06	0.07	0.08	0.04
Item nonresponse on income	0.09	0.25	0.30	0.26
Not seeking, not available	0.05	0.18	0.30	0.37

Source: IT-LFS data.

We have found a relatively low but significant value for ρ in predicting item activation from prior working experience: responding “No” allows for a shorter interview duration (i.e., skipping an entire questionnaire section). Some results also show that specific, intensive training sessions aimed at reducing the interviewer's effect in the last quarter have been successful, particularly for the lifelong learning indicator and the response set work satisfaction. Higher intraclass correlation coefficients indicate the interviewer's difficulties in handling sensitive topics; this is evident in the item nonresponse for the income item. In this case, the interviewer effect is high and steady over the last quarter of the period, ranging from 0.25 to 0.30. This confirms the great importance of interviewers' ability to create a climate that allows discussion of sensitive topics.

5. Findings and considerations

In 2006, a Eurostat Task Force was set up to review the quality of the EU-LFS along the dimensions of the quality framework for statistical output of the European Statistical System (ESS), identify weaknesses, and recommend improvements (Eurostat, 2009). The TF recommendations about “Interviewers and fieldwork organisation” represent clear reference points for the proposed work, in particular the following ones: a) provide interviewers with appropriate training on how to conduct the interview, covering both communication skills and survey content. Training should be provided continuously (R20); b) organise periodical focus groups and debriefing for interviewers to review and tackle critical issues (R21); c) instruct the interviewers in general not to adapt questions to the respondent but just to read them out as they are written in the questionnaire, as personal interpretations may lead

to biased results (R22); d) continuously monitor and systematically assess the quality of the fieldwork (R23).

The lack of trained and experienced field interviewers and of adequate field supervision can influence survey measurement in various ways. As has been widely demonstrated, the mere presence of an interviewer induces respondents to give more socially desirable answers than do self-administered questionnaires (Tourangeau and Yan, 2007). Beyond that, the interviewer's tasks may include contacting the respondent and obtaining co-operation, explaining the interview context, formulating questions and selecting and coding answers. Consequently, interviewers can influence many sources of error in a survey. Therefore, as interviewers can be considered a relevant source of error, in the current article, we presented strategies to minimise this impact on data, with a special focus on rigorous monitoring of interviews and processing data to ensure the reliability and accuracy of the collected data.

In the analysis, our intent is not to provide evidence that respondents can evade or cannot adequately differentiate between questions, but to examine the extent to which interviewers mediate these processes and try to counteract the corruptive effects of the data.

The process we implemented is continuous, and monitoring persists. Periodically, the company is informed with a report and required to take action if the interviewer's misconduct is repeated.

Starting from the idea that eliminating interviewer error is impossible, the aim here is to achieve data quality by giving the interviewer a more conscious, collaborative and proactive role to reduce the gap between the actual and collected data. Debriefings are organised for this purpose at various times throughout the year, as part of continuous quality improvement efforts.

Methodological advancements reflect the core of scientific investigation, where theoretical frameworks guide the development of a discipline. By carefully breaking down complex phenomena, researchers can better identify and understand the causal mechanisms at work. This process highlights the importance of taxonomies as vital tools for organising research efforts and strengthening analytical thinking. (Groves and Lyberg, 2010).

These strategies ensure a thorough evaluation of the interview's methodological and content-related aspects, allowing timely interventions when necessary. These activities help ensure proper interview administration, improve interviewer effectiveness and optimise the overall quality of the survey.

However, the extent of these critical issues, among other reasons, also indicates the survey's complexity, organisation and management (Banda, 2003).

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TERRORISM INCIDENTS AND CHARACTERISTICS, A MULTILEVEL LATENT CLASS MODEL

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Abstract. The aim of this study is to explore the impact of the 2001 attacks on the World Trade Center on the characteristics of terrorism worldwide and in individual countries using information from the Global Terrorism Database (GTD), a longitudinal dataset that provides detailed data on terrorist events worldwide. We focus on terrorist activity within a country, organizing the data by attacks and countries to detect latent patterns. We restrict our attention on a limited period of time, namely 7 years, and apply a multilevel latent class model that enables for simultaneous clustering of attacks and events into groups exhibiting distinctive profiles based on observed terrorism-related variables.

1. Introduction

The apparent increase in terrorist activity over time is particularly relevant to longitudinal studies and may partially reflect improvements in data collection rather than actual growth in attacks. Careful interpretation of trends, especially when comparing periods before and after major geopolitical events such as the 11 September 2001 attacks should be employed. The 9/11 attack changed the nature of terrorism, prompting a rapid response from security forces worldwide and modifying the way governments track threats, resulting in tighter surveillance and counterterrorism efforts everywhere (Magnani, 2021; Viney, 2021).

Our analysis aims to explore the impact of the 9/11 attacks on the World Trade Center on the characteristics of terrorism worldwide and in individual countries. To this end, we considered a seven-year window around September 11 2001, from 1988 to 2004, and we applied a Multilevel Latent Class (MLC) analysis introduced by Vermunt (2003) to the GTD data. The hierarchical structure considers terrorist attacks (events) at the lower level nested within countries at the upper level. MLC is typically used for simultaneously clustering or constructing both higher- and lower-level units in latent classes (unobserved populations) with observed variables. However, unlike traditional clustering analyses such as principal component or cluster analysis for single level data, the MLC is a model-based solution. In our analysis, we applied separate and independent MLCs to the data before and after

September 11, 2001. By comparing the classification results, we were able to describe the changes that had occurred in the phenomenon of terrorism.

The remainder of this paper is organized as follows: Section 2 describes the data analyzed in this work, and Section 3 describes the MLC. Results of the empirical applications are reported and commented in Section 4. Finally, Section 5 draws some conclusions.

2. The data

The Global Terrorism Database (GTD) is a comprehensive, event-level database that documents more than 200000 terrorist attacks worldwide since 1970. It is managed by the National Consortium for the Study of Terrorism and Responses to Terrorism (START) at the University of Maryland. Data have been collected from a wide range of media sources and subjected to a systematic coding and validation process to ensure consistency (START, 2022). The GTD dataset is freely available from the University of Maryland and allows users to filter incidents based on varying thresholds of ideological motivation, intent, and target type. Additionally, the GTD contains a rich set of variables - over 45 for most incidents, and more than 120 for recent years - enabling detailed temporal, geographic, and typological analyses. GTD is the most widely used in academic research and accessible source for empirical analyses of terrorism patterns. It is widely used in academic research, policy analysis, and risk assessment, and its event-level structure makes it particularly well suited to the statistical modelling of terrorism over time and across space. The GTD has become an empirical resource for the quantitative study of terrorism. It has been employed across a range of methodological approaches including machine learning, survival analysis and time series approach (see, for instance, Python *et al.*, 2021; Guo, 2019; Singer and Golan, 2019).

In order to evaluate the possible effect of the World Trade Center attacks in New York on the characteristics of terrorism, we selected a period of seven complete years and divided it into two: before (pre in the following) and after (post in the following) September 11, 2001. This resulted in the two groups having different lengths of time and numbers of cases.

The variables were selected according to the following two criteria: absence of missing values and low sparsity. To avoid sparsity, the considered variables were dichotomized. The 13 variables used for the analysis are as follows:

- *Extended*: 1 if the duration of an incident extended more than 24 hours
- *Doubt*: 1 if there is doubt as to whether the incident is an act of terrorism
- *Multiple*: 1 if the attack is part of a multiple incident
- *Success*: 1 if the incident was successful

- *Suicide*: 1 if the incident was a suicide attack
- *Bomb*: 1 if bombs and assaults were used during the attack
- *Firearms*: 1 if explosives and firearms were used during the attack
- *Claimed*: 1 if a group or person claimed responsibility for the attack
- *Killed*: 1 if victims or attackers died as a direct result of the incident
- *Wounded*: 1 if victims or attackers wounded as a direct result of the incident
- *Property*: 1 if the incident resulted in property damage
- *Hostages*: 1 if presence of hostages or kidnapped in the incident
- *International*: 1 if a perpetrator group attacked a target of a different nationality.

Only countries that experienced at least fifty terrorist attacks in either periods (before and after 9/11) were selected. This approach avoids convergence problems when fitting the model (see Section 3) while ensuring that all countries most affected by terrorist attacks are considered. Twenty-seven countries from all over the world were selected. Tables 4 and 5 show the number of attacks in all the selected countries before and after 9/11, together with some results of the analysis.

3. The Multilevel Latent Class Analysis

Latent class (LC) analysis (Goodman, 1974) is usually applied in social sciences for clustering or constructing typologies with observed variables. When data have a multilevel structure, with level 1 (or individual or lower-level) units nested in level 2 (or group or higher-level) units, the multilevel approach is useful to correct inferences since the usual assumption of independent observations is violated (Snijders and Bosker, 2012). In this situation, a multilevel LC model (MLC) approach allows model parameters to differ across level 2 units (Vermunt, 2003). The application of MLC models simultaneously clusters individuals and groups into unobserved clusters (latent classes or mixtures). Lower-level units are classified into one of L latent classes based on differences in the distribution of observed responses, while higher-level units are assigned to one of H higher-level latent classes, which vary in the distribution of the lower-level latent classes.

In our data, y_{kji} is the observed value on the i -th variable ($i = 1, \dots, I$), on j -th lower-level unit ($j = 1, \dots, n_k$) in the k -th ($k = 1, \dots, K$) higher-level unit. According to the hierarchical nature of the data, i -th variables are the attack characteristics, terrorist attacks are lower-level units j , and countries are higher-level units k . The total number of countries is $K=27$, while the number of attacks, n_k , differs for each country; $N = \sum_{k=1}^K n_k$ is the total number of lower-level units. The variables of each attack are described in Section 2 ($I=13$). The vectors $\mathbf{y}_{kj} = (y_{kj1}, \dots, y_{kji}, \dots, y_{kjl})$

and $\mathbf{y}_k = (\mathbf{y}_{k1}, \dots, \mathbf{y}_{kj}, \dots, \mathbf{y}_{kn_k})$ contain the I -variate responses of attack j in country k . The unobservable variables representing the lower- and higher-level latent classes membership are denoted by $x_{kj} = l$ ($l = 1, \dots, L$) and $w_k = h$ ($h = 1, \dots, H$).

The MLC model can be expressed in two basic equations (Vermut 2003). The first equation defines the mixtures model for $f(\mathbf{y}_k)$, the marginal density for the full response vector of group k ; that is:

$$P(\mathbf{y}_k) = \sum_{h=1}^H P(w_k = h) \prod_{j=1}^{n_k} P(\mathbf{y}_{kj} | w_k = h) \quad (1)$$

where $P(w_k = h)$ is the probability that group k belongs to higher-level LC h , and $P(\mathbf{y}_{kj} | w_k = h)$ is the conditional density for the response vector of level 1 unit j in level 2 unit k . The second equation is:

$$P(\mathbf{y}_{kj} | w_k = h) = \sum_{l=1}^L P(x_{kj} = l | w_k = h) \prod_{i=1}^I P(y_{kji} = 1 | x_{kj} = l, w_k = h) \quad (2)$$

where $P(x_{kj} = l | w_k = h)$, is the probability that the level 1 unit j of level 2 unit k belongs to LC l given that group k belongs to LC h , and $P(y_{kji} = 1 | x_{kj} = l, w_k = h)$ is the conditional density for response variable i of level 1 unit j in level 2 unit k given the membership to lower-level LC l and to higher-level LC h .

In our analysis, we use the specification $P(y_{kji} = 1 | x_{kj} = l, w_k = h) = P(y_{kji} = 1 | x_{kj} = l)$ (Vermunt 2003, 2008). In this case, $P(y_{kji} = 1 | x_{kj} = l)$ is estimated freely, but the parameters defining the conditional distributions are assumed to be independent of the higher-level class membership. This structure is the one used in almost all the applications aiming at the simultaneous clustering of higher- and lower-level units (Lukociene *et al.*, 2010), and the clustering of higher-level units is performed by “pushing up” the information contained in the multiple lower-level responses via the lower-level class memberships.

In equation (1) conditional independence between units is assumed inside each higher-level class, and in equation (2) conditional independence is assumed between the variables measured on the first-level units. The probability of observing a particular response pattern for a country, $P(\mathbf{y}_k)$, is expressed by three components: (i) the probability that country k belongs to higher-level LC, (ii) the probability that event j belongs to first-level LC, given the country latent class membership, (iii) the probability that the attack characteristic i of terrorist attack j in country k is equal to 1, given the terrorist attack latent class membership. Components (i) and (ii) are modelled through multinomial logit equations, while the third component (iii) is modelled through a logit equation.

For parameter estimation, we used the syntax module of the Latent GOLD v. 6.0 software (Vermunt and Magidson, 2021), using the EM algorithm adapted to the multilevel framework by Vermunt (2003).

4. Terrorist attacks and MLC analysis

As introduced, we applied two separate MLC models for terrorist attacks before and after September 11, 2001. The two analyses were carried out independently on the same variables and share the higher-level units. The two classifications of countries resulting from the two MLCs, which are based on different datasets, highlight the proximity and distance of second-level units determined under different conditions.

In the application of the MLC, the choice of the number of LCs at both levels is an important issue. In our analysis, the sample size is quite large ($N_{pre}=4712$, $N_{post}=3759$) which systematically favors more complex models when using standard comparison methods like likelihood-ratio tests. Additionally, when the null hypothesis lies at the boundary of the parameter space - as is the case when comparing models with varying numbers of latent classes - conventional asymptotic theory does not apply (Agresti, 2013). Consequently, we relied on penalized information criteria, such as the Bayesian information criterion (BIC). Following Lukociene *et al.* (2010), we used BIC with number of level-1 units as the sample size, BIC(N), to choose the number of lower-level classes, and BIC with number of groups as the sample size, BIC(Nk), to choose the number of higher-level classes. To contrast the tendency of information criteria to suggest a very high number of LCs, we compared the percentage difference between the information criteria of two successive models. In addition, we used substantive considerations related to the size and interpretation of the latent classes to choose the number of higher- and lower-level classes. Finally, we also used the geometric mean likelihood index $\exp(LL/N)$ proposed by Agresti and Caffo (2002), where LL represents the logarithm of the maximized likelihood function for a model. This index removes the dependence of LL on the overall sample size N , and the closer to 1, the better the fit. As for the information criteria BICs, we also compared the percentage difference between the $\exp(LL/N)$ index of two successive models. Table 1 shows the results of goodness of fit for MLC models before 9/11. Both in lower- and higher-level, we observe an edge point for $h=3$ and $l=3$, that we chose as our final model. Similar results are obtained for MLC models after the September 11, 2001 attack.

Table 1 – Information criteria and geometric mean likelihood index. MLC model before 9/11.

$h-l$	BIC(N)	BIC(Nk)	BIC(N) % diff	BIC(Nk) % diff	exp(LL/N)	exp(LL/N) %diff
$1-1$	55776.1				0.0027	
$1-2$	52987.6		-5.00		0.0037	36.13
$1-3$	51871.5		-2.11		0.0042	14.00
$1-4$	50783.3		-2.10		0.0048	13.66
$2-3$		50348.3		-2.51	0.0049	14.89
$3-3$		49976.5		-0.74	0.0051	4.12
$4-3$		49851.6		-0.25	0.0051	1.43

The comparative reading of the results before and after 9/11 will focus on the aggregations (second-level latent classes) of the second-level units (countries) obtained through the MLCs, and whether these are preserved or not in the two periods. It is important to note that the MLCs results take into account also the transformation of the phenomenon as a whole.

For the interpretation of our results at the second-level of analysis, important elements come from the description of the first-level latent classes: Table 2 shows the estimated conditional probabilities (in percent) of each characteristic conditional on unit k belonging to the lower-latent class. For example, 2.04% is the probability of the attack being extended, conditional on unit k belonging to the lower-level latent class 2.

Table 2 – Lower-level latent classes. MLC models before and after September 11, 2001 attacks.

i	<i>pre</i>			<i>post</i>		
	$l=1$	$l=2$	$l=3$	$l=1$	$l=2$	$l=3$
Extended	0.19	2.04	78.48	0.09	0.16	38.95
Doubtterr	20.86	17.02	16.67	16.46	12.14	14.58
Multiple	15.5	28.68	16.13	9.34	32.27	8.91
Success	93.6	82.07	99.75	94.22	80.96	99.24
Suicide	4.07	0.00	1.21	12.02	0.00	0.53
Bomb	88.67	72.71	17.44	94.48	80.26	14.71
Firearms	91.26	70.89	62.44	98.39	78.99	54.41
Claimed	8.46	20.73	16.89	15.96	21.7	19.09
Killed	68.05	13.55	38.32	75.6	2.62	66.01
Wounded	55.54	20.01	14.96	63.82	17.33	15.22
Property	46.97	62.26	19.19	41.07	66.91	13.62
Hostages	0.01	0.00	98.97	0.00	0.00	52.29
International	1.85	38.21	23.59	10.7	18.39	18.71

As for the PRE data, latent class 1 ($l=1$, *pre*) is characterized by assaults with bombs and explosives, wounded and killed, latent class 2 ($l=2$, *pre*) is characterized

by multiple attacks and property damage, and latent class 3 ($l=3$, *pre*) is characterized by events that last longer than 24 hours, are successful, and involve hostages. The proportions of lower-level units in the three latent classes are: 46%, 44%, and 10%. The results of MLC using POST data show important similarities in the structure of the lower-level latent classes. The proportions of lower-level units in the three latent classes are: 47%, 37%, and 16%.

As for the higher-level latent classes, we chose the solution with three classes in both *pre* and *post* analyses. The proportions of countries in the three latent classes are 37%, 37%, 26%, and 31%, 40%, 30% in the *pre* and *post* data, respectively. Table 3 shows the composition of the higher-level latent classes relative to the first-level latent classes.

Table 3 – Higher-level latent classes. MLC models before and after September 11, 2001 attacks.

	<i>pre</i>			<i>post</i>		
	<i>h=1</i>	<i>h=2</i>	<i>h=3</i>	<i>h=1</i>	<i>h=2</i>	<i>h=3</i>
<i>l=1</i>	44.6	89.9	0.7	50.4	78.7	5.9
<i>l=2</i>	38.0	4.0	97.8	27.0	10.3	91.0
<i>l=3</i>	17.4	6.0	1.4	22.7	11.1	3.1

In both analyses, the higher-level latent class 1 ($h=1$) is composed of all three lower-level latent classes, although with a slight predominance of the lower-level latent class 1, the higher-level latent class 2 ($h=2$) is predominantly composed of lower-level latent class 1 (bombs, dead and wounded explosives), while higher-level latent class 3 ($h=3$) is characterized by the predominance of lower-level latent class 2 (multiple attacks, property damage, and a complete absence of suicide).

In the following we combine the results of the two MLCs, using the classification of the countries based on the empirical Bayesian posterior distribution. In particular, we analyze which countries classified in the same higher-level latent class in the *pre* analysis are still, or not, classified together in the *post* analysis. The fact that there is a correspondence between lower-level classes in the two periods allows us to evaluate not only how countries aggregate, but also if their profiles modify in time with respect to the observed variable. Just to give an example, countries A and B are classified in $h=1$ by the MLC using *pre* data. It may happen that A and B are still classified together by the MLC using *post* data, but not in $h=1$. This means that the two countries are still similar, but they share a different profile with respect to observed variable.

Table 4 – *Combinations of higher-level latent classes in MLC models before and after September 11, 2001 attacks.*

<i>h=1, pre – h=1, post</i>			<i>h=2, pre – h=2, post</i>			<i>h=3, pre – h=3, post</i>		
Country	<i>n,</i> <i>pre</i>	<i>n,</i> <i>post</i>	Country	<i>n,</i> <i>pre</i>	<i>n,</i> <i>post</i>	Country	<i>n,</i> <i>pre</i>	<i>n,</i> <i>post</i>
Afghanistan	36	228	Algeria	482	300	France	99	85
Colombia	495	344	India	542	533	Greece	103	28
Lebanon	82	14	Israel	84	142	Kosovo	116	15
Turkey	184	53	Pakistan	171	149	Spain	247	101
Uganda	77	68	Russia	324	237	United King	280	63
			Sri Lanka	165	64	United Stat	152	99
			WB&Gaza	153	205	Yugoslavia	103	3

Out of the nine possible combinations of higher-level latent classes in the *pre* and *post* analyses (with each country associated with one of the three second-level clusters in both analyses), we observe only six because the countries classified as *h=3* in the *pre* analysis belong to the same group in both analyses. Macedonia is the only country that moves from *h=1* in *pre* MLC to *h=3* in *post* MLC. Tables 4 and 5 show the countries belonging to each higher-level combination, together with the number of events in both *pre* and *post* period.

Table 5 – *Combinations of higher-level latent classes in MLC models before and after September 11, 2001 attacks.*

<i>h=1, pre – h=2, post</i>			<i>h=2, pre – h=1, post</i>		
Country	<i>n,</i> <i>pre</i>	<i>n,</i> <i>post</i>	Country	<i>n,</i> <i>pre</i>	<i>n,</i> <i>post</i>
Angola	109	13	Burundi	72	45
Indonesia	248	100	Nepal	48	151
Iraq	32	431	Philippines	218	199
Thailand	21	67			

Figures 1-4 show the *pre* and *post* profiles of the identified combinations of countries, describing the evolution of the phenomenon over time. The profiles of the group of countries belonging to *h=1* in *pre* MLC and those belonging to *h=1* in *post* MLC remained nearly unchanged in the two analyses, and the same happen for *h=2* (see Figures 1 and 2).

A country that moves from one higher-level latent class to another, not only belongs to a different aggregation but also shows a different profile in the two analyses. As an example: Angola (together with Indonesia, Iraq and Thailand, Table 5) is in *h=1* in *pre* MLC, and moves to *h=2* in *post* MLC (and aggregates with India, Pakistan, Israel, etc. that were already in *h=2* in *pre* MLC and still are in *h=2* *post* MLC, Table 4, second column). The countries moving from *h=1* in *pre* to *h=2* in

post show an increase in killed and wounded (Figure 3), while we observe a softening of these characteristics for countries such as Burundi, Nepal and Philippines migrating from $h=2$ in *pre* MLC to $h=1$ in *post* MLC.

Figure 1 – Profiles of higher-level latent classes. MLC models before and after September 11, 2001 attacks.

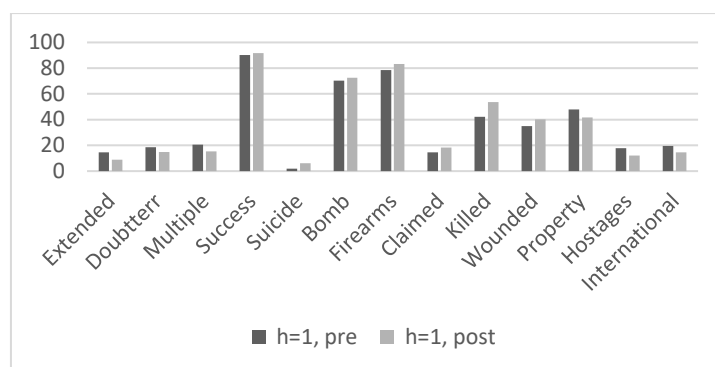


Figure notes. Authors' elaboration. MLC models on GDT data.

Figure 2 – Profiles of higher-level latent classes. MLC models before and after September 11, 2001 attacks.

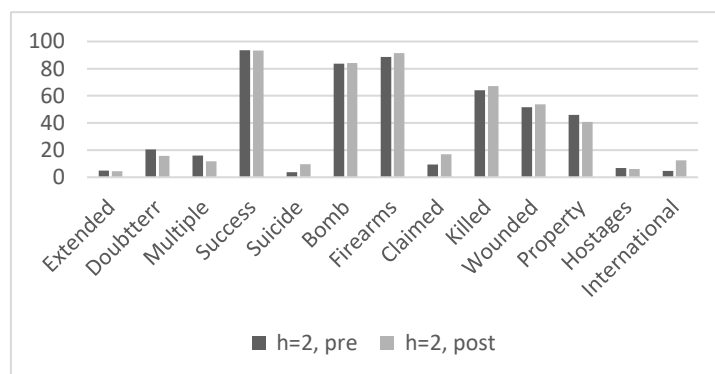


Figure notes. Authors' elaboration. MLC models on GDT data.

The group of countries belonging to $h=3$ in *pre* MLC (composed by France, Greece, Kosovo, Spain, the United Kingdom, the United States, and Yugoslavia) still aggregate together in *post* MLC (Macedonia joins in the post analysis but with a small number of events, and therefore does not influence the class profile), as shown in Table 4. This group is the one that shows the most pronounced changes in its profile with respect to the observed variables. Indeed, while there is a substantial

reduction in the number of events (in the post period, the number of events is reduced to just over one-third, except for France), their profile shows a different distribution among the different types of terrorist attacks: bomb and explosives attacks proportionally increase while hostage involvement decreases. Furthermore, as this group of countries is mainly characterized by $l=2$ in *pre* and *post* analyses (Table 3), we observe in Table 2 a reduction of the probability of international attacks, from 38.21 to 18.39, and a reduction of the probability of victims killed from 13.55 to 2.62. All of these countries, seem to be the ones that have seen the most relevant changes following the attack on the World Trade Center on September 11, 2001.

Figure 3 – Profiles of higher-level latent classes. MLC models before and after 9/11.

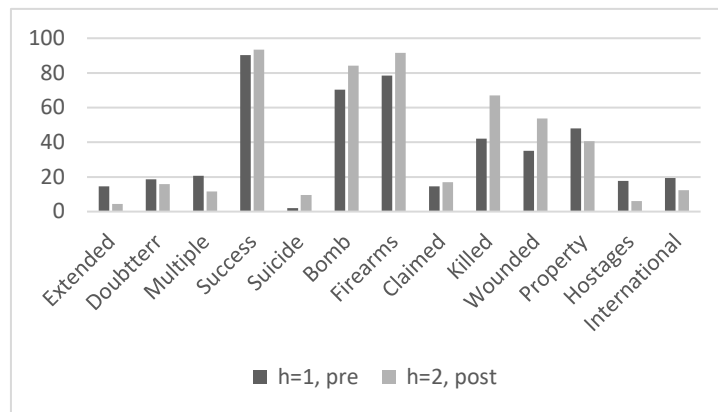


Figure notes. Authors' elaboration. MLC models on GDT data.

Figure 4 – Profiles of higher-level latent classes. MLC models before and after 9/11.

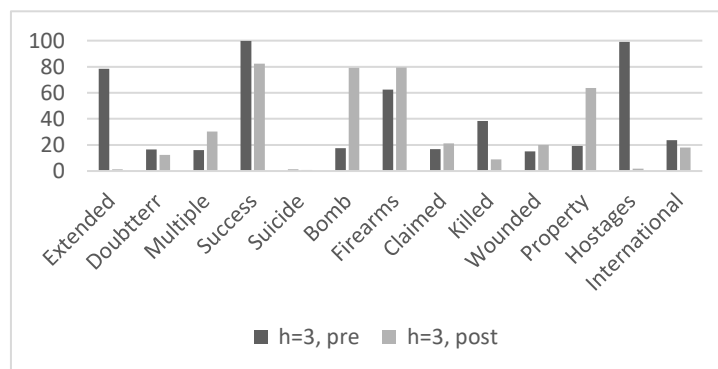


Figure notes. Authors' elaboration. MLC models on GDT data.

5. Results and conclusions

In this study, we analyzed a subset of the GTD dataset using a multilevel latent class analysis restricting our attention on a period of seven years from 1988 to 2004. This enabled us to evaluate the impact of the attack of September 11, 2001 on the characteristics of terrorism worldwide. The multilevel approach enabled us to describe changes in single countries by a classification based not only on their marginal profile but also on their composition with respect to different kinds of attacks. The drawbacks of this type of analysis is that it has requirements regarding data structure. We selected second-level statistical units with a 'sufficient' number of events and dichotomised the variables describing the attacks to avoid sparseness in the data. This clearly results in a loss of information. Furthermore, this analysis does not take into account the effect of the geographical proximity of countries, which will be an element of interest for future analyses.

The event of 9/11 appear to have had an impact on terrorism in various countries. The multilevel latent class model classifies countries into three (latent) groups h , both in the analysis of data before and after September 11, 2001. The comparison of these results suggested the presence of five subgroups (" $h=1, pre - h=1, post$ ", " $h=2, pre - h=2, post$ ", " $h=1, pre - h=2, post$ ", " $h=2, pre - h=1, post$ " and " $h=3, pre - h=3, post$ "). In fact, with the exception of Macedonia, there are no shifts affecting group " $h=3, pre$ ". The subgroups of countries in " $h=1, pre - h=1, post$ " and " $h=2, pre - h=2, post$ " show a similar profile of terrorist attacks before and after 9/11. The subgroups of countries in " $h=1, pre - h=2, post$ " and " $h=2, pre - h=1, post$ " change their profile, but the most significant change is observed for the subgroup of countries in " $h=3, pre - h=3, post$ ". This is the group of Western countries (European countries and the United States), that remain together in the pre- and post-analysis and show the most significant changes in the characteristics of the terrorist attacks.

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INNOVATIVE DATA COLLECTION STRATEGIES: ISTAT SURVEY ON « WELLBEING AND SAFETY OF PEOPLE »¹

Federica Pellizzaro, Lorella Sicuro

Abstract. The ISTAT survey "Wellbeing and Safety of People" analysed subjective well-being and perceived safety in Italy. It involves a sample of about 25,000 individuals aged 16–75, with 21,000 Italians interviewed via CATI (telephone) and 4,500 foreigners via CAPI (face-to-face). A key innovation was the contact strategy for CATI interviews: participants received an informative letter and a reminder, encouraging them voluntarily provide a phone number through a toll-free number or an ISTAT webpage (via tax code or QR code). Another methodological novelty was the formation of interview quartets, prioritizing individuals who had proactively shared their contact details, thereby reinforcing the link between voluntary action and participation. This paper has the goals to assess the impact of the communication strategy and reminders on response rates and participation patterns by age and geographical area. The approach offers useful insights to improve citizen engagement in future surveys and could serve as a replicable model to reduce territorial inequalities in participation.

1. Introduction

The Italian National Institute of Statistics (Istat) survey “Wellbeing and safety of people”, included in the National Statistical Programme (code IST-02260), has as its main objective an in-depth examination of women's safety, with particular attention to psychological, physical and sexual violence, as well as to the perception of safety in everyday life contexts. The survey, which was also carried out in other European countries for Eurostat (Eurostat, 2021), involves a random sample of about 25,500 women between the ages of 16 and 75, of whom 21,000 are Italian (interviewed by telephone - CATI technique) and 4,500 are foreign (interviewed face-to-face - CAPI technique). To protect the participants, the survey was presented with a generic name and not explicitly referring to gender-based violence, to avoid risk situations in case the communication was read by family members, including potential perpetrators of violence. The general wording also avoided defensive reactions, contributing to a climate of trust and greater willingness to participate. An element of methodological

¹ The paper is the result of the common work of the authors. In particular, paragraph 1, 3, 4.4 and 5 is attributed to Lorella Sicuro; paragraph 2, 4.1, 4.2 and 4.3 to Federica Pellizzaro.

innovation for the CATI part of the survey concerned the voluntary transmission of telephone numbers by the selected women, either via a toll-free number or by filling in a short online questionnaire (also via QR code). In a context marked by distrust of unknown calls, this strategy proved effective in obtaining correct numbers and ensuring direct contact. The communication was constructed according to principles of effective persuasion (Cialdini, 2002, Petty and Cacioppo, 1986). In particular, three persuasion mechanisms were considered especially relevant. First, the principle of authority was activated through the official letter signed by the President of Istat, thereby reinforcing institutional credibility and trust. In addition, the communication clearly explained the purpose of the survey, the safeguards for data protection and the practical relevance of participation. Second, the appeal to social utility and collective benefit emphasised the contribution of individual participation to the improvement of public policies, fostering a sense of civic responsibility. Third, elements of commitment and consistency were embedded in the request to voluntarily provide a telephone number, encouraging an initial active step that could increase the likelihood of subsequent participation in the interview. This strategy made it possible to collect around 36,000 valid numbers, strengthening the quality of the sample and improving operational efficiency. In addition, in the formation of the 21,000 planned quartets of interviewees, priority was given to those who had spontaneously provided the address, to maximise the phone coverage while preserving sample stratification. This paper aims to evaluate the effectiveness of the communication strategy adopted for the CATI component of the survey, with particular attention to: (i) the impact of reminder letters on the timing and volume of voluntary contact provision; (ii) the socio-demographic determinants of telephone number transmission; and (iii) the presence of territorial disparities in the voluntary provision of contact information. By addressing these research questions, the study contributes to the assessment of how structured communication strategies may influence engagement in sensitive official surveys.

2. Communication to participation and delivery

The women selected to take part in the survey had received the letter to their address of residence, presenting the survey and requesting their cooperation in providing their telephone number for the purposes of contact for the interview. The transmission of the telephone number could be done by accessing a special web page of Istat, authenticating with one's id tax code, or by contacting a toll-free number, active six days a week, communicating the unique code indicated in the letter. Furthermore, it was specified that the survey would be conducted between January and June 2025 by interviewers from the company CSA (Centro Statistica Aziendale

S.r.l.), on behalf of Istat. The contact by the interviewers to the selected persons would be made by telephone on weekdays, with a wide time slot, using a telephone number that was explicitly indicated in the letter, thus making the contact identifiable. To persuade the woman to provide the telephone number, the social relevance of the survey, the value of participation and the concrete benefits for the respondents and the community were emphasised. It was also emphasised that providing the telephone number would ensure flexible participation, adaptable to family and work commitments, and that the data provided would be used exclusively for statistical purposes and in a confidential manner. Furthermore, the contribution of individual participation to the improvement of public policies was emphasised, promoting a sense of social utility, active involvement and belonging. Ample space was devoted to the protection of personal data and compliance with statistical confidentiality and privacy regulations, also clarifying the mandatory nature of participation.

The informative letter was sent by ordinary mail at the beginning of November to 126,000 women, and a subsequent reminder at the end of November to 110,000 who had not yet provided their telephone number. The letters were sent in three languages: Italian and German for persons in the province of Bolzano, Italian and Slovene for persons in the Slovene-speaking areas (Friuli Venezia Giulia).

3. Materials and methods

For the purposes of the survey, two samples of women were extracted: the sample consisting of Italian women for whom the telephone interview (CATI technique) and the sample of foreign women with a face-to-face interview (CAPI technique). For the CATI interviews, a sample of 126,000 Italian women aged between 16 and 75 was drawn from the Municipal Population Registers of the National Institute of Statistics (IST-02492), stratified by region and municipal type. An oversampling was therefore carried out to have an adequate number of replacement units and to reach the expected sample size of 21,000 women. The analysis envisaged the use of descriptive and inferential statistical techniques, with the aim of exploring the mode and time of response of the women involved in the CATI survey to the request to provide a telephone number for the interview. In particular, the territorial distribution of the respondents who transmitted their telephone number was analysed, with a focus on the differences by age group and geographical area. Specific attention was given to the way in which the respondents provided their telephone number: through self-compilation or by contacting the toll-free number. This distinction also made it possible to explore some aspects related to the level of digitalisation of the respondents. The time trend of the responses was also examined, considering the

interval between the receipt of the information letter and the transmission of the telephone number, with the aim of assessing the possible effect of a reminder sent during the survey.

Besides, it was described the strategy adopted for forming the interview quartets. Referring to the entire sample of 126,000 women, the Chi-square test was applied between the categorical variables telephone number transmission (yes, no) and geographical division, telephone number transmission (yes, no) and age group, with the aim of examining whether providing one's telephone number was statistically significantly associated ($p < 0.05$) with age group or geographical distribution. To investigate the propensity to provide one's telephone number as a function of geographical area and age group, a logistic regression model was estimated. The model had as dependent variable the information on providing one's telephone number (yes, no), as independent variables geographic affiliation (five geographic distributions: North-West, North-East, Centre, South, Islands) and three defined age groups (16-34, 35-64, 65-74). Interaction effects between age group and geographical area were not included in the final specification to preserve model parsimony and ensure interpretability, given the primarily descriptive objective of the analysis. The results of the model were interpreted through the analysis of statistically significant estimated Odds Ratios ($p\text{-value} < 0.05$). All analyses were conducted using SAS software.

4. Results

4.1. Statistical analysis of the voluntary transmission of telephone numbers

The overall rate of women who voluntarily provided their telephone number was 28.6%, i.e. one in four women. Response rates varied considerably across regions, ranging from over 40% in Valle d'Aosta and around 39% in the Autonomous Province of Trento to below 20% in several Southern regions such as Sicilia, Campania and Calabria (Table 1).

The table 2 shows how the telephone number was communicated for age groups, analysing the difference between autonomous compilation by the user and transmission via a contact centre. Of the total 35,984 cases, the vast majority - 26,756 people, or 74.36% - chose to provide their telephone number autonomously, without the intervention of an operator. In contrast, 25.64% (or 9,228 cases) provided their number through the help of the operator. These data indicate a clear preference for the autonomous mode of telephone number communication. Relating the channel chosen and age, it is observed that as age increases, the propensity to use autonomous modes decreases, while reliance on the contact centre increases. In the youth and

adult groups (16-24, 25-34, 35-44), the percentage of autonomous compilation is very high, exceeding 88%, with a peak of 93% among 25-34-year-olds. A progressive decline in self-compilation is observed in the intermediate age groups (45-54, 55-64): from 79.9% among 45-54-year-olds, down to 64.2% in the 55-64 age group. Among the over-65s, only 49.8% filled in autonomously, while the remaining 50.2% relied on the contact centre.

In addition, analysing how the telephone number was communicated for geographical area, although the differences are not substantial, the data suggest that users in the North-East are more inclined to use the self-completion channel (79.5%), while those in the North-West tend to rely slightly more on assistance from the Contact Center (72.9%). The other geographical areas fall within a narrow range around the national average, showing moderate uniformity in channel preference. (Table 3)

Table 1 – *Voluntary transmission of telephone numbers by women who received the informative letter for participation in the survey, absolute values and percentages.*

Region	Yes	No	Total	%
Abruzzo	1,325	3,853	5,178	25.6
Basilicata	1,254	3,564	4,818	26
Calabria	855	4,713	5,568	15.4
Campania	1,150	6,476	7,626	15.1
Emilia-Romagna	2,365	4,325	6,690	35.4
Friuli-Venezia Giulia	1,977	3,171	5,148	38.4
Lazio	1,912	5,564	7,476	25.6
Liguria	1,708	3,667	5,375	31.8
Lombardia	3,384	6,228	9,612	35.2
Marche	1,763	3,511	5,274	33.4
Molise	1,230	3,438	4,668	26.3
Piemonte	2,324	4,516	6,840	34
Provincia autonoma di Bolzano	997	3,718	4,715	21.1
Provincia autonoma di Trento	1,862	2,908	4,770	39
Puglia	1,470	5,244	6,714	21.9
Sardegna	1,337	4,069	5,406	24.7
Sicilia	1,051	6,125	7,176	14.6
Toscana	2,196	4,254	6,450	34

Table 1 (cont.) – *Voluntary transmission of telephone numbers by women who received the informative letter for participation in the survey, absolute values and percentages.*

Region	Yes	No	Total	%
Umbria	1,622	3,322	4,944	32.8
Valle d'Aosta	1,878	2,676	4,554	41.2
Veneto	2,324	4,672	6,996	33.2
Total	35,984	90,014	125,998	28.6

Table 2 – *Voluntary transmission of telephone numbers by age and communication method, self-completion or Contact Centre, absolute values and percentages.*

Age groups	Self-compilation	Contact Center	Total	% Self-compilation
16-24	3,241	346	3,587	90.3
25-34	4,198	314	4,512	93.0
35-44	4,849	626	5,475	88.6
45-54	5,672	1,425	7,097	79.9
55-64	5,220	2,914	8,134	64.2
65+	3,576	3,603	7,179	49.8
Total	26,756	9,228	35,984	74.4

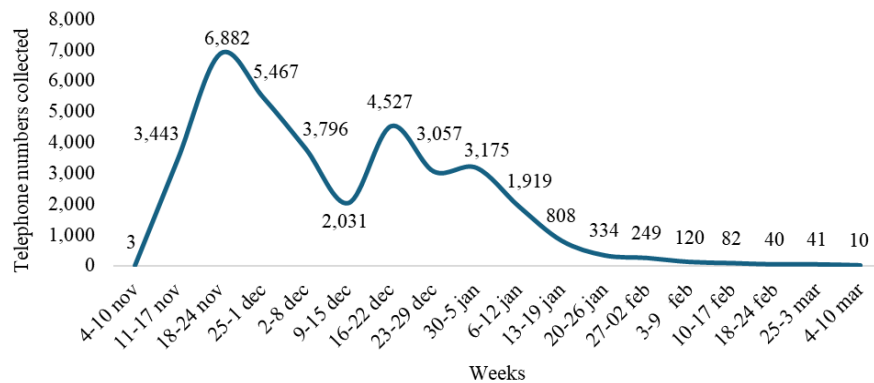
Table 3 – *Voluntary transmission of telephone numbers by geographical area and communication method, self-completion or Contact Centre, absolute values and percentages.*

Geographical Area	Self-compilation	Contact Center	Total	% Self-compilation
North-East	4,120	1,063	5,183	79.5
North-West	9,946	3,690	13,636	72.9
Centre	5,477	2,016	7,493	73.1
South	5,418	1,866	7,284	74.4
Islands	1,795	593	2,388	75.2
Total	26,756	9,228	35,984	74.4

4.2. Time course of telephone number transmission

An analysis of the time trend in responses (Figure 1) clearly shows how communication actions played a decisive role in promoting and supporting participation in the survey. After the initial informative letter was sent out on 30 October, the first two weeks of November were characterised by a very low number of telephone numbers received. This initial trend can be interpreted as a physiological phase, during which the recipients received the communication, began to take notice and become familiar with the instructions provided. Starting from the week of 11-17 November, there was a first important increase in the number of feedback, culminating in a peak in the following week (18-24 November), when 6,882 cards were received. Thereafter, the flow of participation remained steady thanks to the sending of a reminder on 30 November. This second communication intervention had the effect of reinforcing the focus on the survey and prolonging the involvement of participants. In fact, in the following weeks, until 22 December, a regular and continuous flow of mailings was observed, with weekly values of between 3,000 and 5,000 telephone numbers.

During the Christmas holiday there was a physiological decline, probably due to the temporary absence of many people from their homes or the suspension of usual daily activities. However, upon returning from the holidays, there was a slight upturn in the number of responses. As the weeks pass a gradual decline in participation was observed, leading to an almost complete cessation of mailings around mid-March. Overall, the temporal analysis of the trend in responses highlights the effectiveness of the communication tools used, both in terms of initial activation (thanks to the informative letter) and maintaining involvement over time (thanks to the reminder). The overall total of 35,984 telephone numbers collected was achieved mainly thanks to intense activity concentrated in the period between mid-November and the end of December, when the greatest number of responses occurred.

Figure 1 – Time course of telephone number transmission.

4.3. Construction of the quartets for final sample formation

The methodology developed for the survey focuses on building groups of four respondents (“quartets”) from an initial random sample of six (“sextets”), with the aim of optimizing telephone contact of the CATI campaign. To this end, a reserve pool of contactable individuals was integrated using a priority-based algorithm in three R scripts. These scripts allowed for the creation, updating, and formatting of the quatrain to ensure coverage, stratification and data quality. The process emphasized the reuse of the best available telephone numbers (preferably self-reported, which were placed at the first position of each quatrain and, when possible, also at the second position), ensuring replicability and minimizing the need for manual intervention in future iterations of the survey.

4.4. The propensity to provide the telephone number

The chi-square tests of independence (Tables 4 and 5) were elaborated to assess the existence of statistically significant associations between telephone number sharing (yes/no) and each of the two categorical variables (age group 16-34, 35-64 and 65-74 and geographical areas Northwest, Northeast, Centre, South and Islands). The results showed that the observed differences were statistically significant in relation to both age group ($p < 0.001$) and geographical area ($p < 0.001$), displaying the presence of a relationship between these individual characteristics and the propensity to share one's contact. The logistic regression analysis (Table 6) carried out subsequently made it possible to assess the effect of age group and geographical

area (independent variables) on the propensity of passing on the telephone number (dependent variable). The model was statistically significant, as confirmed by the Likelihood Ratio test comparing the fitted model with the intercept-only specification ($p < 0.001$), indicating a significant improvement in model fit. Pseudo- R^2 indices showed limited explanatory power (Cox & Snell $R^2 = 0.0208$; Nagelkerke $R^2 = 0.0298$), suggesting that age group and geographical area account for approximately 2–3% of the variance in the propensity to provide a telephone number. Although modest, such values are common in large-scale social surveys examining individual behavioural decisions with a restricted set of socio-demographic predictors. Participation in a sensitive survey is likely influenced by additional unobserved factors—such as institutional trust, digital literacy, privacy concerns, and broader cultural attitudes—which were not included in the model. Nevertheless, the estimated effects remain statistically robust and substantively consistent. The results, expressed in terms of Odds Ratio (OR), showed that adult women (35-64 years) have a slightly higher inclination of passing on the telephone number than younger women (16-34 years) (OR = 1.045; IC95%: 1.014-1.077), while older women (65+) show a lower propensity (OR = 0.930; IC95%: 0.895-0.966). These differences were statistically significant, indicating that age plays a role in contact-sharing behaviour. Regarding geographical distribution, compared to women residing in Central Italy (reference category), those resident in the North-West and North-East had a higher inclination of passing on the telephone number, with Odds Ratios of 1.209 (IC95%: 1.165-1.255) and 1.125 (IC95%: 1.085-1.168) respectively. In contrast, the propensity was significantly lower among residents in the South (OR = 0.593; IC95%: 0.571-0.616) and the Islands (OR = 0.520; IC95%: 0.494-0.548), compared to the Centre.

Table 4 – *Chi-square test between age group and telephone number transmission ($p < 0.05$).*

Telephone number transmission			Chi-square test	
Age groups	no	yes	Total	
16-34	21,638	8,499	30,137	<.0001
35-64	50,363	20,848	71,211	
65+	17,975	6,637	24,612	
Total	89,976	35,984	125,960	

Table 5 – *Chi-square test between geographical distribution and telephone number transmission ($p < 0.05$).*

Telephone number transmission			Chi-square test
Geographical Area	no	yes	Total
Centre	16,645	7,493	24,138
Islands	10,193	2,388	12,581
North-East	18,788	9,525	28,313
North-West	17,072	9,294	26,366
South	27,278	7,284	34,562
Total	89,976	35,984	125,960

Table 6 – *Logistic regression model with dependent variable (DP) the transmission of the telephone number (yes, no) and as independent variables the age group (16-34, 35-64 and 65+ with reference mode 16-34) and the geographical distribution (North-east, North-west, Centre, South and Islands with reference mode Centre), related Odds Ratio and 95% Confidence Intervals.*

Regression logistic model			
DP: Telephone number transmission (yes/no)	Odd Ratio	95 % Confidence Interval	
35-64	1.045	1.014	1.077
65+	0.930	0.895	0.966
North-East	1.125	1.085	1.168
North-West	1.209	1.165	1.255
Islands	0.520	0.494	0.548
South	0.593	0.571	0.616

5. Conclusion

Effective communication is one of the crucial elements for the success of statistical surveys, especially when the active and voluntary participation of those involved is required. The way a survey is presented, the language adopted, the clarity of the message, and the communication channels used can significantly affect response rates and data quality. In this context, the experience of the “Well-being and safety of people” survey offers a case in point. The findings confirm the effectiveness of the communication strategy adopted to encourage the voluntary transmission of telephone numbers. With an overall response rate of 28.6%, the information campaign reached a significant proportion of participants. The communication approach adopted - based on transparency, flexibility and the social

value of participation - proved to be consistent with international recommendations for increasing involvement in sensitive surveys (Eurostat, 2021).

The statistical analysis revealed strong differentiations in the propensity to send the telephone number in relation to socio-demographic factors. Age was found to be a significant predictor: preference for autonomous transmission (web or QR code) declines from around 90% among younger women to 49.8% among those aged 65 and over, who rely more frequently on the Contact Centre. This confirms the findings of previous studies on the generational digital divide (van Deursen & Helsper, 2015) and underlines the importance of offering alternative channels (such as using a Contact Centre) to ensure equity of access. The predominance of the autonomous mode (74.4%) highlights the growing importance of digitalisation in survey implementation, although human support remains essential for older and vulnerable groups. These findings confirm the need for a multi-channel, inclusive approach combining digital and traditional modes, as recommended in mixed-mode survey research (de Leeuw, 2005).

The results also confirm the effectiveness of the reminder sent, which encouraged a significant number of selected women to voluntarily submit their telephone number, confirming the ability of reminders to maintain interest and further stimulate participation.

Response rates varied geographically, exceeding 35% in Northern and Central Italy and falling below 20% in the South. These disparities may reflect differences in institutional trust, socioeconomic conditions, and digital culture, consistent with recent findings on civic participation in Italy (Istat, 2023). Although the initial sample was probabilistic, the voluntary provision of contact details introduced a self-selection component at the contact stage, as women who shared their telephone numbers may differ systematically from those who did not. However, this did not alter the probabilistic foundation of the design. To limit operational distortions, a fully automated and replicable algorithm was implemented to construct and update contact quartets, maximising telephone coverage while preserving stratification and minimising manual intervention. In conclusion, the strategy adopted by Istat proved to be effective and replicable for future surveys. Voluntary involvement, supported by clear communication focused on social utility, strengthened the quality of the sample and ensured greater compliance. However, the persistence of territorial and generational gaps calls for more targeted policies on the front of statistical culture and digital inclusion, so that more and more people feel motivated to participate and contribute to statistical surveys. Although the communication strategy was designed in alignment with international methodological recommendations (Eurostat, 2021), its generalisability beyond Italy should be considered with caution. The underlying principles—transparency, multi-channel access, institutional authority, and behavioural commitment—are theoretically transferable; however, their

effectiveness may depend on contextual factors such as levels of institutional trust, cultural norms, and prior exposure to official surveys. Survey methodology research suggests that response behaviour is strongly shaped by these macro-level conditions (Groves *et al.*, 2009; Harkness *et al.*, 2010). Cross-national applications would therefore be necessary to assess the robustness and replicability of the strategy across different settings.

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SOCIAL QUALITY AS A MULTIDIMENSIONAL CONSTRUCT FOR ACTIVE AGEING: EVIDENCE FROM STRUCTURAL EQUATION MODELING

Adriana Cerasuolo



Abstract. Active Ageing policies in Europe often focus on elderly's productivity, overlooking broader structural and relational factors. To address this gap, we propose Social Quality (SQ) as a theoretical and methodological framework encompassing four dimensions: Social Empowerment, Social Cohesion, Social Inclusion, and Socioeconomic Security. Using Structural Equation Modeling (SEM) on data from the Italian ISTAT "Aspects of Daily Life" survey (2022), we validated a new SQ measure in a sample of adults aged 55–74. Results show robust links between SQ and subjective well-being, highlighting the importance of network resources and institutional support for older individuals' participation and overall quality of life.

1. Introduction

Increasing life expectancy now poses significant policy challenges at both national and European levels, and the "Active Ageing" (AA) paradigm has been a dominant response (Foster and Walker, 2015). However, in the European context, this model has increasingly shifted toward older adults' productivity and individual responsibility, potentially overlooking the multidimensional nature of aging (Moulaert and Paris, 2013; Paliotta, 2022). Indeed, not everyone possesses the necessary material, relational, or health-related resources to remain continuously active in the labor market or in caregiving roles (Xu *et al.*, 2020).

This critical perspective has prompted calls for policies that, while safeguarding financial sustainability, also consider structural diversity and emphasize both collective and individual well-being (Walker, 2011).

This study adopts Social Quality (SQ) as a theoretical and methodological framework to move beyond the productivity-focused vision of Active Ageing, proposing a broader perspective that integrates well-being, equity, and participation.

Despite its conceptual development, SQ has rarely been applied empirically to ageing. To our knowledge, this is the first attempt to operationalize the framework using Italian microdata. Based on 12,000 individuals aged 55–74 from the 2022 ISTAT "Aspects of Daily Life" survey, we estimated a second-order SEM model with four latent domains: Empowerment, Cohesion, Inclusion, and Socioeconomic

Security. We then investigated how Social Quality relates to individual well-being, operationalized through self-reported satisfaction with life and health.

Adopting an exploratory perspective, this study addresses two guiding questions: to what extent is Social Quality associated with life and health satisfaction among Italian adults aged 55-74? And how is Social Quality distributed across age, gender, and geography? We expect a positive association with subjective well-being, and systematic disadvantages in Social Quality across age groups, geographic areas, and gender.

The findings show that older age and living in Southern Italy correlate with lower SQ scores, particularly in socioeconomic security and empowerment, while gender differences are more nuanced: women show higher averages in cohesion yet report fewer social and economic resources. Overall, our results confirm a robust positive link between SQ and subjective well-being, suggesting that wherever older people benefit from stronger resource networks and institutional support, they report higher satisfaction in terms of health and life.

The results of this study validate a new SQ measure – replicable at both national and European levels – and emphasize the role of complex systems of relationships and resources in shaping later-life outcomes. We therefore call for SQ-based strategies to complement Active Ageing agendas with more context-sensitive and equitable interventions.

2. Background

Active Ageing, in its productive variant, has increasingly been used as a governance tool to reduce pension dependency and promote older adults' economic contributions (Moulaert and Paris, 2013; Foster and Walker, 2015; Paliotta, 2022). While this may respond to demographic pressures, it presents important theoretical and policy limitations. Prioritizing productivity tends to obscure the multidimensional nature of ageing, neglecting emotional, relational, and subjective dimensions central to later-life well-being (Xu *et al.*, 2020).

Moreover, by promoting a uniform model of individual responsibility (Rozanova, 2010) the dominant framing of Active Ageing gives rise to prescriptive policies that assume equal access to enabling resources – such as health, education, or income. This overlooks both structural inequalities and the diversity of ageing trajectories. Positive ageing in later life depends not on the quantity of codified activities, but on the alignment between participatory practices and the resources individuals are able to mobilize (Ramia and Voicu, 2022). By neglecting this alignment, the dominant paradigm of AA risks reproducing exclusion and weakening welfare systems' ability to guarantee inclusion, justice, and a dignified old age (Pfaller and Schweda, 2019).

A key institutional expression of this productivist shift within the European paradigm is the Active Ageing Index (AAI), promoted by UNECE and the European Commission in 2012 to monitor and compare how countries support Active Ageing (Zaidi *et al.*, 2013). The index primarily reflects economic and productivity-related aspects – particularly employment and volunteering – while underrepresenting fundamental dimensions such as social security and subjective well-being. Its fixed and imbalanced weighting structure tends to overlook individual diversity and contextual specificities (De São José *et al.*, 2017; Zannella *et al.*, 2021), effectively shifting the burden of responsibility onto individuals and underestimating the influence of context and opportunity structures for older adults.

These dynamics become even more evident when considering territorial and gender disparities. In Italy, regional applications of the AAI have revealed significant North–South divides linked to GDP and public service quality, highlighting how official weightings penalize regions with low employment rates among older adults (Quattrociocchi *et al.*, 2021). In parallel, Zannella *et al.* (2021) have shown that AAI scores diverge substantially by gender. At the European level, cluster analyses by Przybysz and Stanimir (2023) demonstrate how national contexts produce heterogeneous ageing profiles, reinforcing the need to recalibrate the AAI's official weightings to better reflect territorial and demographic diversity.

Recognizing that ageing should encompass security, relationality, and personal development, we propose Social Quality as a broader and more inclusive framework. SQ emphasizes the individual's capacity to participate meaningfully in community life under conditions that promote well-being (Walker, 2011), viewing ageing as a comprehensive experience of citizenship shaped by social and institutional contexts (Lin and Herrmann, 2022). This perspective is grounded in four conditional factors: (1) Socioeconomic Security, ensuring access to essential resources and protection from deprivation; (2) Social Cohesion, capturing trust and the strength of social bonds; (3) Social Inclusion, reflecting equal access to civic, political, and cultural rights; and (4) Social Empowerment, fostering autonomy and the capacity to influence decisions (Van de Maesen and Walker, 2005).

As George (2010) and Ryff (2014) emphasize, well-being in later life depends not merely on the presence of activity, but on the individual's capacity to exercise control, maintain meaningful relationships, and pursue personally relevant goals. Participation, therefore, contributes to well-being only when it aligns with one's values and circumstances. Only when older people enjoy real freedom of choice – supported by adequate health, financial security, and social connections – can engagement in social or economic activities foster subjective well-being and continuity of identity (Cerase, 2024; Ramia and Voicu, 2022).

The SQ framework is operationalized through 95 indicators across 18 domains (Van de Maesen and Walker, 2005), from which this study derives its empirical

measures. By integrating these dimensions into a functional-structural approach, the Social Quality framework expands the concept of Active Ageing beyond productivity metrics, adopting an enabling perspective that emphasizes the structural conditions sustaining diverse forms of participation and well-being in later life.

3. Data, Method and Results

3.1. Data

The study uses data from the 2022 edition of ISTAT's "Aspects of Daily Life"(AVQ) survey, part of the Multipurpose Household Surveys system. It gathers information on education, work, health, relationships, participation, and service use, offering a broad view of socioeconomic conditions and perceived well-being. We extracted a subsample of about 12,000 individuals aged 55–74, consistent with the age range used by the Active Ageing Index to assess employment and participation. The sampling design, covering municipalities of all sizes, ensures national representativeness and accounts for key sociodemographic and territorial differences.

3.2. Method

To empirically operationalize the multidimensional construct of Social Quality, we employed Structural Equation Modeling (SEM) – a robust statistical framework suited for testing complex relationships between latent variables and observed indicators in the social sciences. SEM is particularly appropriate for capturing abstract constructs such as SQ, which are not directly observable but emerge from consistent patterns across multiple items (Byrne, 2016).

This study adopted a reflective measurement approach, in which latent variables are conceptualized as the underlying source of variation in observed measures. Factor loadings, standardized for comparability, quantify the strength of this relationship (Kline, 2016; Brown, 2015).

Social Quality was specified as a second-order latent construct composed of four first-order dimensions: Social Empowerment, Social Cohesion, Social Inclusion, and Socioeconomic Security. These dimensions were measured using ordinal-response items from the AVQ survey.

Given the nature of the data, we employed the DWLS estimator, which uses polychoric correlations and minimizes bias in non-normal distributions (Rhemtulla *et al.*, 2012).

A stepwise estimation strategy was adopted: first-order factors were validated through individual CFA models and then integrated into a hierarchical SEM specifying Social Quality as a second-order latent construct. Two outcome variables – life satisfaction and health satisfaction – were added to the second-order SEM to

assess predictive validity, confirming SQ's relevance as a multidimensional predictor of well-being in later life (George, 2010; Ryff, 2014).

Table 1 details the observed variables used to estimate the first-order factors.

Table 1 – *The observed variables used to estimate the first-order factors.*

First Order Factor	Observed Variables
Social Inclusion	Perceived freedom of expression
	Perceived freedom of political group activity
	Perceived freedom of action for civic organizations
	Perceived equality of rights regardless of personal orientation
	Perceived gender equality in rights
	Perceived freedom to practice one's religion
	Perceived fairness of the judicial system
Social Cohesion	Having friends to rely on in times of need
	Frequency to meet friends
	Satisfaction with friendships
	Satisfaction with family relationships
	Satisfaction with leisure time
	Trust in strangers
Social Empowerment	General trust in others
	Frequency of going to the cinema
	Time spent using the computer
	Frequency of dining out
	Educational level attained
	Frequency of visiting monuments
	Frequency of visiting museums
	Participation in volunteer work
Socioeconomic Security	Participation in cultural events
	Participation in political/associative activities
	Perceived economic security of the household
	Satisfaction with current economic situation
	Comparison of current vs. past economic situation
	Perceived personal safety
	Satisfaction with environmental quality in area of residence

Model fit for the CFA and the SEM model was evaluated using key fit indices: CFI (Comparative Fit Index), TLI (Tucker–Lewis Index), RMSEA (Root Mean Square Error of Approximation), and SRMR (Standardized Root Mean Square Residual). In line with the literature (Hu and Bentler, 1999; Schermelleh-Engel *et al.*, 2003), model fit was considered satisfactory if CFI/TLI exceeded 0.95, RMSEA was below 0.06, and SRMR was below 0.08.

In parallel, the internal reliability of each first-order factor was assessed using ordinal alpha (Zumbo *et al.*, 2007), which employs polychoric correlations, and

Composite Reliability (CR), which accounts for factor loadings and measurement error (Raykov, 1997). We adopted a threshold of 0.70 as the minimum acceptable CR value, but following Bagozzi and Yi (1988), also accepted values between 0.60 and 0.70 for theoretically heterogeneous constructs or in the presence of non-unidimensional indicators.

To verify model stability across sociodemographic subgroups, we performed a three-level factorial invariance analysis – configural, metric and scalar (Meredith, 1993) – using $\Delta CFI < 0.010$ as the acceptance threshold (Cheung and Rensvold, 2002). Results confirmed that the structure held across age, gender and geographic macro-areas, legitimizing latent-mean comparisons. Because the study is descriptive/exploratory and includes only five fixed macro-regions – not enough to support reliable estimation of level 2 variance (McNeish and Stapleton, 2016) – we retained a single-level multi-group SEM instead of a multilevel alternative, which would have added complexity without clear analytical benefit.

Once the second-order model was validated, individual factor scores were extracted with the regression method (Brown, 2015). Weighted by loadings and measurement error, these scores surpass simple averages for descriptive and subgroup analyses; we rescaled them to 0–100 to facilitate interpretation and used them to profile Social Quality and its four domains among older Italians.

3.3. Results

The CFA models for the four first-order factors – Social Empowerment, Social Cohesion, Social Inclusion, and Socioeconomic Security – showed high CFI and acceptable RMSEA and SRMR values (Hu and Bentler, 1999; Schermelleh-Engel *et al.*, 2003). As shown in Table 2, each domain displayed adequate internal consistency, supporting the validity of items grouping (Brown, 2016). Although some constructs had CR values slightly below 0.70, the strength of the CFA models and their theoretical foundation justified inclusion (Bagozzi and Yi, 1988).

Table 2 – Fit indices and internal consistency for each domain.

First Order Factor	CFI	TLI	RMSEA	SRMR	CR	Ordinal Alpha
Social Empowerment	0.994	0.991	0.032	0.041	0.851	0.854
Social Cohesion	0.988	0.975	0.044	0.042	0.645	0.684
Social Inclusion	0.998	0.998	0.043	0.026	0.952	0.951
Socioeconomic Security	0.99	0.976	0.043	0.029	0.623	0.639

Subsequently the second-order SEM model confirmed the robustness of Social Quality (SQ) as a multidimensional construct. Indeed, the inclusion of four first-order factors in a second-order SQ model maintained excellent fit indices. CFI was 0.97 and TLI was 0.967, while RMSEA (0.045) and SRMR (0.066) were within the

commonly accepted thresholds (Hu and Bentler, 1999; Schermelleh-Engel *et al.*, 2003).

Structurally, the factor loadings of the four primary domains were all significant ($p < 0.001$) and of acceptable magnitude, ranging from 0.34 (Social Cohesion) to 0.80 (Social Inclusion). This suggests that, although each domain plays a specific role, they synergistically contribute to the formation of a general factor (Byrne, 2016). Moreover, residual correlations and items thresholds indicate that response categories were sufficiently distinct, ensuring adequate discriminant power in measuring Social Quality and its constituent dimensions (Kline, 2011).

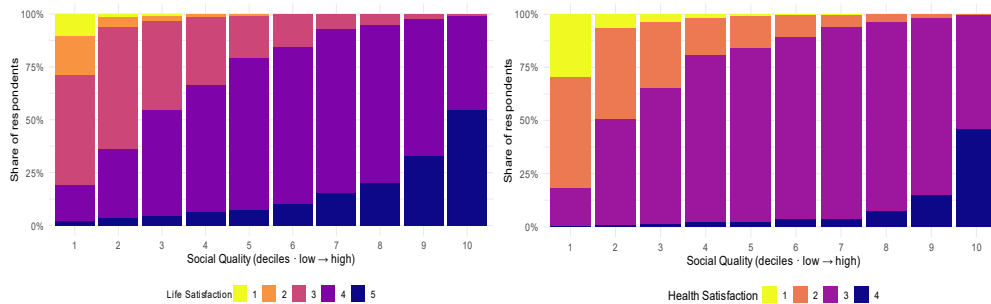
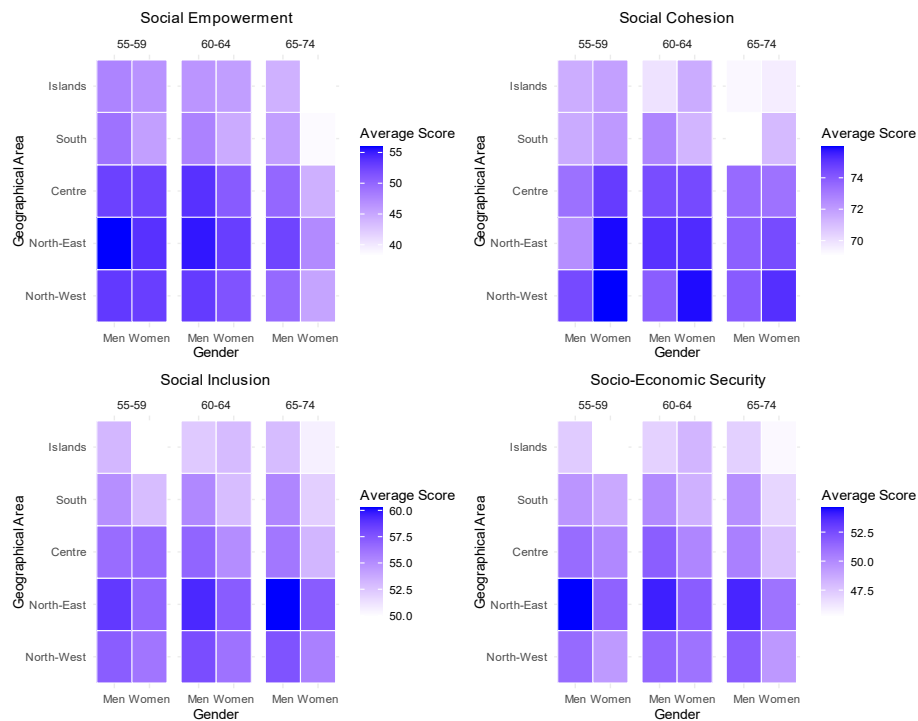
The analysis of outcome variables – health satisfaction and life satisfaction—revealed standardized positive and consistent effects ($\beta = 0.583$ and $\beta = 0.562$, respectively), highlighting the enabling role of Social Quality in fostering ageing processes characterized by participation and individual well-being (George, 2010; Ryff, 2014).

Figure 1 displays a clear monotonic empirical relationship between Social Quality and both life and health satisfaction. As SQ increases, the share of respondents reporting high satisfaction rises sharply, while low-satisfaction categories progressively disappear. Notably, for life satisfaction, the top score “5” jumps from $\approx 5\%$ in the bottom decile to $>60\%$ in the top; health satisfaction shows a similarly steep climb. Even modest SQ improvements in mid-range (5-6) groups already yield significant well-being gains.

This study also offers a key comparative contribution through the analysis of factor scores derived from the second-order SQ model, enabling meaningful comparisons of average Social Quality levels across age groups, gender, and geographical areas.

Figure 2 shows how age particularly affects three dimensions: empowerment, socioeconomic security, and social inclusion tend to decline with increasing age. The impact of ageing becomes especially evident in these areas, suggesting a progressive erosion of the structural conditions that sustain meaningful participation in later life. Social cohesion, by contrast, appears to remain more resilient – showing limited decline across age groups and regions. An exception is observed among men aged 65-75 in Southern Italy, who report notably lower scores. Gender reveals a mixed pattern: women report higher scores than men in social cohesion but are less advantaged in terms of socioeconomic security and access to social and cultural resources (empowerment) – domains in which men tend to score higher. Moreover, social inclusion appears to decline with age, except among women in the Islands, where younger cohorts report even lower scores than older ones – an inversion that may point to territory - or generation-specific disadvantages.

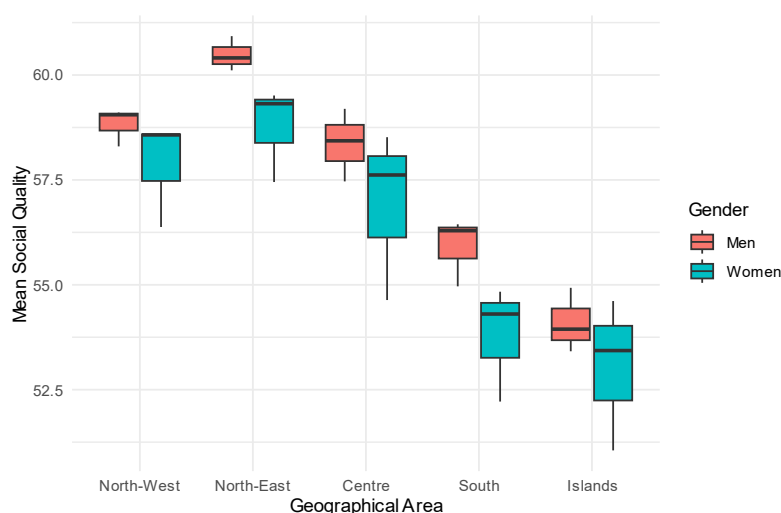
Territorial inequalities are also evident highlighting a persistent North-South divide to the disadvantage of Southern Italy (especially the Islands).

Figure 1 – Life and Health Satisfaction Across Social Quality Deciles.**Figure 2 – Average Scores by Age, Gender and Geographical Area.**

Finally, Figure 3 confirms a consistent gender gap across all geographical areas, with women scoring on average 1-2 percentage points lower than men in overall Social Quality scores, and with distributions systematically shifted downward. Additionally, total SQ score also declines steadily from the North-East to the Islands,

with the Southern regions averaging about 5 percentage points below the Northern ones.

Figure 3 – Social Quality by Geographical Area and Gender.



4. Conclusion

This study contributes to redefining the concept of “good ageing” shifting the focus from a narrow, productivity-driven model to a broader perspective centered on full citizenship, self-realization, and well-being.

Unlike the Active Ageing Index (AAI), which assigns fixed weights to its four domains based on expert judgment, our Social Quality approach is grounded in a latent structure empirically validated through Structural Equation Modeling. This enables a data-driven weighting scheme that reflects the actual interrelations among indicators. By focusing on structural interdependencies rather than direct measures of participation, the model redirects attention to the conditions that enable or hinder individual agency. Moreover, while the AAI draws on aggregated and objective data our approach is based on micro-level individual data, allowing for a more granular understanding of inequalities. Finally, by employing newly introduced indicators on social cohesion (available from 2021 in the AVQ survey), the model captures recent changes in the social fabric and reflects emerging contextual dynamics.

A key limitation of this study concerns the exclusion of indicators related to essential services – such as healthcare – due to the high proportion of missing data in the relevant subsample of the AVQ survey. While these dimensions are included

in the dataset and conceptually embedded in the Social Quality framework, their limited empirical reliability prevented their integration into the model. Moreover, the cross-sectional nature of the analysis constrains our capacity to determine causal directions or observe temporal dynamics. Future research will overcome these limitations by drawing on longitudinal and more complete datasets (e.g., the European Social Survey), thus enabling a more robust and comparative validation of the Social Quality model across both national contexts and time periods.

In practical terms, a Social Quality indicator system could be adopted by national and local governments to monitor territorial disparities and guide the planning of age-friendly policies – for instance, by targeting areas with low empowerment scores with investments in cultural infrastructure or community-based programs for older adults.

In conclusion, while demographic pressures increasingly call for the prolonged participation of older adults, this imperative cannot ignore questions of social justice and individual well-being. Moreover, measuring the extent of participation alone does not ensure that people are genuinely empowered to remain active. Integrating the productivity-oriented logic of the Active Ageing Index with the Social Quality approach means shifting the focus to the conditions that make such participation truly possible. A combined dashboard could thus help assess not only whether older people are participating, but under what circumstances – and to what extent this reflects autonomy, inclusion, and fairness.

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EXPLORING THE LINK BETWEEN SELF-RATED HEALTH AND VULNERABILITY AMONG REFUGEES IN ITALY

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Luigi Campaniello, Ezio Sorti

Abstract. The literature indicates that migrants tend to be a selected group from the population of their country of origin, particularly with respect to health status. In contrast, asylum seekers and refugees typically represent a less selected group as highlighted by empirical evidence. The health status of these specific subgroups of migrants remains under-researched for the Italian context. However, asylum seekers and refugees may have specific health needs stemming from their pre-migration and travel experiences that warrant further investigation. This study addresses this gap by examining self-rated health among asylum seekers and refugees residing in Italy. Health status is analyzed in relation to socio-demographic characteristics and various dimensions of vulnerability. We draw on data from a unique survey conducted in 2024 on asylum seekers and refugees living in Italy with a total sample of 1,327 individuals. Our results highlight a positive relation between social support networks and health status. Conversely, experiences of discrimination, economic deprivation, female gender, and older age are negatively associated with health outcomes.

1. Introduction

Literature suggests that migrants often represent a selected group from their country of origin in various aspects, including health (Aldridge *et al.*, 2018). In contrast, refugees tend to be less selected, as their migration is often forced, urgent, and unplanned due to conflict or disaster, leaving them with limited preparation and resources. As a result, they face increased physical and mental vulnerability, shaped by traumatic experiences both before and during migration (Crepet *et al.*, 2017; Simonnot *et al.*, 2016). Although research on refugee health has grown in recent years, this subgroup remains underexplored, particularly beyond the domain of mental health (Lindert *et al.*, 2009; Steel *et al.*, 2009; Kirmayer *et al.*, 2011; Schweitzer *et al.*, 2011). Moreover, in Italy, the health status of refugees remains significantly under-researched (Barbiano di Belgiojoso *et al.*, 2024). Asylum seekers and refugees may have specific health needs stemming from their pre-migration and travel experiences that warrant further investigation. The existing literature highlights the significant challenges, arising from legal and informal barriers, that migrant populations face in accessing healthcare services across different host

countries. In many European countries healthcare access for irregular migrants and asylum seekers is limited to emergency services only (Norredam *et al.*, 2006; Cattacin and Björngren-Cuadra, 2010). Additionally, migrants often encounter further obstacles such as lack of awareness of their entitlements, language barriers, cultural misunderstandings, and administrative difficulties (Harmsen *et al.*, 2003; Biffi, 2003; Allegri *et al.*, 2025).

In this study, vulnerability is conceptualised as a dynamic and multidimensional condition shaped by socio-economic disadvantage, social exclusion, and post-migration living conditions, which influence both exposure to health risks and the ability to cope with them. Within this framework, self-rated health represents a suitable outcome for capturing vulnerability, as it reflects both objective health conditions and individuals' subjective evaluation of their overall well-being. Importantly, self-rated health is sensitive to cumulative disadvantage linked to economic hardship, discrimination, and barriers to healthcare access, which are central dimensions of refugees' vulnerability. Several studies indicate that limited access to healthcare contributes to worsening health outcomes, particularly in managing chronic or long-term conditions (Robjant *et al.*, 2009; Coffey *et al.*, 2010). Research specifically focused on refugees has further shown that those with regular healthcare access report higher social inclusion, better mental well-being, and improved self-rated health (Jaschke *et al.*, 2021; Bozorgmehr *et al.*, 2015; Morris *et al.*, 2009).

The aim of this study is to address this gap by analyzing how self-rated health among asylum seekers and refugees living in Italy is associated with key dimensions of vulnerability. Specifically, we ask whether socio-economic disadvantage, experiences of discrimination, and social support are related to self-rated health, and whether these associations vary by age and gender.

2. Data and method

2.1 Data and sample

We used data from the project *Assessing the Vulnerability of Refugees and Asylum Seekers in Italy (AVRAI)*, which investigates multiple dimensions of vulnerability among asylum seekers and refugees, including economic status, health, social networks, integration, and discrimination. Data were collected through the *ITRAS* survey, an ad hoc survey conducted between April and July 2024, involving 1,327 asylum seekers and refugees residing in Italy who arrived after 2011. The survey targeted individuals aged 18 and older, encompassing a wide range of legal-administrative statuses, including refugee status, subsidiary protection, temporary

protection, humanitarian permits, long-term residence permits (EU), residence permits, and citizenship. It also included individuals awaiting the outcome of their asylum application or those in the appeal process following a rejection. Conversely, rejected applicants without an active appeal and individuals with expired permits and no pending appeal were excluded from the survey. While the dataset includes individuals with multiple nationalities, for our analysis we focused to the most represented citizenship groups in the sample (those with at least 70 respondents): Bangladesh, Egypt, Eritrea, Nigeria, Pakistan, Ukraine, and a residual other category.

2.2 Methods and variables

To examine the relationship between different dimensions of vulnerability and health outcomes, we estimated a logistic regression model using self-rated health (SRH) as a binary dependent variable.

Our models control for age, along with its squared term to account for potential nonlinear effects, as well as gender and level of education. In addition, we included selected socio-demographic characteristics and key dimensions of vulnerability. Economic vulnerability was assessed through reported experiences of economic deprivation, while integration was proxied by experiences of discrimination, the availability of a social support network in case of need, and the presence of a cohabiting partner. Finally, to capture the stability of the migration experience, we included the length of stay in Italy along with its squared terms to account for potential non-linear effects on health outcomes.

2.2.1 Variable description

Regarding the construction of the dependent variables, self-rated health was measured as a binary variable, where respondents who answered "very good" to the question "*How is your health in general?*" (on a scale from 0 to 5, with 5 indicating very good) were assigned a value of 1, while all other responses were coded as 0.

The dependent variable was dichotomized to isolate respondents reporting the highest level of self-rated health. This operationalization aims to capture a condition of optimal health and is supported by evidence indicating that individuals tend to use extreme response categories sparingly when assessing their health, often favoring intermediate options instead (Barbiano di Belgiojoso *et al.*, 2024).

Regarding the independent variables, economic deprivation was measured as a dummy variable based on 13 items reflecting the respondent's inability to afford essential goods and services, including furniture, heating, meat, clothing, shoes, internet, holidays, unexpected expenses, leisure activities, meeting friends, pocket

money, and car ownership. Following the Eurostat definition¹, severe economic deprivation was defined as scoring 7 or more on this scale. The variable *experienced discrimination* was constructed based on responses to the question: “Have you ever experienced discrimination?” Respondents who reported having been subjected to any of the following experiences - receiving threats or harassment, being treated with less respect, receiving worse service, being perceived as less intelligent, or being treated as though others were afraid of them - were classified as having experienced discrimination. Those who reported none of these experiences were classified as not having experienced discrimination. The presence of a social network was captured through two variables: Italian network and non-Italian network. Respondents were classified as having a social support network if they reported having at least one friend with whom they could easily discuss personal problems. Those who reported having no friends or being unlikely to discuss their problems were classified as not having a support network.

3. Results

Descriptive results show that 27% of respondents rated their health as “very good,” while 48% described it as “good”. Reports of poor health were relatively infrequent: only 7% of the sample indicated either “poor” or “very poor” health.

When comparing their current health status to that prior to migration, 18% reported improved health, 63% reported no change, and 20% reported worse health. Additionally, 16% of respondents reported an unmet need for healthcare.

Among those with unmet healthcare needs, the most commonly reported reasons were waiting lists (38.6%), financial constraints (24.3%), inability to take time off work (23.6%), bureaucratic obstacles (23%), language barriers (17%), and a decision to wait and see if the problem would resolve on its own (12%).

¹ Eurostat defines material and social deprivation as the inability to afford a set of specific goods, services, or social activities that are considered by most people as essential for an adequate quality of life. The material and social deprivation rate is defined as the share of the population unable to afford five or more of these thirteen items. The severe material and social deprivation rate applies to those unable to afford seven or more.

Table 1 –Odds ratios, significance and confidence intervals (in parentheses) of the logistic regression model

<i>Odds Ratios</i>	<i>Very good SRH</i>
Gender (ref. male)	
Female	0.66**[0.48; 0.91]
Age	0.94**[0.91; 0.98]
Age squared	0.92[0.67; 1.27]
Severely Deprived (ref. no)	
Yes	0.67**[0.48; 0.93]
Education (ref. lower)	
Medium-higher	0.94[0.68; 1.32]
Length of stay	0.98[0.82; 1.16]
Length of stay squared	1.01[0.99; 1.02]
Experienced discrimination (ref. no)	
Yes	0.67**[0.48; 0.91]
Italian friendly network (ref. no)	
Yes	1.5**[1.10; 2.05]
Not Italian friendly net. (ref. no)	
Yes	0.54**[0.38; 0.78]
Relationship status (ref. single or widow)	
Cohabiting partner	3.01***[2.11; 4.26]
Non-cohabiting partner	2.41***[1.60; 3.63]
Nationality (ref. Bangladesh)	
Egypt	3.64**[1.38, 9.61]
Eritrea	1.62[0.55; 4.71]
Nigeria	2.86**[1.26; 6.47]
Pakistan	2.71**[1.18; 6.18]
Ukraine	2.41** [1.11, 5.23]
Other	3.07**[1.50; 6.25]

Source: authors' elaborations on AVRAI data.

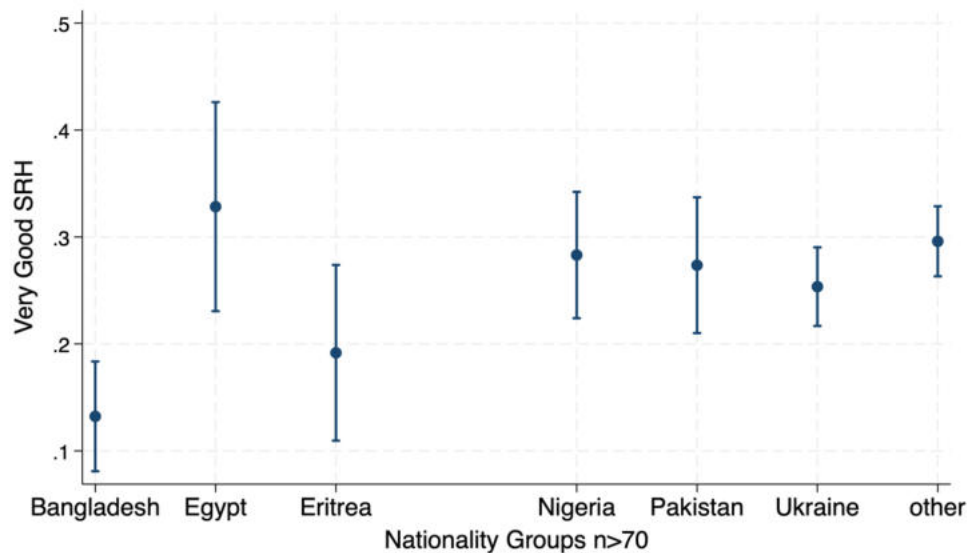
Notes: Odds ratios reported, with 95% confidence intervals in brackets.

* $p < 0.05$; ** $p < 0.01$; *** $p < 0.001$.

Our empirical findings (Table 1) indicate that men are more likely to report very good self-rated health while age is negatively associated with this outcome. Economic deprivation is associated with lower probabilities of reporting very good health while no association emerges with the educational level. With regard to length of stay in Italy, the results do not suggest a linear relationship with health outcomes. Individuals who have experienced discrimination are less likely to report very good self-rated health. Social networks are associated with health outcomes. Having a support network composed of Italian friends is related to a higher likelihood of reporting very good self-rated health. In contrast, having a network composed of non-Italian friends appears negatively related to the probability of reporting very

good self-rated health. Most importantly, a strong association with the partnership status emerged: individuals with a partner, whether cohabiting or not, are more likely to report very good self-rated health. The size of this effect is substantial, with odds ratios exceeding 2.4 and reaching values around 3 for cohabiting individuals, suggesting that partnership status captures a combination of protective factors such as emotional support, shared economic resources, and greater stability in everyday living conditions. Nationality also appears strongly associated with health outcomes (Figure 1).

Figure 1 - Adjusted Predicted Probabilities of Reporting Very Good Self-Rated Health by country of origin.



Source: authors' elaborations on AVRAI data.

Respondents from Egypt, Nigeria, Pakistan, Ukraine, Eritrea, and other nationalities are more likely to report very good self-rated health compared to the reference group (Bangladesh). However, the relatively large odds ratios observed for several national groups should be interpreted with caution, as they may reflect unobserved heterogeneity in migration trajectories, legal pathways, and post-migration conditions rather than inherent health differences between nationalities. We also tested an alternative model using a binary health variable in which the value 1 included both “good” and “very good” self-rated health, rather

than only “very good.” This alternative model confirmed the same general patterns, although the results were less pronounced.

4. Discussion and Conclusion

Our findings align with previous literature on the association between poor health outcomes, female gender and older age (Pavli *et al.*, 2017; Gerritsen *et al.*, 2006). Similarly, individuals who experience discrimination are more likely to report poor self-rated health (Noh and Kaspar, 2003; Kenny *et al.* 2024; Van Tubergen, 2025). In addition, social network support, family reunification, and marital status emerge as protective factors for health, underscoring the critical role of social integration in migrant well-being (IOM, 2021; Grochtdreis, 2020; Fuller-Thomson *et al.*, 2011). The health disparities observed across nationalities in our data may also reflect cultural differences in the way health is perceived and reported (Mazzetti, 2019). The differing roles of Italian and non-Italian support networks observed in our results can be interpreted in light of existing literature on migrant social networks (e.g. Ortensi and Barbiano di Belgiojoso, 2017). Research suggests that in the early stages of migration, social ties are primarily formed with individuals from the same geographical or cultural background (Ryan, 2011; Village *et al.*, 2017). These *bonding ties* provide immediate support and reinforce a sense of belonging within the migrant community. However, they may also limit access to resources and opportunities outside of that community. In contrast, successful integration into the host society and the development of a broader sense of belonging to the new environment require the formation of *bridging ties*, which extend beyond ethnic and cultural boundaries (Pearce, 2008; Lancee, 2016). These connections facilitate access to more diverse forms of support, information and opportunities that are often unavailable within co-national networks. The negative association observed for non-Italian networks should not be interpreted as a detrimental effect of these ties *per se*. Rather, it may reflect selection processes whereby individuals in poorer health or more vulnerable conditions rely more heavily on co-national networks due to limited access to broader social resources.

This study has some limitations. First, self-rated health may be subject to reporting bias and cultural differences in health perception across groups. Second, the sample does not include the most vulnerable irregular migrants, which may lead to an underestimation of health inequalities.

Given the extensive range of variables available to assess vulnerability, further analysis is necessary to test the robustness of these findings. Other dimensions, such as the characteristics of the area of residence in Italy and of the dwelling will be

explored in future work. Moreover, we aim to incorporate other health outcome variables available in the dataset, which capture additional dimensions of well-being.

This study provides valuable insights into the health of refugees and asylum seekers in Italy, a context that remains underexplored in migration and health research. The findings highlight the importance of targeted policies to mitigate the adverse health impacts of migration. In particular, gender-sensitive policies, interventions that promote economic integration, and measures fostering social inclusion are essential to improving health outcomes among refugees and asylum seekers. Ensuring equitable access to healthcare services is equally crucial to addressing unmet healthcare needs and enhancing the overall well-being of migrant and refugee populations.

Policymakers should prioritize the reduction of barriers to healthcare, address discrimination, and strengthen support networks to facilitate better health outcomes for refugees and asylum seekers.

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R&D EXPENDITURE AND REGIONAL INNOVATION IN ITALY: EVIDENCE FROM A PANEL DATA ANALYSIS

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Abstract. This study investigates the relationship between Research and Development (R&D) expenditure and innovation across Italian regions, employing patent applications as a proxy for innovation output. The primary objective is to assess the extent to which different types of R&D expenditure — higher education, business, and public sector — contribute to regional innovation capacity, under the assumption that knowledge constitutes a fundamental driver of economic growth. The findings reveal that higher education R&D expenditure has a significant and positive long-term impact on patent production, while business and public R&D expenditures show no statistically significant effects. These results highlight the central role of universities in Italy's innovation system and suggest policy implications aimed at enhancing university-industry collaboration and improving the effectiveness of public R&D funding.

1. Introduction

Since the late 1980s, endogenous growth theories have emphasized the crucial role of Research and Development (R&D) expenditure as key drivers of economic growth (Romer, 1990; Aghion & Howitt, 1992; Grossman & Helpman, 1991). Within this framework, R&D is recognized not only as a source of innovation but also to accumulate technological capabilities and absorb existing knowledge (Islam, 2009). Numerous empirical studies have shown that countries and regions investing more in R&D tend to experience faster economic growth and enjoy higher levels of social welfare (OECD, 2007; Edquist, 2011).

However, not all R&D investments yield equivalent impact. Business R&D targets patentable innovation and commercialization, whereas public and university research primarily drives fundamental knowledge, human capital formation, and spillovers within evolving innovation models (Guerrero *et al.*, 2015; Carayannis & Campbell, 2009). In the Italian context, this issue is particularly relevant due to significant territorial disparities and the strong presence of a public university system. Understanding the differentiated impact of R&D sources is thus essential to identifying the most effective levers to promote innovation at the regional level.

This study aims to empirically assess the impact of R&D expenditure on regional innovation performance in Italy. Innovation is measured by the number of patent applications, a widely used proxy in the literature (Bottazzi & Peri, 2003; De Rassenfosse *et al.*, 2013). Despite being a common measure, patents capture only formalized and patentable aspects of technological knowledge and do not capture non-patentable forms of innovation, such as tacit knowledge, process improvements, or organizational innovations. However, as stated by Griliches (1998), patent statistics remains a relevant tool, owing to their wide availability, their ability to capture inventiveness, and their slowly changing standard. Results should thus be read as reflecting one important dimension of regional innovation.

The analysis employs a Panel Autoregressive Distributed Lag (ARDL) model estimated through the Pooled Mean Group (PMG) estimator, which allows for both short-run dynamics and long-run equilibrium relationships.

2. Literature review

The role of Research and Development (R&D) expenditure as a fundamental driver of technological innovation and sustained economic growth. Endogenous growth theories pioneered by Romer (1986, 1990) and Lucas (1988) place knowledge accumulation and human capital at the heart of growth dynamics, emphasizing the non-rival and cumulative nature of technological progress. Within this framework, R&D investment is the key input that fuels the discovery of new ideas, enhancing productivity and long-term economic performance (Aghion & Howitt, 1992, 1998; Jones, 1995).

Innovation is commonly proxied by patent counts. Despite capturing only formalized knowledge, patents remain the most reliable output indicators due to their traceability, territorial specificity, and suitability for international comparisons (Griliches, 1990; Archibugi, 1992). Patent-based measures have been critically examined in literature, recognizing both their merits and limitations (Hall & Harhoff, 2012). Elasticity analyses, based on the newly introduced worldwide count of priority patents, confirm a stable long-run association between R&D intensity and patent propensity (De Rassenfosse *et al.*, 2013).

The literature delineates R&D expenditure into three principal components: business R&D (BRD), public R&D (PRD), and higher education R&D (HRD), each contributing differently to the innovation ecosystem. Business R&D is typically motivated by commercial objectives and serves as a crucial endogenous factor for economic growth (Wei *et al.*, 2001).

The entrepreneurial role of universities is framed by the Triple and Quadruple Helix models, which highlight their function as intermediaries connecting science,

industry, and government (Etzkowitz, 2003; Guerrero *et al.*, 2015; Perkmann *et al.*, 2013). Universities not only conduct fundamental research but also engage in technology transfer, patent licensing, and spin-off creation, thereby amplifying knowledge spillovers and enhancing regional innovation capacity (Audretsch & Keilbach, 2011). Moreover, public–private collaboration policies have been found to strengthen the effectiveness of R&D investments, specifically by moderating knowledge flows and enhancing the transfer of university knowledge to firms (Azagra-Caro & Consoli, 2016; Bellucci & Pennacchio, 2015).

Empirical research has consistently demonstrated a positive and statistically significant relationship between R&D expenditure and innovation output across multiple levels of analysis, including national contexts (Porter & Stern, 2000) and regional systems (Bottazzi & Peri, 2003; Barra & Zotti, 2018). Cross-country and regional analyses confirm that corporate and university research significantly enhance patent output, driving innovation at the national (Furman & Hayes, 2004) and regional level (Buesa *et al.*, 2006), while public R&D often shows more variable or context-dependent effects, underscoring the importance of efficient coordination and institutional design (Bilbao-Osorio & Rodríguez-Pose, 2004).

In Germany, firm cooperation with public research institutions has been shown to positively influence patenting activity, emphasizing the value of collaborative innovation networks (Fritsch & Franke, 2004). Broader European evidence also confirms the importance of R&D for innovation: analyses by Pegkas *et al.* (2020) show a positive relationship between R&D expenditure and innovation output across EU countries, and according to the European Patent Office (EPO, 2024), universities and public research organizations accounted for about 8% of European patent applications in 2023, with a steady increase among the most active academic institutions, especially in digital technologies and life sciences. Furthermore, Wolszczak-Derlacz (2025) demonstrates that institutional size, age, research orientation, and funding structure are the main determinants of university patenting and co-patenting performance, suggesting that targeted policies can foster higher patent output.

In the Italian context, Barra and Zotti (2018) show that while all three R&D components contribute significantly to regional innovation performance, the R&D investments from universities and the private sector benefit the regional innovation activities the most. They also highlight the strategic role of intermediation structures, such as university technology transfer offices. However, the Italian innovation system faces specific challenges, including the predominance of SMEs, relatively low private R&D intensity, and fragmentation within public research, which limit the conversion of R&D expenditure into patentable innovations (Sterlacchini, 2008; Malerba *et al.*, 1999; Evangelista & Vezzani, 2010). Recent studies further highlight the strategic role of universities as central actors in innovation systems, both through

direct patent production and via collaboration with private firms. For instance, Rusciano (2024), analyzing the “third mission” in Italian universities, shows how university–industry collaborations can amplify technology transfer capacity and improve the quality and impact of patents.

There are structural reasons to expect a stronger impact of HRD on patenting compared to other forms of R&D. The Italian university system is predominantly public and centrally governed, with evaluation frameworks (e.g., ANVUR, VQR) that promote third mission objectives. Many universities have Technology Transfer Offices (TTOs), incubators, and consortia that foster the translation of research into intellectual property (Perkmann *et al.*, 2013; Abramo & D’Angelo, 2022). In contrast, public R&D is often aimed at broad goals, while business R&D is fragmented across SMEs with limited resources for patenting or a preference for informal protection strategies (Bugamelli *et al.*, 2018). These features help explain the greater empirical significance of HRD in regional patent output.

3. Data and methodology

The empirical analysis is based on a panel data comprising the 20 Italian regions over the period 1995-2022. The variables were derived from the EUROSTAT and the Ministry of Enterprise and Made in Italy¹. The aim of this study is to assess the impact of the different components of Research and Development (R&D) expenditure on innovative activity. This is measured through the annual number of patent applications (PAT), recognised as an established proxy for quantifying technological innovation in regional studies of knowledge spillovers (Bottazzi & Peri, 2003) and innovation system efficiency (Barra & Zotti, 2018). The explanatory variables considered include R&D expenditure of the business (BRD), public sector (PRD) and Higher Education (HRD).

Initially, unit root tests were employed to examine the order of integration of the variables in the panel dataset. Different unit root tests were estimated, according to Im *et al.* (2003), Dickey and Fuller (1979, 1981) and Phillips and Perron (1988), to test the hypothesis that each panel data series has a common unit root process.

Table 1 shows the results of panel unit roots tests for each variable, first in levels and next in first differences.

¹ Data are available in:

https://ec.europa.eu/eurostat/databrowser/view/rd_e_gerdreg/default/table?lang=en&category=scitech.rd.rd_e for Eurostat data; https://www.uibm.gov.it/bancadati/single_search/text_search/index/ for Ministry of Enterprise and Made in Italy data.

Table 1 – Panel unit roots tests.

Variables		Stationarity tests					
		Im, Pesaran and Shin W-test		ADF-Fisher test		PP-Fisher test	
PAT	Level	-4.0927	***	116.2672	***	142.0158	***
	First difference	-9.8124	***	339.6962	***	569.0605	***
BRD	Level	1.1284		10.2161		9.6490	
	First difference	-3.5090		116.8009	***	293.5381	***
PRD	Level	2.3200		17.8998		49.5938	
	First difference	-5.7731	***	194.1608	***	49.5938	
HRD	Level	-0.0231		44.3347		47.0223	
	First difference	-2.8028	***	143.9037	***	47.0223	

Source: Authors' elaboration

Notes: Selection of lags based on Akaike information criterion (AIC); Newey and West (1994) bandwidth selection using Bartlett kernel; Probabilities for Fisher tests are computed using an asymptotic Chi-square distribution; All other tests assume asymptotic normality; H_0 : Unit root (assumes individual unit root process).

*** Significant at 1% level

The null hypothesis of a unit root is not rejected for the explanatory variables in levels. On the contrary, all tests reject the null hypothesis when applied to the first differences, for each variable. Based on these combined results, the series appear to be non-stationary in levels and become stationary after first-order differencing. Therefore, it is concluded that each explanatory variable is integrated of order one, i.e., $I(1)$. In contrast, the dependent variable (PAT) is stationary in levels, and thus classified as $I(0)$.

To assess the existence of a long-run relationship among the variables, we implement the cointegration test proposed by Westerlund (2007). Unlike residual based approaches, Westerlund's procedure directly tests for the presence of an error correction mechanism and is particularly robust in the presence of cross-sectional heterogeneity and dependence—features that characterise our regional panel.

Table 2 reports the results, confirming the existence of a long-run relationship between the dependent and explanatory variables.

Table 2 – Cointegration test.

Westerlund test for cointegration	Value
Group-t statistics	-2.9675***
Panel-t statistics	-1.7743**

Source: Authors' elaboration.

Note: ***, ** indicate rejection of the null hypothesis of no cointegration at 1% and 5% level of significance, respectively.

The confirmation of a long-run equilibrium relationship among the variables, as indicated by the Westerlund cointegration test, provides a sound econometric justification for estimating a Panel ARDL model in its error-correction form. To this end, a Panel ARDL (1,1,1,1) specification is estimated using the Pooled Mean Group (PMG) estimator developed by Pesaran *et al.* (1999).

The PMG estimator is particularly well-suited for this empirical context, as it allows for the joint modelling of short and long-run dynamics in panel data settings with a mixture of $I(0)$ and $I(1)$ variables, provided that none of the series is integrated of order two ($I(2)$). Although the dependent variable is stationary in levels ($I(0)$), the use of Westerlund's (2007) test remains appropriate in the presence of $I(1)$ regressors, to assess whether a long-run equilibrium relationship exists driven by persistent dynamics in the independent variables.

A further advantage of the PMG estimator lies in its ability to accommodate regional heterogeneity in the short-run coefficients and adjustment speeds, while simultaneously imposing homogeneity in the long-run coefficients across regions.

This assumption is particularly appropriate in the case of Italian regions, which—despite exhibiting structural and economic differences—operate under a common institutional, legal, and policy framework that may generate similar long-run innovation dynamics.

The estimated model is expressed in an error-correction representation, capturing both the transitory responses of patenting activity to changes in R&D expenditure and the speed at which deviations from the long-run equilibrium are corrected.

The model is specified as follows:

$$\Delta pat_{i,t} = \phi EC_{i,t} + \beta_{i,1} \Delta BRD_{i,t} + \beta_{i,2} \Delta PRD_{i,t} + \beta_{i,3} \Delta HRD_{i,t} + \lambda_i \Delta PAT_{i,t-1} + \epsilon_{i,t} \quad (1)$$

$$EC_{i,t} = pat_{i,t-1} - \theta_1 BRD_{i,t-1} - \theta_2 PRD_{i,t-1} - \theta_3 HRD_{i,t-1} \quad (2)$$

Where:

$\Delta pat_{i,t}$ represents the annual change in patent applications in region i at time t , that is, the first difference of the variable pat .

$EC_{i,t}$ is the error correction term for region i at time t , which measures the deviation from the long-run equilibrium.

ϕ_i is the speed of adjustment coefficient toward the long-run equilibrium in region i ; it is expected that $\phi_i < 0$ to ensure model stability (confirming cointegration).

$\beta_{i,j}$ are the short-run coefficients associated with the changes in the explanatory variables in region i , with $j=1,2,3$ corresponding to BRD, PRD, e HRD.

λ_i is the autoregressive coefficient of the lagged difference of the dependent variable in region i , capturing short-run dynamic dependence.

This error correction specification allows us to capture both the short-run dynamics — i.e., the immediate responses of innovation (patent applications) to changes in R&D spending — and the long-run equilibrium relationship between innovation and its structural determinants.

The model also quantifies the speed at which regional innovation converges back to its long-run equilibrium following a shock, offering valuable insights into the dynamic stability and temporal persistence of innovation responses.

4. Preliminary results

Table 3 reports the PMG estimates of the Panel ARDL model. The long-run coefficient associated with university R&D expenditure is positive (0.8866) and highly significant ($p < 0.01$): a 1% increase in HRD translates, *ceteris paribus*, into a 0.88% rise in patent applications. This finding underscores the pivotal role of universities as generators of fundamental knowledge, providers of skilled human capital, and key nodes in technology transfer processes through dedicated structures such as incubators and spin-offs.

Table 3 – Full Panel ARDL Estimation.

Pooled Mean Group Estimator		
Variables	Coefficient	Standard Error
	Long-Run Coefficients	
BRD	-0.025843	0.034408
PRD	0.123676	0.098231
HRD	0.886631***	0.063682
Short-Run Coefficients		
COINTEQ01	-0.207576***	0.080136
D (BRD)	-0.016120	0.095018
D (PRD)	-0.003467	0.080812
D (HRD)	-0.186619	0.233631

Source: Authors' elaboration.

Note: All variables are expressed in natural logarithms to reduce heteroscedasticity and allow interpretation of the estimated coefficients as elasticities.

By contrast, the coefficients for business and public R&D expenditure are not statistically significant, indicating that these components do not exert a persistent impact on patent output. This outcome, although unexpected, is consistent with the literature. Italian firms, especially SMEs, show a low propensity to patent, often relying on informal protection strategies or incremental innovations (Sterlacchini, 2008; Evangelista & Vezzani, 2010; Lotti & Schivardi, 2005). Limited R&D budgets and ownership structures further constrain patenting (Giuri *et al.*, 2007), while regional disparities—particularly weaker innovation environments in the South—dilute the aggregate impact of BRD and PRD (Leogrande, 2024). This aligns with broader evidence of structural weaknesses in Italy's productivity and innovation system (Bugamelli *et al.*, 2018). For PRD, resources are often misaligned, being directed toward publications, infrastructure, or general programmes rather than patentable outcomes (Abramo & D'Angelo, 2009).

In the short run, none of the R&D components is significant, reflecting the long lags of innovation processes. Early studies (Hall, Griliches & Hausman, 1984; Griliches, 1990) and later work (Wang & Hagedoorn, 2014) show that the R&D–patent link unfolds gradually. In Italy, continuous R&D efforts are fragile and frequently interrupted (Bontempi *et al.*, 2024). Moreover, capitalization of R&D expenditures has been shown to anticipate future patenting, underscoring the forward-looking nature of R&D returns (Herb *et al.*, 2025). Overall, the short-run insignificance of BRD and PRD should not be seen as inefficacy, but as evidence of the slow and cumulative nature of innovation.

The error correction term ($ECT = -0.2076$; $p < 0.01$) is negative and significant, indicating that roughly 21% of deviations from the long-run equilibrium are corrected within one year. This confirms the presence of a stable adjustment mechanism and highlights the predominance of long-run effects of R&D on innovation.

5. Concluding remarks

Overall, the empirical evidence corroborates the hypothesis that only university R&D expenditure exerts a direct, positive, and lasting influence on regional patenting activity. This finding aligns with a broad strand of literature highlighting the unique capacity of academic institutions to produce fundamental knowledge, stimulate collaboration networks, and facilitate knowledge spillovers through structured mechanisms such as Technology Transfer Offices, incubators, and spin-offs. In contrast, public and private R&D spending—although substantial in absolute terms—appear less effective in translating into measurable innovation outputs unless complemented by more efficient allocation strategies and stronger links with the

local innovation ecosystem. Strengthening the connection between non-academic R&D actors and formal channels of technological valorisation may therefore be a critical step toward enhancing the overall productivity of research investments across regions.

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NOTARIES AS “PUBLIC GOOD” INTERMEDIARIES: ANALYSIS OF THEIR FUNCTIONS USING OECD PMR AND THE WORLD BANK B-READY INDICATORS

Bruno Deffains, Claudio Ceccarelli, Antonio Cappiello

Abstract. The exploration of OECD PMR and World Bank data, allowed to understand the impact of regulation on the notarial activity as well as the notarial performances (property transfer and company incorporation) compared to countries not adopting notaries. The last edition of the PMR indicator, as in the past OECD report, shows a trend of negative correlation between level of regulation and cost paid by the consumer for the property transfer. A higher level of regulation therefore tends to produce better results for consumers precisely because the notary is part of the administration of justice and his services represent a "public good". As regards the comparison of scores between countries that adopt the notary and others that adopt other systems, the analysis of the B-Ready data shows better performances of the countries with notaries both for real estate transfers and for company incorporation.

These findings invite a broader reconsideration of how regulation is conceptualized and measured in the context of legal services. From an economic standpoint, the civil law notariat is not a regulatory anomaly, but a functionally efficient institutional design that internalizes market failures, such as information asymmetry, contractual incompleteness, and enforcement risk, at the very heart of transactional life. The data presented throughout the paper demonstrate that regulation does not necessarily entail inefficiency. On the contrary, well-calibrated regulatory frameworks—such as those governing notaries—may reduce total transaction costs by providing legal certainty *ex ante*, thereby lowering litigation, renegotiation, and enforcement costs *ex post*. Therefore, this paper calls for a redefinition of what constitutes “efficient regulation” in the legal sector. It advocates for evaluation tools that take into account not only market openness but also the institutional role of legal professionals in delivering public value through trust, risk reduction, and systemic coherence. Such a shift is not merely technical; it is foundational for ensuring that regulatory reform enhances both market performance and legal robustness.

1. Introduction

The notarial profession represents a distinctive case among regulated professions. In civil law countries, notaries are integral to the administration of justice and perform delegated public functions aimed at ensuring legal certainty, protecting

contracting parties, and preventing negative externalities for third parties. Unlike purely market-oriented professional services, notarial activity combines private service provision with the exercise of public authority, notably through the authentication of legal acts and the production of enforceable titles. Despite this institutional specificity, notaries are assessed within the OECD Product Market Regulation (PMR) framework, which is primarily designed to evaluate barriers to competition in product and service markets. At the same time, the World Bank's new Business Ready (B-Ready) indicators evaluate the efficiency and quality of legal and administrative processes relevant to property transfers and business incorporation, two core areas of notarial activity in civil law systems. This paper examines whether higher levels of regulation in the notarial profession, as measured by the OECD PMR indicators, are associated with higher costs and lower efficiency, and whether countries adopting civil law notaries perform differently from other systems when evaluated through the B-Ready framework. Using the most recent OECD PMR data and the 2025 B-Ready results, we show that stronger notarial regulation is not associated with higher transaction costs and that countries adopting Latin notaries systematically achieve better outcomes in terms of quality, time, and cost for property transfers and company incorporation.

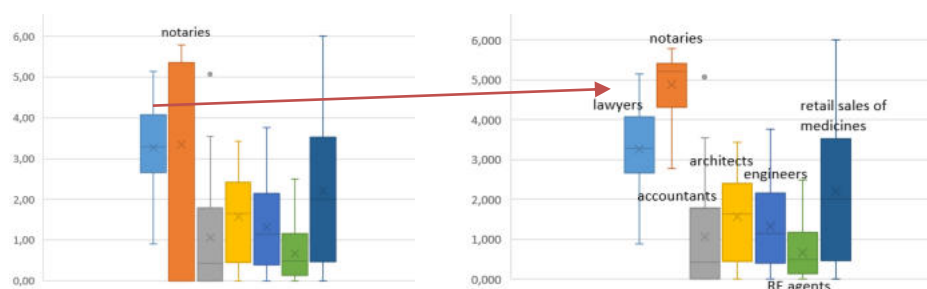
2. PMR Indicators and the Conceptual Limits of Competition-Based Assessment

The OECD PMR indicators aim to measure how regulations affect competition by focusing on entry restrictions, conduct regulation (including fees and advertising), and exclusive professional competences. While this approach is appropriate for market-based professional services, it presents structural limitations when applied to civil law notaries. Notaries exercise public authority within a constitutional and legal framework that prioritizes *ex ante* legality, contractual certainty, and the prevention of disputes. Their regulation is therefore not a distortion of competition but a prerequisite for institutional trust and legal security. Evaluating notaries through indicators that penalize licensing requirements, fixed tariffs, or restrictions on advertising risks conflating rent-seeking regulation with rules designed to safeguard impartiality and universal service. As a result, notaries consistently appear as highly regulated outliers within the PMR distribution of professional services. This outcome reflects a categorical mismatch rather than inefficiency: PMR scores capture formal regulatory intensity but not the functional contribution of notaries to reducing transaction risks, litigation, and enforcement costs.

3. Evidence from the OECD PMR Data

When the PMR data are examined using a homogeneous sample of countries (fig. 1) adopting civil law notaries—excluding systems such as notaries public in common law countries¹—the dispersion of PMR scores becomes markedly narrower.

Figure 1 – Distribution of PMR score in regulated professions (original/adjusted sample for the notaries – homogeneous sample in the right frame).



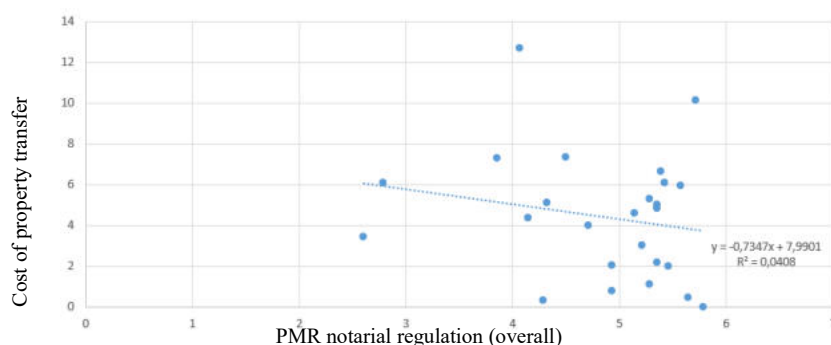
Source: elaboration of the authors on the OECD PMR report 2023

This compact distribution is typical of a profession exercising a standardized public function rather than competing in a liberalized market. More importantly, empirical analysis of OECD countries shows no positive correlation between the overall PMR score for notaries and the cost of real estate transfers as a percentage of property value (fig 2). On the contrary, the relationship is weakly negative: countries with higher levels of notarial regulation often display equal or lower transaction costs. This finding directly challenges the assumption that regulation necessarily increases consumer costs. In the notarial context, regulation contributes to cost containment by bundling legal verification, risk prevention, and enforceability into a single institutional process. Regulated and capped fees enhance price transparency and predictability, reducing search costs and protecting consumers in highly asymmetric information settings.

The same conclusion emerges when focusing specifically on the PMR sub-indicator concerning fees and charges (fig. 3). Countries with more stringent fee regulation do not experience higher property transfer costs. Instead, regulated tariffs often support universal access, cross-subsidization of low-margin legal acts, and systemic stability—functions that resemble public utility pricing rather than anti-competitive behavior.

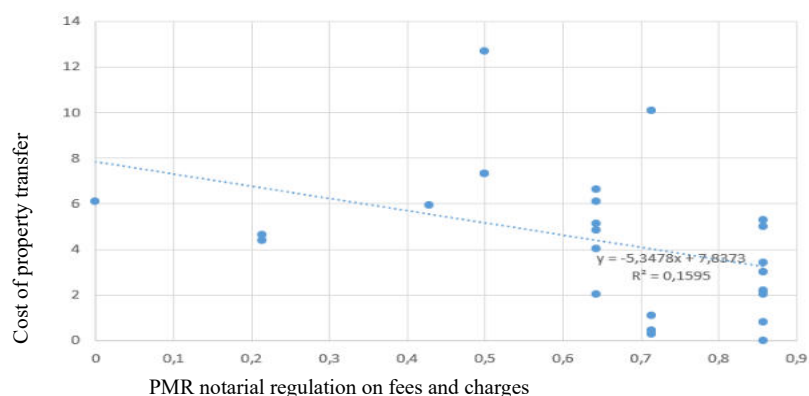
¹ The homogenous sample also excludes countries that do not fit the OECD definitions on notaries.

Figure 2 – Correlation between PMR score and Cost of real estate transfer (World bank DB).



Source: elaboration of the authors on OECD PMR report 2023

Figure 3 – Correlation between PMR score on conduct regulation: (Fees and Charges) and Cost of real estate transfer (World bank DB).



Source: elaboration of the authors on OECD PMR report 2023

4. The B-Ready Framework and Methodological Improvements

The World Bank's B-Ready report, introduced in 2024, represents a methodological evolution from the former Doing Business indicators. It adopts a broader perspective on the business environment, combining regulatory framework, public services, and operational efficiency across ten topics. Two B-Ready topics are particularly relevant for notarial activity: Business Location (including property transfers) and Business Entry (company incorporation). Unlike Doing Business, B-Ready places greater weight on qualitative dimensions of legal infrastructure,

which account for approximately two-thirds of each topic's score. A key methodological improvement concerns the measurement of time. Under the former Doing Business approach, the number of procedures mechanically increased the measured duration, even when procedures were completed simultaneously. This produced a paradox whereby highly efficient systems—such as those relying on notaries—were penalized. The B-Ready methodology now measures actual elapsed time, independent of the number of formal steps, correcting this distortion and better reflecting real-world efficiency. Hereafter a table summarizing some main improvements of the B-Ready methodology (tab. 1).

Table 1 – Main improvements of B-Ready methodology affecting notaries.

Qualitative improvement: now the indicators are somehow weighted more on “qualitative aspects”. The first two pillars (“firm flexibility” and “social benefits”) evaluate the quality legal framework and account for 66 % of the score of each topic. The criticism on the lack of qualitative evaluation ² were partially rewarded firstly with the inclusion of a qualitative indicator for the former Doing Business Registering Property indicator and now also with its extension to all topics in the B-Ready methodology.
Revision of the methodology on time measurement: now the time indicator, as underscored in 2014 ³ , considers only the actual time needed to complete the whole set of procedures. Therefore, as above mentioned, the filing of several procedures in x days should count just x days and it is not related to the number of procedures (the number of procedures is not computed as score).
Scientific basis: the empirical analyses ⁴ (criticism to the methodology) were cited by the World Bank independent evaluation report of WB ⁵ (pp. 209 and 219) and now these claims become part of the parameters of the B-Ready ⁶ as concerns the efficiency pillar (see pp. 85- 86 of the article) which cited the article in reference literature of the handbook.

5. Property Transfers: Comparative Results

The 2025 B-Ready results show that countries adopting Latin notaries perform better on average in the Business Location indicator than countries relying on

² Meeting Cappiello (CNN expert) and World Bank officers responsible of starting a business and registering property (V. Saltane and F. Meunier) in 2014 at Washington DC headquarter.

³ Antonio Cappiello *World Bank Doing Business project and the statistical methods based on ranks: the paradox of the time indicator*, Rivista Italiana di Economia Demografia e Statistica Volume LXVIII n.1 Gennaio-Marzo

2014 http://www.sieds.it/listing/RePEc/journal/2014LXVIII_1_RIEDS_79_86_Cappiello.pdf

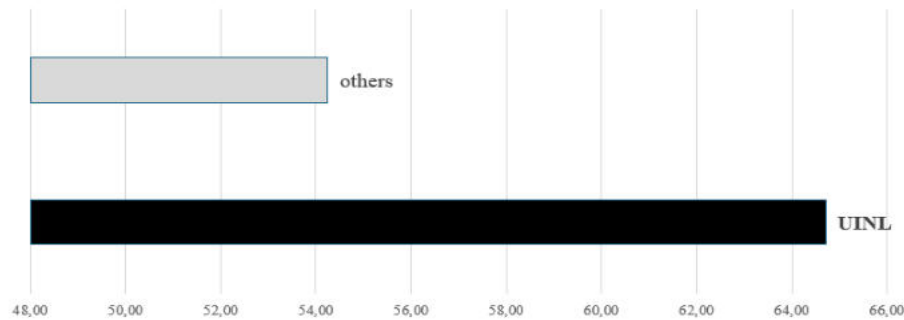
⁴ See above note

⁵ The Development Effectiveness of the Use of Doing Business Indicators Fiscal Years 2010–20 (This evaluation assesses the strategic relevance of the Doing Business indicators to both the development agenda of the World Bank Group and the reform priorities of its client countries. It also examines the extent to which the use of the indicators, including the discontinued ease of doing business country rankings, contributed to development effectiveness <https://ieg.worldbankgroup.org/sites/default/files/Data/Evaluation/files/DoingBusinessEvaluation.pdf>)

⁶ World Bank, Business Ready, Methodology Handbook, Second Edition, October 2024 p.33

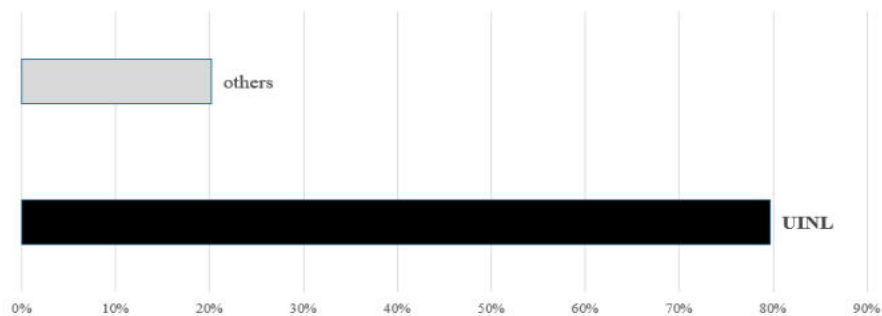
alternative systems (fig. 4). This advantage is not driven by isolated components but is systematic across most sub-indicators (fig. 5). Notarial countries achieve higher scores in legal quality, procedural transparency, cost predictability, and operational efficiency. From an economic perspective, notaries function as institutional intermediaries that internalize coordination costs and mitigate information asymmetries. Their involvement enhances the enforceability of property rights and supports market liquidity, particularly in real estate transactions where legal certainty is critical for credit access and investment.

Figure 4 - *Business Location indicator (including property transfers): UINL countries average performances vs other countries.*



Source: elaboration of the authors on the B-Ready report 2025

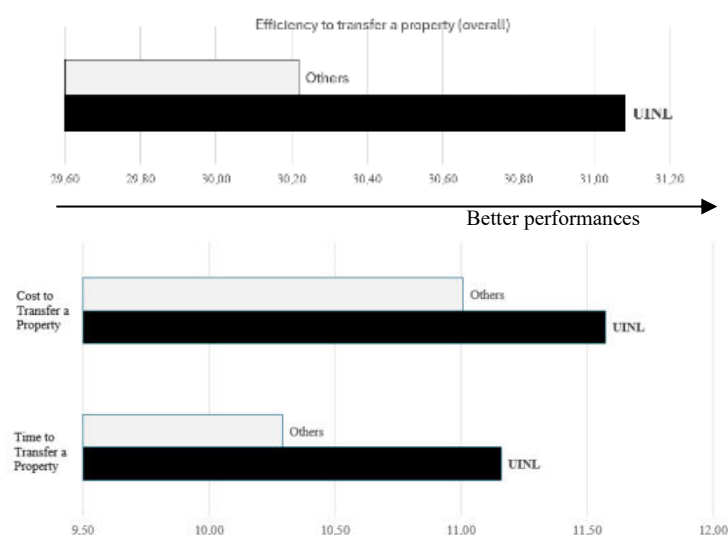
Figure 5 – *Percentage of Business Location sub-indicators where UINL perform better than other countries systems.*



Source: elaboration of the authors on the B-Ready report 2025.

Notes: UINL countries, in average (black histogram), perform better in 80% of the Business location sub-indicators.

Figure 6 - UINL countries average performances (black histograms) as concerns efficiency (with details on time and costs) for a property transfer (higher score means less time and costs).



Source: elaboration of the authors on the B-Ready report 2025 N.B. higher scores correspond to better performances in terms of time and costs

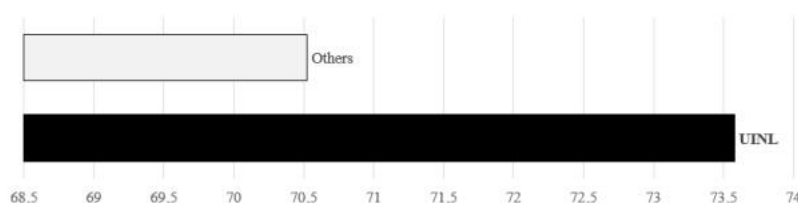
With the corrected time measurement, they also complete property transfers faster and at lower overall cost (fig. 6). These results indicate that notarial intervention reduces legal friction by consolidating procedures, ensuring completeness and legality at the source, and minimizing the need for ex post corrections or litigation.

6. Company Incorporation and Business Entry

A similar pattern emerges for company incorporation. B-Ready data show that countries where notaries are involved in the incorporation process outperform other systems on average in the Business Entry indicator (fig. 7).

Notarial countries achieve higher scores in identity verification, beneficial ownership requirements, availability of digital services, and electronic authentication (fig. 8 - 9). Contrary to deregulation-based expectations, the involvement of a regulated legal professional does not slow down business creation. On the contrary, notarial systems often match or outperform alternative models in terms of time and cost (fig. 10).

Figure 7 – Business Entry (company incorporation) UINL countries* performances (black histograms) vs other systems (average).



*if the notary is involved in company incorporation

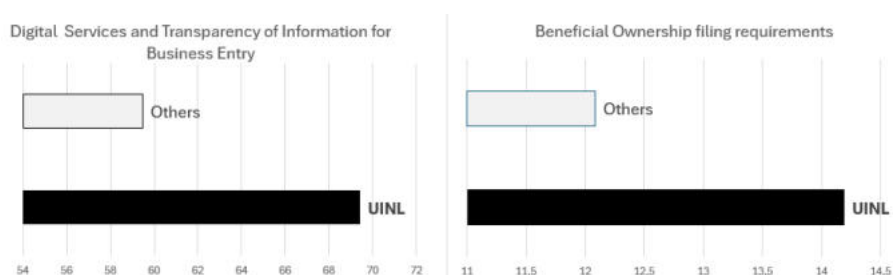
Source: elaboration of the authors on B-Ready 2025 N.B. higher scores=better performances

Figure 8 – “Business Entry” average score (company incorporation: Identity verification and availability of electronic signatures), UINL (if notary involved in company incorporation) vs other systems.



Source: elaboration of the authors on B-Ready 2025 N.B. higher scores=better performances

Figure 9 – Average Business Entry average scores (availability of digital services and beneficial ownership requirements) UINL countries performances vs other systems.

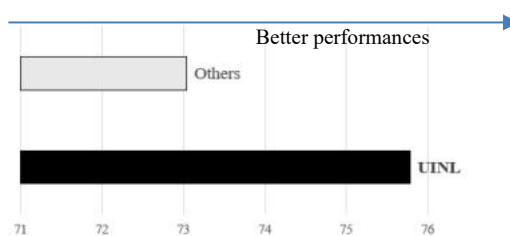


Source: elaboration of the authors on B-Ready 2025 N.B. higher scores=better performances

This outcome reflects process integration. In many civil law jurisdictions, notaries act as a single coordination point, ensuring legal compliance, authenticating documents, and transmitting validated acts directly to public registers. This reduces

errors, rejections, and subsequent amendments, leading to lower total transaction costs over the firm's lifecycle. Countries with notaries involved in company incorporation also perform better as concerns the availability of digital services and the filing requirements for Beneficial ownership (scores details in Fig. 9). Rather than representing regulatory overreach, notarial involvement in business formation can be seen as an institutional efficiency enhancer, particularly in legal environments where contractual enforcement and stakeholder accountability are paramount. UINL countries have definitely better performances (fig. 8) as concerns the identity verification process (one of the core notarial activities).

Figure 10 – *Business Entry Average Operational Efficiency indicator (=average including time and cost of the incorporation process) UINL countries performances (black histogram) vs other systems.*



Source: elaboration of the authors on B-Ready 2025
N.B. higher scores=better performances

7. PMR Scores versus Real-World Performance

The comparison between OECD PMR indicators and B-Ready outcomes reveals a persistent divergence. Countries with highly regulated notarial systems tend to score poorly in PMR rankings while performing strongly in outcome-based measures of efficiency and quality. This divergence highlights a methodological blind spot. PMR indicators emphasize formal regulatory constraints but do not capture whether regulation delivers public value by improving legal certainty and reducing systemic risks. B-Ready, by focusing on actual performance and institutional quality, provides a more accurate assessment of how legal professions with public mandates affect economic activity. Using competition-based indicators alone to guide reform risks encouraging deregulation in areas where regulation is efficiency-enhancing. In the case of notaries, such reforms could undermine legal infrastructure and increase downstream costs associated with disputes, fraud, and enforcement failures.

8. Conclusions and Policy Implications

The analysis of OECD PMR and World Bank B-Ready data shows that higher levels of notarial regulation are not associated with higher transaction costs. On the contrary, countries adopting civil law notaries systematically perform better in property transfers and company incorporation when evaluated using outcome-oriented indicators. From a law and economics perspective, the civil law notariat should not be viewed as a regulatory anomaly but as an institutional design that internalizes market failures related to information asymmetry, contractual incompleteness, and enforcement risk. By providing legal certainty *ex ante*, notaries reduce litigation, renegotiation, and enforcement costs *ex post*. These findings call for a redefinition of what constitutes efficient regulation in the legal sector. Evaluation frameworks should distinguish between regulation that protects rents and regulation that delivers public value. For professions exercising delegated public authority, performance should be assessed in terms of legal quality, trust, and systemic coherence—not solely market openness. Greater coordination between international organizations, including the OECD and the World Bank, could support the development of tailored indicators capable of capturing the institutional contribution of notaries. Such an approach would improve cross-country comparability and help ensure that regulatory reforms strengthen, rather than weaken, the legal foundations of economic activity.

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ROME (UN)CHANGING: PERSISTENCE AND PECULIARITIES OF ITS POPULATION

Cecilia Reynaud

Abstract. Rome — the largest municipality in Italy and one of the largest European capitals — offers a revealing case for understanding how national demographic decline translates into urban change. Combining long-run census evidence with annual resident-population stocks, demographic-balance components, and a municipality-level analysis, the study shows that Rome’s recent trajectory broadly parallels the national pattern but with a delayed transition to decline. The decomposition of annual change indicates that natural decrease has become structurally negative, while migration plays a decisive role: international migration remains systematically positive, whereas internal mobility changes sign over time and is crucial in shaping shifts from growth to decline. As of 1 January 2025, Rome’s population structure is close to the national profile in terms of ageing, yet it differs from other large cities in its level of ageing and internationalisation, with a particularly small child population. Within the city, Rome’s 15 administrative subdivisions (“municipi”) exhibit extreme heterogeneity in size, population, growth and structure: only a small number of peripheral municipi continue to grow, while others — most notably the historic centre — experience marked decline.

1. Introduction

Demographic trends in Italy have led to a profound and largely silent transformation, as the country has entered a phase of population decline and sustained ageing. The decline is due to a persistently negative natural balance, caused by very low fertility, a decrease in the number of women of childbearing age, and an increase in the number of deaths linked to the increasing size of older age groups. Specifically, the persistent decline in births and the continuous improvement in survival at older ages have shaped and intensified the ageing of the resident population. Similar trends have characterised much of Europe, where negative natural change has become increasingly widespread and structural, with deaths exceeding births in a growing number of countries (Eurostat, 2025). Across Europe, migration has increasingly become the main driver of demographic change, offsetting negative natural balances; in Italy, however, although foreign

immigration initially mitigated these effects, delaying demographic decline and moderating ageing, more recently it has proved insufficient to compensate for the structural deficit in births (Istat, 2025). At the same time, national-level demographic trends often mask substantial territorial disparities, with pronounced regional differences and persistent contrasts between urban and rural areas (Kashnitsky *et al.*, 2021; Cuadrado-Roura, 2023). In this uneven territorial landscape, large cities assume particular strategic relevance (Newsham and Rowe, 2023). Historically, large cities have experienced population growth and attracted both internal and international migration, often mitigating negative natural change. In European countries with a persistently negative natural balance, large metropolitan areas have often acted as demographic buffers, delaying population decline or showing slight growth due to positive net migration (Wolff and Wiechmann, 2018). However, aggregate metropolitan indicators can be misleading, as they often conceal significant intra-urban differences in demographic dynamics and population structure (Haase *et al.*, 2016).

Rome is the largest municipality (a Local Administrative Unit, LAU, under Eurostat classification) in Italy by population and among the largest in Europe in terms of territorial extent. Over the long term, Rome has undergone irregular residential expansion, characterised by marked spatial and temporal discontinuities. As a result, Rome represents a heterogeneous demographic space, where population change observed at the city level may conceal divergent trajectories across its administrative subdivisions. After a period of renewed growth in the 2000s, Rome has recently entered a phase of population decline, in line with the national trend but with different timing and intensity. This recent shift has occurred despite Rome's continued demographic attractiveness, largely linked to migration inflows, especially from abroad.

In-depth demographic analyses have been developed for several major European cities and capitals — such as Paris (Ogden and Schnoebelen, 2005) and Athens (Benassi and Salvati, 2020) — while comparative studies have documented the diversification of demographic trajectories across European urban agglomerations (Kabisch and Haase, 2011; Wolff and Wiechmann, 2018). Despite its demographic and territorial significance, Rome has received relatively limited and fragmented attention in demographic research, especially when compared with other large European cities and capitals, and in particular with regard to systematic evidence on intra-urban demographic heterogeneity. What has been the demographic evolution of Rome over the recent decades, and to what extent does it converge with or diverge from national trends and those observed in other large Italian cities? Which components of population change (natural change and migration) have driven Rome's recent shift from growth to decline, and how do these components vary across the city's administrative subdivisions? Is population

ageing in Rome less pronounced than at the national level — as suggested by the comparatively slower ageing often observed in large European cities — or does Rome display a distinctive ageing pattern driven by its internal heterogeneity? Our hypothesis is that Rome's recent demographic decline reflects not only a persistently negative natural balance, only partially offset by net migration, but also a reduced capacity to retain its residents. We also hypothesize that city-level trends mask highly divergent demographic trends among Rome's administrative subdivisions, particularly in terms of the intensity of ageing and population changes.

The aim of this work is to analyse Rome's demographic evolution over recent decades and its transition from growth to decline, comparing it with national trends and those observed in other large Italian cities. It also examines intra-urban heterogeneity across Rome's administrative subdivisions, focusing on the components of demographic change and key indicators of population structure.

2. Data and methods

In order to examine long-term demographic trends for Rome, comparing them with other Italian principal cities and with Italy, we use data from various sources. First, we use population census data from the Italian National Institute of Statistics (Istat) for the period 1951–2021 to reconstruct population change and intercensal growth rates for Rome, for the seven other most populous cities (Turin, Milan, Genoa, Bologna, Florence, Naples, and Palermo), and for Italy. Second, we use Istat's annual demographic balance series (Population balance estimates for 2001–2018 years and Demographic balance for 2019–2024 period) for the same territorial levels, to compare natural change and net migration in Rome with the other cities and with Italy. Third, in order to study demographic change and its components across Rome's administrative subdivisions in the recent period, we use Population Register data at 1 January for the years 2015–2025.

Annual growth rates are computed as $r = 1,000 \times \ln(P\{t+n\}/P\{t\})/n$ where n is the number of years. Natural balance and net migration are expressed as annual rates per 1,000 residents.

To deepen the analysis, using the same sources mentioned above, we also construct key indicators of population structure for Rome, the other principal cities, Italy and the 15 administrative subdivisions of Rome. In particular, we calculate the ageing index (population aged 65+ per 100 population aged 0–14), the share of children aged 0–4, and the share of residents with foreign citizenship. All structure indicators are computed as of 1 January 2025.

Based on these sources, we conduct a long-term descriptive analysis of demographic changes and the components of this change. We therefore analyse population growth, changes in natural balance and net migration, and the structural characteristics of Rome's population, comparing them with other territorial contexts (other major Italian cities) and with the overall Italian context. Although descriptive, the analysis is particularly comprehensive. First, it covers a very long period, allowing for an understanding of long-term trends. The territorial level is also particularly detailed, as not only are trends at the municipal level examined, but for the city of Rome, the sub-municipal level is also considered. In this way we can analyse and understand similarities and differences across cities and within Rome, thereby providing a detailed framework of demographic changes over time and space.

3. Results

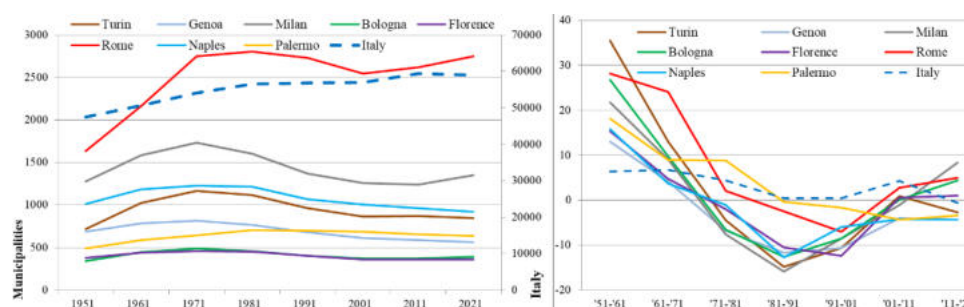
3.1. Long-term intercensal population change (1951–2021)

At the 1951 population census, Rome already exceeded 1.6 million residents (1,632,402) and was Italy's largest municipality; by the 2021 census it had reached 2,749,031 residents. During the same period, Rome's exceptionally large administrative area (1,287.4 km², the largest in Italy) provides an essential interpretative key to understanding intercensal change, as part of the suburban expansion may have taken place within the municipal boundaries rather than in neighbouring municipalities, as has often been the case in other urban areas. Rome is among the largest capital cities in Europe in terms of surface area, comparable in size to Greater London (1,572 km²) and smaller than Moscow (2,561.5 km²), bearing in mind that these figures refer to administrative boundaries rather than functional urban areas, which are larger in many other cases, such as Paris. Between the 1951 and 1971 censuses, Rome experienced very rapid average annual intercensal growth (28.2‰ in the period 1951–1961 and 24.0‰ in 1961–1971), well above the national average (6.3‰ and 6.7‰, respectively), as shown in Figure 1, and generally higher than that of most other large cities (second only to Turin in 1951–1961), consistent with the urbanisation phase in the urban-cycle framework (Van Den Berg *et al.*, 1982).

From 1971 to 1991, several northern cities experienced marked population losses (e.g., Milan, Turin, Genoa), consistent with a phase of population deconcentration and suburbanisation in the urban-cycle framework (Salvati and Carlucci, 2016), while Rome displayed a comparatively milder pattern (+2.0‰ in 1971–1981 and –2.6‰ in 1981–1991). The 1991–2001 decade marked a broader

phase of urban decline, with Rome also recording a negative intercensal rate (-7.1%), bringing its trajectory closer to that of other large municipalities, while the national trend remains close to zero. Between the 2001 and 2011 censuses, Rome returned to growth ($+2.7\%$), in line with the renewed expansion observed in several major European capitals during the 2000s (Eurostat, 2016). Despite a negative national rate in 2011–2021 (-0.7%), renewed growth was recorded in Rome ($+4.9\%$), together with Milan ($+8.3\%$) and Bologna ($+4.3\%$), while Naples and Palermo continued to decline.

Figure 1 – Resident population (left panel, thousands) and intercensal population growth rate (right panel, per 1,000 inhabitants) in Italy and the eight most populous municipalities (Rome, Turin, Milan, Genoa, Bologna, Florence, Naples, Palermo), 1951–2021 censuses.



Source: our elaboration on ISTAT data.

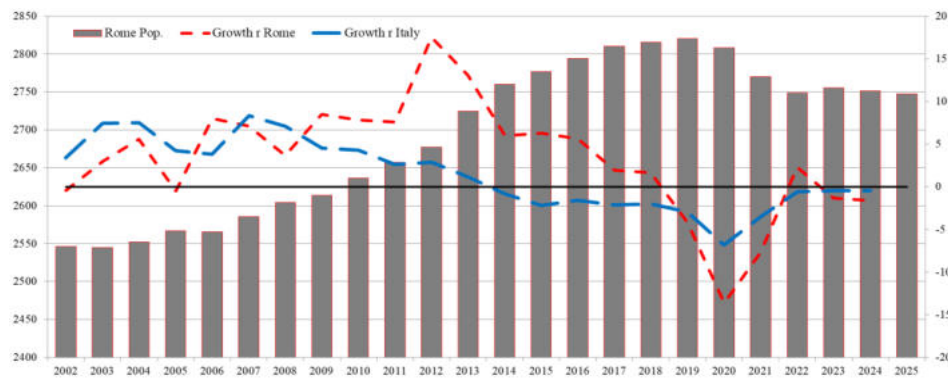
Overall, Rome's long-term trajectory combines intense post-war expansion with a relatively moderate phase of de-concentration and renewed growth in the last two decades, which warrants closer examination of the most recent period against a national backdrop of population decline recorded since the mid-2010s. At the national level, recent trends in Italy's resident population have increasingly relied on positive net international migration, largely driven by foreign immigration, which has only partially offset the persistently negative natural balance; in Rome, however, both international migration and within-country internal mobility need to be considered to interpret the recent demographic balance.

3.2. Recent annual population dynamics

Looking at recent trends in the resident population, Rome has also entered a phase of decline that was not apparent from intercensal evidence: from 1 January 2002 to 1 January 2025, the trend in Rome's resident population essentially follows

the national profile. It experienced growth in the 2000s followed by a subsequent slowdown, but it follows a clearly different timeline in the transition to decline compared with the national level. In Italy, the annual growth rate turned negative in 2014, whereas in Rome this occurred only in 2019, with a temporary recovery in 2022, indicating a delay in the onset of demographic decline at the capital level (Figure 2). At the local level, economic and social factors have a stronger influence in conditioning demographic dynamics, particularly internal mobility within Italy, within a shared national demographic framework (Buonomo *et al.*, 2024; Wolff and Wiechmann, 2018).

Figure 2 – Resident population in Rome (thousands) at 1 January and annual growth rate (%) in Rome and Italy, 2002–2025.

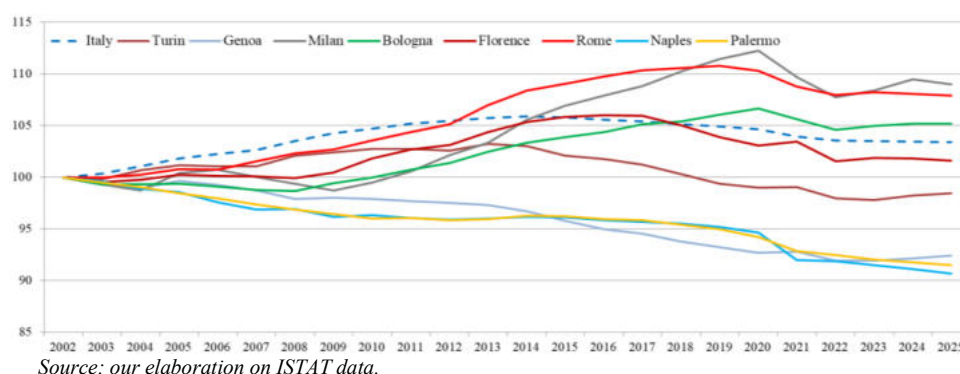


Source: our elaboration on ISTAT data.

In line with long-term evidence, Rome remains one of the major Italian municipalities with the strongest population growth, together with Milan, as the largest and most connected urban centres can preserve demographic resilience longer than the national average before eventually converging towards the broader demographic crisis. However, demographic trajectories of Rome and Milan—observed by indexing the resident population in 2002 (=100), regardless of initial size—diverge over time (Figure 3). Rome expanded more rapidly in the first decade, while Milan has been more resilient in recent years, in line with its role as the country's main economic centre and its greater capacity to attract resources and population (Buonomo *et al.*, 2024). Genoa, on the other hand, stands out as a city in long-term decline: its demographic contraction began earlier and was associated with natural decrease and population ageing, subsequently reinforced by out-migration linked to suburbanisation processes (Haase *et al.*, 2016). Southern cities, Naples and Palermo, are also experiencing persistent population decline, reflecting a combination of negative internal balances (strong net outflows), negative natural

change, and a more limited compensatory effect of international migration (Buonomo *et al.*, 2024).

Figure 3 – Resident population at 1 January (indexed values; 2002=100) in eight major Italian municipalities, 2002–2025.



A central hypothesis is that in Rome migration has mitigated an increasingly negative natural balance, while internal migration may be consistent with the redistribution processes often associated with suburbanization and peri-urbanization (Buonomo *et al.*, 2024; Crisci and Casacchia, 2013).

3.3. Demographic components of population change (2002–2024)

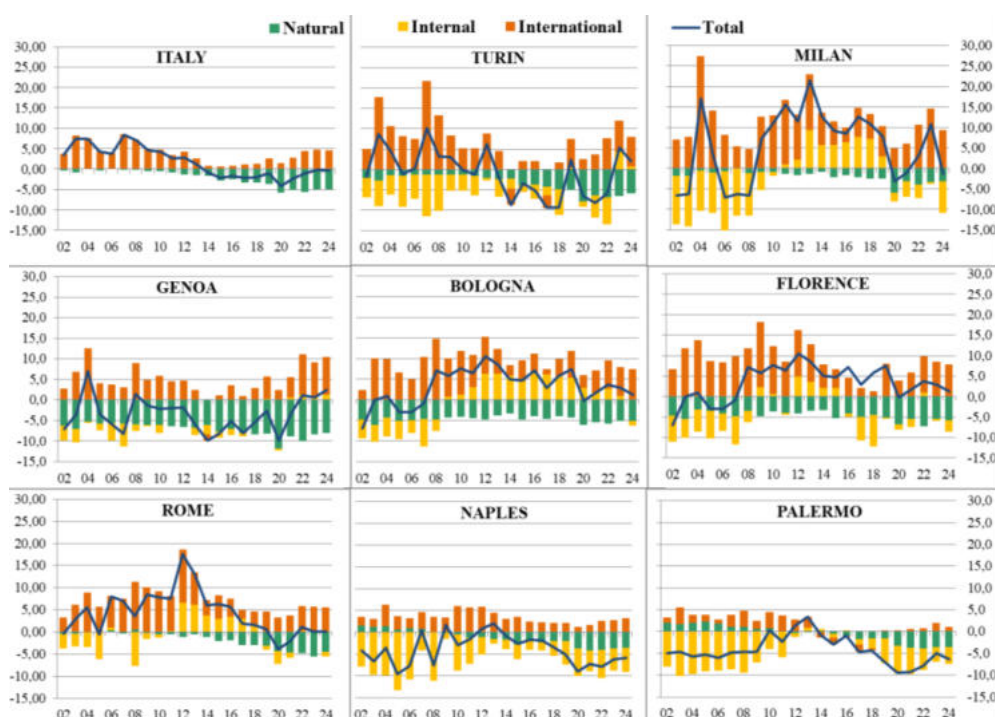
The different timing and trajectory of population growth in Rome compared to those of Italy reflect changes in the natural balance and net migration, distinguishing, at the municipal level, between internal and international migration (Figure 4), following an accounting framework widely used to interpret recent urban dynamics in Italy (Strozza *et al.*, 2016; Buonomo *et al.*, 2024).

Since the natural balance is negative for most of the period in both Rome and Italy, the sign and intensity of population growth increasingly depend on net migration. At the national level – where internal migration is structurally zero by definition – net international migration more than compensated for the natural deficit in the first part of the period. In subsequent years, its counterbalancing effect weakened, particularly in the aftermath of the economic crisis and during the Covid-19 pandemic, while the natural balance became increasingly negative, leading to a sustained population decline driven mainly by the continuing decrease in births (Reynaud and Miccoli, 2019; Buonomo *et al.*, 2024). A similar trend can be observed in Rome, but with the important difference that municipal growth also

depends on internal migration, which changed direction over time. The internal migration rate ranged between -5.9‰ and -2.7‰ in 2002–2005, then became clearly positive in the 2010s (from $+0.3\text{‰}$ up to $+6.7\text{‰}$ in 2011–2018), before weakening again after 2019, fluctuating between -2.7‰ and $+0.5\text{‰}$ in 2019–2024 (Figure 4). This sign reversal in internal migration may be consistent with redistribution processes often associated with suburbanization and peri-urbanization —also considering that Rome’s large municipal territory can keep part of peri-urban redistribution within administrative boundaries—while net international migration is consistently positive and provides a stable counterbalance (Crisci and Casacchia, 2013; Salvati and Carlucci, 2016; Buonomo *et al.*, 2024). With natural decrease intensifying in recent years (between -3.3‰ and -5.5‰ in 2019–2024), positive international migration — still systematically positive (around $+3.3\text{‰}$ to $+5.5\text{‰}$ in 2019–2024) — is no longer sufficient to offset the combined effect of the natural deficit and renewed internal losses; this helps to explain the shift to decline observed at the end of the 2010s (Buonomo *et al.*, 2024; Crisci and Casacchia, 2013).

Compared with other large cities, Rome’s natural balance turns negative later, in a timing closer to that observed in Naples and Palermo, whereas in most other large municipalities it is negative throughout the period (Strozza *et al.*, 2016). International migration provides Rome with a structurally positive contribution across the whole period, although in many years the international component is even stronger in Milan and, in some years, in Turin and Florence; in the other municipalities it is generally weaker and only sporadically negative, notably in Palermo (Figure 4). The key differentiating factor, however, is internal mobility: in Rome, its contribution is substantial only in specific sub-periods and with opposite signs, whereas other cities display more stable patterns, with internal gains concentrated in the middle of the period in Milan and Bologna and more persistent internal deficits in cities such as Turin, Naples and Palermo (Figure 4). These contrasts suggest that the delay in population decline in Rome reflects a specific combination of components: a late deterioration in natural change and a temporary phase of positive internal migration, which, together with consistently positive international migration, sustained growth for longer than in most other municipalities. Then, the same national demographic crisis translates into different urban trajectories depending on how these components interact locally (Buonomo *et al.*, 2024; Crisci and Casacchia, 2013).

Figure 4 – Demographic components of population change (%)—natural balance, net internal migration, and net international migration—in Italy and eight major municipalities, 2002–2024.



Source: our elaboration on ISTAT data.

3.4. Population structure and ageing

The long- and short-term demographic dynamics described above translate into a population structure as of 1 January 2025 that varies across the considered areas (Table 1). Population ageing emerges as the dominant common feature in Italy — rooted in persistently low fertility and increasing longevity and reflected in a structurally negative natural balance — while the intensity and pace of ageing vary considerably from one municipality to another (Golini *et al.*, 2003; Kashnitsky *et al.*, 2021; Reynaud and Mingione, 2025). In this context, urban demographic profiles increasingly depend on the selective contribution of migration, which reshapes both the working-age and child populations and interacts with local demographic structures, thus differentiating large cities even within a shared national demographic framework (Buonomo *et al.*, 2024; Kashnitsky *et al.*, 2021).

As of 1 January 2025, Rome's age structure is aligned with the national profile, but it sits in an intermediate position between the oldest northern municipalities and the relatively younger southern cities (Table 1). In Rome, population ageing is slightly below the national level and lower than the most aged northern benchmarks, while still higher than Naples and Palermo: the share of population aged 65+ is 24.0% (Italy: 24.7%) and the ageing index is 202.8 (Italy: 207.7). Genoa stands out as the most aged municipality, in line with the fact that Liguria has long been Italy's oldest region. This highlights that ageing is widespread nationally but unfolds unevenly across local units: southern cities appear to be somewhat less aged overall, although ageing has progressed rapidly in recent years (Reynaud and Mingione, 2025). Despite being located in North-West Italy — the macro-area with the oldest demographic structure — Milan has a lower share of residents aged 65+ than Rome (22.4% versus 24.0%) and a lower ageing index (193.7 versus 202.8). This gap may reflect, on the one hand, Milan's stronger labour-market pull as Italy's main economic centre, which increases the weight of working-age residents. On the other hand, Milan's small municipal territory and physical continuity with neighbouring municipalities may facilitate short-distance residential relocation outside the city proper, whereas Rome's unusually large municipal area can retain part of this redistribution within its administrative boundaries (Buonomo *et al.*, 2024; Crisci and Casacchia, 2013; Salvati and Carlucci, 2016). Considering younger ages, the share of children aged 0–4 is very low in Rome (3.3%), slightly below the national level (3.4%) and below Milan (3.5%) and Bologna (3.4%); among the considered cities, only Genoa records a lower value (3.0%), while Florence and Turin are very similar (3.2%) (Table 1). The lower percentage in Rome, as well as in older cities, is largely due to the decline in the number of births and the resulting negative natural balance observed in recent years. This may be driven not only by lower fertility, but also by the comparatively lower presence of foreign residents, whose younger age profile and higher fertility may have partially mitigated the decline in the child population (Kashnitsky *et al.*, 2021; Crisci and Casacchia, 2013). More specifically, as of 1 January 2025, Rome recorded a share of foreign residents of 12.9%, significantly higher than the national level (9.1%) but well below Milan (19.6%) and other large municipalities in Centre-Northern Italy, such as Turin (15.7%), Bologna (15.1%), and Florence (15.6%) (Table 1). By contrast, the share of foreign residents remains much lower in the southern macro-areas (Naples, 6.6% and Palermo 4.1%). This highlights that Rome's 'internationalisation' is substantial in national terms, but not as intense as in the main economic centres of Centre-Northern Italy, nor as in many major European capital cities, where foreign-born shares often rank among the highest nationally (Eurostat, 2016).

Table 1 – Population structure indicators at 1 January 2025 in Rome, Italy and selected major municipalities.

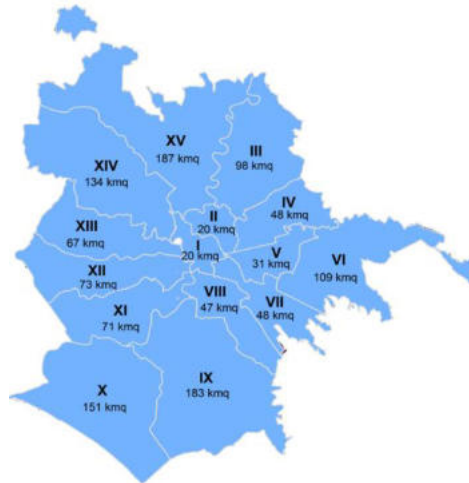
Territorial unit	Aged 0-4 (%)	Aged 65+ (%)	Ageing index	% Foreigners
Turin	3.2	25.9	238.1	15.7
Milan	3.5	22.4	193.7	19.6
Genoa	3.0	28.8	275.0	12.0
Bologna	3.4	24.4	221.3	15.1
Florence	3.2	26.6	243.8	15.6
Rome	3.3	24.0	202.8	12.9
Naples	3.8	22.4	172.9	6.6
Palermo	3.9	23.5	176.2	4.1
Italy	3.4	24.7	207.7	9.1

Source: our elaboration on ISTAT data.

Overall, the demographic structure as of 1 January 2025 confirms Rome as a distinctive and demographically important case: although it is broadly in line with the national profile, it does not fully coincide with it and differs from other large municipalities in the way ageing and internationalisation combine. Taken together, the demographic dynamics and structural characteristics make the Municipality of Rome a key context for further study, especially when considering its internal heterogeneity.

3.5. Intra-urban heterogeneity across Rome's administrative subdivisions

Rome is divided into 15 administrative subdivisions called “*municipi*” (hereafter *Municipi* I–XV), which also provide a useful territorial subdivision for scientific analysis; these *municipi* differ considerably in territorial size and population, resulting in substantial internal heterogeneity (Figure 5; Table 2). The two largest administrative subdivisions—*Municipio* XV (187.31 km²) and *Municipio* IX (183.31 km²) — are predominantly peripheral units extending to the municipal boundary and, despite their very large surface area, are not among the most populous (respectively 160,620 and 183,043 residents as of 1 January 2025). By contrast, the two smallest — *Municipio* I (20.09 km²) and *Municipio* II (19.66 km²) — are located in the central part of the municipality, with *Municipio* I corresponding to the historic centre. The most populous is *Municipio* VII, which, with 311,895 residents and a relatively limited area (47.60 km²), includes densely settled neighbourhoods in the inner urban belt close to (but outside) the historic core.

Figure 5 – Rome’s 15 administrative subdivisions (“municipi”).

Source: Roma Capitale, Statistical Yearbook 2025.

Over the last decade, recent trends in resident population growth vary considerably among Rome’s 15 administrative subdivisions, confirming that city-level dynamics conceal substantial internal differences (Table 2). In the period between 1 January 2015 and 1 January 2025, most administrative subdivisions recorded population decline, in line with the overall slowdown and recent downturn observed at the city level; contractions are particularly marked in *Municipi* I, VI and IV (−18.53%, −7.90% and −5.30%, respectively) (Table 2). These losses tend to concentrate in the consolidated city. However, four administrative subdivisions still recorded positive annual growth rates — *Municipi* XV, IX, VII and XIV (+2.00%, +1.81%, +1.63% and +0.30%, respectively) — indicating that growth is more likely in large peripheral subdivisions and in some densely settled sectors of the inner urban belt (Table 2) although these variations are also partly affected by recent administrative boundary adjustments for a subset of *Municipi*. The spatial pattern of these divergences fits the centre–periphery gradient widely discussed in the literature on Rome. It may reflect a combination of outward residential redistribution, linked to housing-market pressures and functional reorganisation within the consolidated city, and continued settlement expansion along selected peripheral corridors (Lelo *et al.*, 2019; Crisci and Casacchia, 2013; Salvati and Carlucci, 2016; Egidi *et al.*, 2020). The steep decline recorded in *Municipio* I over 2015–2025 (Table 2) appears to reflect a broader process of residential “emptying” of the historic centre, driven by the conversion of dwellings to short-term rentals and other tourism-oriented uses that reduce the stock available for long-term residents (Lelo *et al.*, 2019; Carminucci *et al.*, 2014).

Table 2 – Population size, area and recent growth by municipio (1 January 2015–1 January 2025).

Administrative subdivision	Resident Population at 1 January 2015	Resident Population at 1 January 2025	Area (Km ²)	Annual Growth rate (1.1.2015–1.1.2025) ‰
I	194,546	161,647	20.09	-18.53
II	167,986	163,097	19.66	-2.95
III	204,056	202,442	98.03	-0.79
IV	177,191	168,039	47.95	-5.30
V	244,662	239,925	30.57	-1.96
VI	261,969	242,069	109.47	-7.90
VII	306,837	311,895	47.60	1.63
VIII	131,054	127,086	47.15	-3.07
IX	179,763	183,043	183.31	1.81
X	229,642	226,842	150.74	-1.23
XI	153,861	151,057	71.48	-1.84
XII	140,976	138,694	73.07	-1.63
XIII	133,496	130,333	66.93	-2.40
XIV	189,337	189,909	133.55	0.30
XV	157,441	160,620	187.31	2.00

Administrative boundaries of Rome's municipi were partially revised during the period considered. In 2021, part of the boundary between Municipio VI and VII was modified, with the recorded population decreasing in Municipio VI and increasing in Municipio VII. In 2023, boundaries were partially revised again among Municipio IV, V and VI, with recorded population decreasing in Municipio IV and VI and increasing in Municipio V.

Residents not assigned to any Municipio ("not localised") are excluded from our Municipio-level analysis.

Source: our elaboration on Roma Capitale data.

These demographic trends are mirrored by marked differences in population structure across the administrative subdivisions (Table 3). As of 1 January 2025, there are significant differences in demographic structure across Rome's 15 administrative subdivisions, confirming that the city's overall profile conceals strong intra-urban contrasts. A particularly evident axis of differentiation is ageing. The historic-centre subdivision (*Municipio I*) stands out as the oldest area (share of aged 65 and over = 27.3%; ageing index = 304.8) and, at the same time, has the lowest share of children aged 0–4 (2.3%), whereas the youngest profile is observed in *Municipio VI* (share of aged 65 and over = 18.1%; ageing index = 129.6; 0–4 = 3.8%). This gap implies that the natural component and demographic "momentum" differ profoundly within the same municipality, reflecting a socio-spatial structure that is far from homogeneous. Even in a context of generally low fertility, the share of children varies considerably across subdivisions—from 2.3% in *Municipio I* to 3.8% in *Municipio VI*, with several intermediate areas around 2.8–3.3%—

suggesting that some parts of Rome are structurally more exposed to decline than others and may enter population decline at different times.

Table 3 – *Population structure indicators at 1 January 2025 in Rome’s administrative subdivisions.*

Administrative subdivision	Aged 0–4 (%)	Aged 65+ (%)	Ageing index	% Foreigners
I	2.3	27.3	304.8	21.7
II	2.9	26.6	237.5	13.0
III	3.3	25.2	212.0	9.6
IV	3.0	25.6	232.1	10.8
V	3.2	23.1	202.2	18.4
VI	3.8	18.1	129.6	19.1
VII	3.0	25.2	228.1	11.1
VIII	2.9	26.9	250.6	11.7
IX	3.2	23.4	193.2	8.7
X	2.9	22.7	190.0	11.5
XI	3.1	23.7	203.4	14.2
XII	2.8	26.2	240.4	12.5
XIII	2.9	24.4	220.2	15.7
XIV	3.3	23.3	193.7	13.0
XV	3.0	22.7	196.4	20.3

Source: our elaboration on Roma Capitale data.

Internationalisation is very uneven within the city. The share of foreign residents varies from 8.7% (*Municipio IX*) and 9.6% (*Municipio III*) to 21.7% (*Municipio I*) and 20.3% (*Municipio XV*), with high values in *Municipi VI* (19.1%) and *V* (18.4%). This dispersion suggests that migration is not simply a “city-level buffer”: it reshapes local demographic profiles in very different ways across Rome, interacting with age structures and contributing differently to the working-age and child populations in each subdivision.

Overall, these contrasts indicate that the demographic drivers identified at the city level operate through markedly different local configurations across Rome, making any aggregate reading inherently partial.

4. Discussion and conclusions

The evolution of Rome’s resident population is best understood as a sequence of distinct phases rather than a single linear trajectory. Long-term intercensal data show intense post-war expansion, followed by a relatively moderate phase of de-concentration and subsequent renewed growth. This long-term profile places Rome

among the large Italian municipalities that have maintained demographic resilience for longer than most. In comparative terms, Rome's long-run path is closer to that of the growing cities—especially Milan and, to a lesser extent, Bologna—than to the persistent decline observed in Genoa and in the southern cities considered.

Annual data refine this picture and identify turning points that do not emerge from intercensal comparisons. Rome broadly follows the national pattern—growth in the 2000s and a gradual slowdown thereafter—but enters the decline phase later. While Italy's annual growth rate turns negative earlier, Rome's turns negative later and shows a brief rebound in the early 2020s. In this sense, Rome is also affected by the broader demographic crisis but experiences it with different timing and a more articulated trend. A similar divergence emerges from a comparison between the main municipalities: Rome remains one of the few large cities that have maintained growth for longer, together with Milan and, to a lesser extent, Bologna; while Genoa and the southern cities entered sustained decline earlier.

The decomposition of annual change clarifies the mechanisms underlying this delay. Natural change becomes structurally unfavourable and increasingly constrains population growth. Migration therefore becomes the decisive component, but its role is not uniform: international migration remains systematically positive throughout the period and provides stable support, while internal mobility changes sign over time and is fundamental in shaping the transition from growth to decline. The evidence is therefore consistent with the hypothesis that Rome's recent downturn reflects both a worsening natural balance and a reduced ability to retain residents when internal migration weakens or turns negative again. At the same time, the results show that a persistently positive international component, although essential, cannot alone prevent decline when the natural deficit intensifies and internal balances no longer support growth.

The population structure as of 1 January 2025 reinforces this interpretation. Rome's level of ageing is broadly similar to that of Italy as a whole, while the base of the demographic pyramid is particularly narrow. This combination points to weak demographic momentum. Rome is also markedly more internationalised than Italy overall, although less so than the most internationalised economic centres of Centre-Northern Italy. The key point is that Rome's structure does not fully coincide with the national profile and differs from other large municipalities in the way ageing, a small child population and internationalisation combine.

It is essential to look beyond the city level. The *Municipi* reveal extreme internal differentiation in size, population concentration, recent growth and structure. Over the last decade, only a small number of peripheral *Municipi* have continued to grow, while most are in decline. The historic centre stands out for the steepest contraction, in line with a broader process of residential depopulation in the core. At the same time, structural indicators vary considerably across *Municipi*:

older areas differ profoundly from younger ones in terms of both population ageing and the presence of children, and internationalisation is highly uneven within the city. Overall, the evidence supports the second hypothesis by showing highly differentiated local configurations, implying that “Rome” cannot be treated as a demographically homogeneous unit.

Rome's demographic resilience is not a static condition, but the result of changing combinations of natural change and migration over time. At the same time, the data show that these components do not operate uniformly across the city: they produce markedly differentiated local configurations within the same municipality. This intra-urban differentiation means that managing social and demographic change is inherently complex, because city-wide averages can mask opposing dynamics and needs in different parts of Rome. It is important to note that the size of Rome's administrative subdivisions is considerable in itself: some *Municipi* are territorially extensive and, in population size, comparable to medium-sized Italian cities. This suggests that further progress requires an even finer spatial resolution, moving beyond the *Municipio* level to capture heterogeneity at the neighbourhood scale. A key priority for future work is to better identify the spatial destinations of internal mobility: municipal net balances do not reveal whether redistribution occurs within the municipality or towards other municipalities, yet this distinction is essential for interpreting demographic change.

Overall, the analysis highlights Rome as a key demographic case in which trends can only be understood through their highly differentiated local configurations.

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INNOVATION DRIVERS AT FIRM LEVEL: THE ROLE OF UNIVERSITY COLLABORATION IN R&D (PRELIMINARY REMARKS)

Andrea Ciccarelli, Audrey De Dominicis,
Alessandro Faramondi, Silvia Lombardi, Ilaria Straccamore

Abstract. Numerous studies agree that innovation has a key role in economic development. A common conclusion among these studies is the central importance of innovation in fostering economic development, with R&D investments seen as essential to enhancing national competitiveness.

Within this framework, collaborative networks between firms and universities play a strategic role, as they facilitate knowledge transfer.

Building on the work of Ciccarelli *et al.* (2025), which analyzed the macroeconomic spillovers of universities and firms R&D regional expenditure on value added, this study shifts the focus to the micro-level in order to provide a more comprehensive understanding of these effects. Using data from Permanent Business Census carried out by ISTAT since 2019, this paper shows the importance of R&D, and particularly the effect on firm performance of collaboration with universities.

1. Introduction

This research takes its cue from the work of Ciccarelli and De Dominicis (2025), which investigated the impact of regional spending on research and development on productivity in Italy¹. Recent ISTAT research, on the other hand, have studied the emerging issues related to productivity and use of from Business Census micro data (ISTAT, 2025; De Panizza *et al.*, 2024).

Starting from this context, a collaboration stems from the need to explore, through microdata, dynamics previously analysed using a macro approach (Ciccarelli *et al.*, 2025). The goal is to integrate academic and statistical expertise for a more detailed and robust understanding of socio-economic phenomena.

In a constantly evolving economic context, the ability of companies to establish effective relationships with other economic actors — other companies, public or

¹ , The research activity of the working group at the University of Teramo was carried out as part of a larger project called “Vitality project”, an initiative funded by the NRRP (National Recovery and Resilience Plan) aimed at promoting the development and transfer of innovation to strengthen the competitiveness of regional production systems, improving their sustainability and quality of life in urban and rural areas.

scientific institutions — represents an important factor of competitiveness (Arvanitis *et al* 2020).

This paper analyses data relating to collaborations established by approximately 280,000 Italian companies with more than 3 employees in 2022, offering an overview of the main contractual forms adopted, the structural characteristics of the companies involved and the associated economic performance. Particular attention is paid to collaborations with universities and research centres, which are still limited but associated with higher levels of productivity.

At this stage of the project, the present study aims to provide a preliminary analysis of the relationships between interaction networks, organizational structures, and economic performance. In particular, this investigation seeks to identify patterns, potential correlations, and interpretative frameworks that may guide subsequent, more structured empirical analyses. The main finding that emerges from this paper is that collaboration between businesses and institutions – especially universities – represents not only a crucial tool for increasing innovation and competitiveness, but also a key mechanism for knowledge transfer, developing qualified human capital, and strengthening productivity in the long run.

This paper has been organized as follows: in Section 2 we briefly discuss the main literature about the topic; in section 3 methodology and data are presented; in section 4 we discuss the results; in section 5 concludes the paper.

2. Literature review

Since the earliest contributions to the literature on the relevance of external knowledge for firms, Allen and Cohen (1969) and Arrow (1974) argue that companies cannot rely solely on their internal resources for their development. Instead, they must leverage external knowledge to gain advantages that would then be transformed into innovation (Grimaldi *et al.*, 2021).

Such external knowledge is a key factor for firm performance (Coehn, 2010), with the main sources being suppliers, customers and finally research partners. Among these, collaborations between universities and firms are the fundamental pillar for transferring scientific and technological knowledge (Metcalfe, 1995; Hagedoorn *et al.*, 2000; Hall *et al.*, 2003). A wide range of interactions between universities and firms are oriented towards the transfer of scientific knowledge (Rosenberg *et al.*, 1994; Marques *et al.*, 2024).

The positive link resulting from collaboration between firms and universities has been identified in several European countries. Consider, for instance, the work of Laursen and Salter (2004), which analyzes the United Kingdom, and Segarra-Blasco and Arauzo-Carod (2008) for Spain. A broader comparison can be found in the work of Fontana, Geuna, and Matt (2006), who examine various European countries such

as Denmark, France, Germany, Greece, Italy, the Netherlands, and the United Kingdom.

In Italy, over the past 15 years, universities have given a boost to what is referred to as the *third mission* - the generation and transmission of knowledge outside the academic boundaries to support socioeconomic development (Hall *et al.* 2003; Cohen *et al.*, 2025), including territorial development.

Universities primarily engage in collaborative relationships with firms in the field of R&D, which can be of either commercial or non-commercial nature (Arranz *et al.*, 2008). Such relationships take general formal forms such as research contracts, consultancy agreements, joint R&D projects, collaborative research initiatives. Such collaborations have also been widely adopted as policy tools to foster innovation within firms (Perkmann e Walsh, 2007).

According to Leydesdorff (2012), collaborations are crucial in innovation-driven model of growth, and their effects have been analyzed at different levels: firms, sector and territory (Grimaldi *et al.*, 2021).

Following Aschhoff and Schmidt (2008) and Malerba and Orsenigo (1996), Cohen (2010), our analysis incorporates respectively both sector and firm size. It is within this framework that our research is situated, capturing some typical characteristics of the Italian entrepreneurial landscape, highlighting its limitations in building effective university–firm networks.

3. Methodology and data sources

To fully explore the role of business relations with universities and R&D, we make use of the integration of two relevant official statistics data sources:

- (i) Permanent Business Census: a sample survey carried out every 3 years since 2019, which provides information on emerging issues such as business organization, business relationships and production filières, competitiveness and environmental sustainability, finance (i.e. credit rationing). The unit of observation and analysis is the legal unit and the reference year of the analysis is 2022. The use of this statistical source is very relevant as the field of observation of the survey are enterprises with 3 or more employees, active in industry and services and resident in the Country. Survey design is complex: on a census basis for enterprises with more than 20 employees while it is a sample for enterprises with less than 20 employees.
- (ii) Business Register on Structural Business Statistics (Frame SBS), annually produced by Istat by extending the basic Register Statistical Archives of Active Enterprises (ASIA) through the integration of administrative, tax and survey sources. Frame SBS register provides the information available on the main economic variables: revenues, turnover, costs of goods and

services, labour costs, wages and salaries, value added. It covers the classes of the Nace Rev.2 classification for sections B to S, except for financial and insurance activities (section K), Public Administration, defence and compulsory social insurance (section O) and division 94 (activities of membership organization).

Overall, our integrated data source is sample of about 280,000 enterprises with 3 or more employees representing about 1 million enterprises and represent 22.5% of Italian firms, 85% of value added, 75% of employees. Relevant variables selection for the purpose of our analysis and descriptive statistics: nominal labour productivity (measured by value added per employee) and key metrics as: width of business networks, type of network, type of stakeholder sourced from direct survey. We also make an in-depth exploration on the subsample of firms with more than 10 employees which were asked to answer a specific question on the type of business functions involved in university collaborations.

4. Results

The available data allow for very detailed reflections on innovation dynamics and on the system of relationships between universities and firms; however, some preliminary considerations are necessary in order to properly understand the results.

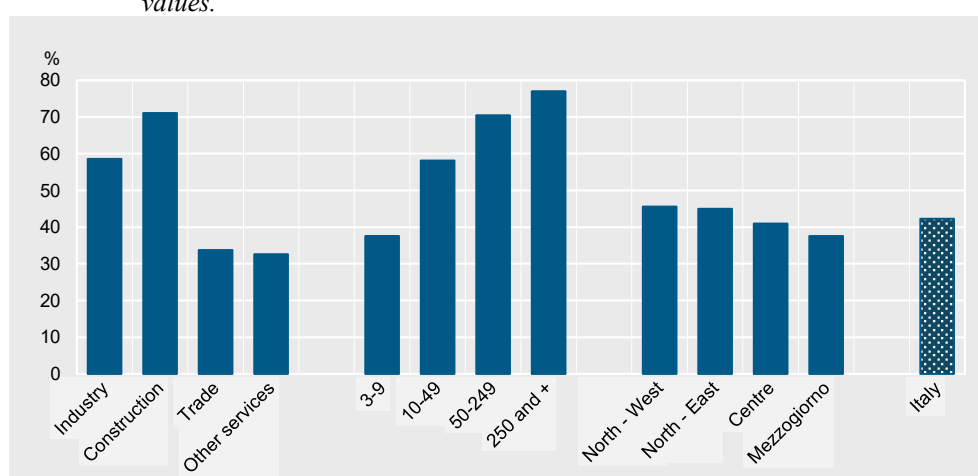
First, potential information distortions should be acknowledged, mainly due to the fact that the measures reported are based on firms' self-declarations and may, in some cases, overestimate (or underestimate) the intensity of the relationships between firms and universities. Moreover, it should be emphasized that the present study must be assessed within a purely descriptive, rather than causal, framework: we have investigated the existence of possible network relationships, but at this stage we do not make any claims regarding potential causal links between the presence of such relationships and firms' performance.

Companies often benefit from collaborating with other businesses or institutions to carry out activities or functions effectively. Working in partnership can be more advantageous than operating independently. In 2022 around 430,000 businesses — 42% of companies with three or more employees — have made this choice, having at least one business relationship with other companies or institutions. Analysing these companies' profiles, particularly with regard to the breadth of their business networks, the types of contracts with their stakeholders, the stakeholders involved, and their economic performance, provides valuable insights into their organisational structures and strategic approaches.

Firstly, in terms of economic sector, business relationships are more prevalent among construction and industrial companies, involving around 71% and 59% of units, respectively. In the trade and other service sectors, business relationships are

less common, affecting around 33% of companies in both cases (Figure 1). Relationships grow significantly as business size increases. This phenomenon involves 38% of micro-enterprises (3-9 employees), 58% of small enterprises (10-49 employees), 70% of medium-sized enterprises (50-249 employees) and 77% of large enterprises (250 or more employees). Collaborations are more prevalent in northern Italy, where around 45% of companies are involved, than in southern Italy (38%).

Figure 1 – *Business relationships by sector, size and macro area. Year 2022. Percentage values.*



Sources: our elaborations on Permanent Business Census 2023.

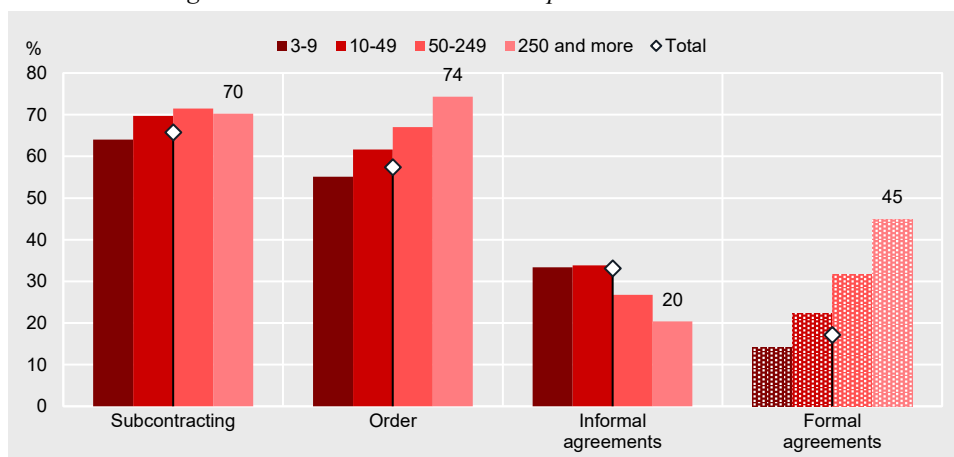
Business relationships are established through various types of contracts (Figure 2). Among firms that have at least one relationship with other entities, subcontracting² is the most prevalent (66%), followed by order contracts³ (57%). Informal and formal agreements⁴ are less common, involving around 33% and 17% of units, respectively. The size of a company affects which type of contract it adopts. Subcontracting and orders are common across businesses of all sizes.

² The company is a supplier that sells goods and/or services based on technical specifications and designs provided by the buyer, rather than from a catalog.

³ The company is the client. It orders and/or purchases goods and/or services and provides technical specifications and designs.

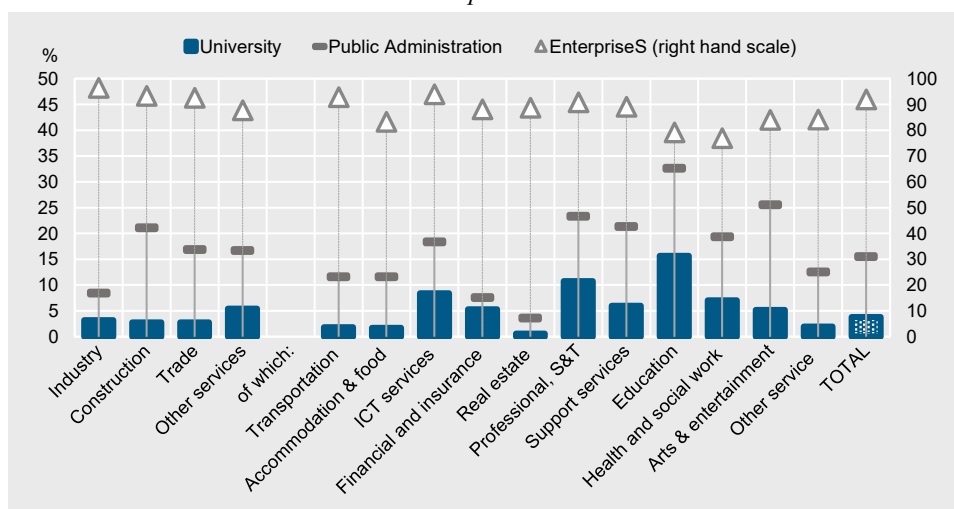
⁴ Formal agreements include consortia, joint ventures, franchises, and temporary business associations.

Figure 2 – Type of business relationship by size. Year 2022. Percentage values on enterprises having at least one business relationship.



Sources: our elaborations on Permanent Business Census 2023.

Figure 3 – Type of stakeholders by sector. Year 2022. Percentage values on enterprises with at least one business relationship.



Sources: our elaborations on Permanent Business Census 2023.

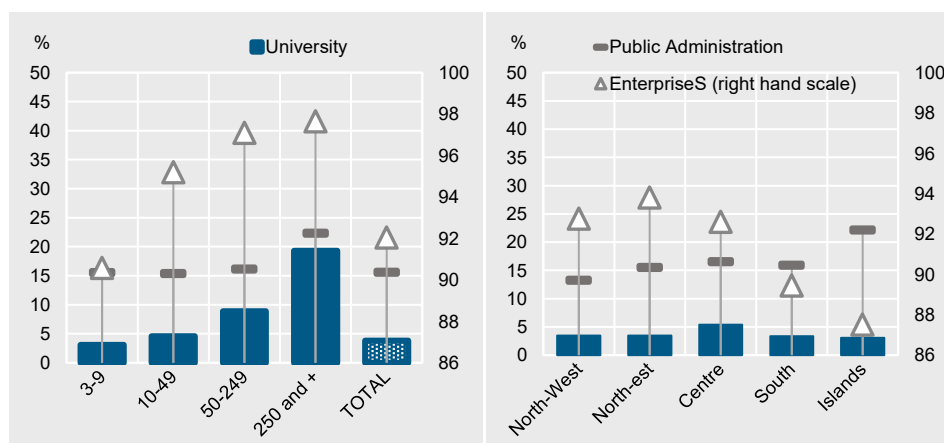
Adoption rates for subcontracting range from 64% among micro-enterprises to 71% among medium-sized businesses, while order rates range from 55% among micro-enterprises to 74% among large companies. Furthermore, formalised contractual relationships are more prevalent among larger firms (45%) compared to

14% of micro-enterprises. By contrast, informal agreements are more prevalent among smaller enterprises, with around a third of micro and small businesses using them, compared to 20% of large firms.

Business relationships are predominantly established with other enterprises, with 92% of companies reporting at least one such partnership (Figure 3). Collaborations with public administrations involve 16% of companies (approximately 67 thousand), while collaborations with universities or research centres are less frequent, involving 4% of companies (approximately 16 thousand). Linkages with universities or research centres are mainly established by enterprises operating in the other services sector, particularly in education, professional, scientific and technical activities, and information and communication technologies (ICT).

As businesses grow in size, their relationships with universities and research centres become significantly stronger (Figure 4). The respective percentages of businesses with at least one such relationship are 3% for micro-businesses, 5% for small enterprises, 9% for medium-sized enterprises and 19% for large enterprises.

Figure 4 - *Type of stakeholders by size and macro area. Year 2022. Percentage values on the total of enterprises with at least one relationship.*



Sources: our elaborations on Permanent Business Census 2023.

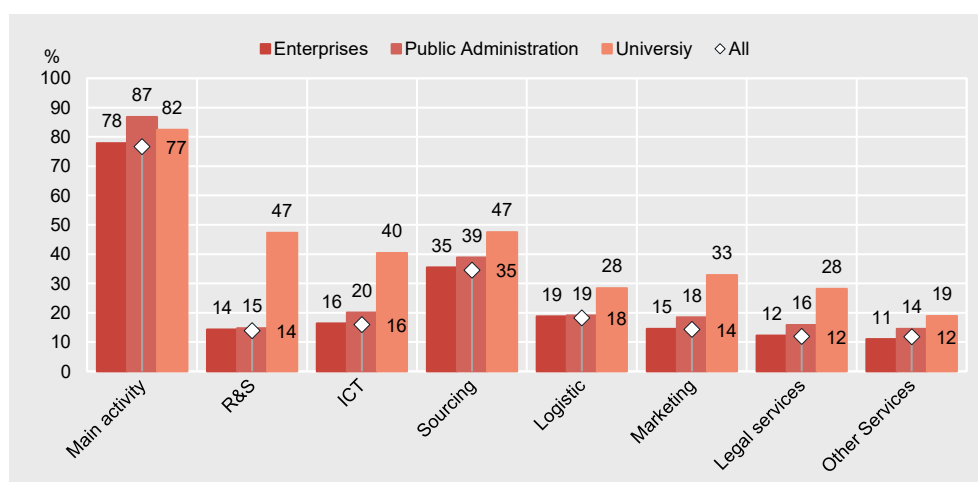
At territorial level, companies in central Italy, particularly those in the Lazio region, are the most likely to collaborate with universities and research centres.

We now focus on the subsample of firms with more than 10 employees to unveil the type of business functions involved in university collaborations, in R&D in particular. Therefore, we now focus only on small, medium and large firms.

This segment of enterprises accounts for over 216 thousands: 129 thousands (59.7%) has at least one business linkage with other subjects (stakeholders). The

majority (95%), in line with the surveyed population, declares to have business linkages with their firms, 13% has linkages with public administration, and 5.4% has linkages with universities. Several business functions may be involved in the relationship, ranging from firm's main activity to logistics, legal services as well as ICT and R&D. As expected, firms mainly activate business relations for their main activity (77%), especially with PA and university (Figure 5). Among other business functions, R&D functions ranks 7th together with sourcing among eight functions considered, but when involved the preferred stakeholder is university (47%).

Figure 5 – *Type of stakeholders by business function. Year 2022. Percentage values on enterprises 10+ with at least 1 business relationship.*



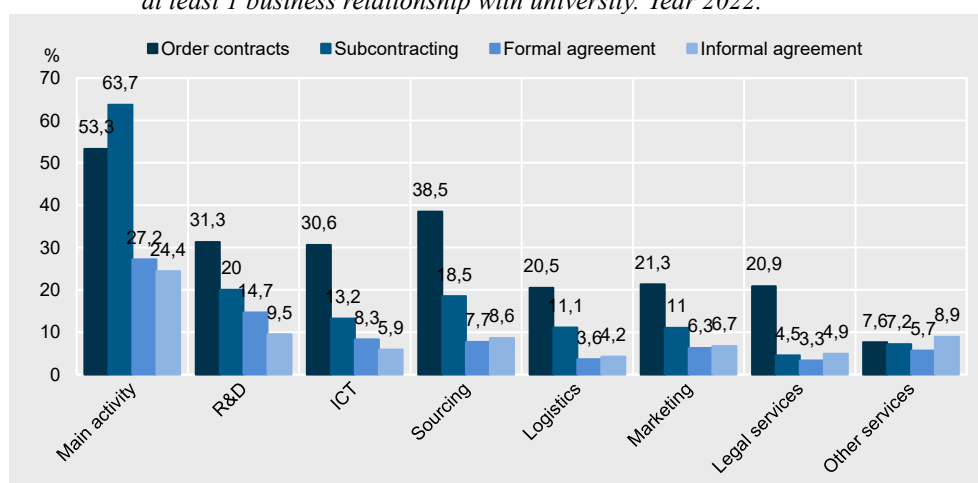
Sources: our elaborations on Permanent Business Census 2023.

Figure 6 further focuses on enterprises with 10 or more employees that activate business relations with university: they account for about 7,000 firms (5.4%) of total and are mainly subcontractors for universities in their main activities, meaning that firms usually sell to universities products and services related to their main business. By contrast, firms source from universities in the forms of order contract other functions. The most frequent are sourcing (38.5%), R&D (31.3%) and ICT (30.6%). These figures underline and quantify therefore the role of firms-university linkages in R&D.

Finally, we explore nominal productivity levels (measured by value added per employee) of firms by type of network (Figure 7). We find out that, compared to companies that operate in isolation, those that collaborate with others are more productive. Interestingly, labour productivity is higher in companies that collaborate with universities and research centres. This is true across all macro sectors, enterprise

sizes and macro area, except for the North-west of Italy. Such evidence is even more marked when considering statistical moments of the distribution of enterprises by type of business network. Labour productivity the upper 90th percentile of firms collaborating with universities is remarkably higher than other firms while lower productive firms are more evenly distributed among types of relations (Figure 8).

Figure 6 - Type of relation by business function. Percentage values on enterprises 10+ with at least 1 business relationship with university. Year 2022.

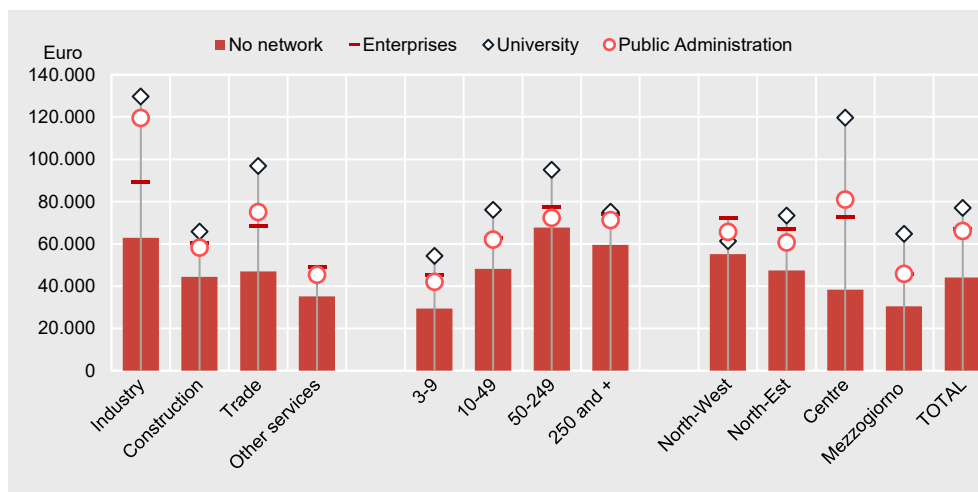


Sources: our elaborations on Permanent Business Census 2023.

5. Conclusions and future research

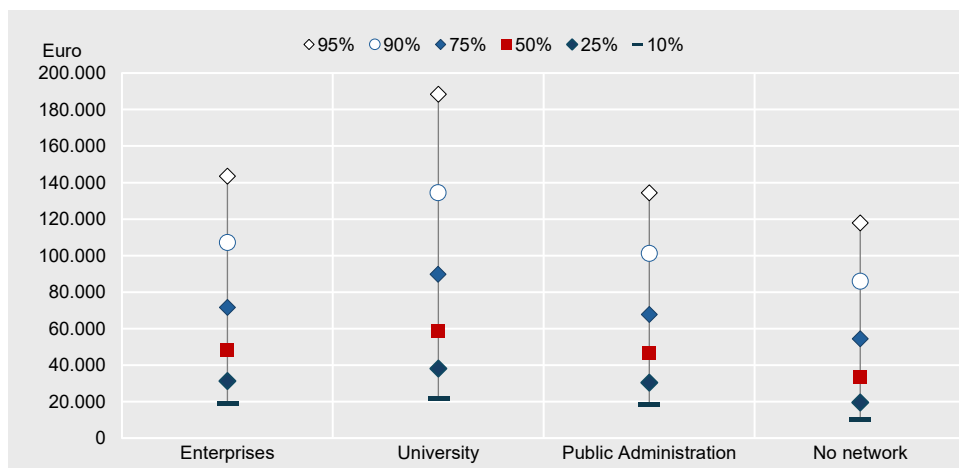
This study explores the relationships that the Italian regional industrial fabric has with other economic actors. The analysis conducted shows that collaboration between businesses and institutions – and in particular with universities – is a key driver for increasing innovation and productivity. Collaboration is more widespread in certain areas of the country (Central Italy) and among larger companies, and interaction takes place both within the scope of their core activities and in cross-cutting, high value-added areas such as Research and Development and ICT. Although the percentage of companies that have relationships with Universities or Research Centers remains low (which also depends on the type of company), companies that interact with universities show above-average productivity levels.

Figure 7 - Business networks and labour productivity by sector, size and macro area. Year 2022 Values in euros.



Sources: our elaborations on Permanent Business Census 2023.

Figure 8 – Statistical moments of distribution of labour productivity by type of business network. Year 2022 Values in euros.



Sources: our elaborations on Permanent Business Census 2023.

These results confirm the importance of collaboration networks for business competitiveness and suggest the opportunity to promote policies that encourage links between academia and industry, especially for the benefit of smaller companies that

struggle to support R&D activities on their own, especially in a country where enterprises are small and can hardly internalize the R&D activities.

The future step is to identify the correct econometric models to estimate relationships between variables and impact, both in a macroeconomic and a microeconomic perspective: on the one hand the impact on productivity and value added and on the other hand the determinants that drive firms and universities to build networks with each other.

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MIGRANTS' SOCIO-ECONOMIC INTEGRATION: AN ANALYSIS OF THE ITALIAN CASE

Roberta Defazio, Anna Paterno

Abstract. Numerous studies have shown that securing a first job is a crucial step in the integration of migrants. In Italy, the labour market is highly segmented, often penalising migrants based on their gender, country of origin, age at arrival, as well as their migration motives and long-term settlement intentions. This study uses unique data from the 2024 FOLCSI Survey, funded by AGE-IT Project Spoke 1, to analyse the socio-demographic and migration determinants associated with access to first paid employment in Italy. Binary logistic regression models are used to examine how individual and migratory characteristics influence the likelihood of obtaining a first paid job. The results highlight significant disadvantages for women and non-economic migrants, while factors such as age at arrival and educational attainment also play a crucial role. When analysed separately by gender, the results confirm the existence of structural barriers that hinder access to employment at the beginning of the migration process. This highlights the importance of considering individual characteristics upon arrival in order to better understand employment disparities among migrants.

1. Introduction

Once a country of emigration, Italy has become a key destination in Southern Europe (Colombo and Dalla Zuanna, 2019; Fellini *et al.*, 2023). The country represents one of the European countries where employment plays a central role in migrants' socio-economic integration. However, migrants' integration into the Italian labour market remains problematic, due to a highly segmented employment model characterised by informality and limited vertical mobility, particularly for women (Reyneri and Fullin, 2011; Ambrosini, 2013; Avola, 2015).

The structure of the Italian labour market tends to favour the employment of foreign labour in low-skilled sectors, thereby limiting access to stable positions that are consistent with the skills acquired in their countries of origin (Reyneri and Fullin, 2011; Ballarino and Panichella, 2015). This phenomenon is further exacerbated by factors related to the geographical origin and the motivation to migrate, both of which have a significant influence on the likelihood of being employed (Cantolini *et al.*, 2023; Impicciatore and Molinari, 2025).

Furthermore, the transition to the first paid job follows different paths. On one hand, men tend to migrate more frequently for economic reasons and are more likely

to find employment upon arrival. On the other hand, women migrate more often for family reunification reasons and have lower overall participation rates (Ballarino and Panichella, 2015). Intentions upon arrival also play a crucial role in shaping employment trajectories, in fact individuals planning a long-term stay pursue structured employment and social integration from the initial stage, on contrary migrants who declare temporary migration plans tend to prioritize rapid entry into the labor market, accepting precarious but remunerative forms of employment (Ambrosini, 2013).

The study makes use of unique data derived from the Survey on “Formation, Employment, Care Work and Health of Immigrants and persons with migratory background in Italy” (FOLCSI - Italian acronym), carried out in 2024 and funded by the Extended Partnership “AGE-IT Ageing Well in an Ageing Society” (see Data and Methods Section for further information on the Survey).

Binary logistic regression models were used to estimate the likelihood of obtaining a first paid job as a function of variables referred to the time of arrival, (i.e. collected through retrospective responses provided at the time of the survey) including gender, age at arrival, country of origin, reason for migration and migration intentions.

The analysis pursues two main objectives: first, to isolate the effect of pre-migration characteristics at the time of entry into the labour market; second, to identify possible systematic differences between migrant categories. Specifically, the aim is to assess whether certain characteristics—such as being female, coming from non-EU countries, or migrating for non-economic reasons—constitute persistent disadvantages already at the early stages of the integration process.

The structure of the paper is as follows. Section 2 presents the theoretical framework and a review of the literature on the structural barriers and differential opportunities that shape migrants’ access to and positioning within the Italian labour market. Section 3 describes data, variables and models used in the analyses. Section 4 presents the descriptive analyses and discusses the results of the estimated models. Conclusions and future steps follow.

2. Theoretical background, literature and research hypotheses

The integration of migrants into the Italian labour market has been a key topic in demographic, sociological and economic debates for over two decades, particularly with regard to the quality of integration and access to paid employment (Reyneri and Fullin, 2011; Dustmann *et al.*, 2016). Italy is a particularly interesting case in the European context for several reasons. Firstly, it is a country of relatively recent immigration, having undergone a rapid and chaotic transition from an emigration country to a destination for migrants (Colombo and Dalla Zuanna, 2019). Secondly, migrants show a low risk of unemployment, but face strong disadvantages in

accessing skilled or non-manual jobs (Reyneri and Fullin, 2011; Avola, 2015; Cantalini *et al.*, 2023). The Italian labour market is highly segmented and often informal. This segmentation is exacerbated by the geographical origin of migrants: non-EU migrants face higher barriers to accessing skilled jobs, while Eastern Europeans concentrate in low-skilled sectors (Reyneri and Fullin, 2011).

Entry into first employment represents a crucial stage in migrants' working careers. Numerous studies have shown that characteristics at the time of arrival—such as gender, reason for migration, age, and human capital—significantly influence both the access to and the quality of employment (Chiswick, 1999; Ballarino and Panichella, 2015). Economic migrants tend to enter the labor market more easily and quickly, although often in low-skilled sectors. On the contrary, migrants who leave their country for family or humanitarian reasons encounter greater obstacles, related to legal constraints, lack of support networks and less transferability of skills (Impicciatore and Molinari, 2025).

Migration intentions at the time of arrival also influence employment strategies. Temporary migrants often accept precarious but well-paid jobs, whereas those who intend to stay permanently tend to seek greater professional and social integration (Ambrosini, 2013; Ballarino and Panichella, 2015).

Furthermore, gender plays a crucial role, in fact female migrants show lower labour force participation and greater occupational segregation. They are often disadvantaged both in terms of access to employment and quality of the jobs they obtain, regardless of their educational level or the skills acquired in their country of origin, which often exceed the requirements of the positions they occupy in Italy, frequently concentrated in the care sector (Ballarino and Panichella, 2015). In particular, migrant women have lower job mobility and take much longer than men to find their first job, especially in cases of migration for family or humanitarian reasons. When they do find work, they tend to be concentrated in low-skilled sectors with poor prospects for advancement, often remaining trapped in precarious or unrewarding jobs or relegated to care work and caregiving (Impicciatore and Molinari, 2025).

Finally, age at arrival is a key factor in determining migrants' employment opportunities. Those who arrive at a young age are more likely to acquire host-country-specific skills, learn the language and build more stable and consistent employment pathways over time (Dustmann *et al.*, 2016).

Considering the theoretical framework outlined and consistent with the national and international literature, this study aims to test the following hypotheses:

H1. Migrants who arrived in Italy for economic reasons have a higher likelihood of accessing a first paid job than those who came to this country for family or humanitarian reasons, due to a stronger orientation towards the labour market and a more favourable selection in terms of employment characteristics.

H2. Migrants who, upon arrival, declare stable migratory intentions, need more time and efforts to obtain a first job than those with temporary, flexibles or indefinite plans. Long-term planning is associated with strategies that are more oriented towards professional integration.

H3. Migrant women encounter more difficulties in accessing their first job than men, particularly if they come from non-European countries or hold poorly recognised qualifications. The gender dimension, in interaction with origin and human capital, produces specific forms of occupational disadvantage.

H4. Age at arrival is a crucial factor: migrants arriving at a young age are more likely to enter the labour market quickly, thanks to a more effective acquisition of human capital specific to the Italian context.

3. Data and Methods

The analyses are based on data from the FOLCSI Survey (Italian acronym for “Formation, Employment, Care Work and Health of Immigrants and Persons with a Migratory Background in Italy”). The survey, that is based on a targeted and non-probabilistic sampling strategy, set up according to the Centre Sampling Method (Baio *et al.*, 2011), involved 12,608 individuals with a migrant background. Out of these, 9,797 were first-generation immigrants aged 18 or older at the time of the interview, and they constitute the analytical sample used in this study. The sample includes immigrants with different legal statuses – regular, irregular, or awaiting regularisation. It was collected in 2024 in four Italian regions characterised by a significant portion of the foreign population in Italy and diverse socio-occupational contexts: Lombardy, Lazio, Campania, and Apulia.

The aim of the present study is to analyse the socio-demographic and migratory determinants that influence migrants' access to their first paid job in Italy. To this end, we employ binary logistic regression models, where the dependent variable is dichotomous: it takes value 1 if the individual obtained a first paid job after arrival in the country, and 0 otherwise.

Diverse socio-economic factors influence the likelihood of finding a first paid job in Italy. The independent variables included in the models are gender, age upon arrival, year of arrival, country of origin, reason for migration (economic, family, political, or other), migration intentions declared at the time of arrival (permanent vs. temporary/indefinite). Finally, education qualification and region of residence are included in the models as control variables. All explanatory variables were collected at the time of the interview, but referred to the time of arrival through retrospective questions, following methodological recommendations to avoid anticipatory bias (Hoem and Kreyenfeld, 2006; Mize *et al.*, 2019; Long and Mustillo, 2021).

In order to address the issue of endogeneity, several tests were conducted by adding one variable at a time and carefully analysing changes in odds ratios. The first model includes only the variables referred at the moment of arrival in the host country (M1), the second introduces the level of education (M2), while the third also considers the region of residence, distinguishing between Lombardy, Lazio, Campania and Apulia (M3). The models are also estimated separately for men and women, with the aim of highlighting possible gender differences in access to first employment. This analytical approach makes it possible to assess in detail the impact of individual conditions observed exactly at the moment of arrival on first job placement, considering that the characteristics and motivations behind migration can differentially influence employment opportunities.

The final sample shows important differences regarding first job of migrants in Italy. A first overview of the data highlights substantial gender disparities in employment outcomes. Men represent the majority of the employed group (56.69%), whereas women are overrepresented among the non-employed (62.32%), suggesting a persistent gender gap in labour market integration. Age at arrival appears to play a critical role. Migrants who arrived between the ages of 18 and 29 show the highest employment rates (53.43%), while those who arrived after age 45 are markedly less likely to be employed, representing just 4.13%. Migration motives also distinguish individuals' employment trajectories. Those who reported economic reasons for migration are the most likely to be employed (52.09%). In contrast, migrants arriving for family reunification (38.44% of the non-employed), political reasons (20.48%), or other non-economic motivations (20.48%) show significantly lower employment outcomes. Migration intentions declared at the time of arrival also play a relevant role. Migrants with a non-permanent migration plan show higher share of employed individuals (36.54%) compared to those without a defined project (23.99%). Interestingly, their employment levels are also slightly higher than those of individuals with a declared permanent migration plan (39.46%), suggesting that short-term or flexible strategies may facilitate earlier entry into the labour market. Labour market access also varies by period of arrival. Migrants who arrived before 2010 show higher share of employed individuals, while those who arrived more recently (2017–2024) make up the largest share of the non-employed (60.25%), indicating greater difficulty in entering the labour market. Finally, considerable differences emerge by country of birth. Migrants from the Philippines, Romania, Perù, and other Eastern European countries display the most favourable share of employed individuals. Conversely, lower employment levels are observed among migrants from Pakistan, Egypt, and Southeast Asia. These disparities suggest persistent structural barriers linked to origin-based stratification in the Italian labour market.

4. Results

Table 1 shows the results of the regression models and highlights the significant role of gender: women are much less likely to be employed compared to men. The odds of being employed are about 67% lower for women (OR = 0.33). Age at arrival also matters: compared to migrants aged 18–29, those arriving over the age of 45 have significantly lower employment odds (OR = 0.56). The period of arrival is negatively associated with employment: individuals who arrived between 2017 and 2024 are significantly more disadvantaged (OR = 0.19) compared to those who arrived before 1999. Reasons for migration strongly influence employment outcomes. Compared to those who migrated for economic reasons, individuals who arrived for family reunification (OR = 0.21), political reasons (OR = 0.31), or other reasons (OR = 0.22) are significantly less likely to obtain employment. Migration intentions declared at arrival show weaker effects. Migrants with a non-permanent project are slightly more likely to be employed than those with a permanent plan (OR = 1.16).

Country of origin remains a strong predictor of first labour market access. Compared to Albanian migrants (reference group), those from Romania (OR = 1.78), Eastern Europe (OR = 2.07), Philippines (OR = 2.83), Peru (OR = 3.60), and other Latin American countries (OR = 1.79) exhibit significantly higher employment odds. Conversely, migrants from Bangladesh (OR = 0.62), other Southeast Asian countries (OR = 0.43), and Egypt (OR = 0.47) experience greater difficulties in accessing work. Education is positively associated with employment. Migrants with lower secondary (OR = 1.30), upper secondary (OR = 1.57) and university education (OR = 2.32) all have higher odds of being employed compared to those with no education or only primary schooling. Finally, when regional controls are added in Model 3, no significant territorial differences emerge. Binary logistic regression models were estimated separately for men (Table 2) and women (Table 3) to explore gender-specific determinants of access to a first paid job.

Overall, several patterns are consistent across both groups. For both men and women, being over 45 at the time of arrival is associated with significantly lower employment likelihood, as arriving more recently (2017–2024). Migration for non-economic reasons (family or political) significantly reduces employment odds for both genders. This effect appears stronger among women, who are more frequently associated with family-related migration.

However, migration intentions show a gendered effect: among women, having a non-permanent migration plan is significantly associated with higher employment odds (OR = 1.46), whereas for men, no significant association is found for non-permanent plans, and the absence of a defined project is negatively associated with employment (OR = 0.76). Furthermore, differences by country of origin are more pronounced among women. While men from Peru (OR = 3.02) and the Philippines

(OR = 2.93) display high odds of being employed, the highest odds among women are observed for those from Romania (OR = 2.08) and other Eastern European countries (OR = 1.86). Conversely, women from Bangladesh, Pakistan, Egypt, and Southeast Asia face particularly strong disadvantages. Education remains a key predictor for both genders, especially for those with university degrees, although the effect is slightly stronger for women (OR = 2.67 vs. 1.86 for men).

Table 1 - Odds Ratios from Binary Logistic Regression Models Predicting Access to a First Paid Job among Migrants.

	M1	M2	M3
Variables	OR	OR	OR
Woman (Ref. Man)	0.35 ***	0.33***	0.33***
Over 45 (Ref. 18 – 29)	0.53 ***	0.56***	0.56***
From 2000 to 2009 (Ref. Arrival Until 1999)	1.14 **	1.14*	1.14**
From 2010 to 2016	0.76*	0.76*	0.76*
From 2017 to 2024	0.19***	0.19***	0.19***
Family reasons (Ref. Economic reasons)	0.22***	0.21***	0.21***
Political reasons	0.33***	0.32***	0.31***
Other reasons	0.27 ***	0.22***	0.22***
Non-permanent project (Ref. Permanent project)	1.27**	1.16*	1.16*
Romania (Ref. Albania)	1.71 *	1.78*	1.78*
Other Eastern Europe	2.23**	2.10***	2.07***
Bangladesh	0.65*	0.66*	0.62*
Cina	1.62*	1.60*	1.57*
Philippines	3.05***	2.89***	2.83***
Other Southeast Asia	0.49*	0.43**	0.43**
Egypt	0.48***	0.46***	0.47***
Other Sub-Saharan Africa countries	1.16	1.39*	1.37*
Perù	3.85***	3.69***	3.6***
Other Central and Latin America countries	1.95***	1.83**	1.79**
Lower secondary education (Ref. No education and Primary)	-	1.30*	1.3**
Upper secondary and Post secondary	-	1.57***	1.57***
University education	-	2.32***	2.32***
<i>Constant</i>	<i>34.04</i>	<i>24.71</i>	<i>26.04</i>
<i>-2 log likelihood</i>	<i>3788.599</i>	<i>3731.8312</i>	<i>3730.4586</i>
<i>Pseudo R²</i>	<i>0.2141</i>	<i>0.2206</i>	<i>0.2209</i>
<i>N</i>	<i>9,434</i>	<i>9,370</i>	<i>9,370</i>

Source: Own elaboration on FOLCSI 2024 data. 95% confidence intervals shown. Significance levels: * $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 2 – Odds Ratios from Binary Logistic Regression Models Predicting Access to a First Paid Job among Migrant Men.

	M1	M2	M3
Variables	OR	OR	OR
Over 45	0.37***	0.38***	0.37***
From 2000 to 2009 (Ref. Arrival Until 1999)	2.36**	2.44**	2.45**
From 2010 to 2016	1.81*	1.86*	1.89*
From 2017 to 2024	0.16***	0.16***	0.16***
Family reasons (Ref. Economic reasons)	0.47***	0.44***	0.44***
Political reasons	0.47***	0.46***	0.47***
Other reasons	0.29***	0.26***	0.26***
Non-permanent project (Ref. Permanent project)	0.98	0.86	0.86
No defined project	0.78*	0.76*	0.76*
Romania (Ref. Albania)	0.98	1.03	0.99
Other Eastern Europe	0.79	0.86	0.88
Bangladesh	1.91*	2.03*	2.15*
Cina	1.33	1.28	1.32
Philippines	3.04*	2.97*	2.93*
India	1.84	1.97*	2.01*
Pakistan	1.29	1.47	1.59
Other Southeast Asia countries	0.50	0.51	0.53
Egypt	1.46	1.53	1.50
Morocco	1.15	1.40	1.45
Other North African countries	1.68	1.94*	1.96*
Nigeria	0.94	1.14	1.17
Other Sub-Saharan Africa countries	1.38	1.73*	1.82*
Perù	3.17*	3.14*	3.02*
Other Central and Latin America countries	1.67	1.59	1.59
Lower secondary education (Ref. No education and Primary)	-	1.65***	1.60***
Upper secondary and Post secondary	-	1.78***	1.69***
University education	-	1.96***	1.86**
Constant	20.87	13.36	11.18
-2 log likelihood	1578.4146	1548.8641	1546.5205
Pseudo R ²	0.2073	0.2166	0.2178
N	4,921	4,888	4,888

Source: Own elaboration on FOLCSI 2024 data. 95% confidence intervals shown. Significance levels:

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

Table 3 – Odds Ratios from Binary Logistic Regression Models Predicting Access to a First Paid Job among Migrant Women.

	M1	M2	M3
Variables	OR	OR	OR
Over 45	0.57***	0.62***	0.61***
From 2000 to 2009 (Ref. Arrival Until 1999)	0.88	0.88	0.88
From 2010 to 2016	0.57***	0.56***	0.57***
From 2017 to 2024	0.20***	0.21***	0.21***
Family reasons (Ref. Economic reasons)	0.23***	0.21***	0.21***
Political reasons	0.24***	0.22***	0.21***
Other reasons	0.28***	0.21***	0.21***
Non-permanent project (Ref. Permanent project)	1.56***	1.47***	1.46***
No defined project	1.30**	1.29**	1.29**
Romania (Ref. Albania)	1.91*	2.07*	2.08*
Other Eastern Europe	2.13***	1.90**	1.86**
Bangladesh	0.27***	0.26***	0.24***
Cina	1.57	1.57	1.53
Philippines	2.52**	2.30**	2.26**
India	0.50**	0.52**	0.52**
Pakistan	0.33**	0.33**	0.32**
Other Southeast Asia	0.58	0.47*	0.46*
Egypt	0.23***	0.21***	0.22***
Morocco	0.65	0.72	0.73
Other North African countries	0.82	0.85	0.83
Nigeria	0.51**	0.64	0.63
Other Sub-Saharan Africa countries	1.38	1.70*	1.66*
Perù	3.64***	3.48***	3.40***
Other Central and Latin America countries	2.02**	1.91**	1.87**
Lower secondary education (Ref. No education and Primary)	-	1.06	1.06
Upper secondary and Post secondary	-	1.52***	1.53***
University education	-	2.66***	2.67***
<i>Constant</i>	<i>13.36</i>	<i>9.81</i>	<i>10.66</i>
<i>-2 log likelihood</i>	<i>4125.7394</i>	<i>4043.7622</i>	<i>4038.3254</i>
<i>Pseudo R²</i>	<i>0.2313</i>	<i>0.2415</i>	<i>0.2426</i>
<i>N</i>	<i>4,512</i>	<i>4,481</i>	<i>4,481</i>

Source: Own elaboration on FOLCSI 2024 data. 95% confidence intervals shown. Significance levels:

* $p < 0.05$, ** $p < 0.01$, *** $p < 0.001$.

5. Conclusions and future steps

The results of this study confirm that the likelihood of obtaining a first paid job in Italy is strongly influenced by individual and migratory characteristics measured at the time of arrival. In line with the literature (Ambrosini, 2013; Ballarino and Panichella, 2015; Impicciatore and Molinari, 2025), the results show that gender, migration motives, and country of origin are key axes of stratification that generate significant disparities in early integration into the labor market. In particular, migrants from different origins show divergent patterns, with non-EU citizens facing greater disadvantages in accessing employment. Moreover, education level emerges as an important predictor, as higher qualifications are positively associated with the likelihood of being employed.

In particular, the results support our first hypothesis (H1), showing that migrants who arrived for economic reasons are more likely to obtain early employment than those who migrated for family reunification or humanitarian protection. This finding reflects a stronger labour market orientation and a more favourable self-selection in terms of employability (Impicciatore and Molinari, 2025). The second hypothesis (H2) is only partially supported. While migration intentions declared upon arrival are significantly associated with access to first paid employment, the effect is in the opposite direction than expected. Individuals with non-permanent migration plans show higher odds of employment, particularly among women. This suggests that short-term migration projects often involve prioritising rapid labour market entry, even in precarious or low-quality jobs, over long-term integration strategies (Ambrosini, 2013). The third hypothesis (H3), concerning the gendered patterns of early employment, is confirmed as well. Migrant women, especially those from non-European countries or with low-recognition qualifications, show significantly lower employment odds than their male counterparts, highlighting persistent gender-based inequalities shaped by origin and human capital interaction (Reyneri and Fullin, 2011; Cantalini *et al.*, 2023). Finally, our fourth hypothesis (H4) is corroborated: age at arrival appears to be a crucial determinant of access to employment, with younger migrants more likely to integrate rapidly due to greater capacity to accumulate country-specific human capital (Dustmann *et al.*, 2016).

However, some limitations should be addressed in future analyses. First, while our models take into account several variables measured at arrival, it would be useful to include family-related factors, such as marital status or number of children. Although not measurable retrospectively, an indicator can be derived by combining current characteristics with the declared reference year (Impicciatore and Molinari, 2025). Second, future research should take into account language skills at the time of arrival, which can be inferred from current reported skills, as language barriers are likely to play a key role in determining access to job opportunities (Portes and Rumbaut, 2014; Colombo and Dalla Zuanna, 2019).

Further analyses should also consider employment not only as a binary outcome, but by distinguishing between types of jobs, sectors, and quality of employment. This would allow for a better understanding of occupational segmentation, particularly among overqualified migrants (Reyneri and Fullin, 2011; Cantalini *et al.*, 2023). In addition, the length of stay in the host country and the time needed to access the first paid job should be analyzed in more detail. Estimating the time between arrival and entry into the labor market, particularly in relation to migration motives and gender, can provide crucial insights into how structural constraints delay labor market participation. Such delays can produce cumulative disadvantages over time, particularly for women and humanitarian migrants (Portes and Rumbaut, 2014; Ballarino and Panichella, 2015; Impicciatore and Molinari, 2025). Finally, estimating gender-stratified expected employment likelihood may help clarify whether the observed disadvantages stem from individual preferences, systemic barriers, or their interaction (Avola, 2015; Fellini *et al.*, 2023).

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LIFE EXPECTANCY AND ENVIRONMENT IN THE MEDITERRANEAN AREA: STATISTICAL RELATIONSHIPS AND SPURIOUS CORRELATIONS

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Abstract. Several interrelated factors are behind the good health and life expectancy of local populations. Today, large datasets are available at UN level to analyse the relationships between economic, social and environmental factors. All dimensions that are now considered essential for a sound assessment of the sustainability of national development paths.

Using a clustering analysis, this study focuses on the Mediterranean area to highlight how variations in life expectancy across the region are shaped by factors such as economic conditions, healthcare systems and political stability of the countries, rather than climate or physical geography alone. The application of multivariate techniques allows evaluating the multiple relationship among the indicators nowadays available in the WB statistical databases, taking into account the limitations in the data while their correlations, eventual connections or spurious correlations.

The paper highlights further data and development needed in the future. Based on present results, some useful conclusions for policy are drawn.

1. Introduction

In this paper we identify common factors in countries having similar health profiles and similar life expectancies, of the population living at the border of the Mediterranean Sea.

The region is a special geographical area where three continents meet (Europe, Africa and Asia), with different populations' history and of long-lasting migration. Furthermore, climate and natural conditions diverge moving from the south of Europe and the Balkans to the Middle East and North Africa. Despite this environmental diversity, research shows that further factors play a dominant role in determining health outcomes.

Healthcare systems, political stability, and economic growth have a far more significant impact on life expectancy than physical geographic conditions.

A study by Wilkinson and Pickett (2006) highlights the role of income inequality in determining health outcomes, showing that countries with more equitable wealth distribution tend to have higher life expectancies. Similarly, research by Mackenbach et al. (2019) demonstrates that countries with robust healthcare systems

and greater access to medical care, such as Norway, tend to experience longer lifespans, regardless of their geographic location. Additionally, studies on political stability, such as one by Franco et al. (2004), have found that stable governance and reduced conflict contribute significantly to better health outcomes and longer life expectancy, as seen in Japan, compared to unstable regions like Syria or Afghanistan. These findings emphasise that life expectancy is more closely linked to social, economic, and political determinants than to physical geography.

Similarly, in the Mediterranean area we expect to find the same factors behind life expectancy dishomogeneity. Using data from the World Development Indicators (WDI) provided by the World Bank and available for most of the political entities, eventually integrated with further statistical sources, our goal is to identify groups with similar life expectancy and to demonstrate that, within each group, they share common characteristics at the political, economical and social level, not just in terms of climate factors.

2. Political Subdivision and Geographical Overview of the Mediterranean Area

Numerous countries of different sizes overlook the Mediterranean, from city states (Gibraltar and Monaco), islands (Malta and Cyprus) to large countries that extend well beyond the Mediterranean Sea towards the Sahara Desert (Algeria, Libya, Egypt) or other seas (Turkiye, France, Spain). The political entities in the region are 24, not all fully recognized at UN and international level: North Cyprus and Palestine have still a limited international status.

The main political agglomeration of the region can be identified in the northern part of the sea, the European Union (EU) which include 7 countries (Spain, France, Italy, Malta, Slovenia, Croatia, Greece and Cyprus) plus 4 additional candidates (Bosnia -Herzegovina, Montenegro, Albania and Turkiye).

At the south of the sea, we have a second political union: the Arab League, with 8 members (Morocco, Algeria, Tunisia, Libya, Egypt, Palestine, Lebanon and Syria).

The different national coalitions reported above reflect cultural history and political identity (European and Maghreb-Middle Eastern), resulting in different social and economic conditions.

In addition, the area also experiences diverse climates, from the temperate conditions of northern countries to the hot, arid climates of southern nations. Island nations have distinct microclimates influenced by the sea, further contributing to the region's environmental diversity.

Table 1 – Dimensional, development and climatic indicators of the Mediterranean countries (Year 2023, last available).

Country	Cooling Degree Day (CDD)	GDP per capita (current US\$)	CO2 emissions	Population, total (thousands)	Surface (sq. Km) (thousands)	Population density (pop. Per km2)	Population growth (annual %)
Albania	809.8°	8368	1.5°	2746.0	28750 [†]	102.6 [†]	-1.1
Algeria	5135.0°	5260	3.7°	45606.5	2381741 [†]	18.5 [†]	1.6
Bosnia and Herzegovina	394.6°	8426	6.3°	3210.8	51210 [†]	63.9 [†]	-0.7
Croatia	663.1°	21460	3.9°	3853.2	88070 [†]	69.3 [†]	-0.1
Cyprus	2593.7°	34701	5.5°	1260.1	9250 [†]	134.7 [†]	0.7
Egypt, Arab Rep.	4022.2°	3513	2.0°	112716.6	1001450 [†]	109.8 [†]	1.5
France	455.0°	44461	4.0°	68170.2	549087 [†]	123.8 [†]	0.3
Gibraltar	NA	NA	NA	32.7	10 [†]	3266.9 [†]	0.1
Greece	1236.8°	22990	4.8°	10361.3	131960 [†]	82.0 [†]	-0.6
Israel	2828.0°	52262	6.3°	9756.7	22070 [†]	433.1 [†]	2.1
Italy	888.5°	38373	4.7°	58761.1	302068 [†]	200.0 [†]	-0.3
Lebanon	1572.9°	3824	3.8°	5353.9	10450 [†]	546.7 [†]	-2.5
Libya	3879.4°	7330	6.7°	6888.4	1759540 [†]	3.8 [†]	1.1
Malta	1830.4°	37882	3.1°	553.2	320 [†]	1620.4 [†]	4.1
Monaco	691.9°	24086*	NA	36.3	90 [†]	17603.6 [†]	-0.5
Montenegro	404.3°	12017	4.1°	616.2	13810 [†]	46.0 [†]	-0.2
Morocco	2412.6°	3672	1.8°	37840.0	446550 [†]	83.1 [†]	1.0
North Cyprus							
Palestine							
Slovenia	328.8°	32164	5.9°	2120.9	20480 [†]	104.7 [†]	0.4
Spain	1010.3°	32677	4.3°	48373.3	505965 [†]	94.9 [†]	1.2
Syrian Arab Republic	3292.0°	421 [†]	1.2°	23227.0	185180 [†]	116.1 [†]	4.9
Tunisia	2997.1°	3895	2.4°	12458.2	163610 [†]	78.9 [†]	0.8
Turkiye	1114.3°	12986	4.9°	85326.0	785350 [†]	109.3 [†]	0.4

Last available year: * = 2022; † = 2021; ° = 2020.

Data from World Bank database; missing data of Monaco, North-Cyprus and Palestine from national authorities and CIA data.

Table 1 presents an overview of the dimensional, development, and climatic indicators of Mediterranean countries. A cooling degree day (CDD) is a measurement designed to track energy use. It is the number of degrees that a day's average temperature is above 18°C (65°F). Daily degree days are accumulated to obtain annual values. Cooling degree days can describe the overall need for cooling. The CDDs values highlight distinct climate patterns across the Mediterranean countries. Algeria (CDD: 5,135), Libya (CDD: 3,879.4), and Egypt (CDD: 4,022.2) experience hot arid climates with extremely high cooling demands. Israel (CDD: 2,828) and Cyprus (CDD: 2,593.7) also have high CDD values, reflective of their hot Mediterranean climates, while southern European countries, such as Italy (CDD: 888.5) and Greece (CDD: 1,236.8), have more moderate CDD values, indicating

warm but less extreme summers. In contrast, northern Mediterranean countries such as France (CDD: 454.9) and Slovenia (CDD: 328.8) experience cooler summers, with much lower cooling demands.

Economically, there is significant variation in GDP per capita, with Monaco (\$240,862) as an extreme outlier, while Syria (\$421) and Lebanon (\$3,824) have much lower figures, reflecting their economic difficulties. GDP per capita does not consistently align with population density or country size. For example, Cyprus and Malta have relatively different population densities (134.7 and 1,620.4 people/km², respectively), yet their GDP per capita differs (\$34,701 for Cyprus and \$37,882 for Malta).

CO₂ emissions show a different pattern, largely linked to industrial activity. Libya (6.68 CO₂ tons) and Bosnia and Herzegovina (6.31 CO₂ tons) have among the highest CO₂ emissions, likely due to their reliance on fossil fuels and industrial sectors. Israel (6.35 CO₂ tons) and Cyprus (5.47 CO₂ tons) also show high emissions. In contrast, Egypt (1.96 CO₂ tons) and Tunisia (2.41 CO₂ tons) maintain relatively low CO₂ emissions, likely due to less industrialization. France (3.95 CO₂ tons) has moderate emissions, potentially owing to its reliance on nuclear energy.

Population growth also varies significantly. Some countries, like Israel (2.1%) and Malta (4.1%), are experiencing robust growth, while others, particularly in Southern Europe, like Italy (-0.3%) and Greece (-0.6%), are seeing population decline. Notably, higher population growth does not correspond to higher GDP per capita; for example, Syria, with a high growth rate of 4.9%, has one of the lowest GDP per capita figures, reflecting the impact of conflict and instability.

Neighbouring Mediterranean countries can show contrasts in their economic and demographic indicators. For example, Italy and France, though geographically close, differ in GDP per capita (\$38,373 vs. \$44,461), with Italy having a higher population density but lower economic output. In North Africa, Algeria and Morocco also show differences: Algeria has a larger land area and lower population density but a higher GDP per capita (\$5,260 vs. \$3,672). Similarly, Israel and Lebanon differ sharply—Israel has a much higher GDP per capita (\$52,262 vs. \$3,824) despite both having high population densities. These differences highlight how geographic proximity does not always translate to similar economic and demographic outcomes.

3. Life expectancy the Mediterranean Area

If we want to study the health conditions of the population living in this area and after analysing the factors underlying the differences that we will find, a widely

available statistical indicator is the life expectancy at birth. This indicates the number of years a new-born infant would live if the mortality patterns prevailing at the time of its birth were to stay the same throughout his life (World Bank, 2024).

Figure 1 – Life expectancy across Mediterranean countries in 2022.



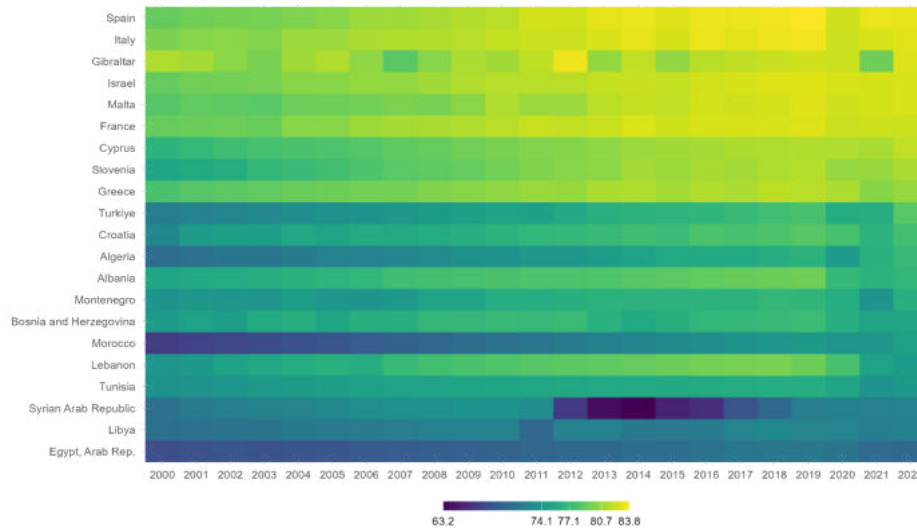
Figure 1 shows the life expectancy across Mediterranean countries in 2022 and Figure 2 between 2000 to 2022

In 2022, life expectancy varied significantly across Mediterranean countries. Spain showed the highest life expectancies at 83.2 years. Similarly, France and Italy also had high life expectancies, reinforcing the trend in Southern Europe. In contrast, Egypt and Morocco exhibited lower life expectancies, around 70 to 72 years.

Over time, life expectancy across Mediterranean countries has generally improved, but the pace of this improvement has also varied significantly. In Spain, France, and Italy, life expectancy has steadily risen. Similarly, Slovenia and Croatia have shown steady gains in life expectancy, although slightly lower than their Western European neighbours. In contrast, North African and Middle Eastern countries, like Egypt and Morocco, have seen slower improvements in life expectancy over the years. Egypt, for instance, reached around 70 years in 2022, a modest increase compared to European countries. Conflict and instability in Syria have also contributed to more erratic changes in life expectancy, with significant fluctuations during the years. For example, during the Syrian Civil War in 2014, life expectancy dropped to 63.1 and in Libya, during the Arab Spring and Civil War in

2011, life expectancy was 70.1. Additionally, in 2020 - 2021, life expectancy decreased across all countries due to the COVID-19 pandemic.

Figure 2 – *Life expectancy across Mediterranean countries between 2000 and 2022.*



4. Climate and Life Expectancy: Impact of Cooling Degree Days

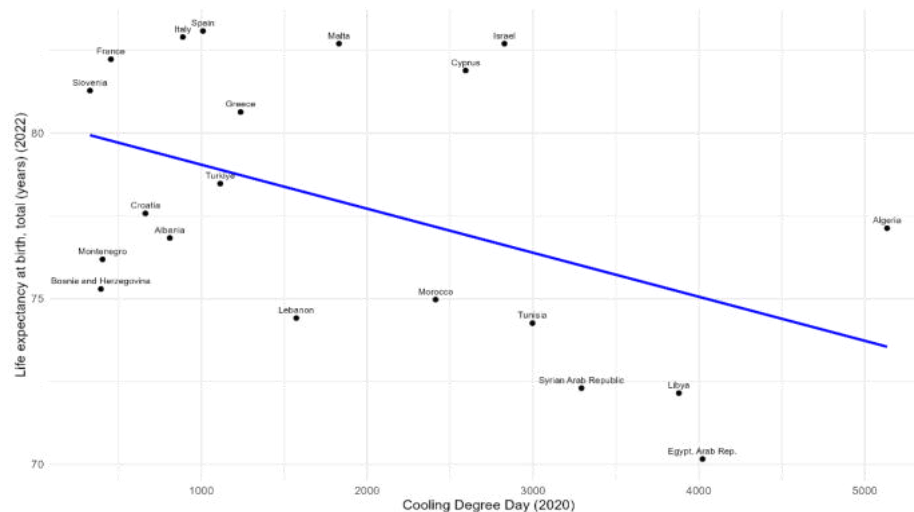
An ANOVA test revealed statistically significant differences in life expectancy among the Mediterranean countries (Table 2).

Table 2 - *ANOVA results for differences in life expectancy among Mediterranean countries.*

Source	Df	Sum Sq	Mean Sq	F value	Pr(>F)
Country	20	7225	361.3	137.6	<2e-16
Residuals	462	1213	2.6		

A first research hypothesis is if the inequality of this indicator depends on the climate conditions of the countries. A possible indicator is the CDD in the countries.

Figure 2 – Life expectancy at Birth (total) (Year 2022) and CDD (Year 2020) in the Mediterranean area.



Among countries with high CDD (above 2,500), Libya and Egypt show lower life expectancy (around 71-72 years), while Algeria has a slightly higher one (76.9 years). Israel stands out with a much higher life expectancy (81.6 years). Among countries with moderate CDD (between 1,000 and 2,499), Spain (83.1 years) shows the highest life expectancy, in contrast with Lebanon (78.8 years). Even in the lowest CDD group (below 999), disparities are evident, ranging from the highest life expectancy in France (83.0 years) to the lowest in Bosnia and Herzegovina (77.1 years).

There appears to be a limited negative correlation ($r = 0.45$) (Figure 3), suggesting that higher temperatures (leading to more cooling degree days) may be moderately associated with reduced life expectancy. However, given the moderate strength of this relationship and the potential high dispersion of data across countries, further analysis is needed to assess its robustness.

5. Identifying Socioeconomic and Health Patterns Across Mediterranean Countries

A clustering analysis was conducted to identify distinct clusters of countries with similar life expectancy. A K-means clustering was performed on life expectancy data in 2022 with $k=3$ (the optimal number of clusters was determined using the Elbow

Method), effectively grouping the countries into three distinct clusters based on their life expectancy trends.

The three clusters (High Life Expectancy, Medium Life Expectancy and Low Life Expectancy) are shown in Figure 2.

Figure 3 – Socioeconomic and Health Patterns across the three clusters of Mediterranean Countries.

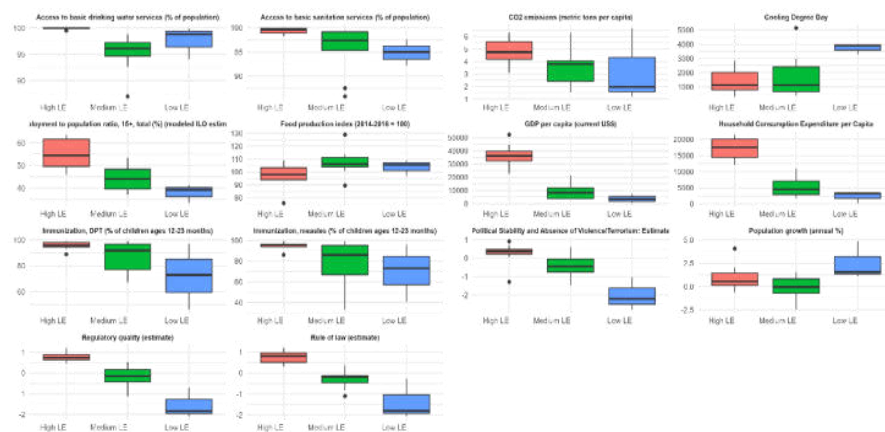


Figure 3 shows the socioeconomic and health patterns across the three clusters.

Countries with High Life Expectancy (between 80.6 and 83.1 years) have strong economies with a GDP per capita ranging between \$20,000 and \$50,000, stable political conditions, and robust governance, marked by high regulatory quality and rule of law. Health systems are well-developed, providing near-universal access to clean water and sanitation, and high immunization rates above 90%. CO2 emissions are moderate, typically between 4 and 6 metric tons per capita. Socially, employment rates are high and food production is secure.

Countries with Medium Life Expectancy (between 74.3 and 78.5 years) have moderately developed economies, with GDP per capita ranging from \$10,000 to \$20,000, along with relatively stable governance, though not as robust as high-life-expectancy nations. Access to water and sanitation is good but not universal, and immunisation rates remain high, though slightly lower. CO2 emissions are moderate, reflecting industrial development. Employment rates and food security are mixed.

Countries with Low Life Expectancy (between 70.2 and 72.3 years) have lower GDP per capita, often below \$10,000, and experience weaker governance and higher political instability. Health infrastructure is more limited, with less than 90% of the population having access to clean water and sanitation, and immunisation rates

are lower. CO2 emissions vary but tend to be lower due to less industrialization. Employment is high but often in informal sectors and food production is less secure.

Countries with high life expectancy show a wide range of CDD, from 328.8 in Slovenia to 2828 in Israel. Similarly, countries with medium life expectancy also display variation, with CDD values ranging from 394.6 in Bosnia and Herzegovina to 5135 in Algeria. Notably, some medium-life-expectancy countries, like Algeria, have higher CDD values than any high-life-expectancy country, while others, like Bosnia, have much lower values, close to those of high-life-expectancy nations. Overall, there is no clear distinction in CDD between the high and medium life expectancy groups, indicating that CDD does not strongly differentiate between these categories.

6. Data Issues and Methodological Approach

We extracted the data for this study from the World Development Indicators (WDI) database, a comprehensive source of global development data maintained by the World Bank. We gathered a wide range of indicators covering various domains, including health, environment, economy, and social factors, for the years 2000 to 2023 using the WDI package in R. Indicators with more than 15% missing data were excluded from further analysis to ensure the reliability of the results. This threshold was chosen to balance dataset completeness with the need to retain a sufficient number of indicators.

We further decide to restrict the descriptive analysis of each cluster to selected variables (showed in Figure 3) allowing for a focused investigation into the factors that potentially correlate with life expectancy.

Each variable was chosen based on its potential to influence health outcomes and quality of life. For instance, access to water and sanitation directly impacts public health, while GDP per capita and employment rates reflect economic conditions that often correlate with access to healthcare and social services. Similarly, variables like CO2 emissions and Cooling Degree Days provide insight into environmental conditions, which can affect health through pollution and climate extremes. Governance indicators, such as political stability, regulatory quality, and the rule of law, capture the societal structures that can enhance or hinder life expectancy through governance and social welfare.

We used only the latest available data, even though the year of the data varies across variables. CO2 emissions and Cooling Degree Day data go back to 2020, but given the nature of these variables, significant changes are not expected between 2020 and 2022.

Regarding COVID-19, while the pandemic caused disruptions in various sectors, it likely had a limited direct effect on variables like CO₂ emissions and Cooling Degree Days in the long term. CO₂ emissions may have temporarily dropped due to lockdowns, but they have generally rebounded quickly post-pandemic, while Cooling Degree Days are driven by climatic factors, largely unaffected by short-term events like the pandemic.

The study focused on Mediterranean countries and includes: Albania, Algeria, Bosnia and Herzegovina, Croatia, Cyprus, Egypt, France, Greece, Israel, Italy, Lebanon, Libya, Malta, Montenegro, Morocco, Slovenia, Spain, Syria, Tunisia, and Turkey. Monaco and Gibraltar were excluded due to their small size and limited data availability. Palestine was not included due to a lack of data and no distinction was made between Cyprus and North Cyprus (following the World Bank classification).

7. Conclusions

Life expectancy is considered in this article as a main indicator of health conditions in different Mediterranean countries. The three groups identified through cluster analysis highlight the multiple factors shaping population health, offering insights into how socio-economic and environmental characteristics are shared among countries with similar life expectancy. The findings from this analysis provide guidance for policymakers regarding which instruments should be prioritised to improve health and promote sustainable development in the region.

The results demonstrate that economic factors, such as GDP per capita, along with access to basic services, like clean water and sanitation, play crucial roles in shaping life expectancy. Governance instruments, including regulatory quality and the rule of law, are also strong determinants, suggesting that robust political institutions and effective policies contribute positively to health outcomes. These findings imply that policy interventions aimed at strengthening healthcare systems, improving access to essential services, and fostering economic growth will have the most direct impact on increasing life expectancy. On the other hand, climatic factors, even if correlated with life expectancy, are not connected with this indicator considering the differences we found in neighbouring countries, resulting in spurious correlations.

Despite the evidence found in this analysis, there are some limitations. The data used vary in availability across countries and years, and some potential confounding variables, such as detailed health behaviours or cultural factors, were not included. Finally, data are needed for all the political entities in the region, even if very small or with limited political status, as Malta, Gibraltar, Palestine and North-Cyprus, along with the internal variability of these indicators.

In conclusion, addressing the socio-economic and governance drivers of health will be key to improving life expectancy, achieving sustainable development in the Mediterranean region.

Additionally, future research is necessary to determine the relationships and factors directly associated with life expectancy, and to better understand how these factors influenced health outcomes over time.

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