VOLUME LXXVIII – N. 3 LUGLIO – SETTEMBRE 2024

RIVISTA ITALIANA DI ECONOMIA DEMOGRAFIA E STATISTICA

SIEDS
SOCIETÀ ITALIANA
DI ECONOMIA DEMOGRAFIA E STATISTICA

SEDE LEGALE:
C/O Studio Associato Cadoni, Via Ravenna n. 34 – 00161 ROMA

info@sieds.it

rivista@sieds.it

VOLUME FUORI COMMERCIO – DISTRIBUITO GRATUITAMENTE AI SOCI

INDICE

SHAPING THE FUTURE OF ITALIAN EDUCATION: OVERCOMING CHALLENGES AND SEIZING OPPORTUNITIES[1]

Federico Visconti

Abstract. This conference speech discusses key findings from the ISTAT Annual Report 2024 on Italy's education system, highlighting both progress and significant challenges. While Italy performs comparably to other European countries in bachelor's and master's degree attainment, it lags in doctorate and specialized degrees, as well as overall education levels among young people, many of whom hold only secondary school diplomas. These gaps stem from systemic issues but can be addressed through joint efforts by families, students, and universities. Families should foster resilience and independence rather than overprotection, while students must demonstrate accountability, motivation, institutional discipline, and a commitment to learning. Universities, in turn, must embrace their evolving role by teaching lifelong learning skills, aligning with labour market needs, fostering innovation, and strengthening ties with businesses and other institutions. Pursuing high-quality academic research to enhance institutional reputation and to grow doctorates, adopting innovative teaching practices, improving resource allocation, and collaborating effectively with external stakeholders including companies are essential steps to transform universities into drivers of growth, benefiting young people, businesses, and Italian society as a whole.

I take my cue from three passages (stated on page 78) in the ISTAT Annual Report 2024.

The first: "Between 2013 and 2021, in Italy, the trend in the share of graduates with a bachelor's degree or equivalent in relation to the population aged between 20 and 29 maintained the same levels and growth profiles observed in France, Germany and Spain".

The second: "Italy is midway between the highest in France and the lowest in Germany for master's degree or single-cycle degree graduates, which are also growing, while it is in last place and in retreat for doctorates or specialised graduates".

And the third: "In spite of progress, in 2022 the overall level of education of the population aged between 25 and 34 remains on average lower than in the countries surveyed due to the effect, as in Spain, of a still high proportion of young people

[1] Conference speech at the LX Scientific Meeting of SIEDS, Castellanza, 2024.

with at most a secondary school leaving certificate (22 percent, compared with around 11 percent in France), and to the low prevalence of short-cycle university degrees, mostly of a technical nature".

The evidence is on a razor's edge, between structural deficits (whose origins go back a long way) and encouraging trends (all to be verified, consolidated, and developed).

This is not the place to dissect the strengths and weaknesses of the Italian education system, probing what has been happening for decades at school desks and in university classrooms. It is, however, an opportunity to launch a few provocations on what is happening and how the role of the university might evolve.

I have often commented on trends in the education sector using the metaphor of a stormy sea. Macro-trends in university education, evolving learning models, demographic scenarios, technological development, the spread of artificial intelligence, competitive dynamics between players..., are phenomena that are there for all to see.

I emphasise one aspect: the intensity, speed and irreversibility of the challenges at hand. To cope with it, a kind of 'general mobilisation' of the entire civil society would be needed. Yes, it would serve! In fact, Paolo Crepet's words come to mind: "The educational challenge and its intrinsic crisis seem to reject an idea of radical change, which would challenge privileges and accommodations that have convinced entire generations, despite the evidence of how close we are approaching an 'educational catastrophe', as Pope Francis has lucidly called it".[2]

Navigating in the stormy sea, facing the risk of an 'educational catastrophe', bringing about a revolution of historic proportions is not the exclusive task of a university, or even of a school. It is everyone's responsibility. In this regard, I shall not dwell on this, I will mention just two references, among many possible ones.

First, the role of the family, increasingly oriented towards protecting children, avoiding their stresses, and softening their trials. In the words of Massimo Gramellini, columnist for Corriere della Sera: "I begin to doubt that what dictates certain defensive measures is not so much the increased fragility of the recipients, but that of parents who are terrified at the idea of young people measuring themselves against a test whose outcome includes failure".

And second, the role of students, from whom one can legitimately expect accountability and institutional discipline, strong motivation and hard work, depth of thought and constructive criticism, et cetera. This is often the case. Occasionally it is not. And what is the direction of the 'sense of work'? Again, from the columns of the Corriere della Sera, Ferruccio De Bortoli observes: "In the new generations we have to note that work is no longer at the centre of their lives. Perhaps for today's

[2] Paolo Crepet, Lezioni di sogni, Mondadori, 2022, p. 7

older ones it has been too much so. But are we sure that this devaluation of work, sometimes reduced to a mere source of livelihood, is a sign of the times to be accepted as inescapable? And is there not an Italian declination that questions us on the quality of our education and training in general? In other European countries, even richer than ours, this is not the case. Not to mention the rest of the world, where there is an atavistic hunger for work, where a desire for redemption and social revenge bites".

And so, to the role of a university, which has never shone much in the imagination of Italians. Beyond the rhetoric about young people, the proclamations on the development of human capital, the circumstantial celebrations on research (emblematic are those at the time of the pandemic), occasional scandals continue to make more headlines than the structural brain drain. The litmus test, if proof were needed, is the allocation of resources, which are insufficient and poorly allocated.

In order to take a step forward, the contribution to the country's growth must be communicated with determination. The ISTAT Annual Report 2024 does this effectively in several places in the section on 'education and training in the labour market'. I quote one of them: "Investment in human capital is confirmed as a development factor for businesses. The analyses conducted indicate complementary strengths between business strategies, investment in human resources, innovative skills and technology adoption on the one hand, and performance on the other. The companies that are most active in all these aspects, qualified in the Report as highly dynamic, are also those that have created employment, and have absorbed a university-educated workforce".

This is not enough, however. At the same time, we must put our mission in order, update our educational objectives, rethink our teaching content and the services offered to students. The 'profession' of a university is undergoing intense evolution, partly as a result of the epochal changes I mentioned in the introduction. Derek Bo, Chancellor of Harvard, saw this coming more than thirty years ago, addressing his students with these words: "If you think you are coming to this university to acquire specialisations in exchange for a better future, you are wasting your time. We are not capable of preparing you for a job that will almost certainly no longer exist around you. Nowadays, work, due to structural, organisational and technological changes, is subject to rapid and radical change. We can only teach you to become capable of learning, because you will have to re-learn all the time".

The derivation is spontaneous, even obvious: if the mission of a university is increasingly to teach how to learn, how do you do it?

A few pointers, as a convinced corporatist, and as a deep admirer of good management. Quality academic research must be pursued, so as to develop reputational capital, to grow doctorates, and to nurture dissemination activities that, in turn, generate strong links with stakeholders. It is necessary to keep research and

teaching closely linked: investing in them strengthens market positioning, attracts outstanding resources, and projects oneself in the international context. It is essential to innovate teaching, in all its components: lectures, exercises, experiential activities, assessment models, career service, et cetera. And it is becoming increasingly important to manage the 'transmission belt' linking a university with the worlds of education and business.

I could continue with examples of 'related actions', and of 'virtuous circularity', but it is no use dwelling on them. Instead, it is useful to observe that, within a university system, something is happening in this direction.

Much remains to be done: a university, like other institutions in the country, now struggles to fully express the existing potential for innovation. The road forward is marked, where change and repositioning are a must, and where constraints and resistance must be removed… for the good of young people, businesses and the entire civil society.

Federico VISCONTI, LIUC - Università Cattaneo, fvisconti@liuc.it

ASSESSING FRAILTY IN OLDER ADULTS: STRATEGIES AND TOOLS FOR EFFECTIVE POLICY AND RESEARCH

Annalisa Donno, Margherita Silan, Giovanna Boccuzzo

Abstract. The progressive ageing of the population, not accompanied by a corresponding increase in healthy life expectancy, brings to the forefront the study of the health of older adults from a holistic perspective. The concept of frailty aligns with this perspective, as it considers a broader condition of vulnerability involving mainly older individuals, which is much more difficult to define and measure. This article aims to provide an overview of the concept of frailty, the various definitional approaches, and, consequently, the measurement methods, while also focussing on the relationship between frailty and the two main concepts that define health: multimorbidity and disability. Following a brief overview of the types of data and their role in the study of frailty, the article concludes with an analytical approach for defining a measure of frailty.

1. Frailty in old age: From concepts to measures

1.1 The longevity paradox

Population ageing is an irreversible global trend, with every country in the world experiencing growth in both the size and proportion of older people in the population, though at different paces and speeds. According to United Nations estimates, in 2020, about 9.3% of the global population was 65 years or older. This proportion is expected to increase, reaching 16% by 2050, with a projected 1.5 billion of old population. In Europe and North America, the proportion of people 65 and older is especially high, at 19% in 2020, and is expected to exceed 25% by 2050. These figures underscore a significant challenge for social and economic policies, which must adapt to an increasingly ageing population and address its impact on healthcare, pension systems, and social inclusion (United Nations, 2020). This trend is driven primarily by two main mechanisms: advances in medicine and demographic dynamics. Over the past decades, demographic factors, particularly low and decreasing fertility rates, have altered population structures, resulting in shrinking proportions of young people and an increasing number of older individuals. At the same time, significant medical progress has driven a substantial increase in life expectancy worldwide, allowing more people to live longer lives.

However, there is a crucial distinction between lifespan – the total number of years of life– and healthspan – the number of years lived in good health. Although many people live longer, these additional years are not always characterised by good health.

Globally, life expectancy at birth reached 73.3 years in 2024, with an increase of 8.4 years since 1995 (United Nation – DESA, 2024). Further reductions in mortality are projected to result in an average longevity of around 78.2 years globally in 2050 (Vollset et al., 2024).

Healthy life expectancy (HALE, the average number of years a person can expect to live in good health) has also increased from 58.3, in 2000 to 63.7, in 2019, mainly due to declining mortality rather than reduced years lived with disability, and it has been projected to increase further to about 67.4 years in 2050 (Kyu et al., 2018; Vollset et al., 2024; Ward and Goldie, 2024; WHO, 2024). Even if both trends go in the same direction, the increase in HALE does not seem to keep pace with the increase in life expectancy.

This means that as people live longer, but not necessarily healthier, an increasing number of older individuals spend a significant proportion of their lives deprived of full health due to diseases, deficits, and disabilities. This "longevity paradox" (Fries, 1980; Garmany et al., 2021) results in heavy consequences both at the individual and at the macro level. Conditions such as reduced physiological functions, cardiovascular diseases, diabetes, and neurodegenerative disorders become more prevalent with age (Kennedy et al., 2014; Vos et al., 2017) and contribute to reduced independence, social isolation, and psychological distress, thus worsening individuals' quality of life (Vermeiren et al., 2016). Compressing morbidity, delaying disease onset, and/or reducing disease severity, and identifying strategies to address the complex needs of an ageing population are paramount.

In this context, the study of frailty becomes crucial because it plays a significant role in these dynamics, by highlighting the vulnerability of older adults to adverse health outcomes and emphasising the need for targeted interventions to improve their overall health and quality of life (Fried et al., 2001). Frailty, characterised by a decrease in physiological reserve and a higher susceptibility to stressors, is associated with increased risks of hospitalisation, disability, and mortality (Clegg et al., 2013). Understanding frailty can lead to better screening, prevention, and management strategies, ultimately aiming to extend healthspan along with lifespan (Rockwood & Mitnitski, 2007).

1.2 Ageing and frailty

At the biological level, ageing is a process that results in a progressive and irreversible decline in physical function across all organ systems, induced by the accumulation of a wide variety of molecular and cellular damage over time, in response to a variety of endogenous and exogenous stressors (Tenchov et al., 2024). Gradual functional decline impairs the organism's intrinsic ability to defend, maintain and repair itself to function efficiently, a concept traditionally defined as homeostasis (Campisi, 2013; López-Otín et al., 2013; Tenchov et al., 2024). Homeostasis declines with age. The defence and repair mechanisms are generally good enough in early life to enable normal growth and development, but they do not provide indefinite protection in older age. This process is associated with the inability to activate and/or modulate several adaptive responses and leads to a gradual decrease in physical and mental capacity, to an increased susceptibility and vulnerability to diseases, and ultimately to death.

Even if chronological age is widely recognized as the most significant predictor and risk factor for negative health outcomes (Cesari et al., 2016; Shock et al., 1984), individuals of the same chronological age can significantly differ in their health status. As populations age, the association between chronological age and health status is increasingly heterogeneous (Kirkwood 2005; Moguilner et al., 2021; Santoni et al., 2015): some individuals are more vulnerable than others due to underlying differences in their physiological and biological resilience, in its turn influenced by multiple factors: lifestyle aspects (diet, exercise, smoking habits, stress), environmental factors such as pollution and climate change, as well as social factors (loneliness, social support, socio economic status).

The concept of frailty was first introduced in Vaupel's seminal work, whose objective was to account for the heterogeneity in mortality rates among individuals of the same chronological age, under the assumption that individuals have varying levels of susceptibility to adverse health outcomes (Vaupel, 1979). Such a susceptibility has been conceptualised as frailty: an underlying, unmeasured variable affecting population-level mortality patterns. This work laid the groundwork for the emergence of an important strand of scientific research focused on ageing and frailty. Such interest has been fuelled over time by population ageing processes, calling for the attempt to define and measure frailty, and understand its relations with adverse health outcomes at older ages. From then on, the need to identify frail individuals and predict their risk of developing negative health outcomes to find tailored interventions and care plans has been central in the ageing debate.

This article aims to provide an overview of the concept of frailty, the various definitional approaches, and, consequently, the methods of measurement, while also focusing on the relationship between frailty and the two main concepts that define

health: multimorbidity and disability. Following a brief overview of the types of data and their role in the study of frailty, the article concludes with an analytical approach for defining a measure of frailty.

2. Definitions and measures of frailty

Within the epidemiological literature, frailty is considered a multidimensional, unobservable concept that encompasses physical, psychological, sensory, and social factors, making individuals vulnerable (Gobbens et al., 2010; Fried et al., 2001). The challenge of defining frailty arises from its complex nature and from the need to consider multiple facets together. Over the past 30 years, various definitions have been proposed, that reflect differing professional perspectives and areas of expertise. Initially studied and conceptualised exclusively from a physical standpoint, frailty's definition has evolved to incorporate social, psychological, and cognitive aspects, thus recognising its multidimensional nature (Rockwood et al., 2005; Clegg et al., 2013). This complexity, coupled with the difficulty of differentiating frailty from other clinical conditions such as disability and multimorbidity, makes it a debated concept. The presence of multiple facets that need to be considered together generates the challenge of determining a unique, universally accepted conceptual definition of frailty, which at the moment is still missing. In the following sections the three most recognised and widely adopted paradigms for defining and measuring frailty will be presented.

2.1 The biomedical paradigm

Definition of Frailty according to the biomedical paradigm

In the biomedical framework, frailty is defined as a biological syndrome of decreased reserve and resistance to stressors, resulting from declines in multiple physiological systems, causing vulnerability to adverse outcomes. Such a definition highlights the systemic nature of frailty and its impact on the body's ability to respond to stressors (Fried et al., 2001).

Decreased physiological reserve is a hallmark of frailty, reflecting the diminished capacity of the body's multiple systems to withstand and recover from both internal and external stressors. This decline in reserve spans critical systems, including the musculoskeletal, neuroendocrine, and immune systems, increasing the vulnerability of older adults to adverse health events. The physiological changes that accompany ageing, such as sarcopenia (loss of muscle mass), reduced mobility, and impaired balance, are central to this process. These changes significantly increase the risk of

adverse outcomes, including falls, fractures, and a consequent loss of independence. Furthermore, they contribute to higher mortality rates among frail older adults (Fried et al., 2001).

The biomedical paradigm of frailty, while fundamental in geriatric research, has faced significant criticism: its focus on physiological factors is seen only as a narrow and reductionist approach that neglects other crucial dimensions of ageing. This frailty conceptualisation does not consider cognitive and psychosocial factors that, together with biological elements, are fundamental to the health and well-being of older adults. Ignoring these aspects can result in a partial and incomplete understanding of frailty, hindering the development of comprehensive intervention strategies that address the multifaceted nature of frailty (Rolfson et al., 2006).

Measures of Frailty according to the biomedical paradigm

The most widely recognised and used tool for the measurement of frailty based on the biomedical conceptualisation is the Frailty phenotype (Fried et al., 2001). The Fried Frailty Phenotype is a pivotal clinical tool based on the assessment of five elements: unintentional weight loss, exhaustion, weakness, slowness, and low physical activity.

Unintentional weight loss is defined as a loss of 10 pounds (4.5 kg) or more, or 5% or more of body weight over the past year.

Exhaustion is characterised by a persistent feeling of extreme fatigue or an inability to move on most days. This is usually measured using self-report items from the Centre for Epidemiological Studies Depression Scale (CES-D). Specific questions include the frequency with which individuals feel that everything they do requires effort or that they cannot get going. Responses indicating exhaustion on three or more days per week are considered indicative of this criterion.

Weakness is typically assessed through grip strength, a reliable proxy for overall muscle strength. Measurement is carried out using a hand dynamometer, with the highest value recorded from three attempts in each hand. The cut-off values for weakness vary according to sex and body mass index (BMI), with lower grip strength values suggesting that the individual meets the weakness criterion.

Slowness is defined by a reduced walking speed, typically measured as the time taken to walk a set distance, commonly 15 feet (4.57 metres). The time to complete this walk is recorded and the cut-off points are determined according to sex and height.

Finally, low physical activity is evaluated using self-report questionnaires, such as the Minnesota Leisure Time Activity Questionnaire. Participants report on the type and amount of physical activity they engage in, allowing for the calculation of total energy expenditure. Individuals with the lowest levels of activity, usually below

a specific calorie expenditure threshold per week, are considered to meet the criterion for low physical activity.

Once the five elements have been evaluated, individuals are classified as frail if they meet three or more criteria, prefrail if they meet one or two.

Empirical studies have consistently demonstrated that frailty, measured by the Fried Frailty Phenotype, is significantly associated with an increased risk of adverse health outcomes and mortality. In the seminal study by Fried et al. (2001), frail individuals exhibited a markedly higher risk of falls, worsening mobility or disability, hospitalisation, and death compared to non-frail counterparts. Subsequent research has reinforced these findings (Bandeen-Roche et al., 2006; Kojima 2016; Clegg et al., 2013).

2.2 The cumulative deficit paradigm

Definition of Frailty according to the cumulative deficit paradigm

The cumulative deficit paradigm represents a more complex approach to the understanding of frailty in the elderly, since it takes into account not only biomedical aspects, but also cognitive, psychosocial, and geriatric factors (Rockwood, et al., 1994). According to this perspective, frailty is defined as "a state of chaotic disorganisation of physiological systems that can be estimated by assessing functional status, diseases, physical and cognitive deficits, psychosocial risk factors, and geriatric syndromes with the aim of building as complete a picture as possible of risk situations for adverse events" (Rockwood et al., 2007).

The cumulative deficit paradigm of frailty builds upon Brocklehurst's (1985) dynamic model of breakdown, which emphasises the delicate balance between assets (factors that help a person to maintain her independence in the community, namely health, functional capacity, positive attitude toward health, and other social, financial, and environmental resources) and deficits (factors that threaten independence, namely morbidity, cognitive impairments, mood disorders, chronic disease, disability, burden on caregivers) that determine an individual's capacity to maintain autonomy and independence within the community.

As people age, they experience deficits that are likely to accumulate, making them more susceptible to adverse health outcomes. A vulnerability state can be considered as the result of a precarious balance between assets and deficits. Frailty occurs when deficits outweigh positive resources, leading to noticeable functional decline and loss of autonomy. It is thus the consequence of a cumulative breakdown of multiple elements, where the concurrent decline of several factors across different systems exacerbates the overall individual functional deterioration.

Although the deficit accumulation approach to frailty has been widely adopted and provides a comprehensive framework, several limitations and challenges have been underlined in the literature. The broad and inclusive nature of the deficit accumulation approach can lead to the overdiagnosis of frailty, particularly in individuals with multiple chronic conditions, but who may still maintain functional independence (Clegg et al., 2013). Furthermore, the identification of multiple deficits can present challenges in designing and prioritising interventions. Addressing a wide range of deficits may require complex, multifaceted approaches that are difficult to implement and evaluate effectively (Rodríguez-Mañas et al., 2013).

In order to provide a robust framework for the construction of valid and reliable frailty indices, thus facilitating their application in research and clinical practice while assessing and monitoring older adults' health, a standardised and validated approach for the development of accumulation-based frailty measures has been proposed in the literature (Searle et al., 2008). This approach establishes five fundamental guidelines:

The variables included in the frailty index must be intrinsically related to an individual's health status. Each deficit should reflect a meaningful aspect of health decline that contributes to frailty.

The prevalence of each deficit should generally increase with age, acknowledging that the prevalence of certain conditions may decline in very advanced ages due to survival effects. This ensures that the index accurately reflects the age-related accumulation of health deficits.

Deficits included in the index should not reach saturation too early. Conditions or diseases that become almost universal at a certain age should be excluded, as their inclusion would diminish the index's ability to differentiate between varying levels of frailty in older populations.

The selection of variables should be balanced across different physiological systems. Over-representation of deficits related to a single system would compromise the index's validity, transforming it from a general frailty index into one that reflects the health of a specific system.

When using the frailty index repeatedly on the same individuals, it is crucial to ensure that the same variables are used consistently. This allows for reliable longitudinal assessments of frailty, ensuring that changes over time reflect true changes in health status rather than variations in the composition of the index.

The optimal number of deficits to include when constructing a frailty index typically ranges between 30 and 40. Generally, as the number of variables used increases, the precision of the frailty index estimates also improves. However, estimates become unstable when the number of deficits is too low. On the other hand,

including an excessively large number of deficits does not significantly enhance the accuracy of the index.

Measures of Frailty according to the cumulative deficit paradigm

Several measures have been proposed in the literature, based on the accumulation of deficits perspective (Mitnitski et al., 2001; Romero-Ortuno, 2013; Bennett et al., 2013; Blodgett et al., 2015; Jones et al., 2004; Rolfson et al., 2006). The Frailty Index (FI) (Mitnitski et al., 2001) is one of the most widely used. In a multidimensional perspective, it encompasses a wide range of clinical signs, symptoms, disabilities, and laboratory abnormalities. Unlike phenotype-based measures, the FI does not rely on a predefined set of criteria, but instead uses a comprehensive list of potential deficits, which can number between 30 and 70 or more, depending on the availability of the data and on the study design. Each deficit is assigned a value of 1 if present and 0 if absent, with intermediate values possible for partial deficits. The elements generally taken into account can be categorised into several macro-areas: physical health, sensory impairments, respiratory and cardiovascular conditions, functional status, cognitive function, mental health, nutritional status, social and economic factors, and general symptoms like fatigue, pain, and sleep disturbances. The index is calculated by adding the values of all present deficits and dividing by the total number of deficits considered. Unlike the Frailty Phenotype, which provides a clear classification of individuals into frail, pre-frail, and robust categories, the Frailty Index (FI) does not inherently offer such distinctions. Instead, it provides a score that reflects the proportion of deficits accumulated by an individual. However, to address the need for classification similar to the biomedical approach, a two-threshold system has been proposed in the literature (Romero-Ortuno et al., 2010). This system sets specific cut-off points on the FI scale to categorise individuals into frail, pre-frail, and robust groups, thereby facilitating clinical decision-making and research comparisons. The FI is robust in its predictive validity for adverse outcomes such as mortality and hospitalisation (Mitnitski et al., 2001; Rockwood and Mitnitski, 2007; Chang et al., 2018).

2.3 The bio-psycho-social paradigm

Definition of frailty according to the bio-psycho-social paradigm

The bio-psycho-social paradigm for frailty offers a comprehensive framework that integrates biological, psychological, and social factors in understanding and addressing frailty in older adults. Unlike models that focus solely on physical or biomedical aspects, this paradigm recognises that frailty is a multidimensional syndrome influenced by a complex interplay of various determinants. Gobbens et al.

(2010) define frailty as "a dynamic state affecting an individual who experiences losses in one or more domains of human functioning (physical, psychological, and social), which are caused by the influence of a range of variables and which increase the risk of adverse outcomes". This definition is the result of a comprehensive review of the literature and consultations with experts in the field, ensuring that this conceptualisation of frailty is evidence-based and reflective of clinical realities.

Biologically, frailty is associated with age-related changes such as sarcopenia, inflammation, and hormonal imbalances, which contribute to decreased physiological reserves and increased vulnerability to stressors. Psychologically, cognitive impairment, depression, and anxiety are critical components, as mental health significantly affects an individual's ability to cope with and recover from illnesses and disabilities. Socially, factors such as social support, socioeconomic status, and living conditions play crucial roles in determining an individual's frailty status. Social isolation, financial hardship, and lack of access to healthcare resources can exacerbate frailty, underscoring the importance of a supportive social environment.

This holistic approach is based on the idea that interventions targeting multiple individual life domains – such as combining physical exercise with social engagement and mental health support – are more effective in mitigating frailty and protecting against adverse health outcomes than those focussing on a single aspect.

Measures of frailty according to the bio-psycho-social paradigm

Presented by Gobbens and coauthors in 2010, the Tilburg Frailty Indicator (TFI) is based on 15 items collected across three domains via a self-administered questionnaire. These domains include physical components, psychological factors, and social elements. The physical domain includes health, weight loss, difficulty walking, balance, hearing, vision, grip strength, and fatigue. The psychological domain covers memory, feeling down, anxiety, and coping. The social domain addresses living alone, social isolation, and social support.

Each item is scored 1 for the presence and 0 for the absence of the specific problem. The physical domain ranges from 0 to 8, the psychological domain from 0 to 4, and the social domain from 0 to 3. In total, there are 15 items, 11 of which are dichotomous with "yes" and "no" categories, while 4 have three categories: "yes", "sometimes", and "no", but are then dichotomized. The index value is equal to the sum of the present characteristics, ranging from 0 to 15. Individuals are considered frail if they score 5 or more. The cut-off points for physical, psychological, and social frailty are 3, 2, and 2, respectively. People can be frail on one or more domains simultaneously, while overall non-frail people can be frail with regard to one of the separate domains.

3. Frailty, disability, and multimorbidity: Three distinct concepts

The concept of frailty is relatively newer compared to the concepts of disability and multimorbidity, but together they contribute to a more comprehensive understanding of an individual's health. First, it is important to clarify that these are three distinct, but interrelated, concepts.

Multimorbidity is a term that has been increasingly used in recent years, as opposed to the term comorbidity, which was introduced over 40 years ago. Multimorbidity is broadly defined as the coexistence of two or more chronic conditions, where none necessarily dominates the others. Comorbidity, on the other hand, refers to the coexistence of medical conditions in an individual, where an index disease occurs first (Espinoza et al., 2018). Multimorbidity is often quantified by counting the number of diseases, but well-known comorbidity indices, such as the Charlson Comorbidity Index (CCI) or the Cumulative Illness Rating Scale (CIRS), are also used. The CCI includes 19 chronic diseases, selected and weighted based on their association with mortality (Charlson et al., 1987). CIRS categorises chronic conditions within different body systems and counts the number of systems affected by at least one chronic disease (Hudon et al., 2005). However, there is no consensus in the literature on the cut-off values to define multimorbidity using these measures. Consequently, the prevalence of multimorbidity varies depending on the definition and cut-off points used.

Disability refers to the condition of individuals who, due to one or more impairments, have a reduced ability to interact with their social environment compared to what is considered the norm. As a result, they may be less autonomous in carrying out daily activities and often face disadvantages in participating in social life (WHO, 2001). Disability assessment is based on the ability to perform activities, from the simplest to the most complex, and to maintain a social role. In relation to complexity and difficulty, the activities of daily living can be defined as "basic" Activities of Daily Living (ADLs) or "instrumental" Activities of Daily Living (IADLs). ADLs include fundamental functions related to self-care, such as walking, dressing, eating, hygiene, and sphincter control (Katz et al., 1963). IADLs involve more complex functions, such as shopping, managing money, cooking, maintaining a household, and using the telephone (Lawton & Brody, 1969). Independence in IADLs is crucial as it often determines whether an individual can live alone or not.

From the definitions provided (and the associated measures), it is clear that frailty, multimorbidity, and disability are distinct concepts and that individuals may experience one or more of these conditions.

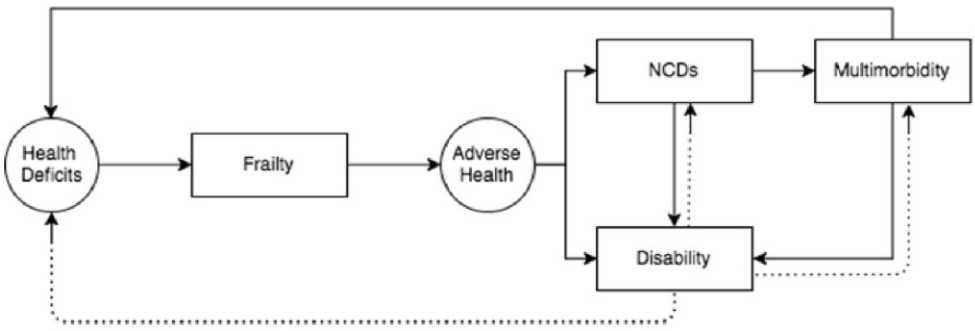
Fried et al. (2004) showed that among 100 frail individuals, only 27.2% are also disabled, 67.7% have multimorbidity (Fried uses the term comorbidity, which is now recognised as multimorbidity), and 21.5% of frail individuals are both disabled and

have multimorbidity. Only 2.8% of the total sample exhibits all three characteristics simultaneously. Boeckxstaens et al. (2015) observed that Fried et al. used a relatively limited measure of multimorbidity, including only nine chronic diseases, and suggested that a more comprehensive measure might reveal a closer relationship between multimorbidity and frailty. In their study, which considered 22 chronic diseases, the overlap between frailty, disability, and multimorbidity was only 2.3%. In Pivetta et al. (2020), the overlap was 5.4%, but the sample size was small (n=166) and limited to individuals aged 80 and over.

As we have seen, the overlap between frailty, multimorbidity, and disability is quite small, making it interesting to explore the relationship between these three phenomena. It is very challenging to define the relational structure linking them. Much of the literature describes disability as one of the adverse health outcomes to which frailty leads, but this does not negate the fact that disability can also exacerbate frailty. Multimorbidity, being a more nuanced and widespread concept, is even more difficult to categorise.

Villacampa-Fernández et al. (2016) propose an extremely effective relational schema.

Figure 1 - *Flowchart of the System Failure Process. Circles represent inputs/outputs, rectangles represent clinical conditions, continuous lines represent direct effects, and dotted lines represent indirect or secondary effects. NCDs = non-communicable diseases (from Villacampa-Fernández et al., 2016).*



According to this chart, frailty and multimorbidity are both predictors and outcomes of each other, as well as predictors of disability. The system failure process starts with an accumulation of health deficits that leads to a clinical state characterised by depletion of physiological reserve and redundancy, known as frailty. This frail system is more vulnerable to any stressor, thereby increasing the

risk of adverse health outcomes due to an inability to recover homeostasis. By adverse health outcomes, the authors refer to the full range of possible diseases and/or impairments, with institutionalisation and mortality as the worst-case scenarios. These adverse health outcomes, in turn, increase the risk of multimorbidity and disability. The consequent multimorbidity leads to further accumulation of deficits and thus to frailty. Disability also increases the risk of deficit accumulation and frailty, although its effect is considered more indirect or secondary. Furthermore, multimorbidity directly increases the risk of disability, while disability is a consequence of chronic diseases and multimorbidity.

Several authors have attempted to understand the role of frailty, multimorbidity, and disability in the occurrence of adverse events, usually mortality, with sometimes discordant results. For example, Aarts et al. (2015) showed that frailty (as measured by Fried's phenotype), when not accompanied by disability and/or multimorbidity, does not lead to a higher risk of mortality or institutionalisation compared to non-frail individuals. Abizanda et al. (2014) demonstrated that frailty is a risk factor for mortality and/or disability in individuals younger than 80 years, but not in those aged 80 years and older. Boeckxstaens et al. (2015) found that multimorbidity is independently associated with disability but not with frailty. In a study by Ritt et al. (2017), frailty was found to be a better predictor of mortality than disability. Leme et al. (2019) showed that frail older adults, with or without multiple simultaneous chronic diseases and disabilities, had shorter survival times. These findings highlight the importance of frailty as a predictor of a shorter survival time, independently of functional status and the number of simultaneous chronic diseases. Abizanda et al. (2014) reported similar results, providing a clear explanation: “Perhaps the most important reason that could explain the exclusion of comorbidity or multimorbidity from the models is that older adults with multimorbidity are heterogeneous in terms of illness severity, frailty, functional status, mental status, geriatric syndromes, prognosis, personal priorities, and risk of adverse events even when diagnosed with the same pattern of conditions. Thus, it is not the disease but the underlying disability, biological vulnerability or frailty, age-related conditions, time to adverse event conditioned by age, and model of care that will determine the risk of adverse events. Health services and health policies for older adults should take into account age, frailty, and disability, and not only comorbidity or multimorbidity.”

Regarding the relationship between frailty and disability, it seems that in older adults under the age of 80 years, prevention, detection, and treatment of frailty should be the main focus of health policies. However, for those over 80 years of age, the focus should shift to disability, probably because frailty at that age may have already triggered detected or undetected disability, and the contribution of disability to adverse events surpasses that of frailty. Physical frailty, unlike most disabilities, can potentially be prevented or treated with specific approaches, such as exercise,

protein-calorie supplementation, vitamin D, and reduced polypharmacy (Morley et al., 2013). Therefore, identifying pre-frail and frail older adults should be a clear goal for screening people older than 70 years in order to implement primary and secondary prevention to reduce incident disability.

4. Data to Measure and Analyse Frailty

The different definitions and, therefore, measures of frailty are based on significantly different content, as we discussed in Section 2. For example, the frailty phenotype defined by Fried et al. (2001) is based on concepts such as unintentional weight loss or low activity, which can only be measured through specific surveys conducted on particular groups of subjects. Similarly, Gobbens' psychosocial approach refers to specific psychological and social aspects in the construction of the Tilburg Frailty Indicator. On the other hand, the cumulative deficit perspective (Rockwood et al., 2005) uses a range of deficits that are readily available in survey or clinical data, many of which can be potentially retrieved for the entire population based on administrative data such as hospitalisation records.

In addition to the definitional aspects, different types of data are necessary depending on the research objectives.

From a public health perspective, in Italy, there is an increasing need to address and manage the challenges related to chronic diseases (which constitute a significant part of the country's health burden), to implement a population stratification process identifying homogeneous subgroups in terms of needs and characteristics (individual and socio-familial factors that may influence the individual's capacity to manage the pathology), and to create a model of integrated and personalised healthcare, targeted and personalised interventions, thus optimising the effectiveness of care and the use of healthcare resources. These needs are emphasised in the National Plan for Chronicity (NPC) (Ministry of Health, 2016) and the Sector Reform of the National Recovery and Resilience Plan (PNRR, Decree No. 77 - May 23, 2022).

From an epidemiological perspective, the objectives are quite different, as there is an interest in understanding the risk factors of frailty, assessing inequalities, comprehending causal relationships, and the role that those multiple aspects (social, economic, lifestyle, relationships, etc.) play in the risk of frailty.

We can essentially divide the types of available data for frailty analysis into two major groups: administrative data and data from surveys (sample surveys or surveys on specific subgroups of the population, such as residents of nursing homes). These two types allow us to answer different research questions. Administrative sources, typically health records held by Local Health Authorities, have complete coverage of the assisted population and therefore allow for actual population stratification, as

required by the Italian legislation. These data are collected for administrative purposes, so the type of available data is limited to the information necessary for the objectives for which the data flow was created. Thus, such data generally inform on hospitalisations and their causes, used medications, exemptions, causes of death, etc. These data have total coverage and systematic updating; since they often need to meet spending objectives, they are of good quality and are available at a low or no cost. From a public health perspective and to quantify frail individuals in the population, administrative data are clearly indispensable.

However, being collected for administrative purposes, the available information is limited to what is strictly necessary to meet the treatment objectives. Everything that goes beyond administrative purposes, such as information on family networks, lifestyles, health risk factors, etc., is not included. Moreover, there are complex privacy issues that must be properly managed. As a consequence, not everyone can access this type of data.

On the contrary, data from ad-hoc surveys (whether representative of the entire population or of specific groups) have greater informational potential, as the available information spans 360 degrees and refers to lifestyles, family and social networks, support received and given, as well as health conditions and the use of health services. Clearly, the concept of frailty finds its full application in the case of ad-hoc surveys, where a substantial set of objective and subjective information can be utilised. It is possible to obtain measures that embrace different theories, both Fried's phenotype theory and the bio-psycho-social theory, and to explore comparisons between measurement tools. It is also possible to analyse associations and causal relationships between potential risk factors and frailty. From an epidemiological perspective, for a deep understanding of the phenomenon and scientific research, this is certainly the appropriate context.

Nationally, we can refer to the ISTAT health conditions[1] surveys, available to all researchers, or other valuable surveys such as the Italian Longitudinal Study on Ageing (ILSA) (Galluzzo et al., 2023) or the Passi d'Argento surveillance system[2], accessible only to the research groups involved. Internationally, we have the SHARE survey for Europe (Börsch-Supan et al., 2013) and similar surveys for other countries.

Potentially, these two approaches, which we have termed *public health approach* and *epidemiological approach*, could converge by jointly using administrative data and survey data. There are (few) extremely interesting experiences of this type. An example is the linkage between health surveys and mortality and hospitalisation data (Sebastiani et al., 2019), carried out by ISTAT with some regions. However, only

[1] https://www.istat.it/tag/condizioni-di-salute/

[2] https://www.epicentro.iss.it/passi-argento/

restricted groups of researchers have access to this kind of data, following specific agreements between entities and in compliance with complex privacy regulations. It would be desirable to facilitate such research collaboration, bringing us closer to those European countries where health information systems are structured from the outset to allow data integration. For example, in Sweden, each individual has a personal identifier that is used for all records. However, this topic goes beyond this discussion, as it enters the complex field of personal data processing.

5. A path to measuring frailty with administrative data

The excursus presented so far clearly shows how relevant it is to measure frailty in an ageing society and how the measurement process primarily depends on the definition of frailty adopted and on the objectives pursued by proposing a frailty measure.

This section outlines our proposal for an analytical path to create a measure of frailty, based on the requirements expressed by Italian legislation (Section 4): a frailty index for the population, which makes it possible to stratify the population according to health needs and to support healthcare providers in planning service delivery.

It is important to clarify from the outset that many other frailty indexes have been proposed in the literature, some driven by similar objectives to ours and others aimed at different goals, such as those of a more etiological nature.

A brief description of the analytical path is provided in the following, with the aim of highlighting its strengths and weaknesses. The methodological details and results have already been published elsewhere (Silan et al., 2019, 2022).

Let us start with the concept of frailty used, which is linked to the objective of the investigation: from a public health perspective, where prevention and personalised healthcare are priorities, we considered that the most appropriate approach was to adopt the theory that those individuals at higher risk of adverse events are the frail ones. Proper identification and quantification of these individuals enable the healthcare system to implement more effective preventive and care measures.

In the literature, there are several proposals for "Electronic Frailty Indices" (e.g., De Luca et al. 2023; Khanna et al., 2023; Luo et al., 2022; Rebora et al., 2023; Thandi et al. 2024), which draw on Electronic Health Records, but most of them aim to predict at most two adverse events, typically mortality and hospitalisation, or mortality and disability. Furthermore, several works rely on regression models, subsequently providing indicators based on the linear combination of variables weighted by regression coefficients calculated on specific populations. The

underlying assumption is that the results obtained for one population can be generalised to other contexts. Finally, many indices are based on large numbers of variables, making their actual calculation in settings such as healthcare providers very burdensome.

Based on the strengths and weaknesses of the proposals in the literature, our goal is to propose an indicator with the following characteristics:

- It should be a simple tool, based on few variables and therefore replicable and easy to calculate, as it needs to be used by healthcare providers, not by research institutes.
- It must necessarily be based on population data and not on ad-hoc surveys, to allow for the stratification of the entire population.
- It should be a tool that adapts to changes over time (and space), regenerating itself easily.
- It should be capable of capturing multiple adverse health outcomes simultaneously.

With these premises in mind, we briefly describe the analytical path, outlined in Figure 2.

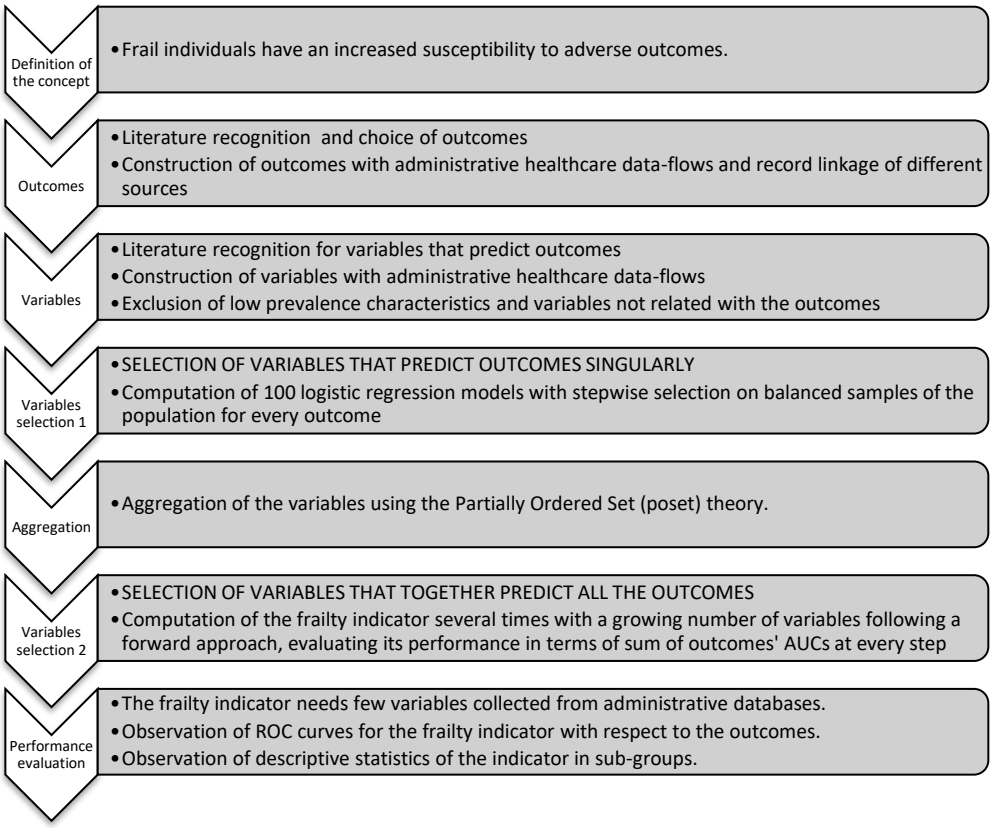
5.1 Selection of adverse health outcomes

Given the choice to identify as frail those individuals most vulnerable to adverse health outcomes, the first step is to identify these health outcomes. The choice and number of outcomes to be considered will affect the variables that compose the frailty indicator, as different outcomes are presumably associated with different explanatory variables.

Death is clearly the outcome that is always considered. Through the study of two important systematic reviews (Sternberg et al., 2011; Wallace, 2014), integrated by our additional analysis of the literature, it emerges that the most common outcomes related to frailty condition are death, disability, hospitalisation, and institutionalisation. the decline in physical performance, home care, falls/incidents, fractures, worsening mobility, worsening disability, emergency hospitalisation, dementia, comorbidities, length of hospital stay, significant use of healthcare and avoidable hospitalisation, are also considered

Clearly, many of these outcomes are strongly associated. For example, Brocco (2020), through analysis of ULSS6 Euganea data for the period 2016-17, shows how emergency hospitalisation includes avoidable hospitalisation and femoral neck fracture, since practically all hospitalisations for these two causes are urgent (99% and 98%, respectively).

Figure 2 - *Analysis path for the construction of an electronic frailty indicator.*



5.2 Construction of variables from current healthcare data flows

Both health outcomes and the variables candidate to compose the frailty index are derived from administrative data related to various current healthcare data flows, such as mortality, hospital discharges, drug prescriptions, first aid, income exemptions, home care service, and medical exemptions. These flows are linked to the health registry, allowing reconstruction of health events for an individual.

The process is very complex; we highlight here the two main points of complexity.

1) Measurement of each health variable, typically a pathology, requires the preparation of complex algorithms for case identification (Canova et al., 2019;

Giraudo et al. 2023). These algorithms indicate which healthcare data flows to consider and which pathology codes to use in each flow, according to the classifications adopted in each healthcare flow.

2) The use of this type of data is subject to regulations on the processing of personal and health data for research purposes. Unless specific projects are authorized by the Data Protection Authority, some of which are included in the National Statistical Programme, the researcher can only analyse anonymised data. The path to anonymised data is complex and requires that data holders - in this case, Local Health Authorities - carry out this process. The process includes a first phase of pseudonymization, in which the tax code (the primary identifying key) is replaced with a pseudonym ID, and all direct identifiers are subsequently eliminated. Note that the pseudonymization algorithm must not be known even to those who apply it. Subsequently, each pseudonymized table is merged with the pseudonymized health registry through deterministic record linkage. Then the anonymisation process follows, consisting of two phases: 1) Generalisation of quasi-identifiers (gender, age, area of residence) to eliminate the risk of subject identification; 2) Verification of the deterministic deductibility of health data, which quantifies the number of subjects at risk of deduction. In the risk assessment phase, predetermined levels of impact for affected individuals are considered, and the acceptance of any risk of deductibility is evaluated based on the value of the deducible information; otherwise, at-risk data are removed from the dataset. Details on the anonymisation process can be found, for example, in Irti (2022).

5.3 Identification and selection of variables composing the indicator

Once the adverse health outcomes have been chosen, the next step is to select the explanatory variables for these outcomes. In fact, the predictors of health outcomes are the candidates to form the indicator.

Various approaches have been presented in the literature for variable selection. Many studies consider multivariate models, typically logistic regressions, where the outcome is defined by the presence of at least one of the selected health outcomes (e.g., mortality and hospitalisation), and variable selection is then performed using standard statistical methods such as stepwise selection, lasso, etc.

Our proposal (Silan et al., 2020, 2022) instead considers several health outcomes separately (death, fracture, emergency room access with red code, urgent hospitalisation, avoidable hospitalisation, onset of disability, onset of dementia) and aims to identify the best subset of predictive variables for all outcomes, starting from

candidate variables that emerged from multivariate analyses performed for each outcome. Analyses are performed separately on each health outcome based on healthcare variables observed in the previous year (in some cases, from the previous two years). The selection procedure, rather complex, is detailed in the aforementioned article and is based on a process of resampling and repetition of analyses and selection of variables that are most often selected for each outcome.

5.4 Construction of the frailty index

Once a broad subset of variables that make up the indicator has been selected, they are aggregated using the partially ordered sets (POSET) method, which, starting from a set of dichotomous and/or ordinal variables, considers each subject's profile (i.e., the set of their characteristics based on the variables considered) and then generates a measure (average rank) based on the comparison of all profiles. For details, see Silan et al. (2020).

Using POSET, it is also possible to construct the indicator using a forward technique, adding variables one by one and stopping when the performance of the indicator worsens with the addition of more variables. The criterion we adopted was the sum of the Areas Under the ROC Curve (AUC) for the various outcomes considered. In this way, we arrive at an indicator composed of a small number of variables, fewer than 10, and, therefore, easy to calculate. The indicator shows very good performance in terms of AUC, even in different populations (according to time and space), comparable to or even better than other deficit accumulation indices that consider many more variables.

5.5 Future developments and limitations

The frailty indicator proposed by Silan et al. (2020, 2022) has many advantages (has very good performance, is based on a small number of variables, considers several outcomes simultaneously, regenerates over time, and does not rely on predefined parameters or weights) and has generated significant interest among healthcare providers and regions. Therefore, further validations are underway and easy-to-use applications are being developed.

The proposed method also has limitations: the average rank assigned by POSET technique strictly depends on the structure of the population in which it is calculated according to both variables forming the indicator and variability of observed profiles. Comparison across space or time is therefore theoretically not possible, unless the observed profiles of the populations being compared are exactly the same, which is

less likely. From a methodological point of view, we are working on a proposal of confidence intervals for the average rank generated by the POSET, which are currently never proposed in the literature.

A more general limitation, not related to our proposal but to the nature of health administrative data, is related to the need to make the definitions and classification systems of all health flows as shared as possible in the various regions, something that has not yet been fully achieved. In the absence of such sharing, the risk is that territorial differences are due (at least in part) to different definition and coding systems. This is a general problem that has always plagued official statistics.

6. Discussion

This work aimed primarily to highlight the different conceptual approaches to frailty in old people, showing the process that starts from the concept, leads to the definition, and then to the measurement tool for frailty. It is evident that different definitions lead to very different measures. Additionally, different types of data allow for one definitional approach over another, resulting in the measurement of different aspects. Thus, in light of a large and general concept of frailty, which describes it as a state of increased vulnerability that makes individuals more susceptible to adverse health events, it is possible to focus more on clinical, biological, or psychosocial aspects, resulting in different measures of frailty.

The researcher, particularly the official statistician, is well aware of these dynamics, which often are the subject of extensive discussions. If we consider, for example, the measurement of health and the underlying concept, we are fully aware of how different it is to talk about self-perceived health, measured through surveys, versus "objective" health, measured through administrative health data.

What is needed is to bring order to the set of definitions and measurement tools and arrive at shared and validated indicators at the international level. The level of discussion is such that we believe that the time is ripe to address this issue.

We then presented a proposed path for the construction of frailty indicators based on administrative health data. This is an increasingly relevant issue for public health management, from a perspective of prevention and appropriate healthcare. In our country, this need has been repeatedly emphasised by regulations and represents an important objective within the PNRR Age-IT partnership, "Ageing Well in an Ageing Society" (https://ageit.eu/wp/). Beyond the methodological aspects, which are gradually resolved by research, the process is made difficult by the many constraints imposed by data privacy regulations, constraints that can only be resolved through constant and intense collaboration with local health authorities or regions, at the local level, and with the Data Protection Authority, at the national level.

Today, the regulatory framework does not allow the full potential of individual-level frailty measures to be exploited. In fact, currently, the calculation of frailty indicators is carried out on anonymised data from which it is not possible to trace back the individual. Contacting at risk individuals in order to define personalised care paths, the so-called "initiative medicine," is therefore not feasible in this context, unless explicit consent from the individual has been obtained (which is currently not possible with retrospective administrative health data), or a specific regulation permits it (which currently does not exist). In fact, initiative medicine does not fall under the processing of health data for ordinary care and prevention activities, but must be considered an "additional and autonomous processing" for which one of the two aforementioned conditions is required.

The scientific community and official statistics are actively engaged in these issues, which require a collective effort that also requires legislators not to become an obstacle to the potential of research and the provision of complete healthcare.

Acknowledgements and funding

The authors sincerely thank LoLa (Laboratory on Longevity and Ageing - https://lola.projects.unibz.it/), which organised the plenary session Investigating the complexity of frailty: thoughts and implications for individuals, families, and society at the SIEDS 2024 conference, http://www.sieds.it/index.php/page-programma/).

The Authors also like to thank ULSS6 Euganea (Padua province, Italy), in particular the Prevention office, with which the Department of Statistical Sciences of the University of Padua activated the StHeP (State of Health in Padua) convention, for the work of data extraction and anonymisation.

This work was supported by Next Generation EU, in the context of the National Recovery and Resilience Plan, Investment PE8 – Project Age-It: “Ageing Well in an Ageing Society”, CUP C93C22005240007 [DM 1557 11.10.2022]. The views and opinions expressed are only those of the authors and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

References

AARTS S, PATEL KV, GARCIA ME, VAN DEN AKKER M, VERHEY FR, METSEMAKERS JF, VAN BOXTEL MP, GUDNASON V, JONSDOTTIR MK,

SIGGEIRSDOTTIR K, JONSSON PV, HARRIS TB, LAUNER LJ. 2015. Co-presence of multimorbidity and disability with frailty: An examination of heterogeneity in the frail older population, *J Frailty Aging*, Vol. 4, pp. 131-8.

ABIZANDA P., ROMERO L., SÁNCHEZ-JURADO P.M., MARTÍNEZ-REIG M., ALFONSO-SILGUERO S.A., RODRÍGUEZ-MAÑAS L. 2014. Age, frailty, disability, institutionalization, multimorbidity or comorbidity. Which are the main targets in older adults?, *J Nutr Health Aging*, Vol. 18, pp. 622-7.

BANDEEN-ROCHE K., XUE Q.-L., FERRUCCI L., WALSTON J., GURALNIK J.M., CHAVES P., ZEGER S.L., FRIED L.P. 2006. Phenotype of frailty: characterization in the women's health and aging studies, *J. Gerontol. A. Biol. Sci. Med. Sci.*, Vol. 61, pp. 262-266.

BENNETT S., SONG X., MITNITSKI A., ROCKWOOD K. 2013. A limit to frailty in very old, community-dwelling people: a secondary analysis of the Chinese longitudinal health and longevity study *Age Ageing*, Vol. 42, pp. 372-377.

BLODGETT J., THEOU O., KIRKLAND S., ANDREOU P., ROCKWOOD, K. 2015. The association between sedentary behaviour, moderate-vigorous physical activity and frailty in NHANES cohorts, *Maturitas*, Vol. 80, pp. 187-191.

BOECKXSTAENS P, VAES B, LEGRAND D, DALLEUR O, DE SUTTER A, DEGRYSE JM. 2015. The relationship of multimorbidity with disability and frailty in the oldest patients: A cross-sectional analysis of three measures of multimorbidity in the BELFRAIL cohort, *Eur J Gen Pract*., Vol. 21, pp. 39-44.

BÖRSCH-SUPAN A., BRANDT M., HUNKLER C., KNEIP T., KORBMACHER J., MALTER F., SCHAAN B., STUCK S., ZUBER S. 2013. Data Resource Profile: The Survey of Health, Ageing and Retirement in Europe (SHARE), *International Journal of Epidemiology*, Vol. 42, pp.992-1001.

BROCCO R. 2020. Approfondimenti metodologici sulla costruzione di un indicatore composito di fragilità degli anziani. Applicazione e validazione nell'Azienda ULSS 6 Euganea. Università degli studi di Padova: Tesi di Laurea Magistrale. (In Italian).

BROCKLEHURST J.C. 1985. The geriatric service and the day hospital. In: BROCKLEHURST J.C., (ed.) *Textbook of Geriatric Medicine and Gerontology*, 3rd edn., Churchill, London, England, pp. 982–995.

CAMPISI J. 2013. Aging, Cellular Senescence, and Cancer, *Annu. Rev. Physiol.*, Vol. 75, pp. 685-705.

CANOVA C., DI DOMENICANTONIO R., CAPPAI G. DANIELI S. SIMONATO L. (Eds.). 2019. Exploiting Healthcare Administrative Databases for case-identification algorithms: a systematic review of the Italian experiences. Epidemiologia & Prevenzione, Vol. 4, Supplemento 2. Milano: Inferenze.

CESARI M., MARZETTI E., THIEM U., PÉREZ-ZEPEDA M.U., ABELLAN VAN KAN G., LANDI F., PETROVIC M., CHERUBINI A., BERNABEI R. 2016. The geriatric management of frailty as paradigm of "The end of the disease era", *Eur. J. Intern. Med.*, Vol. 31, pp. 11-14.

CHANG S.-F., LIN H.-C., CHENG C.-L. 2018. The Relationship of Frailty and Hospitalization Among Older People: Evidence from a Meta-Analysis, *J. Nurs. Scholarsh.*, Vol. 50, pp. 383-391.

CHARLSON ME, POMPEI P, ALES KL, MACKENZIE CR. 1987. A new method of classifying prognostic comorbidity in longitudinal studies: development and validation, *J Chronic Dis*, Vol. 40, pp. 373-383.

CLEGG A., YOUNG J., ILIFFE S., RIKKERT M.O., ROCKWOOD K. 2013. Frailty in elderly people, *Lancet Lond. Engl.*, Vol. 381, pp. 752–762.

CLEGG A., YOUNG J., ILIFFE S., RIKKERT M.O., ROCKWOOD K. 2013. Frailty in elderly people, *Lancet Lond. Engl.*, Vol. 381, pp. 752-762.

DE LUCA V, FEMMINELLA GD, LEONARDINI L, PATUMI L, PALUMMERI E, ROBA I, ARONNI W, TOCCOLI S, SFORZIN S, DENISI F, BASSO AM, RUATTA M, OBBIA P, RIZZO A, BORGIOLI M, ECCHER C, FARINA R, CONFORTI D, MERCURIO L, SALVATORE E, GENTILE M, BOCCHINO M, SANDUZZI ZAMPARELLI A, VICECONTE G, GENTILE I, RUOSI C, FERRARA N, FABBROCINI G, COLAO A, TRIASSI M, IACCARINO G, LIOTTA G, ILLARIO M. 2023. Digital health service for identification of frailty risk factors in community-dwelling older adults: The SUNFRAIL+ Study Protocol, *Int J Environ Res Public Health*. Vol. 20:3861.

ESPINOZA SE, QUIBEN M, HAZUDA HP. 2018. Distinguishing Comorbidity, Disability, and Frailty, *Curr Geriatr Rep.*, Vol. 7, pp. 201-209.

FRIED L.P., TANGEN C.M., WALSTON J., NEWMAN A.B., HIRSCH C., GOTTDIENER J., SEEMAN T., TRACY R., KOP W.J., BURKE G., MCBURNIE M.A., Cardiovascular Health Study Collaborative Research Group. 2001. Frailty in older adults: evidence for a phenotype, *J. Gerontol. A. Biol. Sci. Med. Sci.*, Vol. 56, pp. M146-156.

FRIED LP, FERRUCCI L, DARER J, WILLIAMSON JD, ANDERSON G. 2004. Untangling the concepts of disability, frailty, and comorbidity: implications for improved targeting and care, *J Gerontol A Biol Sci Med Sci.*, Vol. 59, pp. 255-63.

FRIES J.F., 1980. Aging, natural death, and the compression of morbidity, *N. Engl. J. Med.*, Vol. 303, pp. 130–135.

GALLUZZO L, SILANO M. 2023. Analisi epidemiologica della fragilità nella coorte di anziani ILSA (Italian Longitudinal Study on Aging): frequenza,

caratteristiche e progressione nel tempo, *Bollettino epidemiologico nazionale*, 2023, Vol. 4, pp. 20-28. (in Italian)

GARMANY A., YAMADA S., TERZIC A. 2021. Longevity leap: mind the healthspan gap, *NPJ Regen. Med.*, Vol. 6, p. 57.

GIRAUDO M.T., MORI F., GNAVI R., RICCERI F. 2023. Malattie croniche e multimorbidità in Piemonte (2017-2019). Epidemiologia e Prevenzione, quaderni E&P. Milano: Inferenze.

GOBBENS R.J.J., LUIJKX K.G., WIJNEN-SPONSELEE M.T., SCHOLS J.M.G.A. 2010. In search of an integral conceptual definition of frailty: opinions of experts, *J. Am. Med. Dir. Assoc*., Vol. 11, pp. 338-343.

HUDON C, FORTIN M, VANASSE A. 2005. Cumulative Illness Rating Scale was a reliable and valid index in a family practice context. *J Clin Epidemiol*., Vol. 58, pp. 603–608.

IRTI C. 2022. Personal Data, Non-personal Data, Anonymised Data, Pseudonymised Data, De-identified Data. In: Senigaglia R., Irti C., Bernes A. (Eds.), Privacy and Data Protection in Software Services. Singapore: Springer Nature, pp. 49-57.

JONE, D., SONG X., MITNITSKI A., ROCKWOOD K. 2005. Evaluation of a frailty index based on a comprehensive geriatric assessment in a population based study of elderly Canadians, *Aging Clin. Exp. Res.*, Vol. 17, pp. 465-471.

KATZ S, FORD AB, MOSKOWITZ RW, JACKSON BA, JAFFE MW. 1963. Studies of illness in the aged. The index of Adl: A standardized measure of biological and psychosocial function, *JAMA*, Vol.185, pp. 914-919.

KENNEDY B.K., BERGER S.L., BRUNET A., CAMPISI J., CUERVO A.M., EPEL E.S., FRANCESCHI C., LITHGOW G.J., MORIMOTO R.I., PESSIN J.E., RANDO T.A., RICHARDSON A., SCHADT E.E., WYSS-CORAY T., SIERRA F. 2014. Geroscience: linking aging to chronic disease, *Cell*, Vol. 159, pp. 709–713.

KHANNA AK, MOTAMEDI V, BOULDIN B, HARWOOD T., PAJEWSKI N.M., SAHA A.K., SEGAL S. 2023. Automated electronic frailty index–identified frailty status and associated postsurgical adverse events. *JAMA Netw Open.*, Vol. 6: e2341915.

KIRKWOOD T.B.L. 2005. Understanding the odd science of aging, *Cell*, Vol. 120, pp. 437-447.

KOJIMA G., ILIFFE S., JIVRAJ S., WALTERS K. 2016. Association between frailty and quality of life among community-dwelling older people: a systematic review and meta-analysis, *J. Epidemiol. Community Health*, Vol. 70, pp. 716-721.

KYU H.H. et al., 2018. Global, regional, and national disability-adjusted life-years (DALYs) for 359 diseases and injuries and healthy life expectancy (HALE) for 195 countries and territories, 1990–2017: a systematic analysis for the Global Burden of Disease Study 2017. The Lancet 392, 1859–1922. https://doi.org/10.1016/S0140-6736(18)32335-3

LAWTON MP, BRODY EM. 1969. Assessment of older people: self-maintaining and instrumental activities of daily living, *Gerontologist*, Vol. 9, pp. 179-86.

LEME D.E.D.C., THOMAZ R.P., BORIM F.S.A., BRENELLI S.L., OLIVEIRA D.V., FATTORI A. 2019. Survival of elderly outpatients: effects of frailty, multimorbidity and disability, *Cien Saude Colet*., Vol. 24, pp. 137-146.

LÓPEZ-OTÍN C., BLASCO M.A., PARTRIDGE L., SERRANO M., KROEMER G. 2013. The Hallmarks of Aging, *Cell*, Vol. 153, pp. 1194–1217.

LUO J, LIAO X, ZOU C, ZHAO Q, YAO Y, FANG X, SPICER J. 2022. Identifying frail patients by using Electronic Health Records in primary care: Current status and future directions, *Front Public Health*, Vol. 22: 901068

MINISTERO DELLA SALUTE – DIREZIONE GENERALE DELLA PROGRAMMAZIONE SANITARIA. 2016. Piano Nazionale della Cronicità. www.salute.gov.it/imgs/C_17_pubblicazioni_2584_allegato.pdf

MINISTERO DELLA SALUTE. 2022. DECRETO 23 maggio 2022, n. 77 , Regolamento recante la definizione di modelli e standard per lo sviluppo dell'assistenza territoriale nel Servizio sanitario nazionale. (GU Serie Generale n.144 del 22-06-2022)

MITNITSKI A.B., MOGILNER A.J., ROCKWOOD K. 2001. Accumulation of deficits as a proxy measure of aging, *Scientific World Journal*, Vol. 1, pp. 323-336.

MOGUILNER S., KNIGHT S.P., DAVIS J.R.C., O'HALLORAN A.M., KENNY R.A., ROMERO-ORTUNO R. 2021. The Importance of Age in the Prediction of Mortality by a Frailty Index: A Machine Learning Approach in the Irish Longitudinal Study on Ageing, *Geriatrics*, Vol. 6, 84.

MORLEY J.E., VELLAS B., VAN KAN G.A., ANKER S.D., BAUER J.M., BERNABEI R., CESARI M., CHUMLEA W.C., DOEHNER W., EVANS J., FRIED L.P., GURALNIK J.M., KATZ P.R., MALMSTROM T.K., MCCARTER R.J., GUTIERREZ ROBLEDO L.M., ROCKWOOD K., VON HAEHLING S., VANDEWOUDE M.F., WALSTON J. 2013. Frailty consensus: a call to action. *J Am Med Dir Assoc.*, Vol. 14(6), pp. 392-7.

PIVETTA N.R.S., MARINCOLO J.C.S., NERI A.L., APRAHAMIAN I., YASSUDA M.S., BORIM F.S.A. 2020. Multimorbidity, frailty and functional disability in octogenarians: A structural equation analysis of relationship, *Arch. Gerontol. Geriatr.*, Vol. 86:103931.

REBORA P, SCIRÈ CA, OCCHINO G, BORTOLAN F, LEONI O, CIDENI F, ZUCCHELLI A, FOCÀ E, MARENGONI A, BELLELLI G AND VALSECCHI MG. 2023. Development and validation of an electronic database-based frailty index to predict mortality and hospitalization in a population-based study of adults with SARS-CoV-2, *Front. Med.*, Vol. 10:1134377.

RITT M, JÄGER J, RITT JI, SIEBER CC, GAßMANN KG. 2017. Operationalizing a frailty index using routine blood and urine tests, *Clin Interv Aging.*, Vol. 28, pp. 1029-1040.

ROCKWOOD K., MITNITSKI A. 2007. Frailty in relation to the accumulation of deficits, *J. Gerontol. A. Biol. Sci. Med. Sci.*, Vol. 62, pp. 722–727.

ROCKWOOD K., SONG X., MACKNIGHT C., BERGMAN H., HOGAN D.B., MCDOWELL I., MITNITSKI A. 2005. A global clinical measure of fitness and frailty in elderly people, *CMAJ Can. Med. Assoc. J.*, Vol. 173, pp. 489-495.

ROCKWOOD, K., FOX R.A., STOLEE P., ROBERTSON D., BEATTIE B.L., 1994, Frailty in elderly people: an evolving concept. *CMAJ Can. Med. Assoc. J*., Vol. 150, pp. 489-495.

RODRÍGUEZ-MAÑAS L., FÉART C., MANN G., VIÑA J., CHATTERJI S., CHODZKO-ZAJKO W., GONZALEZ-COLAÇO HARMAND M., BERGMAN H., CARCAILLON L., NICHOLSON C., SCUTERI A., SINCLAIR A., PELAEZ M., VAN DER CAMMEN T., BELAND F., BICKENBACH J., DELAMARCHE P., FERRUCCI L., FRIED L.P., GUTIÉRREZ-ROBLEDO L.M., ROCKWOOD K., RODRÍGUEZ ARTALEJO F., SERVIDDIO G., VEGA E., FOD-CC group. 2013. Searching for an operational definition of frailty: A Delphi method based consensus statement: the frailty operative definition-consensus conference project, *J. Gerontol. A. Biol. Sci. Med. Sci.*, Vol. 68, pp. 62-67.

ROLFSON D.B., MAJUMDAR S.R., TSUYUKI R.T., TAHIR A., ROCKWOOD K. 2006. Validity and reliability of the Edmonton Frail Scale, *Age Ageing*, Vol. 35, pp. 526-529.

ROMERO-ORTUNO R. 2013. An alternative method for Frailty Index cut-off points to define frailty categories, *Eur. Geriatr. Med.*, Vol. 4, 10.1016/j.eurger.2013.06.005.

SANTONI G., ANGLEMAN S., WELMER A.-K., MANGIALASCHE F., MARENGONI A., FRATIGLIONI L. 2015. Age-Related Variation in Health Status after Age 60, *PLOS ONE*, Vol. 10, e0120077.

SEARLE S.D., MITNITSKI A., GAHBAUER E.A., GILL T.M., ROCKWOOD K.. 2008. A standard procedure for creating a frailty index, *BMC Geriatr.*, Vol.8, 24.

SEBASTIANI G., DI FILIPPO P., DEMARIA M., CARANCI N., DI MINCO L., TAMBURINI C., D'ERRICO A., GRIPPO F., COSTA G. 2019. Lo studio

longitudinale italiano: integrazione delle indagini sulla salute con dati di mortalità e ospedalizzazione. Metodologia e potenzialità di utilizzo. *Istat Working Papers N. 14/2019*. Roma: Istituto nazionale di statistica.

SHOCK N.W., OTHERS A. 1984. *Normal Human Aging: The Baltimore Longitudinal Study of Aging*. Superintendent of Documents, U.S. Government Printing Office, Washington, DC.

SILAN M., CAPERNA G., BOCCUZZO, G. 2019. Quantifying frailty in older people at an Italian local health unit: A proposal based on Partially Ordered Sets, *Soc Indic Res*, Vol. 146, pp. 757–782.

SILAN M., SIGNORIN G., FERRACIN E., LISTORTI E., SPADEA T., COSTA G., BOCCUZZO G. 2022. Construction of a Frailty Indicator with Partially Ordered Sets: A multiple-outcome proposal based on administrative healthcare data, *Soc Indic Res*, Vol. 160, pp. 989–1017.

STERNBERG S., SCHWARTZ A.W., KARUNANANTHAN S., BERGMAN H. 2011. The identification of Frailty: A systematic literature review, *Journal of The American Geriatrics Society*, Vol. 59, pp. 2129-38.

TENCHOV R., SASSO J.M., WANG X., ZHOU Q.A. 2023. Aging Hallmarks and Progression and Age-Related Diseases: A Landscape View of Research Advancement, *ACS Chem. Neurosci.*, Vol. 15, pp. 1-30.

THANDI M., WONG S.T., PRICE M., BAUMBUSCH J., 2024. Perspectives on the representation of frailty in the electronic frailty index, *BMC Prim. Care*, Vol. 25, 4.

UNITED NATIONS DEPARTMENT OF ECONOMIC AND SOCIAL AFFAIRS, POPULATION DIVISION. 2020. World Population Ageing 2020 Highlights: Living arrangements of older persons (ST/ESA/SER.A/451).

VAUPEL J.W., MANTON K.G., STALLARD E. 1979. The impact of heterogeneity in individual frailty on the dynamics of mortality, *Demography*, Vol. 16, pp. 439-454.

VERMEIREN S., VELLA-AZZOPARDI R., BECKWÉE D., HABBIG A.-K., SCAFOGLIERI A., JANSEN B., BAUTMANS I., GERONTOPOLE BRUSSELS STUDY GROUP. 2016. Frailty and the Prediction of Negative Health Outcomes: A Meta-Analysis, *J. Am. Med. Dir. Assoc.*, Vol. 17, pp. 1163.e1-1163.e17.

VILLACAMPA-FERNÁNDEZ P, NAVARRO-PARDO E, TARÍN JJ, CANO A. 2016. Frailty and multimorbidity: Two related yet different concepts, *Maturitas*. Vol. 95, pp. 31-35.

VOLLSET S.E., et al. 2024. Burden of disease scenarios for 204 countries and territories, 2022–2050: a forecasting analysis for the Global Burden of Disease Study 2021, *The Lancet*, No. 403, pp. 2204–2256.

VOS T., et al. 2016. Global, regional, and national incidence, prevalence, and years lived with disability for 328 diseases and injuries for 195 countries, 1990–2016: a systematic analysis for the Global Burden of Disease Study 2016, *The Lancet*, Vol. 390, pp. 1211–1259.

WALLACE E., STUART E., VAUGHAN N., BENNETT K., FAHEY T., SMITH S.M. 2014. Risk prediction models to predict emergency hospital admission in community-dwelling adults: A systematic review, *Medical care*, Vol. 52, pp. 751–765.

WARD Z.J., GOLDIE S.J. 2024. Global Burden of Disease Study 2021 estimates: implications for health policy and research, *The Lancet*, Vol. 403, pp. 1958–1959.

WORLD HEALTH ORGANIZATION. 2001. International classification of functioning, disability and health: ICF. World Health Organization. https://iris.who.int/handle/10665/42407

Annalisa DONNO, Department of Statistical Sciences, University of Padova, annalisa.donno@unipd.it

Margherita SILAN, Department of Statistical Sciences, University of Padova, margherita.silan@unipd.it

Giovanna BOCCUZZO, Department of Statistical Sciences, University of Padova, giovanna.boccuzzo@unipd.it

CHARACTERISTICS OF THE ELDERLY IN METROPOLITAN CITIES: A GEO STATISTICAL DATA VISUALISATION[1]

Vito Fabio Bellafiore, Donatella Cangialosi, Giuseppe Lancioni

Abstract. A rapidly ageing population, such as the Italian one, has different social demographic characteristics from those of a few decades ago. The general improvement in living conditions makes it possible to consider the elderly today not as a burden on the community but as an opportunity.
The aim of this work is a study on the profile of the elderly and on some social aspects that highlight the changes that have occurred over time in the 14 Italian metropolitan cities. In order to make the reading of the profiles more effective on the territory, a geo-statistical tool for visualising and reading data is implemented.

1. Introduction

The demographic trends that have developed in Italy over the years have led to a strengthening of the ageing process. Migratory dynamics have failed to counteract the natural population dynamics and these factors have led overall to a strong imbalance in the age structure in favour of the elderly component (Reynaud and Miccoli, 2016).

The elderly, conventionally identified as the population aged 65 and over, today have different socio-demographic characteristics from those of the same class a few decades ago. Their age has been superseded by changes in lifestyles, active participation in work and society, educational attainment and improved health conditions (WHO, 2002; Istat, 2023). Old age is no longer only a matter of age itself: the transition from maturity to senility must also take into account the state of mind. A good cognitive level makes it possible to cope actively with old age, with benefits for the individual and the community (Quattrociocchi and Tibaldi, 2020). The active ageing programme, promoted by the WHO, supports a vision of ageing with policies aimed at maximising the physical, mental, social and economic potential of older people (De Santis, 2015).

A significant interpretation of ageing comes from observing the territories of the 14 Italian metropolitan Cities established by Law No. 56 of April 7, 2014. They are territorial entities of vast area born from the aggregation of neighbouring municipalities (replaced provinces). This level of governance offers the territory a new local

[1] The paper has been jointly written by all the authors but § 1 and 4.2 can be attributed to D. Cangialosi, § 2 and 4.1 to V.F. Bellafiore, § 3 and 4.3 to G. Lancioni.

government tool and new opportunities of development for the citizens. The territories involved have specific characteristics due to physical conurbation, geographical location, socio-demographic issues and economic potential or disadvantage. The geography of metropolitan cities allows for an internal classification of the municipalities that are part of them, in which the city, understood as a large urban agglomeration (the capital municipality), is surrounded by an aggregate of municipalities that gravitate around it, forming the first- and second urban belts that allow us the observation of the dynamics of city evolution.

This work therefore proposes an in-depth study of the target elderly population (65+ years) in order to outline its socio-demographic profile through a set of indicators calculated for the 14 Metropolitan Cities (MC) at the municipal level, and to examine the demographic dynamics of the two sub-groups of the 'young elderly' and the 'great elderly' with the aim to highlight the diversity and evolution over time of the metropolitan contexts and their internal articulations. In order to make the various dimensions of the data simultaneously accessible, the descriptive analysis is supported by the implementation of a geo-statistical tool for the dynamic visualization of the processed indicators based on ArcGIS Dashboards technology, navigable in the different territorial levels and articulations of metropolitan cities.

2. Indicators and methods

The analysis of ageing in metropolitan cities and their urban contexts developed through a focus on the elderly (65+ years) offers an informative overview to identify socio-demographic characteristics and to understand social welfare.

To this end, a set of demographic indicators relating to the population structure and dynamics, family network, single-person households of the elderly, educational level and employment status was selected, with the integrated use of different statistical sources. In addition, the demographic dynamics of the two subgroups that make up the population segment of 65 years and over are also examined: the 'young elderly' (65-74 years) and the 'great elderly', aged 85 years and over, i.e. population groups whose psycho-physical functions and thus active role in society are progressively restricted on the basis of the progression of a set of conditions. The indicators have been elaborated in time series for the four territorial sub-domains of the 14 metropolitan Cities (capital municipalities, first and second belt municipalities and other metropolitan city municipalities) and updated to the municipal boundaries on 1 January 2023. The belts have been identified according to a criterion of spatial contiguity: the first belt is formed by the ring of municipalities contiguous to the capital municipality, i.e. sharing its boundary at least at one point; the second belt is composed of the municipalities contiguous to those in the first belt. The remaining municipalities of the metropolitan area form the outer ring. (Istat, 2020).

The statistical analysis is supported by the implementation of a geo-statistical tool for the dynamic visualisation of the calculated indicators, presented in section 3.

In Italy, there are 1,268 municipalities belonging to the 14 metropolitan Cities (16% of Italian municipalities), with 14 capitals, 177 municipalities in the first belt, 213 in the second belt and 864 municipalities in the outer ring of the territory. These municipalities cover an area of 46,637 square kilometres (15.4% of the Italian surface area).

3. Methods

There is a strong request in order to facilitate the access to the information embedded in data published in official statistics, supported by both researchers and students communities, as well as by a growing amount of people interested in socio-demographic phenomena. International institutions are actively backing these needs by periodically publishing recommendations on communication and dissemination strategies, aiming at ensuring and extending accessibility to data and promoting an informed use of data for correct interpretation and analysis of phenomena (Eurostat, 2021; Unece, 2021; Oecd, 2021). With the aim to comply with these requests, a geo-statistical data visualization tool has been developed on elderly analysis. It is based on ArcGIS Dashboards technology.

The key targets of the tool, established from the beginning of the design phase, can be summarized as:

- allowing a simultaneous representation of the different aspects of the phenomena in study, as well as a detailed description of its articulation in the territory;
- promoting structural and geographical comparisons;
- improving the general easy of use and cleaning of design.

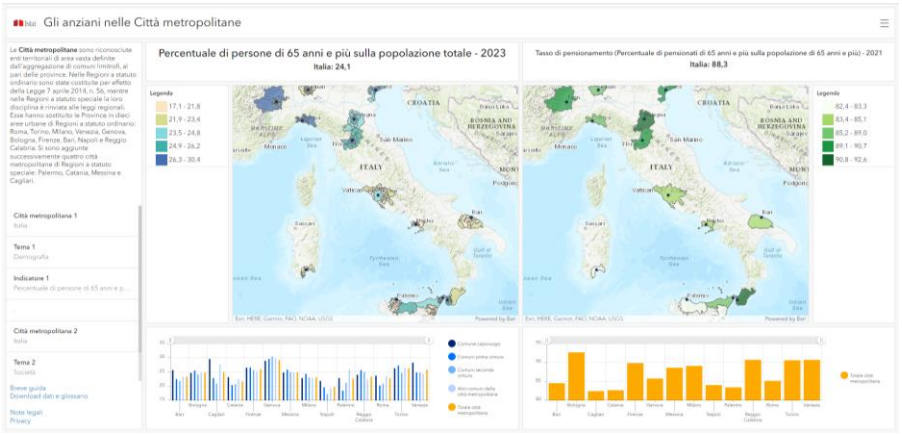
3.1. General layout of the dashboard

The dashboard is based on a clean and simple design, and consists of a single-page web applications with only two graphical objects used to represent statistical information: cartograms and histograms. This boosts the expected effect of immediate data integration and representation. Underlying data, as well as a short guide, are available for download in excel and pdf format, and are accessible by means of web links. Software versions consist of ArcGIS Pro 2.8.0 (Maps creation and editing), ArcGIS Enterprise 10.9.1 (Dashboard creation and editing).

A constant effort has been spent in simplifying as much as possible the interactivity. The general layout is split in two main parts, as shown in Figure 1:

- a *left-side panel*, which contains all the controls and filters;
- a *central area* devoted to data visualization, which in turn is split in two identical panels, each embedding a map and an histogram.

Figure 1 – *Dashboard.*



General layout: the left-side panel with the controls, and the central area split in two identical informative panels, each composed of a map and a histogram showing the same indicator.

The left-side panel is designed to be the control panel of the whole dashboard. All the selectors are gathered in this area, as well as short description and historical summary of the Italian MC, and a set of links to the navigation guide and to the data for downloading. Selectors are all of the same type, namely *categorical*, and are grouped in two identical blocks, one for each of the two visualization panels. They filter two kind of information:

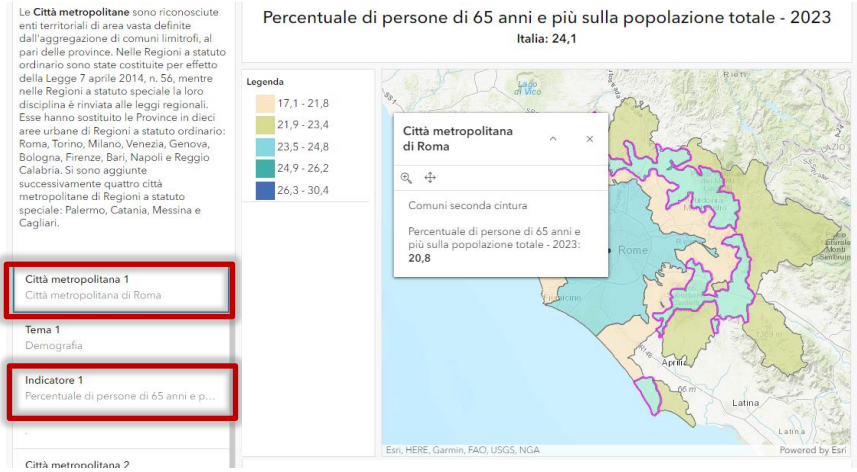
- the *territorial detail*, i.e. the metropolitan city;
- the *indicator* to be shown in both the histogram and the map.

The last characteristic implies the possibility to select a particular layer on the map without acting on the map itself, but by selecting the indicator from an external control. The implementation of this non-trivial characteristic will be discussed in the next subsection.

Having all the filter controls grouped in the same area greatly improves the ease of use and cleaning of design of the whole dashboard, these being some of the key features established from the very beginning of the project phase. Each of the two informative panels of the central area consists of a cartogram and a histogram, for the simultaneous representation of territorial and structural aspects of the information. Also reported is a legend showing the range of the values classified in quintiles, and, on the top of each panel, the name of the selected indicator and its value referred to Italy. Cartograms are based on *ArcGIS map* (Esri, 2019) previously created in ArcGIS Pro suite and imported in the web portal. Details include the urban centres and belts articulations; by clicking a point in the map, a pop-up shows the punctual value of the indicator for that territorial detail (Figure 2). Being identical, they are useful to instantly compare the same theme

on two different territories, or two different aspects of data in the same geographical context, or in general any different pair of: indicator, territory.

Figure 2 – *Cartograms.*



Both the territorial detail and the indicator are selected in the left-side panel; pop-ups reporting punctual values are available by clicking on the map.

The histograms are leveraged to perform a simultaneous comparison between the 14 MC. Territorial structure of urban cities and belts is customizable by clicking the legend icons on the map, toggling visible or not the related detail (Figure 3). Note that in the histogram the option "Total MC" is available, showing the value for the entire MC. This value cannot be visualized in the maps, due to aggregative structure of the belt levels. Punctual value of the columns are available via pop-up, which activates on mouse moving.

3.2. Selection of the layers

Cartograms are ArcGIS maps which consist of multiple layers, each one representing an indicator. A layer, in the form of the ESRI shapefile (ESRI, 1998), is a data object which contains both geographical and thematic information, organized in a data structure that can be visualized as a table. In the standard use case, the indicator to be shown is selected directly *on the map* using specific interaction tools, which shows the list of the available layers with the possibility to toggle visible or not visible each one of them. As per the GIS[2] tools standards and conventions, only the top visible layer is visualized in the map. Note that this interaction affects only the choice of the layers, that is the

[2] Geographic Information System

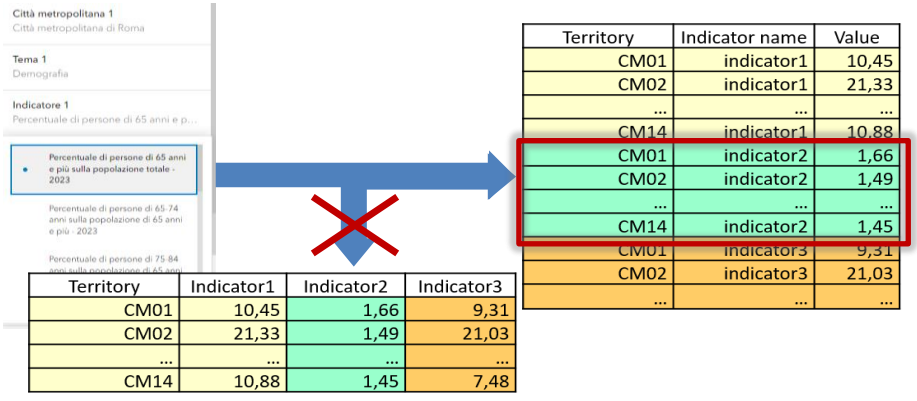
indicator in the map, and *cannot* be used to select the same indicator in the histogram. In contrast, the possibility to select a single layer by the selectors *outside* of the map is a feature that is typically lacking in GIS tools, and ArcGIS Dashboard is not an exception. This limitation frustrates our clean approach, which dictates to use one only control to filter the indicators in both the cartogram and the histogram, and to set all the controls in a specific area.

Figure 3 – *Histograms.*

Left: the list of the available indicators is accessible by the left side panel selectors.
Right: clicking the icons in the legend toggles the related detail visible or not visible.

It has been possible to overcome such setback by a critical rethinking of the dataset structure (Abbate *et al.*, 2024), in which the same set of rows is replicated for each indicator, with only the indicator column being different. In this way, the choice of a specific indicator in the selector filters out all but one set of the rows, exactly the one of the matching indicator name. In other words, with this dataset structure the filter on the indicator is applied to the rows, not to the columns (Figure 4).

Figure 4 – S*electing layers from outside of the map.*



Territory	Indicator1	Indicator2	Indicator3
CM01	10,45	1,66	9,31
CM02	21,33	1,49	21,03
...	...	...	...
CM14	10,88	1,45	7,48

Territory	Indicator name	Value
CM01	indicator1	10,45
CM02	indicator1	21,33
...	...	...
CM14	indicator1	10,88
CM01	indicator2	1,66
CM02	indicator2	1,49
...	...	...
CM14	indicator2	1,45
CM01	indicator3	9,31
CM02	indicator3	21,03
...	...	...

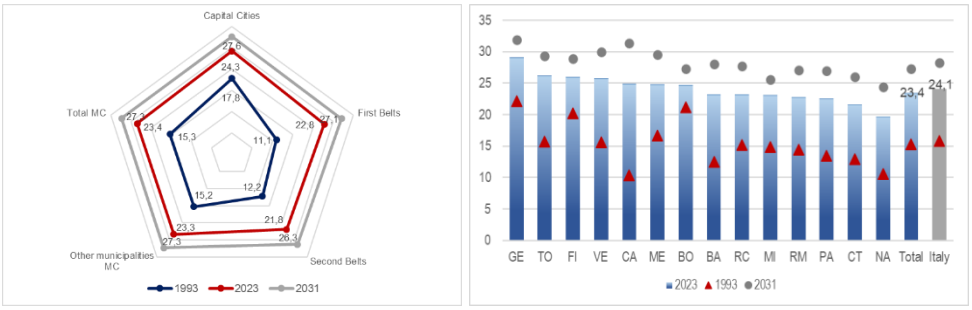
Selection of an indicator in the categorical selector can filter the rows in the right table, but not the columns in the bottom table. Hence dataset is structured as per the right table.

4. Results

4.1 Dynamics and demographic characteristics of the elderly

The 14 metropolitan cities are home to almost 5 million people aged 65 and over, more than a third of the national contingent; they have increased by 1.9 million in 30 years and account for almost a quarter of the total population. There is a predominance of women, and the gender gap widens as people get older, with 77 men for every 100 women 65+ years (the national average is 78.5) due to women's longer life expectancy.

Figure 5 – *Resident population aged 65 years and over in the metropolitan cities and urban belts (% of total) –1993- 2023- 2031.*



Source: elaboration on Istat data, Nowcasting system for demographic indicators.

Residents aged 65 and over live predominantly in the most urbanized contexts: 45% in the capital municipalities, almost a third distributed between the first and second urban belts, and the remaining 24% in the outer ring of the metropolitan city. The incidence of the elderly on the total population in 2023 is higher in the northern metropolitan cities and in those of Cagliari and Messina, lower in the southern ones. Genoa has the highest incidence of the elderly (29%) and Naples the lowest (almost one person in five); there is a greater presence of this segment of the population in the urban poles compared to the first two belts (Figure 5). Forecast estimates confirm a strengthening of the ageing population such that the population aged 65 and over will represent 27.3% of the total population in metropolitan cities in 2031, with remarkable territorial differences.

The indicators measuring the ageing of the population confirm the strengthening of this process: people are living longer and the age structure is becoming increasingly skewed towards the senile ages. The Italian old-age index in 2023 reached its all-time high: there are 193 elderly people for every 100 young people under the age of 15. However, it is lower in the 14 MC as a whole (183 elderly per 100 young people), with the intensity of the phenomenon varying between territories. The ageing gap is more marked in the North where it reaches its peak in Genoa (272.3%); the South on the other

hand is on average 'younger', with the exception of Messina (Figure 6). Within the metropolitan cities, the capitals have an 'older' profile (Cagliari the 'oldest' with 321 elderly for every 100 young people); while the urban belts are demographically younger (first urban ring of Palermo with 112% and second ring of Naples with 110%), probably due to the housing choices of the younger segments of the population caused by the more advantageous housing costs.

Figure 6 - *Old age index in the metropolitan cities – 2023 (%).*

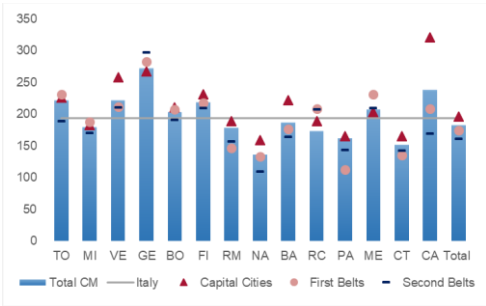
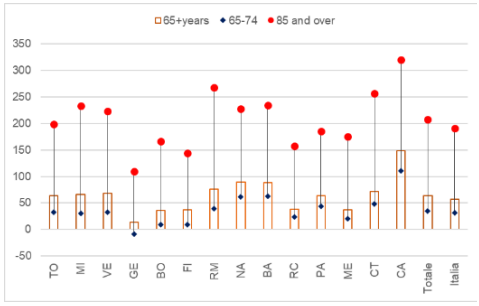


Figure 7 - *«Young» and «great» elderly in the metropolitan cities (change % 2023/1993).*



Source: elaboration on Istat data, Nowcasting system for demographic indicators.

The substantial increase in the 65+ years population over thirty years (+63.6%) encompasses an exponential growth in the segment of the 'great' elderly (+208%); and a slower growth of the 'young' elderly (+35%). Among metropolitan cities Cagliari stands out (Figure 7). The 'young' elderly in urban contexts make up almost half of the aged 65 and over collective and this incidence has decreased by 10 percentage points over thirty years. The lengthening of the average life span has produced above all the increase in the very old, aged 85 and over, who have more than tripled over the same period (there are almost 16 for every 100 people aged 65 and over) in MC and with a gender disparity in favour of women which is accentuated at a very advanced age (52 men for every 100 women aged 85 and over). The age composition of the elderly still shows a divide in the North-South metropolitan axis: the North has the highest incidence of the great elderly (among whom Genoa stands out with almost 19%) while in the metropolitan cities of the South the young elderly have a greater incidence. Naples stands out with over 54%. Within the metropolitan areas, as one moves further away from the capital city, the 'younger' segment of the elderly residing in the first two urban belts increases and the share of the over 75s decreases.

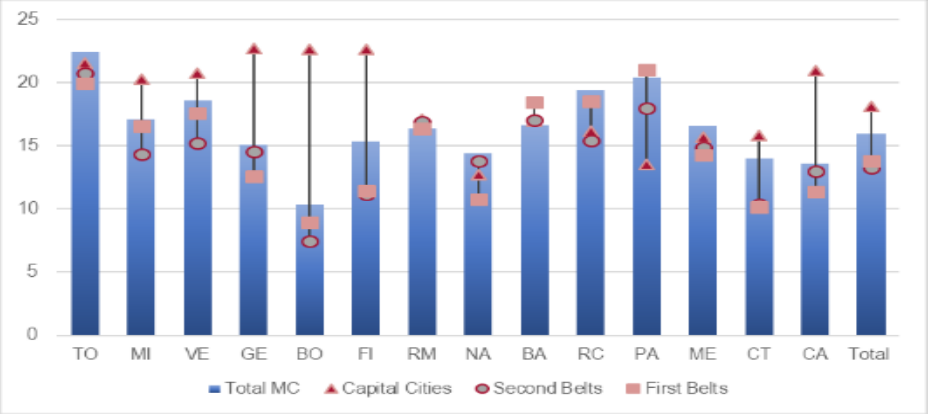
4.2 Support for the elderly and social characteristics

The growing trend of the elderly component of the population has the effect of increasing the proportion of adults who will need to support and care for elderly parents or relatives. The family has a fundamental role in caring for and supporting older members, forming a real social support network. The *Parent Support Ratio* (PSR), ratio of the population aged 85 and over to the population aged 50-64 per 100, indicates that in 2023, in metropolitan cities as a whole, there will be 16 people aged 85 and over for every 100 people aged 50-64 (the national average is 16.5 per cent). The 50-64 year old segment of the population represents the support in the future of very old parents or relatives in need of care and assistance. The need for elderly support is greatest in the metropolitan areas of Turin and Palermo (22.4% and 20.4% respectively), and least in Bologna (10.4%); it is greatest in the capital municipalities (18.1%) especially in those in the Centre-North, especially Genoa, Bologna and Florence (22.7%) (Figure 8).

Moreover, the elderly living alone are 30.2% of the total in the respective age group, with a higher incidence among the northern cities, reaching the highest value in Genoa (37%). In addition, this indicator signals the need for support that may be required for the care and assistance of the elderly.

However, over the years, the people in the collective of those who are at least 65 years old and who, progressively, enter the 'elderly' bracket, have improved their level of education and increased participation and permanence in the labour market. Education represents a competence that can influence social choices, and the attainment of work goals can guarantee greater protection in terms of employment and healthier lifestyles. Generally, high levels of education and training correspond to conditions of individual and collective well-being.

Figure 8 – *Parent Support Ratio (PSR) in the metropolitan cities – 2023 (%).*



Source: elaboration on Istat data, Nowcasting system for demographic indicators.

Table 9 – *Educational qualification and employment rate (%) – 2021.*

Metropolitan cities	Licenza elementare e media	Primary and secondary school	Tertiary education	Employment rate - Total	Employment rate - M	Employment rate - F
Turin	62,1	25,4	8,1	5,7	8,4	3,5
Milan	54,7	30,3	11,5	6,9	10,8	4,0
Venice	66,9	21,2	7,0	6,1	9,4	3,6
Genoa	55,3	30,7	11,4	6,7	10,2	4,1
Bologna	58,0	25,9	12,1	7,4	11,2	4,5
Florence	60,9	23,2	11,6	7,7	11,7	4,8
Rome	49,8	30,8	15,5	7,8	11,5	5,0
Naples	63,8	20,2	9,2	6,5	10,6	3,3
Bari	61,7	20,1	8,9	5,4	8,7	2,7
Reggio Calabria	57,3	20,8	10,1	6,1	9,1	3,7
Palermo	62,0	18,4	10,1	5,5	8,4	3,2
Messina	60,8	21,9	10,6	5,9	8,6	3,8
Catania	59,3	20,4	9,7	6,0	9,1	3,5
Cagliari	54,7	24,8	13,2	7,2	10,3	4,8
Capital Cities	**50,6**	**28,9**	**16,2**	**7,5**	**11,6**	**4,7**
First Belts	**62,5**	**24,4**	**7,5**	6,0	9,0	3,5
Second Belts	**64,9**	**21,4**	**6,5**	5,8	8,9	3,3
Total MC	**58,0**	**25,4**	**11,1**	**6,7**	**10,1**	**4,0**
Italy	**61,9**	**23,3**	**8,8**	**6,5**	**10,0**	**3,8**

Source: elaboration on Istat data, Permanent population census.

In the metropolitan cities, the 65+ years people are better educated than the Italian average. More than a third have at least an upper secondary degree (4.4 percentage points higher than the Italian average) and 11% hold a university degree or other tertiary qualification. In the capital municipalities there is a higher level of education among the elderly (45% with at least a diploma), compared to the urban belts, probably because they are poles of the greatest school and university supply and more densely populated (Figure 9).

Active participation in the labour market is one of the cornerstones of the active ageing approach and the legislative framework, which has raised the age requirements for retirement, has contributed to the extension of working careers. Today, the elderly continue to use their potential, contributing to economic growth and the production of wealth in the territories. However, this permanence in the labour market, if not supported by consistent investments in education, technical and digital skills training, research and innovation, will also adversely affect the younger generations.

In 2021 there will be 328,000 '64 and over' employed in the 14 metropolitan cities (6.7% of the population in the same age group), in line with the national average but decreasing, compared to 2019, by about one percentage point, with a rather marked gender gap: one in ten elderly people is employed, while women are less than half (4%). The metropolitan cities of the Centre-North host the largest workforce of the aged 65 and over, both men and women, with Rome leading the way (7.8% employment rate for the elderly), followed by Florence and Bologna. The capital municipalities have higher employment rates of the '64 and over', although the wide gender gap persists, and among

these the city of Milan holds the record for male employment (14 employed per 100). Moving away from the capital city has an impact on labour market participation in old age: employment decreases by 1.5 percentage points in the municipalities of the first and second urban belt. In particular, greater labour participation emerges in the metropolitan urban belts of the Centre-North.

4.3 Dashboard

Analysis of the results after an extensive session of tests on dashboard prototype proves that it allows an integrated reading of the data through thematic and territorial representations of a selection of indicators. The design choices taken in the planning phase proven crucial in obtaining a balance between completeness and instant comprehension of the phenomenon on study. In particular, the single-page layout, the use of only a limited number of visualization objects and interaction controls, stress the search for the ease of use and the immediacy of the information presented. Moreover, the accurate choice of the set of indicators grants general awareness and comprehension of the phenomenon. On the other side, the crucial choice of using only a selector control to filter the indicator in both the map and the histogram implies that *all* the layers of the map are to be visible, which means a great computational effort. This reflects on the performance, making the dashboard less responsive with respect to a similar layout with standard controls, in which one only layer is visible at a time. During the test sessions, accurate stress tests have been performed with the target to find an optimum trade-off between performance and completeness of the information, i. e. the number of indicators. The result is that a set of about 30 indicators, up to a maximum of 50, can be managed without a relevant performance degradation. Also to reduce the computational burden, the shapefiles representing the geographical layers are chosen in their generalized version (Istat 2024), less detailed than the standard ones, but lighter and less RAM-demanding. For the purposes of this study, the difference in geographical detail is irrelevant.

All that considered, the described dashboard successes in meeting the design specifications, and stands as a useful and powerful tool for the interactive representation and integration of thematic and geographic information.

References

ABBATE R., LANCIONI G., PATRUNO E., TACCINI M. 2024. La mobilità territoriale: un progetto per l'analisi geografica di trasferimenti di residenza e spostamenti quotidiani. In *Conference ESRI Italia, 9 maggio 2024,* https://www.esriitalia.it/component/eventiesri/calendario/858/

DE SANTIS G. 2015. Invecchiamento (c)attivo. In Salvini S. *Longevità, vecchiaia, salute*, Neodemos. pp 69-73. ISBN 978-88-941008-8-4.

ESRI. 1998. *ESRI Shapefile Technical Description*. In ESRI whitepapers.
ESRI. 2019. Getting started with ArcGIS Pro. In ESRI ArcGIS Pro: Essential Workflows, Redlands, California, USA, https://www.esri.com/training/, pp. 15-31.
EUROSTAT. 2021. *Eurostat Communication and Dissemination Strategy 2021–2024*, https://ec.europa.eu/eurostat/about-us/policies/communication-dissemination
ISTAT. 2020. Rapporto sul territorio 2020. Ambiente, economia, società, Roma, ISBN 978-88-458-2014-4.
ISTAT.2023. Gli anziani nelle città metropolitane. Profilo sociodemografico e analisi comparativa fra i contesti urbani. Statistiche Focus (2 agosto).
ISTAT.2024. Rapporto Annuale, Roma.
OECD. 2021. OECD *Report on Public Communication: The Global Context and the Way Forward*, OECD Publishing, Paris, https://doi.org/10.1787/22f8031c-en
QUATTROCICOCCHI L., TIBALDI M. 2020. *Invecchiamento attivo e condizioni di vita degli anziani in Italia*, Roma: Istat, ISBN 978-88-458-2028-1.
REYNAUD C., MICCOLI S. 2016. Invecchiamento demografico: dinamica nelle province italiane, *EyesReg*, Vol.6, N.2.
REYNAUD C., MICCOLI S., MONNI S. 2018. Mezzogiorno: l'invecchiamento della popolazione è sostenibile? *Economia e Politica*, March, ISSN: 2281-5260.
UNECE. 2021. *Strategic Communications Framework for Statistical Institutions*, United Nations, Geneva, https://unece.org/statistics/publications/strategic-communication-framework-statistical-institutions
WHO. 2002. Active ageing. A policy framework. In *Second United Nations World Assembly on Ageing*, Madrid, https://iris.who.int/handle/10665/67215

Vito Fabio BELLAFIORE, Istat, vibellaf@istat.it
Donatella CANGIALOSI, Istat, donatella.cangialosi@istat.it
Giuseppe LANCIONI, Istat, giuseppe.lancioni@istat.it

THE DEMOGRAPHIC TRAP OF ITALIAN CITIES. A MULTIDIMENSIONAL ANALYSIS [1]

Giuseppe Lecardane, Monica Carbonara, Flora Fullone

Abstract. One of the main effects of the demographic crisis facing Italy is the depopulation of entire areas of our country. In 2023, the Italian population fell by 180,000 due to a decline in births and an increase in deaths. The aim of this paper is to analyze the phenomenon of depopulation provincial capitals in recent years, using data from the Istat Census of Population and Housing. The impact of the various components that contribute annually to the population balance in the different areas of the country is assessed. In particular, through an exploratory and multidimensional analysis of the phenomenon, the aim is to identify the main characteristics of demographic decline and the existence of territorial imbalances. The level of fragility of the municipalities is also highlighted which aims to identify the provincial capitals most exposed to environmental and socio-economic risk factors.

1. Introduction

In Italy there is a continuous decline in births which has led to a contraction of the population. Low fertility, which has persisted for 30 years now, and the consequent aging of the population continue to influence the country's demographic decline associated with economic-social uncertainty. Unfortunately, the numbers do not leave room for many doubts and Italy is close to a demographic trap scenario.

The aim of this contribution is to analyze the phenomenon of depopulation in Italy in recent years for the provincial capitals, using data from the Istat Census of Population and Housing and demographic balance. The dynamics and impact of the different components that annually contribute to the demographic balance in the different areas of the country are assessed. In particular, through a multidimensional analysis of the population with the Growth rate (r), the Fragility index and the Wroclaw Taxonomic Method (WTM) as exploratory models for measuring the causes of the phenomenon[2], the aim is to identify the characteristics of the demographic decline, the existence of territorial imbalances and areas most exposed

[1] The paper is the result of the common work of the authors. In particular: sections are attributed as follows: G. Lecardane paragraphs 1. 3 and 6, M. Carbonara paragraphs 2 and 7, F. Fullone paragraphs 4 and 5. A special thanks to Tommaso Damiani for the creation of the geographical maps.

[2] MTW method is very useful as a comparative analysis approach of the units, particularly territorial, observed (C. Tasciotti, 1973).

to environmental and socio-economic risk factors. The study offers stimulating food for thought on the logic and dynamics of our cities and the related urban, social and economic development processes.

2. Population and demographic dynamics in Italy

To describe the population end evolution of demographic dynamics from 2018 to 2023, Istat data on the demographic balance of the resident population and on the permanent population census were used. In 2023 the resident population in Italy is equal to 58.99 million, down by 7,000 units compared to the previous year. The decrease in the population resident is the result of the natural balance (-281 units with fewer births and more deaths) not compensated by the positive values of the migration balance with foreign countries (+274 units). The Southern Italy leads the reduction of the Italian population. (Tab. 1).

Table 1 - *Resident population budget by geographical distribution. 2023 (per 1,000 inhabitants) (a).*

GEOGRAPHICAL DISTRIBUTION	Population	Live births	Deaths	Natural growth	Internal migration balance	Foreign migration balance	Total balance
NORTHERN ITALY	27,490	174	305	-131	57	148	73
North west	*15,905*	*100*	*180*	*-80*	*30*	*96*	*46*
Nord east	*11,585*	*74*	*126*	*-52*	*26*	*52*	*27*
CENTRAL ITALY	11,724	69	133	-65	6	59	1
SOUTHERN ITALY	19,776	137	222	-85	-63	67	-81
South	*13,411*	*94*	*148*	*-54*	*-46*	*47*	*-53*
Islands	*6,364*	*43*	*74*	*-31*	*-17*	*20*	*-28*
ITALY	**58,990**	**379**	**661**	**-281**	**0**	**274**	**-7**

Source: Istat, Demographic balances of the Municipalities and natural movement of the present population (2023, provisional data).
a) Registrations and cancellations for other reasons (mainly due to reappearance or unavailability) are excluded from the calculation of the provisional budget of the citizen).

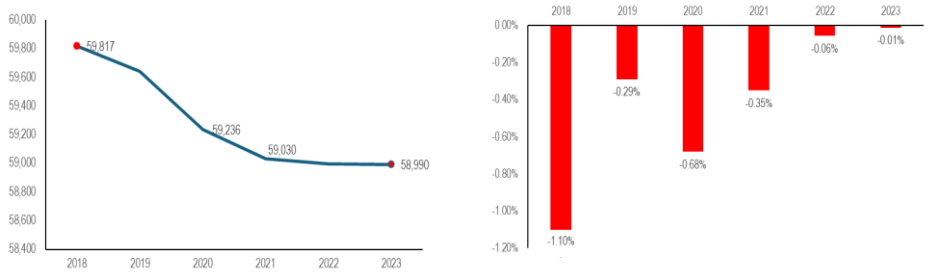
Between 2018 and 2023 the registered resident population in Italy decreases (-1.4 percent). Compared to 2022, the decline is smaller than in 2021 (-0.4 percent) and especially in 2020 (-0.7 percent), years during which the effects of the pandemic accelerated the process (Fig. 1).

In the North, the population decreased by 0.5 percent compared to 2018. In particular, the population change is negative until 2021 (-0.9 percent) but then reaches positive values in 2023 (+0.4 percent) (Fig. 2).

In the Central regions, the decline in the resident population is more sustained (-1.2 percent) than in the North. The population decreases until 2021 (-1.2 percent) and then remains stable in 2023 (Fig. 3).

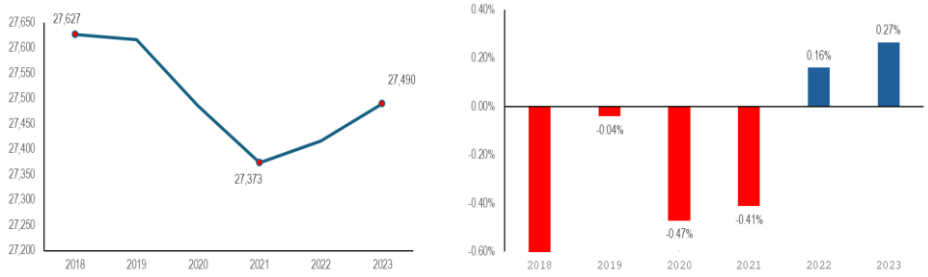
On the other hand, the regions of Southern Italy are more affected, with a negative population balance (-2.7 percent) compared to 2018. From 2020 the decline is more contained (-0.8%) (Fig. 4).

Figure 1 – *Resident population (per 1,000 inhabitants) and percentage change, Italy. 2018-2023.*



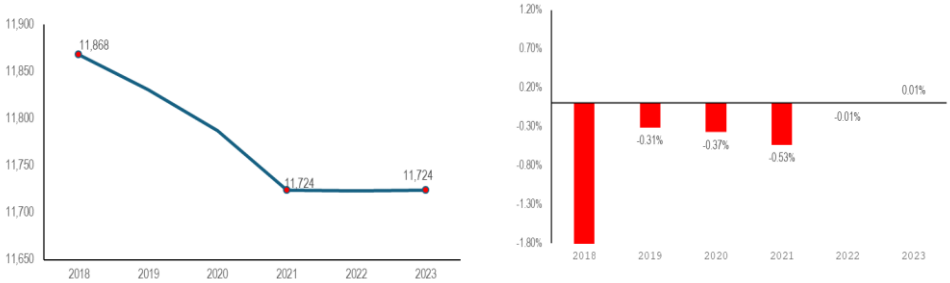
Source: Istat. Population census

Figure 2 – *Resident population (per 1,000 inhabitants) and percentage change Northern. 2018–2023.*



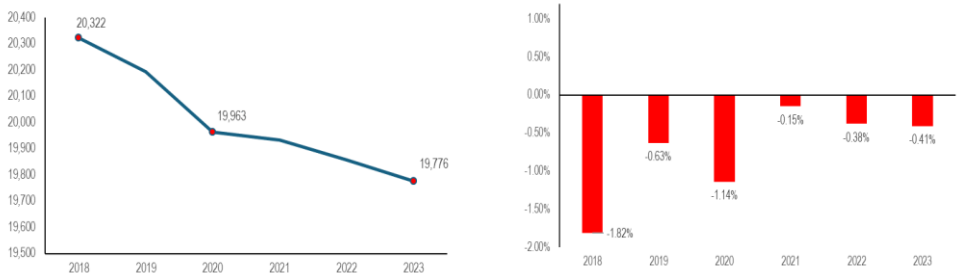
Source: Istat. Population census

Figure 3 – *Resident population (per 1,000 inhabitants) and percentage change, Central. 2018–2023.*



Source: Istat. Population census

Figure 4 – *Resident population (per 1,000 inhabitants) and percentage change, Southern. 2018–2023.*



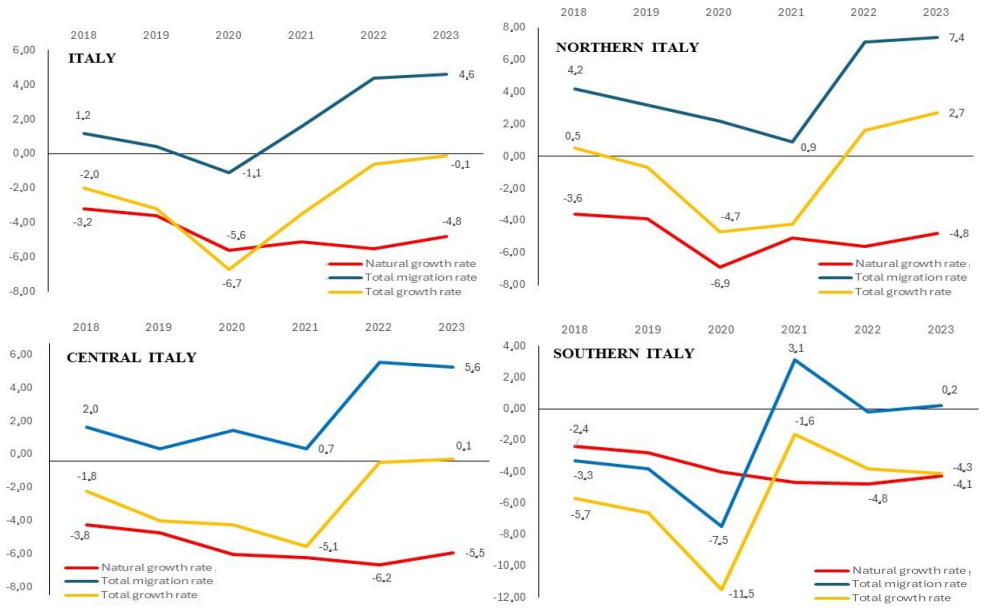
Source: Istat. Population census

3. Natural growth, migratory and total growth rates

The demographic dynamics in Italy in terms of births, deaths and transfers of residence are on the rise after 2020, due to the pandemic and migrations slowed down by the prescription of barriers to entry at national borders and by the limitations imposed on internal movement (Fig. 5).

In relation to the natural, migratory and total growth rates that distinguish the Italian territory, the markedly negative variations are concentrated in the South with a decrease in the natural growth rate (from -2.4 per thousand in 2018 to -4.1 per thousand in 2023) and the migration rate (from 3.1 per thousand in 2021 to 0.2 in 2023) unable to counteract and slow down the decline in the population. The Northern and Central Italy remain the most attractive areas the impact of foreign migration flows continues to be opposed and decisive to that of Italians. The North, in the face of a worsening natural growth rate in 2023 (-4.8 per thousand) compared to 2018 (-3.6 per thousand) confirms once again the area of the Country most attractive for migratory flows. In 2023, the overall migration rate (7.4 per thousand) managed to offset the negative natural balance and raise the total growth rate to the highest levels in the last 5 years (+2.7 per thousand). Also, in Central Italy appreciable results have been recorded although the demographic dynamics are contained with positive effects on the population. It is difficult, however, to hope that immigration will be the only possible solution to the demographic decline. Other factors influence the phenomenon, but demographers and statisticians consider these migratory flows a fundamental variable to reverse the trend of depopulation of our Country. New immigrants from abroad, in fact, contribute to population growth and rejuvenate the age structure.

Figure 5 - *Natural growth, migratory and total growth rates. Italy and territorial distribution. 2018-23 (per 1,000 inhabitants).*



Source: Istat. Population census

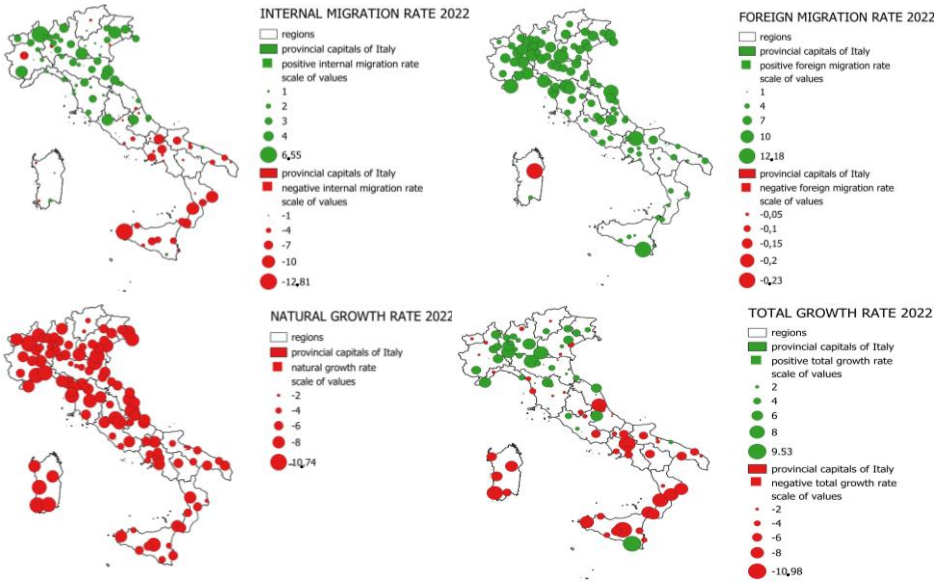
Since the latest data of 2022, depopulation in the territory is evident for most of the country's capital municipalities with negative natural growth rates. However, the migratory component, domestic and foreign, shows favorable levels of concentration in the cities of Central-North with better living conditions and opportunities (Fig. 6).

On the contrary, the cities of Southern Italy lose population mainly due to internal emigration. And it is precisely the «escape from the crisis» that pushes the southern emigration, especially of young people, that could have adverse structural effects both at demographic level and for the southern economy[3]. In fact, southern municipalities are more exposed to risk factors related to the main demo-social characteristics of the population and the economic-productive system, therefore, more subject to the abandonment of their places of residence.

These aspects are highlighted by the composite fragility index calculated by Istat for 2019 (increasing fragility score from 1 onwards) as a result of the combination of 12 elementary indicators describing the main dimensions (territorial, environmental and socio-economic) the fragility of municipal territories.

Figure 6 - *Natural growth, migratory and total growth rates in provincial capital municipalities. 2022 (per 1,000 inhabitants).*

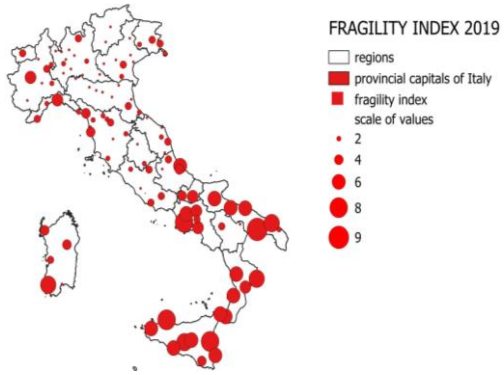
[3] L'emigrazione dei meridionali, la Rivista delle Politiche Sociali/Italian Journal of Social Policy, 4/2017 (S. Boffo and E. Pugliese, 2017).



Source: Istat. Population census

The total growth rate and the fragility index show a clear demarcation between Northern and Southern Italy (Fig. 7). The South is a fragile territory exposed to risks of natural and anthropic origin and to critical conditions in the main demo-social characteristics of the population and the economic-productive system.

Figure 7 – *Fragility index in provincial capital municipalities. 2019.*



Source: Istat – Fragility index

4. Average annual growth rates

Population growth is the result of two components that contribute to population change: natural change (births minus deaths), over a given period, and total net migration (immigration minus emigration), taking into account international and internal migration. Both contributions are evaluated over a given period, usually one year. In examining population growth rates, over several years, the logarithmic growth rate (r) is used as the population development model (Livi Bacci M., 1999).

$$r = \frac{1}{t}\ln\left(\frac{{}_tP}{{}_0P}\right) \tag{1}$$

To obtain average annual rates of birth, mortality and migration, when the reference period is several years, it is necessary to use (AP) person-years[4] as the denominator (Gallo et all, 2021):

$$\boldsymbol{AP} = \frac{\boldsymbol{t({}_tP - {}_0P)}}{\boldsymbol{ln\left(\frac{{}_tP}{{}_0P}\right)}} \tag{2}$$

$$\boldsymbol{r} = \frac{\boldsymbol{1}}{\boldsymbol{t}}\boldsymbol{\ln\left(\frac{{}_tP}{{}_0P}\right)} = \frac{\boldsymbol{\frac{({}_tP - {}_0P)}{t({}_tP - {}_0P)}}}{\boldsymbol{\ln\left(\frac{{}_tP}{{}_0P}\right)}} = \frac{\boldsymbol{\Delta_t N - \Delta_t M + \Delta_t I - \Delta_t E}}{\boldsymbol{\frac{t({}_tP - {}_0P)}{\ln\left(\frac{{}_tP}{{}_0P}\right)}}} \tag{3}$$

$$\boldsymbol{r} = \frac{\boldsymbol{\Delta_t N - \Delta_t M + \Delta_t I - \Delta_t E}}{\boldsymbol{AP}} = \boldsymbol{n - m + i - e = \ S_n \ + \ S_m} \tag{4}$$

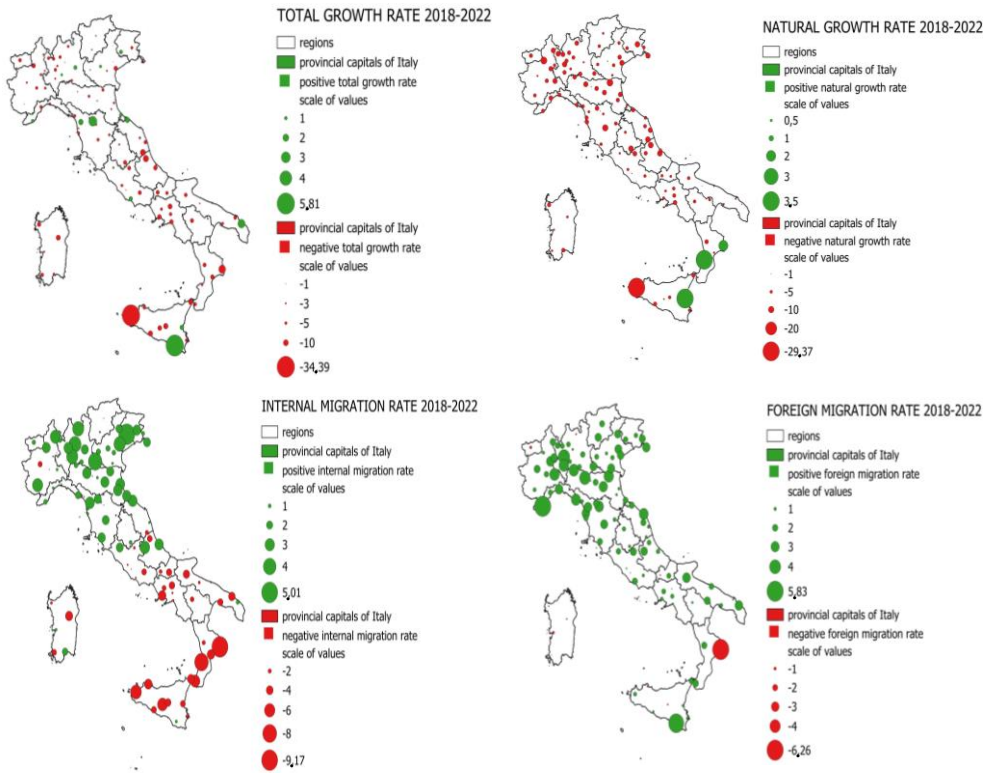
The average annual growth rate (r) over several years can be analysed as the algebraic sum of the following components: the rates of birth (n), mortality (m), immigration (i) and emigration (e), evaluated over the same period (Strozza, Unina), or a sum of natural growth rate (S_n) and net migration rate (S_m). Finally, the net migration rate can be further broken down into internal and external net migration rates.

5. Average annual growth rates over the period 2018-22, in provincial capitals

The total growth rate for the period 2018-2022 has been evaluated in provincial capitals, as described in Eq. (4). As illustrated in Figure 8, depopulation is a widespread phenomenon in provincial capitals throughout the country. However, the intensity of depopulation varies and there are some exceptions. The 14 per cent of provincial capitals have a positive population growth rate (r). Looking at the components of growth over the period, the natural growth rate (Sn) is negative for all Italian provincial capitals, except for Latina in central Italy and Crotone, Vibo Valentia and Catania in the south.

[4] If ${}_tP = {}_0P$ then AP = t*${}_tP$

Figure 8 - *Population total growth rate and components, in provincial capital. 2018-2022 (values per 1,000 inhabitants).*

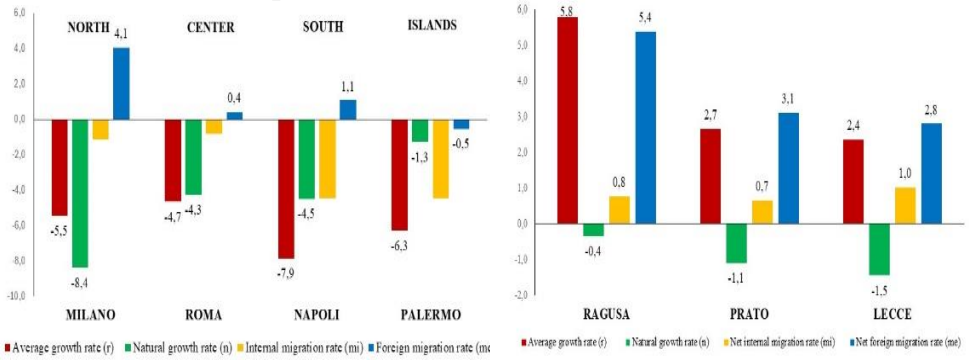


Source: Istat. Population census and Demographic Balance

The net internal migration rate (Smi) is quite polarised in Italy, contributing negatively to growth in the capitals of the southern provinces, while in most capitals of the central and northern provinces the Smi contribution to the growth rate (r) is positive. Finally, the net external migration rate component (S_{me}) is positive in 90 per cent of the provincial capitals, and more relevant in the northwest. A few capitals have a negative contribution of S_{me} to the growth, Aosta and Sondrio in the north (-0.9 and -0.5 per 1,000 inhabitants) and the most evident case of a negative external migration rate is Crotone (-6.3 per 1,000 inhabitants). An analysis of the main Italian capitals by territorial distribution (Fig. 9a) shows that the population growth rate is negative in all cases, but the influence of the rates contributing to the population growth rate of the cities is different. The negative growth rate of Milano population is due to the negative natural growth rate, which is not compensated by the positive net external

migration. The negative growth rate of Roma is mainly due to natural growth influence. In Napoli and Palermo, the influence of negative internal migration rate is also significant. On the other end the average growth rate (r) is positive in Ragusa, Prato and Lecce, (Fig. 9b) italian provincial capitals with the highest average growth rate (r), driven by the positive external migration rate. Finally, the depopulation is most severe in Trapani, driven by the very negative natural balance, Crotone, driven by internal and external migration rate and Teramo affected by negative natural growth.

Figure 9 – Demografic indicators, (a) main Italian cities by territorial distribution. (b) Italian provincial capitals with the highest average growth rate (r); 2018-2022 (Values per 1,000 inhabitants).



Source: Istat. Population census and Demographic Balance

6. Wroclaw Taxonomic Method (WTM)

Wroclaw Taxonomic System (MTW), based on concept of theoretical ideal unity, built on the basis of the best values among those observed for each of the indicators considered. The results produced by this method are transformable into positions of territorial units within a general ranking[5].

To study the phenomenon of depopulation in Italian cities, the *Wroclaw Taxonomic Method* (WTM) was used, a synthetic tool starting from some main demographic indicators considered crucial for their impact on the territory[6]: *Birth rate* (a1), *Mortality rate* (a2), *Internal migration rate* (a3) and *Foreign migration rate* (a4). The WTM measurement model is of the "formative" type and the indicators are considered "cause" of the phenomenon to be measured.

[5] M. Mazziotta, A. Pareto, V. Talucci. *La costruzione di indicatori di disuguaglianza sociale: il caso delle regioni italiane*. XXXI Conferenza Italiana di Scienze Regionali, AISRE. 2010.

[6] C. Tasciotti, *Misura dello sviluppo socio-economico delle regioni italiane. Un'applicazione del metodo tassonomico di Wroclaw*, Bulzoni, Roma, 1973.

The Euclidean distance is then calculated as follows:

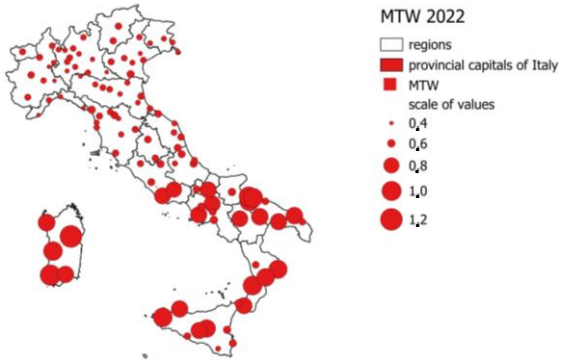
$$D_i = \sqrt{\sum_{j=1}^{m} (z_{ij} - z_{0j})^2}$$

where z_{ij} is the standardised value[7] of the index j for the city i and z_{0j} is equal to $\max_i (z_{ij})$. The composite index for the unit i :

$$WTM_i = \frac{D_i}{\overline{D}_0 + 2\sigma_0}$$

where $\overline{D}_0$ and σ_0 are the mean and the standard deviation of the distances D_i. WTM is a partially compensatory composite index, since we assume that a deficit in one area may be only partially compensated by a surplus in another and viceversa. The index is equal to zero when the distance between a given city and the 'ideal unit' is null (all the values coincide). The higher is the index, the greater is the difference between the two units. With WTM method, a weighting of the elementary indicators is implicitly implemented, which are more influential on the synthetic index, the greater the distances recorded with respect to the ideal situation. Figure 8 shows the map of the WTM index developed for the 109 provincial capitals of Italy. The values taken from the synthetic indicator show the positioning of the Italian cities in terms of population depopulation, which worsens as one proceed towards the highest positions. Also in this study, the result of the analysis returns the classic descending subdivision of the North and South territorial dualism.

Figure 8 – *Map of the WTM index. 2022.*



From the ranking (Tab. 2) we can observe the positioning of Italian municipalities according to the degree of depopulation that is aggravated by proceeding towards

[7] Each indicator is transformed into a standardised variable with mean 0 and variance 1.

the highest scores and positions. The ranking distinguishes among the top five cities of Northern Italy La Spezia (0.404), Mantova (0.416), Vercelli (0.424), Alessandria (0.427) and Imperia (0.431) with positive effects in demographic terms, unlike the southern cities of Sardegna and Puglia such as Nuoro (1.125), Carbonia (1.059), Andria (1.021), Oristano (1.017) and Barletta (0.982) those most affected by demographic depopulation.

Table 2 - *WTM ranking, Provincial capital cities. 2022.*

R	Provincial capitals	WTM	R	Provincial capitals	WTM	R	Provincial capitals	WTM	R	Provincial capitals	WTM
1	La Spezia	0.404	29	Lodi	0.585	57	Trento	0.698	85	Frosinone	0.804
2	Mantova	0.416	30	Siena	0.589	58	Bolzano	0.700	86	Potenza	0.828
3	Vercelli	0.424	31	Asti	0.602	59	Terni	0.703	87	R. Calabria	0.836
4	Alessandria	0.427	32	Livorno	0.604	60	Lecce	0.707	88	Campobasso	0.837
5	Imperia	0.431	33	Belluno	0.605	61	Fermo	0.710	89	Latina	0.838
6	Piacenza	0.470	34	Savona	0.606	62	Torino	0.711	90	Napoli	0.840
7	Treviso	0.471	35	Sondrio	0.613	63	Ravenna	0.715	91	Caltanissetta	0.846
8	Pavia	0.471	36	Cremona	0.614	64	Cosenza	0.717	92	Benevento	0.847
9	Trieste	0.494	37	Lecco	0.616	65	Bari	0.718	93	Taranto	0.850
10	Genova	0.504	38	Vicenza	0.626	66	Agrigento	0.721	94	Palermo	0.855
11	Brescia	0.506	39	Macerata	0.627	67	Pesaro	0.726	95	Cagliari	0.860
12	Firenze	0.514	40	Milano	0.635	68	Perugia	0.731	96	Matera	0.863
13	Como	0.517	41	Venezia	0.636	69	Avellino	0.733	97	Brindisi	0.867
14	Bologna	0.523	42	Rimini	0.637	70	A. Piceno	0.743	98	Sassari	0.877
15	Bergamo	0.533	43	Modena	0.637	71	Isernia	0.749	99	Enna	0.906
16	Forlì	0.541	44	Verbania	0.639	72	Roma	0.755	100	Catanzaro	0.916
17	Pordenone	0.545	45	R. Emilia	0.643	73	Messina	0.756	101	Crotone	0.943
18	Ragusa	0.547	46	Pistoia	0.653	74	Prato	0.758	102	Trani	0.969
19	Novara	0.550	47	Monza	0.655	75	Siracusa	0.760	103	Trapani	0.973
20	Udine	0.558	48	Cuneo	0.658	76	Teramo	0.760	104	V. Valentia	0.977
21	Varese	0.558	49	Pescara	0.659	77	Chieti	0.761	105	Barletta	0.982
22	Padova	0.561	50	Biella	0.661	78	Rovigo	0.769	106	Oristano	1.017
23	Gorizia	0.568	51	Aosta	0.667	79	Rieti	0.772	107	Andria	1.021
24	L'Aquila	0.572	52	Verona	0.673	80	Catania	0.786	108	Carbonia	1.059
25	Ancona	0.574	53	Viterbo	0.677	81	Massa	0.790	109	Nuoro	1.125
26	Pisa	0.574	54	Lucca	0.682	82	Caserta	0.792			
27	Ferrara	0.577	55	Arezzo	0.683	83	Salerno	0.794			
28	Parma	0.584	56	Grosseto	0.693	84	Foggia	0.794			

7. Conclusions

The multidimensional study of the population with the Growth rate (r), the Fragility index and the Wroclaw Taxonomic Method (WTM) as exploratory models for measuring the causes of the phenomenon, have made it possible to analyze and identify the main characteristics of the demographic decline, the existence of imbalances in territorial districts and the areas most exposed to environmental and socio-economic risk factors. The results show an Italy characterized by strong demographic heterogeneity. In the South, depopulation is more marked due to internal migration and natural growth. The Fragility Index also shows a clear demarcation between the provincial capitals of the North and the South, highlighting a direct relationship between depopulation and territorial fragility. In most provincial capitals, the natural growth rate is also negative, while the internal migration rate is negative for southern cities and positive for northern ones. Foreign immigration is highest in the provincial capitals of the North-West.

References

LIVI BACCI M. 1999. Introduzione alla demografia. Loescher ed.

BOFFO S., PUGLIESE E. 2017. *L'emigrazione dei meridionali*, la Rivista delle Politiche Sociali/Italian Journal of Social Policy, 4/2017.

DEL VECCHIO F. 2010. *Statistica per l'analisi di dati multidimensionali*. Padova: CLEUP.

GALLO G. ET ALL. 2021. ISTAT, *Le diseguaglianze tra territori*, Rapporto intermedio AISP. Roma.

ISTAT, 2024. Statistiche REPORT, *Indicatori demografici 2023*. Roma

LECARDANE G., FULLONE F., CARBONARA, M. 2024. *A Multidimensional analysis for monitoring environmental health in Italy*, RIEDS. Rivista Italiana di Economia Demografia e Statistica, Vol. LXXVIII, No. 2, pp. 259-270.

MAZZIOTTA M. PARETO A. TALUCCI V. 2010. *La costruzione di indicatori di disuguaglianza sociale: il caso delle regioni italiane*. XXXI Conferenza Italiana di Scienze Regionali, AISRE.

STROZZA S. *Misure dell'incremento della popolazione*. Materiale didattico, Universita' degli studi di Napoli Federico II

TASCIOTTI C., 1973. *Misura dello sviluppo socio-economico delle regioni italiane. Un'applicazione del metodo tassonomico di Wroclaw*, Bulzoni, Roma.

Giuseppe LECARDANE, Istat, lecardan@istat.it
Monica CARBONARA, Istat, mocarbon@istat.it
Flora FULLONE, Istat, ffullone@istat.it

THE ITALIANS RESIDENT ABROAD IN 2022: MAIN DEMOGRAPHIC AND SOCIAL CHARACTERISTICS ON THE BASIS OF THE PREVIOUS PERMANENT POPULATION CENSUS[1]

Flavio Biasciucci, Gennaro Di Fraia, Valeria Quondamstefano

Abstract. In December 2023, the Permanent Census of Population and Housing published data on the stock of the Italian population residing abroad in 2022. To identify this population figure, in addition to the sources used to determine the count of the population residing in Italy in the same year, two administrative sources, constantly updated, were integrated: the Registry of Italians Resident Abroad (AIRE) of the Ministry of the Interior and the Consular Registers of the Ministry of Foreign Affairs. This novelty represents a valuable resource for better understanding the phenomenon of Italians abroad. The aim of this study is to analyse the stock of Italians habitually residing in Italy in 2021 and recorded as residents abroad in 2022. In particular, both Italians by birth and new fellow citizens are considered, also in relation to the country of destination. Based on characteristics collected in the Census, such as education, occupation, economic activity and family typology, different demographic and social profiles will be identified and compared. This study is a preliminary analysis on the topic of Italians abroad, aims to exploit the potential of the information available with the Permanent Census of Population.

1. Introduction

In December 2023, the Permanent Census of Population and Housing published updated data on the Italian population residing abroad in 2022 (ISTAT, 2023). This publication represents a significant innovation for ISTAT, not only for the specific aggregate of Italians abroad, which has always aroused great interest in relation to our migratory history, but also because it constitutes a first attempt to harmonize data relating to the Italian population as a whole, including both residents in Italy and those abroad. The aim of this study is to delve into the main demographic and socio-economic characteristics of a specific subgroup of Italians abroad, consisting of individuals who were registered in Italy in 2021 and residing abroad in 2022.

Furthermore, the mobility of 'new' citizens who have acquired Italian citizenship is of particular interest for studying the migration behaviors of this group, allowing

[1] The article exclusively expresses the opinions of the authors. Flavio Biasciucci wrote subsections 3.5, 3.6, 3.7 and 3.8, Gennaro Di Fraia wrote sections 1, 2 and 4, Valeria Quondamstefano wrote subsections 3.1, 3.2, 3.3 and 3.4.

for an analysis of how similar the migration dynamics of Italians born in Italy are to those of 'new' Italians born abroad. The literature emphasizes that individuals who have already made an initial migratory move tend to have a greater propensity for further relocations (Conti et al., 2008). Although the acquisition of citizenship is considered by the Council of Europe as an indicator of stabilization and integration, it cannot be ruled out that, especially in the European context, this may be followed by additional migration (Council of the European Union, 2010).

2. Data source

The estimate of the number of Italian citizens residing abroad at the end of the year is the result of integrating various administrative sources and census results related to the population usually residing in Italy. The total number of the population usually residing in Italy is determined by the Permanent Census of the Population, which harmonizes the data on Italians as a whole, whether they reside in Italy or abroad. Therefore, to define the count of Italians residing abroad and to correct or integrate any inconsistencies found in the archives used, not only was the integration of the AIRE (Registry of Italians Residing Abroad) and the Consular Registers of the Ministry of Foreign Affairs utilized, but also 'life signals' in Italy inferred from other administrative sources of the Permanent Census of the Population including the Population Register (ANPR), Retired, and Non-Pension Benefits Registers and the Tax Returns Registry of the Ministry of Economy and Finance, also used to identify deceased individuals[2].

This study analyzes the main demographic and socio-economic characteristics of Italian citizens registered in Italy in 2021 and residing abroad in 2022 (90,639 individuals). Additionally, leveraging information on country of birth and citizenship acquisitions (as of the 2021 Census), the study seeks to highlight the main differences between four demographic groups: Italians since birth born in Italy, Italians since birth born abroad, acquired Italians born in Italy and acquired Italians born abroad. An increasing number of foreign citizens become Italians due to long-term residence in Italy (at least 10 years for non-EU citizens, at least 4 for EU citizens), through being minor children of a parent who has become Italian, through marriage to an Italian citizen, or by being born in Italy and residing [there] continuously until the age of 18, thus choosing Italy as their country of citizenship. Additionally, under the principle of ius sanguinis, descendants of Italian emigrants born abroad have the right to acquire Italian citizenship. In the analyzed population, Italians since birth born in Italy constitute over two-thirds, with 60,436 individuals,

[2] See https://www.istat.it/wp-content/uploads/2022/09/SCHEDA-NOVITA-CENSIPOP-2022.pdf

followed by 13,284 Italians since birth born abroad, 11,972 Italians by acquisition foreign-born and 4,947 Italians by acquisition native-born. Based on characteristics recorded in the Census, such as educational level, occupation, economic sector, and family composition, different demographic and social profiles were identified and compared.

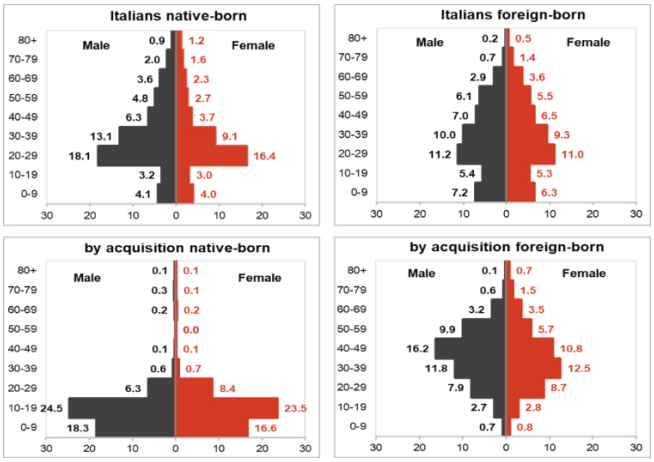
3. Main results

3.1. Demographic characteristics

The analysis revealed some demographic characteristics of Italians resident abroad. Specifically, of the 90,639 Italians resident abroad, 49,446 are male (54.6%), while 41,193 are female (45.5%), with a masculinity ratio of 120.0%.

The average age is 33.7 years old, the underage population accounts for 17.1%. If we consider the 4 subpopulations, we realize that the situation is extremely diverse. Italians resident abroad born in Italy account for 2/3 of Italians living abroad, have higher average age (34.2) and masculinity ratio (127.5) than the overall values, while the percentage of minors is significantly lower (13.1%). This group is contrasted with that of Italians by acquisition born in Italy (5.5% of the total number of Italians abroad). In this case the average age is 13.3 years, the percentage of minors 79.3% and the masculinity ratio 101.0%. This indicates that this subpopulation is most likely composed of the children of Italians resident abroad who were deliberately given birth in Italy and then immediately moved abroad. It is that portion of Italians residing abroad who despite being born in Italy have never lived there. Italians resident abroad but foreign born (the so-called second and third generations), account for 14.7% of Italians abroad, have an average age of 32.8 years and a masculinity ratio of 102.7%. The last subpopulation is represented by Italians by acquisition foreign-born. In this case, the average age is 40.4, minors are 5.7% and the masculinity ratio is 113.3%. All these demographic indicators emphasize that this group is, in most cases, made up of people not born in Italy who acquired Italian citizenship by marriage. To better understand the characteristics of Italians living abroad for each group, age pyramids were constructed (Figure 1).

Figure 1 – *Age pyramids for the four groups of Italians living abroad.*



The group of Italians born in Italy is characterized by a preponderance of people (56.7%) of university age or entering the workforce (ages 20 to 39). From these data there would seem to be links between migration, education and employment. In general, 80.1 per cent are between 20 and 69 years of working age. In this group, the proportion of minors (less than 15%) and advanced ages (70 years and over less than 6%) is low. Italians resident abroad foreign-born present a more homogeneous structure, with a concentration still between 20 and 39 years old (41.5%). Just over 30 per cent (31.6%) are aged between 40 and 69. This means that the working age population between 20 and 69 years accounts for 73.1% of this group. Quite different is the age pyramid of Italians by acquisition native-born, which, as one might expect given the strong presence of minors, is crushed in the age groups between 0 and 29 (97.6%), with a peak between 10 and 19 (48.0%). Finally, the group of Italians by acquisition foreign-born show an older age structure and in particular are concentrated in the 30-59 age group (66.9%). This is the only group in which the moda of the male and female population does not fall into the same age group (for men 40-49 years, for women 30-39 years).

3.2. Household type

The study continues by going to see how the four groups of Italians living abroad are distributed in relation to family type. The following types were considered: Single, Couples without children, Couples with children, Single parent with children and Other.

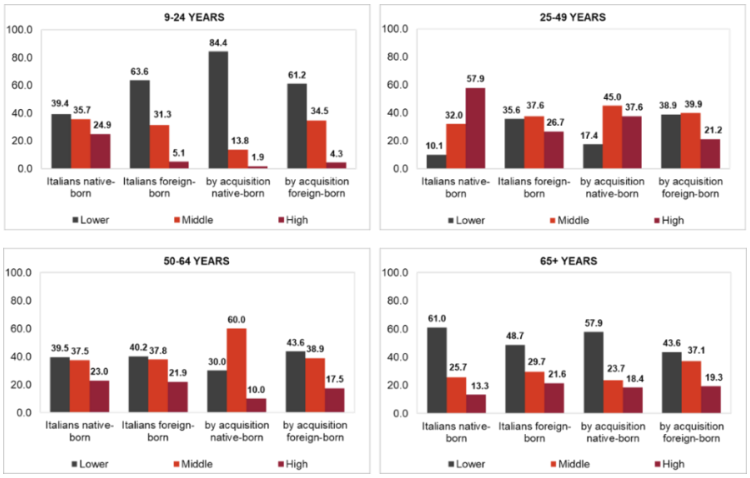
For native-born Italians, couples with children prevail (about 43%), followed by lone parents with children (about 24%) and singles (about 19%). For Italians foreign-born the most frequent family type is People single (about 28%), followed by Lone parent with children (about 26%) and Couples with children (about 21%). Italians by acquisition native-born are concentrated in Couples with children (about 63%), followed by Lone parent with children (about 21%) and Other (about 12%). The last group, Italians by acquisition foreign-born, sees Couples with children prevail (about 38%), followed by Single person (about 21%) and Lone parent with children (about 17%). The Italians native-born present a distribution very similar to that of the Italians by acquisition foreign-born, with a prevalence of Couples with children in both groups. This may indicate, once again, how the first and last groups are linked by household type (Italians resident abroad native-born in Italy are most likely the parents of Italians by acquisition foreingn-born).

3.3. Educational attainment

During the period of large-scale Italian emigration (1870-1914), most emigrants came from rural areas in Southern Italy, where access to education was limited. Many Italians resident abroad was illiterate or had very low levels of education. This low level of education reflected the economic and social conditions of Italy at the time, where the educational system was still developing, and many farming families could not afford to send their children to school (Gabaccia, 2000). In recent decades, the profile of Italian emigrants has continued to evolve. An increasing number of young graduates began to resident abroad in search of better professional and academic opportunities, a phenomenon often described as a "brain drain" (Del Boca and Venturini, 2003). Our data appear compatible with such theories (Figure 2). We considered 4 age groups (9-24, 25-49, 50-64, 65+) and the division of educational attainment into low (up to middle school), medium (the high school diploma) and high (bachelor's degree and above) for the 4 groups of Italians living abroad considered. It must be kept in mind in the analysis that while for the 9-24 age group the educational attainment may still change over time, in the other 3 age groups under consideration, the educational attainment can be considered almost definitive. Among the 9-24 year olds and the over-65s, a low level of education and a very low percentage of graduates prevails strongly for all 4 groups. The greatest percentages of those with high educational qualifications are in the 25-49 age group for Italians native-born (57.9%), then for Italians by acquisition native-born (37.6%), and for Italians foreign-born (26.7%). For the 50-64 age group to prevail, again, is low education (Italians native-born, Italians foreign-born and Italians by acquisition

foreign-born). Only for Italians by acquisition native-born does a medium level of education prevail (same thing occurs for this group in the 25-49 age group).

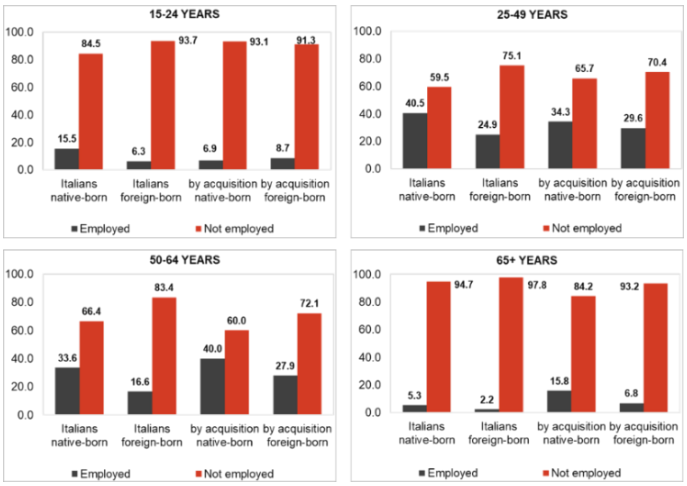
Figure 2 – *Educational attainment per age class for the four groups of Italians living abroad.*



3.4. Current activity status

In recent years, as with educational attainment, the profile of Italians living abroad has further diversified in terms of employment.

Figure 3 – *Current activity status per age class for the four groups of Italians living abroad.*



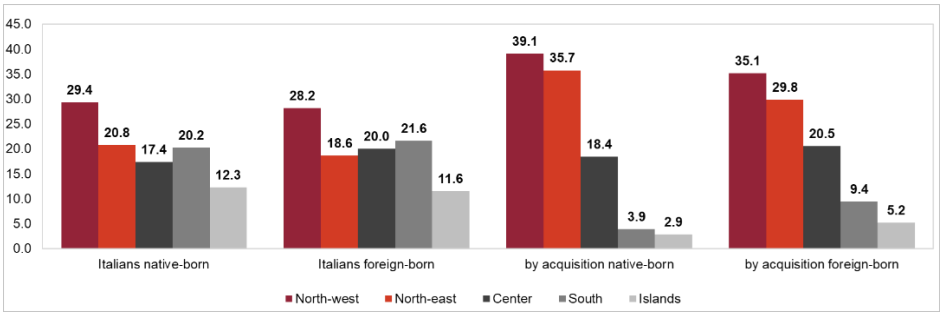
Many highly skilled professionals have emigrated in search of better working conditions. Recalling that the employment figure refers to what Italians living abroad in 2022 had in 2021 when they resided in Italy, it is clear that most of them, in any age group, were unemployed in 2021 (Figure 3).

However, while for younger and older people the unemployed account for almost all of them, with percentages even above 90 percent, among those aged 25-64 there is a fair presence of employed people, particularly for Italians foreign-born.

3.5. Territorial divisions of residence in Italy at 12.31.2021

The next step was an analysis of the departure location from Italy, examining where individuals in the studied cohort resided in Italy according to the 2021 Permanent Population Census.

Figure 4 – *Territorial divisions of residence in Italy at 12.31.2021 by target group.*



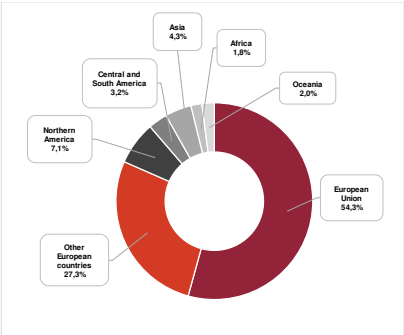
What emerges from Figure 4 is certainly the fact that these individuals mainly come from the northern part of the country; this phenomenon is particularly evident for the acquired individuals, and it is interesting to note that while the latter have very low residence percentages in the South, the same percentages for the natives reach higher levels, so much so that the South, when considered as a whole, surpasses the Center in the rankings and approaches the values of the North.

3.6. Italians native-born and geographical area of destination country

Regarding the place of residence abroad, Figure 5 shows the distribution by geographical area of residence abroad of natives born in Italy. It highlights how more than 80% of individuals prefer a European destination and, in particular, the

European Union (54.3%); there are also significant percentages of residents in North America (7.1%) and Asia (4.3%).

Figure 5 – *Geographical area of residence abroad of Italians native born.*



Area of residence	Total	
	av.	%
European Union	32.813	54,3
Germany	*9.318*	*15,4*
France	*5.701*	*9,4*
Spain	*4.670*	*7,7*
Other European countries	16.486	27,3
United Kingdom	*8.194*	*13,6*
Switzerland	*7.059*	*11,7*
Northern America	4.298	7,1
United States of America	*3.575*	*5,9*
Canada	*716*	*1,2*
Central and South America	1.904	3,2
Brazil	*473*	*0,8*
Argentina	*276*	*0,5*
Venezuela	*263*	*0,4*
Asia	2.626	4,3
United Arab Emirates	*877*	*1,5*
China	*312*	*0,5*
Japan	*235*	*0,4*
Africa	1.089	1,8
Tunisia	*446*	*0,7*
Morocco	*105*	*0,2*
Oceania	1.220	2,0
Total	60.436	100,0

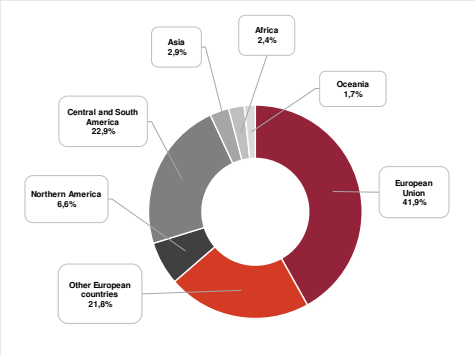
It emerges that Germany is the country most affected by this phenomenon for this target group, with a percentage of over 15%, followed in the European Union by France (9.4%) and Spain (7.7%), in the rest of Europe by the United Kingdom (13.6%) and Switzerland (11.7%), and by the United States (5.9%) in North America. It is also interesting to note the percentage of those who choose to reside in the United Arab Emirates (1.5%), the preferred destination in Asia, which is higher than that of China (0.5%) and Japan (0.4%), as well as that of countries with a history of emigration like Canada (1.2%), Argentina (0.8%), and Brazil (0.5%).

3.7. Italians foreign-born and geographical area of destination country

Natives born abroad confirm what was observed for the previous group, with a preference for European Union countries (41.9%), followed in this case by Central and South America (22.9%) and extra-EU European countries (21.8%) (Figure 6). To confirm this data, it can be observed from table by destination country how the percentages of Brazil (9.1%), Argentina (5.4%), and Venezuela (4.5%) increase significantly. For this target population, a further in-depth analysis was conducted by comparing the country of residence abroad with the country of birth.

As can be seen from Table 1, the highest percentages of those born in the same area as their current residence abroad are recorded in Central and South America with 97.6% and Africa with 86.9%. The situation is different for those residing in Europe, where approximately half are individuals born in Europe, but the other half are individuals born in Central and South America, Africa, and Asia.

Figure 6 – *Geographical area of residence abroad of Italians foreign born.*



Area of residence	Total	
	av	%
European Union	5.565	41,9
Germany	*1.699*	*12,8*
France	*1.090*	*8,2*
Spain	*844*	*6,4*
Other European countries	2.890	21,8
United Kingdom	*1.610*	*12,1*
Switzerland	*1.042*	*7,8*
Northern America	874	6,6
United States of America	*744*	*5,6*
Canada	*130*	*1,0*
Central and South America	3.036	22,9
Brazil	*1.207*	*9,1*
Argentina	*718*	*5,4*
Venezuela	*592*	*4,5*
Asia	385	2,9
United Arab Emirates	*82*	*0,6*
China	*42*	*0,3*
Japan	*37*	*0,3*
Africa	314	2,4
Morocco	*56*	*0,4*
South Africa	*44*	*0,3*
Oceania	220	1,7
Total	13.284	100,0

Table 1 – *Geographical area of residence abroad and geographical area of birth of Italians foreign born.*

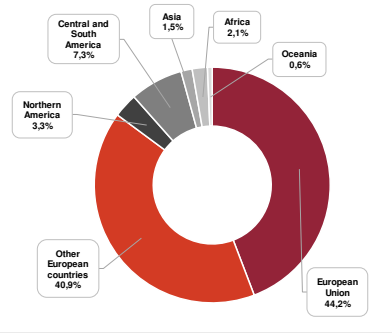
Area of residence	Area of birth							
	European Union	Other European countries	Northern America	Central and South America	Asia	Africa	Oceania	Total
European Union	45.0	7.5	1.3	33.4	2.3	10.3	0.3	100.0
Other European countries	7.0	50.4	2.3	20.8	11.6	7.7	0.3	100.0
Northern America	4.6	5.1	66.2	16.7	3.9	2.5	0.9	100.0
Central and South America	0.9	0.6	0.5	97.6	0.1	0.3	0.0	100.0
Asia	9.9	11.7	5.5	10.6	54.3	6.2	1.8	100.0
Africa	4.1	3.2	0.3	1.6	3.2	86.9	0.6	100.0
Oceania	6.8	6.8	0.9	11.4	5.0	4.1	65.0	100.0
Total	21.4	15.1	5.7	42.4	5.5	8.5	1.4	100.0

3.8. Italians by acquisition and geographical area of destination country

Italians by acquisition, in this case aggregated, are found to reside in 85.1% of cases in Europe and 10.6% in America, particularly in Central and South America

(7.3%). Among the countries of residence, the United Kingdom is the most represented with a percentage of 30.4%, followed by France (19.0%) and Germany (10.7%) (Figure 7).

Figure 7 – *Geographical area of residence abroad of Italians by acquisition.*



Area of residence	Total	
	av	%
European Union	7.480	44,2
France	*3.219*	*19,0*
Germany	*1.816*	*10,7*
Other European countries	6.925	40,9
United Kingdom	*5.140*	*30,4*
Switzerland	*1.402*	*8,3*
Northern America	561	3,3
United States of America	*336*	*2,0*
Canada	*225*	*1,3*
Central and South America	1.231	7,3
Brazil	*680*	*4,0*
Argentina	*270*	*1,6*
Asia	260	1,5
United Arab Emirates	*42*	*0,2*
China	*28*	*0,2*
Africa	354	2,1
Morocco	*107*	*0,6*
Senegal	*73*	*0,4*
Oceania	108	0,6
Total	16.919	100,0

Similar to what was done for the natives, for this group the geographical area of residence abroad was compared with the geographical area of previous citizenship (Table 2).

Table 2 – *Geographical area of residence abroad and geographical area of previous citizenship of Italians by acquisition.*

Area of residence	Area of previous citizenship							
	European Union	Other European countries	Northern America	Central and South America	Asia	Africa	Oceania	Total
European Union	11.6	16.4	0.4	14.5	5.3	51.7	0.1	100.0
Other European countries	2.3	24.8	0.3	7.5	42.4	22.6	0.1	100.0
Northern America	2.5	13.4	27.5	18.7	29.4	8.6	0.0	100.0
Central and South America	1.1	0.6	0.2	97.7	0.2	0.3	0.0	100.0
Asia	4.6	9.2	2.3	6.9	66.2	10.0	0.8	100.0
Africa	1.7	1.1	0.0	2.3	0.6	94.4	0.0	100.0
Oceania	8.3	26.9	0.9	15.7	13.9	13.0	21.3	100.0
Total	6.4	18.2	1.3	17.5	21.8	34.6	0.2	100.0

In this case as well, the highest percentages of individuals with the previous citizenship area being the same as the residence area are in Central and South

America (97.7%) and Africa (94.4%), followed by Asia (66.2%). It is interesting to note that among those who decide to move to the European Union, more than half of the individuals had the citizenship of an African country (51.7%), while 42.4% of residents in extra-EU European countries had the citizenship of an Asian country.

4. Conclusions and future developments Steps

This study aimed to highlight the informative potential of the Permanent Population Census, which enables the analysis of various characteristics of Italians resident in Italy or abroad. Clearly, this is just a starting point in the analysis of this demographic group. Future efforts will focus on implementing new variables for analysis and attempting to reconcile stock data with flow data, similar to the reconciliation of stock data for Italians residing in Italy or abroad. Additionally, a draft law concerning the Census of Italians abroad is currently under consideration. This bill has three main objectives: to leverage the collaboration between ISTAT and the involved Ministries, to reduce the discrepancy between AIRE data and data from Consular Registry, and to improve communication regarding Italian citizens residing abroad between Italian Municipalities and Ministries.

References

CONTI C., GABRIELLI D., PRATI S., STROZZA S. 2008. Misurare l'immigrazione e la presenza straniera: una sfida continua per la statistica ufficiale. In *IX Conferenza Nazionale di Statistica* www.istat.it/it/files/2011/02/Dossier_Istat_stranieri.pdf (retrieved on 04/03/2024).

COUNCIL OF THE EUROPEAN UNION. 2010. Conclusions of the Council and the Representatives of the Governments of the Member States on Integration as a Driver for Development and Social Cohesion. In *Zaragoza meeting*. https://data.consilium.europa.eu/doc/document/ST%209248%202010%20INIT/EN/pdf (retrieved on 07/03/2024)

DEL BOCA D., VENTURINI A. 2003. *Italian Migration*. In J. G. REITZ (Ed.), *Host Societies and the Reception of Immigrants*. San Diego: Academic Press.

GABACCIA D. R., 2000. *Italy's Many Diasporas*. Seattle: University of Washington Press.

ISTAT, 2023. Popolazione residente e dinamica demografica – Anno 2022. https://www.istat.it/it/files/2023/12/CENSIMENTOEDINAMICADEMOGRAFICA2022.pdf (retrieved on 01/03/2024)

Flavio BIASCIUCCI, Istat, biasciucci@istat.it
Gennaro DI FRAIA, Istat, digraia@istat.it
Valeria QUONDAMSTEFANO, Istat, quondamstefano@istat.it

TRACING DEMOGRAPHIC EVENTS THROUGH THE SEASONS IN 18TH AND 19TH CENTURY BOLOGNA

Nadia Barbieri, Hassan Rahnaward Ghulami, Rosella Rettaroli, Francesco Scalone

Abstract. This study explores the seasonality of demographic events, focusing on birth seasonality in Bologna from 1729 to 1860. Utilizing monthly data series, the research investigates the impact of meteorological conditions, specifically rainfall and temperature, on birth trends. The analysis employs Henry's seasonality indicators and OLS regression models to examine the effects of lagged precipitation and temperature on birth rates. The findings reveal a consistent pattern of birth seasonality, with births peaking in the early months of the year and declining in summer. The study concludes that weather conditions had a significant, albeit modest, impact on birth seasonality, highlighting the historical interplay between environmental factors and demographic trends in pre-transition settings.

1. Introduction

This study examines the seasonality of births throughout historical periods, specifically through a dataset that begins in 1729, well before the demographic and epidemiological transition, and extends to 1860. The monthly birth series cover the urban area of Bologna and the surrounding countryside. Bologna was a significant city in Northern Italy, located at the boundary between the southern part of the Po Valley and the Apennine Mountain range. It should be noted that previous studies on birth seasonality in a long historical perspective have focused on entire countries or broad regions, often overlooking the climatic variations that can exist within individual states or regions (e.g. Baroni, 1964). The contribution of this article to existing literature is significant due to the nearly century-and-a-half span of the series.

The data series were collected by Athos Bellettini in the 1960s and are part of a broader project to reconstruct the population of Bologna, drawing from ecclesiastical sources (Bellettini, 1961). In addition to the comparative perspective achieved by examining Henry's seasonality indexes, we will assess how much of the observed birth seasonality was due to temperature and rainfall impacts. Through specific regression models, we will evaluate the impact of meteorological factors on monthly births, accounting for monthly temperatures and precipitation and other potential confounding factors, such as epidemics, which could be linked to seasonality.

2. Area

The study area, Bologna and its environs, is located in a northern Italian region bridging the Po Valley's last stretch and the Apennines' initial hills. Bologna's network of canals, essential to the city's industrial and social fabric, powered proto industries such as silk production and leather tanneries, which were renowned across Europe during the 18th century. However, these industries struggled to adapt to the advancements of the Industrial Revolution, leading to a decline by the mid-19th century.

Before Italy's National Unification in 1861, it was part of the Papal States, characterized by restrictive economic policies, including high customs duties and limited capital flow, alongside challenging transportation conditions. Agriculture remained the cornerstone of Bologna's economy, supplemented by craftsmanship and a handful of local industries that managed to withstand significant national and international competition (Kertzer and Hogan, 1989).

Throughout the 19th century, the suburban zone around Bologna was purely agricultural, with urbanization not beginning until the 20th century. During the period under study, from the 18th century until the National Unification, the countryside of the Bologna area saw sharecropping households contributing to an economy where farming coexisted with manufacturing labor. Despite sweeping socio-economic and political changes, the sharecropper population in the Bologna area remained significant, focusing on profitable crops like wine, silkworms, hemp, and wheat (Rettaroli and Scalone, 2012; Scalone *et al*., 2017; Scalone and Samoggia, 2018).

3. Bologna's Climate

The climate in the Bologna area within Emilia-Romagna is characterized by a temperate subcontinental pattern, with the Bologna plain experiencing varied weather phenomena due to its geographic and climatic positioning. This area undergoes periods of rain and dryness, interspersed with occasional weather events such as snow, frost, hail, and fog during the colder months. Summers are warm and humid, conditions that can favor the growth of insects and mold, potentially affecting crops. This heat is accompanied by high humidity levels, making the climate somewhat challenging. The occurrence of thunderstorms, resulting from the clash of cold and warm air masses, offers temporary relief, which is quickly balanced by strong sunlight and the area's distance from the sea. The unpredictable shift between seasons made agricultural labor somewhat uncertain.

Winter brings its own set of conditions with cloudy skies and intermittent clear spells, alongside dense fog that envelops the plain. This fog, beginning in the lower regions near the Po River, eventually blankets the entire area, contributing to the overall cold winter experience. Precipitation during this season is less common, highlighting the region's subcontinental climate influences. The Bologna plain, therefore, represents a unique climatic zone where the interplay between geography and atmospheric conditions creates varied and distinctive weather patterns, reflecting the broader climatic diversity of the Emilia-Romagna region (Scalone and Samoggia, 2018).

4. Influences on Birth Seasonality in Pre-Industrial Italy

Research indicates that birth seasonality in Southern Italy during the Ancient Regime exhibited a consistent unimodal pattern, with a notable minimum in the summer months, a trend that persisted until the 1960s (Crisafulli, Zuanna and Solero, 2000). This seasonality is significantly influenced by agricultural workload intensity and climatic conditions. Evidence suggests that these factors have a reduced impact in more industrialized regions, where the rhythm of life and work is less directly tied to the agricultural calendar (Breschi and Ruiu, 2020).

The energy balance mechanism plays a crucial role in birth seasonality. Female ovarian function is highly sensitive to energy balance, particularly in agricultural economies where intense workloads and insufficient nutrition during certain seasons are common. This sensitivity can lead to variations in birth rates, aligning them closely with the agricultural cycle and seasonal food availability (Ruiu and Breschi, 2020).

Furthermore, birth seasonality is shaped by both environmental factors, such as temperature, and social factors, such as marriage seasonality. Extreme temperatures, whether hot or cold, have been found to reduce birth rates (Ruiu and Breschi, 2017). This is likely due to the physiological stresses placed on the human body, as well as changes in social behavior and activity patterns during these periods (Ruiu and Breschi, 2017). Social customs, such as the timing of marriages, also play a critical role in determining birth seasonality, as they directly influence conception patterns (Bonneuil and Fursa, 2018).

Studies such as Lam and Miron (1996) found that temperature affects human fertility, with higher temperatures generally reducing conception rates. Additionally, Lam, Miron, and Riley (1994) developed models to describe the seasonality in fecundability, conceptions, and births, highlighting the complex interplay between environmental and biological factors.

Research by Cummings (2010) found that sunshine and environmental light intensity significantly impact birth seasonality, with higher light intensity correlating with increased conception rates. Cummings (2007) provided additional confirmation of this effect, emphasizing the role of environmental light in influencing human conception patterns. Further, Cummings (2002) explored the relationship between cloud cover, melatonin, and the seasonality of human births, demonstrating how variations in light exposure can affect hormonal regulation and birth patterns. Moreover, Barreca, Deschenes, and Gulid (2018) showed that temperature shocks can cause dynamic adjustments in birth rates, underscoring the importance of climatic factors in reproductive behavior.

5. Data

For the city of Bologna and its surrounding countryside, demographic data sources were exclusively ecclesiastical at least until the early 19th century, as the city and its surrounding territory were part of the Church's territorial domain. So our study utilized data from Bellettini's extensive work, derived from these ecclesiastical sources, to trace birth events through the seasons in 18th and 19th century Bologna. Specifically, we used the Monthly Birth Series (1729-1860) from parish registers, encompassing both the town and countryside of Bologna (Bellettini, 1961), enabling us to observe long-term trends and seasonal variations in birth counts. The source used for this analysis consists of 367 volumes in which the baptized individuals are progressively transcribed and numbered month by month (Bellettini, 1961). The data refer to baptisms that occurred within a territory that remained entirely stable over the centuries[1]. The city of Bologna, indeed, is encircled by walls whose boundaries have not changed since the 13th century. Unlike the other demographic events, such as deaths and marriages, which were recorded in individual parishes, baptisms took place at a single baptismal font where newborns from the city, and often those from the countryside, were brought. The territory considered includes the parishes of the walled city and the suburbs, which certainly did not undergo significant changes until at least 1918. Only for the suburbs might there be some variation in the series, due in part to the granting of autonomy in baptismal matters to certain parishes further from the city.

[1] The debate regarding the representativeness of these records for the actual number of births is still ongoing. Among the most frequently considered aspects are: a) the possible non-coincidence between the day of birth and the day of baptism, a negligible issue for Bologna, b) the failure to register live births of infants who died before baptism, c) the exclusion of births from other confessions, such as Judaism, or d) variations in the territories from which the births originated.

To provide an idea of the average order of magnitude of the monthly birth counts in the area analyzed in this article, it can be noted that the average number of births per month from 1729 to 1860 is 246.6.

Furthermore, we incorporated precipitation and temperature data from the University Observatory of the Specola, originally recorded as daily series for the period from 1812 to 1860, and subsequently processed and disseminated as monthly average minimum temperatures and monthly total precipitation by the "HISTALP" and the "GHCNd" projects[2]. By integrating these historical datasets, we conducted a comprehensive preliminary historical analysis, exploring the influences on birth seasonality in pre-industrial Bologna through the integration of demographic and environmental variables.

6. Methods

The analysis was conducted using birth counts for the city of Bologna between the early 18th and mid-19th centuries. However, data for several years were either partially or entirely unavailable and were excluded from the analysis[3].

The analysis was divided into two main parts: firstly, the presence of seasonality in the birth counts was assessed by considering the H index in three time periods. Secondly, Regression Models were fitted to examine the relationship between birth counts and monthly average minimum temperature and monthly total precipitation, utilizing data from 1814 onwards, as meteorological records were only accessible from that year.

6.1. Seasonality Indexes

The presence of seasonality in the birth counts was assessed by using Henry's indexes (Ruiu, 2017). This method is based on the following equation:

$$H_m = \frac{\frac{B_m}{D_m}}{\frac{\sum_{m=1}^{12} B_m}{\sum_{m=1}^{12} D_m}} \quad (1)$$

[2] The monthly total precipitation datasets for Bologna are available at this website: Historical Instrumental Climatological Surface Time Series Of The Greater Alpine Region, https://www.zamg.ac.at/histalp/index.php. The monthly average minimum temperatures are available at this website: Global Historical Climatology Network daily, https://www.ncei.noaa.gov/products/land-based-station/global-historical-climatology-network-daily.

[3] Due to gaps and partial information in the records, we excluded the following years from the analysis: 1816, 1817, 1835-38, 1841-45.

where B_m is the birth count in a given month and D_m is the number of days in that month; therefore, it's possible to compute an index for each month and each year or period. A value of 1 for H_m indicates no evidence of seasonality, while values lower or higher than 1 signify lower or higher birth counts in the *m*-th month compared to the rest of the year.

6.2. A Regression Model

To examine the relationship between birth counts and meteorological variables, we employed regression models using the Newey-West correction to account for autocorrelation and heteroskedasticity (Stock and Watson, 2007). The analysis utilized monthly birth data from 1814 to 1860, considering both absolute values and first differences over 12 months.

For the regression models with absolute levels, the dependent variable was the number of births at time *t*. The independent variables included lagged total monthly precipitation (*Prec*) and average monthly minimum temperatures (*Temp*) at 9, 10, 11-month lags, along with controls for the month of birth, the presence of major epidemics[4] (*Epid*), and period categories (*Per*) based on the year of birth (1814-1820, 1821-1830, 1831-1840, 1841-1850, 1851-1860).

$$Births(t) = \alpha_0 + \sum_{i=1}^{12} \delta_i \, Month(t) + \sum_{p=1}^{5} \varphi_p \, Per(t) + \sum_{j=1}^{k} \omega_j \, Epid_j(t) + \sum_{i=9}^{11} \beta_{i-8} \, Prec(t-i) + \sum_{i=9}^{11} \gamma_{i-8} \, Temp(t-i) + \varepsilon_t \quad (2)$$

For the regression models with first differences, the dependent variable was the change in births over 12 months $\Delta Births(t,12)$. The independent variables were the changes in total precipitation and average minimum temperatures over 12 months at 9, 10, 11-month lags, along with the same controls as the absolute level models.

$$\Delta Births(t,12) = \alpha_0 + \sum_{i=1}^{12} \delta_i \, Month(t) + \sum_{p=1}^{5} \varphi_p \, Per(t) + \sum_{j=1}^{k} \omega_j \, Epid_j(t) + \sum_{i=9}^{11} \beta_{i-8} \, \Delta Prec(t-i,12) + \sum_{i=9}^{11} \gamma_{i-8} \, \Delta Temp(t-i,12) + \varepsilon_t \quad (3)$$

The Newey-West correction accounts for autocorrelation of residuals at a first lag for the model with absolute levels, while it considers a lag of 12 for the model with first differences[5] (Stock and Watson, 2007). This approach addresses potential issues of autocorrelation in the time series data.

[4] The series of epidemics was extracted from the chronology of events that occurred in Bologna from 1796 to the present, available at this website: https://www.bibliotecasalaborsa.it/bolognaonline/cronologia-di-bologna/1796.

[5] The lag correction for absolute levels and 12-month differences for the autoregression of residuals in the regression models, estimated using the Newey-West approach, was determined based on the exploration of the residuals' autocorrelogram.

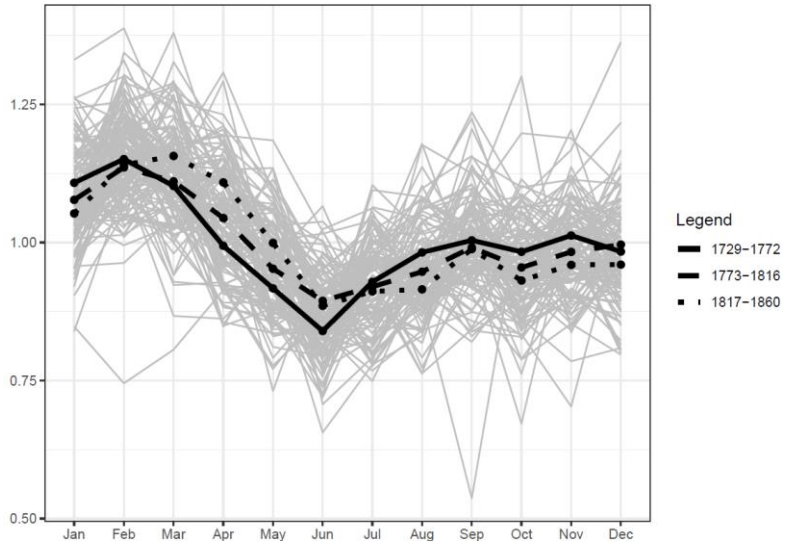
7. Results

This section presents the findings from our analysis of birth seasonality and the impact of meteorological variables on birth counts in Bologna from 1729 to 1860.

7.1. Descriptive Findings

The analysis of birth seasonality in Bologna from 1729 to 1860 reveals typical seasonal patterns. The consistent seasonality pattern shows that births generally peaked in the early months (January to March) and dipped during the summer (May to July). This pattern remained stable from 1729 to 1860, with only subtle changes in the magnitude of the peaks and troughs over time. The persistence of these trends underscores the significant role of both environmental conditions and social customs in shaping birth seasonality (figure 1).

Figure 1 – *Henry Index – Births from 1729 to 1860 in Bologna.*



7.2. Regression Results

In Table 1, we present the effects of months, temperatures, precipitation, and other control variables on the number of births in Bologna from 1814 to 1860. The table includes two types of models: absolute levels and first differences. For each

type, we show both a base model without temperature and precipitation variables and a full model that includes these meteorological variables.

In the models with absolute levels, by comparing the base and full models, we first demonstrate the effect of months (seasonality) on births. Then, we show the same effect while controlling for monthly average minimum temperatures and monthly total precipitation. This approach highlights how much of the seasonality can be attributed to variations in meteorological conditions. Several months show significant coefficients, indicating strong seasonal effects on birth counts. For instance, March shows a positive and significant coefficient (15.56), suggesting a peak in births. Conversely, months like June (-53.80) and July (-27.26) show negative coefficients, indicating a decline in births during these periods. However, when controlling for precipitation and temperature, significance remains only for June and December. All period categories show positive and highly significant coefficients, with the later periods (e.g., 1851-1860) showing the highest coefficients (47.26). This indicates an overall increase in birth counts over time. Significant positive coefficients for epidemics like 1818 (22.94) and 1855 (17.86), indicating an increase in births following these events, potentially as a recovery effect.

In the models with first differences, the effect of months and period trends disappears because the series are detrended. However, these models are still valuable as they provide insight into the impact of temperatures and precipitation. The effect of these variables appears reduced in terms of coefficient size. However, it is important to consider that temperature and precipitation are measured in degrees Celsius and millimeters, respectively. Thus, the regression coefficient represents the variation in the number of births for a change of one degree Celsius or one millimeter of precipitation.

The analysis reveals that higher temperatures have a significant positive effect on birth counts at a 9-month lag, with coefficients of 2.39 and 2.23 in both models, suggesting that increased temperatures lead to more births. However, the temperature effects at other lags are not significant. In contrast, the coefficients for precipitation are negative, especially at the 9-month lag, with values of -0.05 in absolute levels and -0.08 in first differences. This indicates that higher precipitation tends to reduce birth counts, and the significance in the first differences model highlights the sensitivity of births to precipitation variations.

Table 1 – *Effects of Months, Temperatures, Precipitation and Other Control Variables on the Number of Births in Bologna from 1814 to 1860.*

	Absolute Level				12-Month Differences			
	Base		Full		Base		Full	
	Coef.	Pvalue	Coef.	Pvalue	Coef.	Pvalue	Coef.	Pvalue
Month								
Januaray	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
February	-0.17	0.974	-8.34	0.239	1.25	0.874	1.43	0.850
March	29.81	0.000	15.56	0.160	-1.22	0.864	-2.80	0.702
April	6.47	0.247	-11.82	0.425	-1.41	0.849	-0.19	0.980
May	-9.37	0.095	-24.20	0.148	-1.23	0.874	-0.60	0.940
June	-50.95	0.000	-53.80	0.001	-1.57	0.785	-0.39	0.947
July	-36.42	0.000	-27.26	0.059	0.40	0.950	0.56	0.932
August	-35.78	0.000	-12.78	0.314	0.12	0.984	-0.08	0.988
September	-25.28	0.000	3.14	0.789	-1.10	0.851	0.56	0.915
October	-31.95	0.000	-4.52	0.692	-1.57	0.805	-4.51	0.499
November	-34.42	0.000	-15.33	0.089	-0.49	0.942	-3.52	0.595
December	-25.39	0.000	-16.79	0.012	-0.02	0.998	-1.61	0.806
Period								
1814-1820	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.	Ref.
1821-1830	24.38	0.000	24.63	0.000	3.66	0.558	0.16	0.984
1831-1840	16.38	0.000	18.94	0.000	0.37	0.957	-3.64	0.658
1841-1850	27.01	0.000	28.31	0.000	5.89	0.640	0.65	0.957
1851-1860	42.42	0.000	47.26	0.000	2.52	0.721	-2.39	0.778
Epidemics								
1818	24.09	0.006	22.94	0.010	59.46	0.000	57.52	0.000
1822	2.04	0.807	-6.37	0.461	7.45	0.279	-0.69	0.925
1828	-2.21	0.707	-4.16	0.512	-13.05	0.064	-17.14	0.042
1849	-7.42	0.220	-6.81	0.189	-11.19	0.356	-7.13	0.502
1855	-17.66	0.005	-17.86	0.003	17.76	0.003	18.64	0.001
Temp. Lag 9			2.39	0.003			2.23	0.007
Temp. Lag 10			-0.14	0.839			-0.04	0.955
Temp. Lag 11			-0.53	0.416			-1.21	0.097
Precip. Lag 9			-0.05	0.067			-0.08	0.003
Precip. Lag 10			-0.04	0.049			-0.04	0.114
Precip. Lag 11			-0.02	0.453			-0.01	0.742
Constant	257.40	0.000	238.90	0.000	-1.12	0.883	3.54	0.692
N	432		415		384		361	

8. Conclusion

This study offers a detailed exploration of birth seasonality in Bologna from 1729 to 1860, providing insights into the influence of environmental and social factors on demographic trends. By analyzing extensive historical data, we observed distinct seasonal patterns in birth rates, with peaks in early spring and declines during the summer months. Our regression analysis revealed that meteorological variables, particularly temperature and precipitation, significantly impact birth counts, albeit their effects are relatively modest. Higher temperatures showed a positive effect on birth counts at a 9-month lag, while increased precipitation tended to reduce births. These findings highlight the sensitivity of birth rates to climatic conditions, reflecting the broader socio-economic and environmental context of the time.

The increase in birth rates during periods of better weather at the time of conception, characterized by higher temperatures and less rainfall, may be due to improved agricultural working conditions in pre-industrial agricultural societies, which could lead to a greater predisposition for procreation. This hypothesis will be further tested in future research, where we will assume nonlinear effects for temperature and precipitation series, and distinguish between urban and rural areas.

Acknowledgements

This research was funded by the European Union - NextGenerationEU under the National Recovery and Resilience Plan (PNRR) - Mission 4 Education and research - Component 2 From research to business - Investment 1.1 Notice Prin 2022 – DD N. 104 del 2/2/2022, from “Weather and Climate Vulnerability in Italian Demographic History”, proposal code 2022AMC93A - CUP J53D23009270006.

References

BARONI U., 1964. La periodicità delle nascite lungo il secolo delle rilevazioni demografiche in Italia (1862–1962), *Rivista Italiana di Economia, Demografia e Statistica*, Vol. 18, No. 3-4, pp.151-174.

BARRECA A., DESCHENES O., GULDI M. 2018. Maybe Next Month? Temperature Shocks and Dynamic Adjustments in Birth Rates, *Demography*, Vol. 55, No. 4, pp. 1269–1293.

BELLETTINI A. 1961. *La popolazione di Bologna dal secolo XV all’Unificazione Italiana.* Bologna: Zanichelli Editore.

BONNEUIL N., FURSA E., 2018. Optimal seasonality of conception inferred from monthly marriage and birth time series in populations with no contraception, *Mathematical Methods in The Applied Sciences*, Vol. 41, No. 3, pp. 1125-1135.

CRISAFULLI C., DALLA ZUANNA G., SOLERO F., 2000. La stagionalità delle nascite di ancien régime nelle provincie italiane e in Calabria, *Popolazione e Storia*, Vol. 1, No. 1-2, pp. 177-198.

CUMMINGS D.R., 2002. The seasonality of human births, melatonin and cloud cover, *Biological Rhythm Research*, Vol. 33, No. 5, pp. 521–559.

CUMMINGS D.R., 2007. Additional confirmation for the effect of environmental light intensity on the seasonality of human conceptions, *Journal of Biosocial Science*, Vol. 39, No. 3, pp. 383–396.

CUMMINGS D.R., 2010. Human birth seasonality and sunshine, *American Journal of Human Biology*, Vol. 22, No. 3, pp. 316–324.

GONZÁLEZ-MARTÍN A., 2008. Ecological and cultural pressure on marriage seasonality in the Principality of Andorra, *Journal of Biosocial Science*, Vol. 40, No. 1, pp. 1–18.

KERTZER, D.I., HOGAN, D.P. 1989. *Family, political economy, and demographic change: The transformation of life in Casalecchio, Italy, 1861–1921*, Chicago: University of Wisconsin Press.

LAM D., A., MIRON J. A., 1996. The effect of temperature on human fertility, *Demography*, Vol. 33, No. 3, pp. 291–306.

LAM D., A., MIRON J. A., RILEY A., 1994. Modeling seasonality in fecundability, conceptions, and births, *Demography*, Vol. 31, No. 2, pp. 321–346.

RETTAROLI R., SCALONE F., 2012. Reproductive Behavior during the Pre-Transitional Period: Evidence from Rural Bologna, *Journal of Interdisciplinary History*, Vol. 42, No. 4, pp. 615-643.

RUIU G.A., 2017. "Per ogni cosa c'è il suo momento...". La stagionalità dei decessi in Sardegna (1862-2014), *Popolazione e Storia*, Vol. 18, No. 2, pp. 53-73.

RUIU G., BRESCHI M., 2017. Seasonality of livebirths and climatic factors in Italian regions (1863-1933), *Historical Life Course Studies*, Vol. 4, No.1, pp. 145-164.

RUIU G., BRESCHI M., 2020. Intensity of Agricultural Workload and the Seasonality of Births in Italy, *European Journal of Population*, Vol. 36, No.1, pp. 141-169.

SCALONE, F., AGATI, P., ANGELI, A., DONNO, A. 2017. Exploring unobserved heterogeneity in perinatal and neonatal mortality risks: The case of an Italian sharecropping community, 1900–39, *Population Studies*, Vol. 71, No. 1, pp. 23-41.

SCALONE F., SAMOGGIA A., 2018. Neonatal mortality, cold weather, and socioeconomic status in two northern Italian rural parishes, 1820–1900, Demographic Research, Vol. 39, No. 18, pp. 525-560.
STOCK J.H., WATSON M.W. 2007. *Introduction to Econometrics.* New York: Pearson Addison Wesley.

Nadia BARBIERI, Università di Bologna, nadia.barbieri2@unibo.it
Hassan Rahnaward GHULAMI, Università di Bologna, hassan.rahnaward@unibo.it
Rosella RETTAROLI, Università di Bologna, rosella.rettaroli@unibo.it
Francesco SCALONE, Università di Bologna, francesco.scalone@unibo.it

OFFSPRING'S SEX COMPOSITION AND CHILDBIRTH TIMING IN THIRD CHILD TRANSITION AMONG INDIAN MOTHERS BORN BETWEEN 1966 AND 1985

Eleonora Trappolini, Patrizia Farina, Laura Terzera

Abstract. India faces gender discrimination, leading to skewed sex ratios at birth and influencing family size and the sex composition of already-born offspring. Using the National Family Health Survey-4 (2015-2016), we first apply sequence analysis to investigate the sex composition, mothers' age at the first child, and childbirth timing for the first two children among Indian mothers born between 1966 and 1985, all of whom are under 30 years old. Second, using logistic regression, we analyze the determinants of the transition to a third child and examine whether the influence of sex composition, combined with timing, has changed over time. We find that education and wealth indices affect mothers' mean age at first child and the time interval between births. We also observe that women with two daughters are more likely to have a third child, even within younger birth cohorts, despite an overall reduction trend of declining fertility. Through sequence analysis, our study provides unique insights into gender discrimination in India and its implications for fertility across different mothers' birth cohorts. By identifying the trajectories of sex composition and childbirth timing among previously born offspring, we gain a deeper understanding of the role of male offspring in shaping the likelihood of having a third child while controlling for traditional covariates and mothers' birth cohorts.

1. Introduction and literature review

India faces severe discrimination against women, influenced by class, caste, state, religion, and education (Bhalotra *et al.*, 2020). The country ranks 127th out of 146 in the 2023 Global Gender Gap Index[1], with a score of 66.8%. The country has attained parity in enrolment across all levels of education, but it has reached only 36.7% parity on Economic Participation and Opportunity (World Economic Forum, 2023). Despite a general decline in under-five mortality (World Bank, 2022), Indian girls face higher mortality rates than boys (Kashyap & Behrman, 2020).

Cultural and social factors, such as a patrilineal family system and the economic burden of dowries, sustain son preference. Sons are valued for maintaining lineage,

[1] The global gender gap score is a composite index of four components: Economic Participation and Opportunity, Educational Attainment, Health and Survival, and Political Empowerment. In 2023, the gender gap closed by 96% in Health, 95.2% in Education, 60.1% in Economic Participation, and only 22.1% in Political Empowerment across 146 countries.

performing religious duties, and supporting elderly parents, while daughters are seen as a financial burden (Dyson & Moore, 1983). These factors also drive the use of prenatal sex-detection technologies (Anukirty *et al.*, 2016). As fertility rates decline to replacement levels (UNDP, 2022) gender bias intensifies, with families prioritizing sons within a smaller family size (Das Gupta & Mari Bhat, 1997; Chaudhuri, 2012; Farina & Terzera, 2015; Singh *et al.*, 2021; Saikia *et al.*, 2021).

The sex ratio at birth (SRB) reflects these biases, particularly the conditional SRB for second or higher birth orders, which depends on the sex of previous births (Saika et al. 2021). Son preference also manifests in differential stopping behavior (DSB), where couples continue having children until they have the desired number of sons, often resulting in larger families with more girls (Clark, 2000).

Families' socioeconomic factors, including wealth and education, intersect with these practices. While education can mitigate discrimination (Kaur *et al.*, 2016), highly educated women may be more likely to use sex selection (Das Gupta & Mari Bhat, 1997; Singh *et al.*, 2021). Religious beliefs, such as those in Hinduism and Islam, also play a role in son preference (Vlassoff, 1990; Murthy, 1996).

Parity progression analysis confirms parental intentions, showing that women with more sons than daughters are generally less likely to continue childbearing than those with more daughters than sons (Chaudhuri, 2012).

A recent article reports the association between SRB and birth order. Decisions on sex selection are likely to be sequential and depend on the sex of the children born, and such behavior may manifest after the sex of the first birth (UNFPA 2020). Nath (2023) extends this discussion by analyzing how the sex of the first two children affects the timing of the third birth, especially for cohorts born before 1990.

The misuse of prenatal diagnostic techniques (PNDT) also reflects the intentions of couples to control family composition, particularly at higher birth orders (Gellatly & Petrie, 2017).

Although there is extensive research on son preference in India, there is a gap in understanding birth spacing patterns and the combined effects of sex sequences of previous births.

This paper explores how maternal trajectories influence the transition to the third child, providing new insights into this area. Drawing from existing literature, we formulated two research hypotheses to frame our research:

H1: we expect mothers with two daughters to be more likely to have a third child, especially in younger cohorts, regardless of timing patterns.

H2: we expect mothers who give birth at a younger age and have shorter birth intervals to be more likely to have a third child, regardless of the sex composition of previous births.

2. Data and methods

We used the National Family Health Survey 4 (NFHS-4) conducted in 2015–2016, a nationally representative household survey covering all 29 states and seven union territories in India. The NFHS-4 employed a stratified two-stage sampling method[2]. Our analysis used the 'Woman's Questionnaire' for women aged 15–49 (N = 699,686 women), focusing on those born between 1966 and 1985 with at least two children (N = 250,280 women). For computational reasons, we ran the analysis on a stratified random sampling taking a 5% sample from each state, resulting in a subsample of 12,413 women[3]. Henceforth, all the comments and results refer to this subsample.

We used sequence analysis (Abbott & Tsay, 2000) to analyse the sex composition and childbirth timing of the first two children.

This method defines an ordered string of 'states' to represent women's childbearing history and has been used in the analysis of migrant working trajectories (e.g., Barbiano di Belgiojoso & Ortensi, 2019) and family formation among migrants (e.g., Barbiano di Belgioso & Terzera, 2018; Mikolai & Kulu, 2019). This method analyses sequences from a life-course perspective, considering two essential elements to define the sequence: the timing of events (period of observation) (Billari & Piccarreta, 2005) and the 'state space' (the set of all possible states, namely, 'sex sequences').

In the context of sex sequences in India, previous studies have examined offspring sex composition (e.g., Yadav *et al.*, 2020), but often neglect the timing of events, especially for mothers who gave birth before 1990 (Nath, 2023). Farina and Terzera (2015) were the first to apply sequence analysis to this topic.

Our analysis spans 15 years of observation, resulting in sequences that are 30 semesters long (a time unit), and covers women's fertility history from ages 15 to 30 across all birth cohorts. This approach accounts for the consistent mean age of mothers at the first (around 20) and third (almost 25) children, despite a decline in completed fertility over time.

The state-space was defined by self-declared childbirth and the child's sex, identifying seven states, coded as follows: no birth (coded 0); one son (S); one daughter (D); two sons (SS); two daughters (DD); first son then daughter (SD); and first daughter then son (DS). Children who died within the first year of life were not considered.

[2] For further details, see https://dhsprogram.com/pubs/pdf/FR339/FR339.pdf.
[3] Results are robust to different random sample extractions.

We use optimal matching analysis (OMA)[4] to compare sequences by creating a distance matrix[5] that displays the similarity in states' frequency, order, and location. The OMA functions transform one sequence into another by adding, removing, or replacing states, each with assigned 'costs'. The distance between two sequences represents the minimum total cost required for transformation (Billari, 2001; Gauthier *et al.*, 2009), with a lower distance value indicating a more remarkable similarity between the two sequences. By default, inserting or deleting a state incurs a cost of 1, whereas substitution costs 2. We adopted an ad-hoc substitution cost matrix, as in previous studies (Barbiano di Belgiojoso & Ortensi, 2019), to analyse sex sequences of previous births (Table 1).

Table 1 – *Substitution cost matrix for the sequence analysis.*

	0	S	D	DD	SD	DS	SS
0	0	1	0.50	0.75	1.50	1.50	2
S		0			0.50		1
D			0	0.75		1	
DD				0			
SD					0		
DS						0	
SS							0

Notes: 0 = no birth; S = son; D = daughter.

To categorise trajectories (Aassve *et al.*, 2007), we performed a cluster analysis on the OMA distance matrix using Ward's algorithm. We selected an eight-cluster solution based on the Duda and Caliński methods and cluster sizes to optimize classification informativeness (Halpin, 2016).

Finally, we used logistic regression models to examine how sex composition and childbirth timing of previous births affect the probability of having a third child and its determinants. The dependent variable analysed in the logistic regression is the 'transition to the third child', coded as 1 for women with a third child and 0 otherwise.

The primary explicative variable is the 'sex sequence of previous births,' a categorical variable with eight categories which align with the eight clusters obtained from the cluster analysis. We labelled these categories considering the sex composition of previous births, birth interval timing (a short, medium, or long time)[6],

[4] The sequence analysis was performed in Stata 16 using a package implemented by Kohler *et al.,* (2006).

[5] For further details, see Abbot and Tsay (2000), which is one of the available methods.

[6] We categorised the time intervals between births as follows: "short-time" for intervals of less than two and a half years; "medium-time" for intervals between two and a half years and just under three years;

and mothers' mean age at the first child[7]. The categories are 1 'SD, long time, 18-20 years, 2 'SD, long time, >20 years', 3 'SS, long time, >20 years', 4 'SS, medium time, <18 years', 5 'SS, long time, 18-20 years' *–reference*, 6 'DS, medium time, 18-20 years', 7 'DS, long time, >20 years', 8 'DD, long time, >20 years' (details in paragraph 4.2).

Independent variables included birth cohort (1' 1966–1970' *–reference*, 2' 1971–1975', 3' 1976–1980', 4' 1981–1985'); civil status (1 'currently unmarried' *–reference,* 2 'currently married'); educational level (1 'low,' i.e., no education and primary *–reference*, 2 'high,' i.e., secondary and tertiary); type of residence (1 'urban' *–reference*, 2 'rural'); religion (1 'Hinduism' *–reference*, 2 'Islam,' 3 'Christianity,' 4 'other religion'); wealth index (1 'poor' *–reference*, 2 'middle', 3 'rich'). Moreover, to control for infant mortality (i.e., if a woman had experienced the death of a child in the first year of life), we also included in the model the variable at least one child died (1 'no' *–reference*, 2 'yes'). Table 2 shows the characteristics of the sample.

Table 2 – *Percentage distribution of women's characteristics with at least two children.*

Variables	%	Variables	%	Variables	%
Birth cohort		Religion		Children died	
1966–1970	20.9	Hinduism	76.6	No	82.5
1971–1975	23.4	Islam	12.5	Unmet need	
1976–1980	27.5	Christianity	6.3	No	91.7
1981–1985	28.2	Other religion	4.6	Heard family planning	
Current civil status		Wealth index		No	42.7
Unmarried	6.2	Poor	42.3	Mean n. of children	(3.3)
Married	93.8	Middle	20.6	Age at 1st child	
Educational level		Rich	37.1	<20	42.7
Low	63.1	Type of residence		20-24	49.3
High	36.9	Urban	27.8	25-30	8.0
		Rural	72.2		
Number of women			12,413		

Note: The table shows percentages and should be read in columns.
Source: Authors' elaboration on NFHS-4 data (2015-2016).

and "long-time" for intervals greater than three years. These categories were determined through cluster analysis and represent the average time intervals between births, as shown in Table 3. The labels were chosen to ensure clarity when presenting the results.

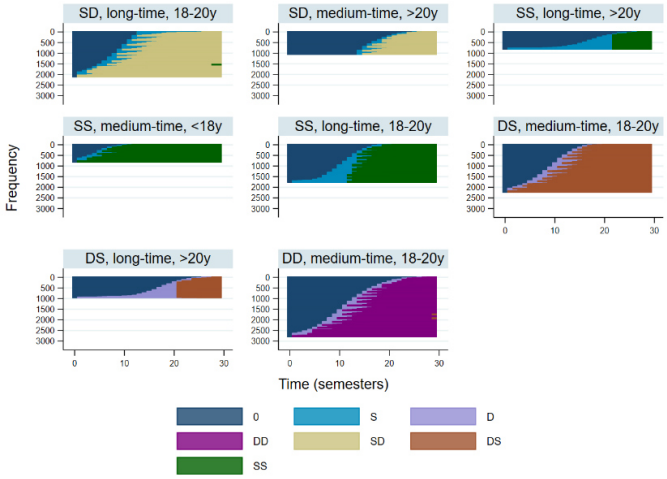
[7] We classified mothers into three groups based on their age at the start of childbearing: those who began before age 18 (<18y), those who started between 18 and 20 years (18-20y), and those who began after age 20 (>20y). These thresholds were determined through cluster analysis and represent the average age at which mothers had their first child.

3. Results

3.1. Sequence analysis and cluster analysis

Cluster analysis identifies eight distinct groups based on sex sequences and timing, labelled by sex composition, birth intervals, and mothers' mean age at the first birth (Fig. 1).

Figure 1 – *Sex sequences of the offspring already born over time and by cluster.*



Percentage distribution of the sample by cluster.

Cluster 1	Cluster 2	Cluster 3	Cluster 4	Cluster 5	Cluster 6	Cluster 7	Cluster 8	Tot
16.9%	8.3%	6.4%	6.5%	14.0%	17.9%	7.6%	22.4%	100.0%

Note: S = son; D = daughter.
Source: Authors' elaboration on NFSH-4 data (2015-2016).

Clusters 1 and 2 (25.2% of women) show a son-daughter (SD) pattern. Cluster 1 has a longer birth interval (three years) and a mean age of 18.3 years at first birth, while cluster 2 has a shorter interval (two years and six months) and a mean age at first child of 23.2 years old. Clusters 3, 4, and 5 (26.9% of women) consist of two sons. In cluster 3, women had their first son after age 20 (mean age 23.2) with a longer gap before the second (around age 26). Cluster 4 includes women who had their first son before age 18 (mean age 16.6) and their second around age 20. In cluster 5, women had their first son between 18 and 20 (mean age 20.0 years old) with a three year-gap between births). Clusters 6 and 7 (25.5% of women) involve a

daughter followed by a son. In cluster 6, the birth interval is 2.5 years, with a mean age of 18.9 at first birth. In contrast, cluster 7 shows a longer time interval (on average, 3.3 years) and a mean age of 23.2 at first birth. Finally, cluster 8 (22.4% of women) consists of women with two daughters, with the first born at mean age of 20.0 and a 2.8-year birth interval.

3.2. Logistic model for the transition to the third child

Table 3 displays adjusted odds ratios (ORs) for the likelihood of having a third child, highlighting key determinants. Higher education and non-poor economic status decrease the likelihood of having a third child, while being married increases it. Younger birth cohorts are less likely to have a third child compared to the older ones (1966-1970), reflecting the decline in fertility among Indian women, though the average age at first two children remains unchanged. Christians and especially Muslims are more likely to have a third child than Hindus, while residence type has no significant effect. Women who have lost a child are more likely to have a child.

Table 3 – *Adjusted ORs for the probability of having the third child.*

	OR		OR
Clusters (ref. 5. SS, long-time, 18-20y)		Educational level (ref. Low)	
1. SD, long-time, 18-20y	1.64***	High	0.41***
2. SD, medium-time, >20y	0.61***	The type of residence (ref. Urban)	
3. SS, long-time, >20y	0.26***	Rural	0.97
4. SS, medium-time, <18y	1.68***	Religion (ref. Hinduism)	
6. DS, medium-time, 18-20y	1.84***	Islam	2.35***
7. DS, long-time, >20y	0.45***	Christianity	1.78***
8. DD, medium-time, 18-20y	2.78***	Other religion	0.93
Birth cohort (ref. 1966–1970)		Wealth index (ref. Poor)	
		Middle	0.69***
1971–1975	0.83***	Rich	0.48***
1976–1980	0.66***	At least one child died (ref. No)	
1981–1985	0.50***	Yes	1.22**
Current civil status (ref. Unmarried)			
Married	1.84***		
Number of women		12,413	

Note: S = son; D = daughter.
*Legend: *p < 0.05, **p < 0.01, ***p < 0.001*
Source: Authors' elaboration on NFSH-4 data (2015-2016).

All clusters differ from cluster 5. Clusters 1, 4, 6, and 8, where women had their first child at 20 years or younger, positively affect the likelihood of having a third child, with, cluster 8 showing the strongest effect. Conversely, clusters 2, 3, and 7, where women had their first child later and the birth interval exceeded two and a half years, negatively affect this likelihood, particularly when the first child is born after age 20. The interval exceeds three and a half years (cluster 3).

Finally, we ran a model with an interaction term between cluster and birth cohort to assess if the effect of the identified clusters varies across birth cohorts.

For the sake of brevity, we only report the results of the interaction terms; control variables remained consistent with the previous model. Table 4 shows that clusters 1–7 have a relatively uniform effect on the likelihood of having a third child across different birth cohorts, with no significant differences compared to the reference category (cluster 5: two sons, long time interval, first son born between ages 18-20, birth cohort 1966-1970). However, cluster 8 (two daughters, moderate time interval, first daughter born between ages 18-20) is linked to a higher likelihood of having a third child in more recent birth cohorts (from 1971 to 1985) compared to the oldest cohort (1966–1970). This may be due to changing fertility patterns in younger cohorts, where the desire for a son appears to be fulfilled at lower parities, unlike in older cohorts where childbearing extended beyond the third child.

Table 4 – *Adjusted ORs for the transition to the third child.*

	OR		OR
Cluster*Birth cohort		Cluster*Birth cohort	
1.*1971–1975	0.85	4.*1981–1985	0.73
1.*1976–1980	0.86	6.*1971–1975	0.95
1.*1981–1985	0.77	6.*1976–1980	0.95
2.*1971–1975	1.40	6.*1981–1985	0.70
2.*1976–1980	1.15	7.*1971–1975	1.10
2.*1981–1985	1.06	7.*1976–1980	1.37
3.*1971–1975	0.88	7.*1981–1985	0.81
3.*1976–1980	1.02	8.*1971–1975	1.51*
3.*1981–1985	1.06	8.*1976–1980	1.82**
4.*1971–1975	0.94	8.*1981–1985	1.50*
4.*1976–1980	1.05		
Number of women		12,413	

Notes: The model controls for civil status, education, type of residence, religion, wealth index, children died, unmet needs, and heard family planning. S = son; D = daughter.

Legend: *p < 0.05, **p < 0.01, ***p < 0.001.

Source: Authors' elaboration on NFSH-4 data *(2015-2016)*.

4. Discussion and conclusion

This study investigates two key aspects: the different combinations of sex composition of already-born offspring and childbirth timing (mothers' age at first child and the interval between births), and how these combinations influence the transition to a third child among Indian mothers born between 1966 and 1985.

Maternal birth trajectories appear to be shaped by personal strategies involving choices about the number and sex of children to welcome into the family.

Using sequence analysis, we identify distinct clusters based on the sex composition of already-born offspring and childbirth timing. Cluster 8 (DD) stands out with mothers who had two first-born daughters, typically becoming mothers between ages 18 and 20, with medium birth intervals and a high proportion of economically disadvantaged mothers (44.8%). In contrast, other clusters (SD, DS, SS) show more diverse patterns in maternal age at first childbirth and birth intervals.

The study findings underscore the significance of two elements in influencing the likelihood of having a third child: the sex composition of previous births (H1) and the timing of these events (H2). Mothers with two daughters are nearly three times more likely to have a third child than those with two sons, especially when they start motherhood between 18 and 20 and have longer birth intervals. Having at least one son is crucial for Indian parents across all birth cohorts, particularly for the youngest cohort (1981–1985, H1).

Our findings indicate an association between starting childbearing before age 20 and an increased likelihood of having higher-order births (H2). However, it is also possible that women who desire more children may choose to begin having them earlier. Conversely, women who start having children after age 20 tend to be less inclined to have a third child.

Furthermore, the results highlight the well-established influence of certain structural variables on the likelihood of transitioning to a third child. Higher education and wealth index reduced the likelihood of a third child. Religion as well emerges as a relevant factor: Hindu mothers are less likely to have a third child compared to others.

Our study has some limitations. First, we lack data on events before the first child. Second, the retrospective nature of self-assessed birth sequences information may lead to under-reporting of female births or sequencing bias, though we mitigated this by asking mothers to list births chronologically. Third, data on prenatal diagnostic technique (PNDT) and sex-selective abortions is missing, though laws and programs in India aim to address this issue. Finally, some explanatory variables (civil status, religion, type of residence, educational level and wealth index) used in the models are measured at the time of the interview due to data constraints.

Despite these limitations, our results provide valuable insights into gender discrimination in India, particularly its potential impact on gender imbalance and fertility.

Our findings highlight that the preference for son remains strong and persist even among younger birth cohorts with declining fertility. As India continues its fertility decline (World Bank Indicators, 2015), this preference may further exacerbate gender imbalances and pose unique challenges, as women aim to have fewer children but also aim to avoid being sonless (Aksan, 2021).

In conclusion, our study underscores the enduring preference for male offspring, which persists among younger generations in India.

References

AASSVE, A., BILLARI, F. C., PICCARRETA, R. 2007. Strings of Adulthood: A Sequence Analysis of Young British Women's Work-Family Trajectories: Parcours de la vie adulte: Une analyse par séquence des trajectoires travail-famille des jeunes femmes britanniques. *European Journal of Population/Revue européenne de Démographie*, Vol. 23, pp. 369-388.

ABBOTT, A., TSAY, A. 2000. Sequence analysis and optimal matching methods in sociology: Review and prospect. *Sociological Methods & Research*, Vol. 29, No.1, pp. 3-33.

AKSAN, A.M. 2021. Son preference and the fertility squeeze in India. *Journal of Demographic Economics* Vol. 87, No. 1, pp. 67-106.

ANUKIRTY, S., BHALOTRA, S., TAM, H. 2016. *On the Quantity and Quality of Girls: new Evidence on Abortion, Fertility, and Parental Investment*. IZA Discussion Paper Series n. 10271.

BARBIANO DI BELGIOJOSO, E., TERZERA, L. 2018. Family reunification–who, when, and how? Family trajectories among migrants in Italy. *Demographic Research*, Vol. 38, pp. 737-772.

BARBIANO DI BELGIOJOSO, E., ORTENSI, L. E. 2019. Satisfied after all? Working trajectories and job satisfaction of foreign-born female domestic and care workers in Italy. *Journal of Ethnic and Migration Studies*, Vol. 45, No. 13, pp. 2527-2550.

BHALOTRA, S., BRULE', R., ROY, S. 2020. Women's inheritance rights reform and the preference for sons in India. *Journal of Development Economics*, Vol. 146: 102275.

BILLARI, F. C. 2001. Sequence analysis in demographic research. *Canadian Studies in Population [ARCHIVES]*, pp. 439-458.

BILLARI, F. C., PICCARRETA, R. 2005. Analyzing demographic life courses through sequence analysis. *Mathematical Population Studies*, Vol. 12, No. 2, pp. 81-106.

CHAUDHURI, S. 2012. The desire for sons and excess fertility: a household-level analysis of parity progression in India. *International Perspectives on Sexual and Reproductive Health*, pp. 178-186.

CLARK, S. 2000. Son preference and sex composition of children: Evidence from India. *Demography*, Vol. 37, No. 1, pp. 95-108.

DAS GUPTA, M., MARI BHAT, P. N. 1997. Fertility decline and increased manifestation of sex bias in India. *Population Studies*, Vol. 51, No. 3, pp. 307-315.

DYSON, T., MOORE, M. 1983. On kinship structure, female autonomy, and demographic behavior in India. *Population and Development Review*, pp. 35-60.

FARINA, P., TERZERA, L. 2015. Sequences of Birth History among Indian Mothers born between 1956–1960. *Indian Journal of Applied Research*, Vol. 5, No. 7, pp. 315-317.

GAUTHIER, J. A., WIDMER, E. D., BUCHER, P., NOTREDAME, C. 2009. How much does it cost? Optimization of costs in sequence analysis of social science data. *Sociological Methods & Research*, Vol. 38, No. 1, pp. 197-231.

GELLATLY, C., PETRIE, M. 2017. Prenatal sex selection and female infant mortality are more common in India after firstborn and second-born daughters. *J Epidemiol Community Health*, Vol. 71, No. 3, pp. 269-274.

HALPIN, B. 2016. *Cluster Analysis Stopping Rules in Stata*. Working Paper WP2016-01. Retrieved May 6, 2022, from http://ulsites.ul.ie/sociology/sites/default/files/wp2016-01.pdf.

KASHYAP, R., BEHRMAN, J. 2020. Gender discrimination and excess female under-5 mortality in India: a new perspective using mixed-sex twins. *Demography*, Vol. 57, No. 6, pp. 2143-2167.

KAUR, R., BHALLA, S. S., AGARWAL, M. K., RAMAKRISHNAN, P. 2016. *Sex Ratio at Birth: the role of gender, class, and education*. United Nations Population Fund (UNFPA) India Technical Report, 43. Retrieved May 6, 2022, from https://india.unfpa.org/sites/default/files/pub-pdf/Sex%20Ratio%20Imbalances%20and%20Crime%20Rates.pdf.

KLEINEPIER, T., DE VALK, H. A., VAN GAALEN, R. 2015. Life paths of migrants: A sequence analysis of Polish migrants' family life trajectories. *European Journal of Population*, Vol. 31, pp. 155-179.

KOHLER, U., BRZINSKY-FAY, C., LUNIAK, M. 2006. Sequence analysis with Stata. *The Stata Journal*, Vol. 6, No. 4, pp. 435-460.

MIKOLAI, J., KULU, H. 2019. Union dissolution and housing trajectories in Britain. *Demographic Research*, Vol. 41, pp. 161-196.

MURTHY, R. K. 1996. Fighting female infanticide by working with midwives: an Indian case study. *Gender & Development*, Vol. 4, No. 2, pp. 20-27.

NATH, S. 2023. Explaining third birth patterns in India: causal effects of sibling sex composition. *Journal of Population Economics*, pp. 1-35.

SAIKIA, N., MEH, C., RAM, U., BORA, J. K., MISHRA, B., CHANDRA, S., JHA, P. 2021. Trends in missing females at birth in India from 1981 to 2016: analyses of 2·1 million birth histories in nationally representative surveys. *The Lancet Global Health*, Vol. 9, No. 6, pp. e813-e821.

SINGH, A., KUMAR, K., YADAV, A. K., JAMES, K. S., MCDOUGAL, L., ATMAVILAS, Y., RAJ, A. 2021. Factors influencing the sex ratio at birth in India: A new analysis based on births occurring between 2005 and 2016. *Studies in Family Planning*, Vol. 52, No. 1, pp. 41-58.

UNDP. 2022. *New threats to human security in the Anthropocene. Demanding greater solidarity*. Special Report, New York: United Nations Development Programme. Retrieved June 12, 2022, from http://hs.hdr.undp.org/.

UNFPA. 2020. *Sex Ratio at Birth in India Recent Trends and Patterns*. Report prepared by Kulkarni P. for United Nations Population Fund.

VLASSOFF, C. 1990. The value of sons in an Indian village: How widows see it. *Population Studies*, Vol. 44, No. 1, pp. 5-20.

WORLD BANK. 2022. *World Development Indicators*. Retrieved May 30, 2022, from https://databank.worldbank.org/source/world-development-indicators.

WORLD BANK INDICATORS. 2015. *Fertility rate, total (births per woman)*. Retrieved May 25, 2022, from https://data.worldbank.org/indicator/SP.DYN.TFRT.IN?locations=IN.

WORLD ECONOMIC FORUM. 2023. *Global Gender Gap Report 2023*. Retrieved October 4, 2024, from https://www3.weforum.org/docs/WEF_GGGR_2023.pdf.

YADAV, A. K., ANAND, A., SINGH, R. A., JUNGARI, S. 2020. Sex composition and son preference in India and major states: Evidence from the National Family Health Survey-4 (2015-16). *Clinical Epidemiology and Global Health*, Vol. 8, No. 4, pp. 1140-1146.

Eleonora TRAPPOLINI, Sapienza University of Rome, eleonora.trappolini@uniroma1.it
Patrizia FARINA, Univeristy of Milan-Bicocca, patrizia.farina@unimib.it
Laura TERZERA, University of Milan-Bicocca, laura.terzera@unimib.it

RESIDENTIAL CONCENTRATION OF NON-NATIONAL POPULATION SUBGROUPS AND POTENTIAL SOCIOECONOMIC VULNERABILITY IN A SOUTHERN ITALIAN URBAN CONTEXT

Maria Carella, Thaís García-Pereiro, Anna Paterno

Abstract. The spatial distribution of residential patterns has often been translated into profound and increasing segmentation of urban contexts, which frequently uncovered deep socioeconomic spatial inequalities. With modern cities as one of the main systems of stratification and fragmentation, the main aim of this article is to investigate the potential socioeconomic vulnerability and the spatial concentration of non-nationals in the city of Bari at the time of the last Census (2021) applying spatial methods to census trats as units of analyses and considering the top five foreign-nationality population subgroups there residing (Georgians, Bangladeshis, Albanians, Romanians and Chinese). Our results show that suburban areas in the city where the potential socioeconomic vulnerability is higher are not necessarily those in which groups non-nationals are over-represented, but interesting differences regarding specific groups of non-nationals emerge. Also, the territorial concentration of non-nationals respect to Italian residents tend to diverge not only across the space but also among subgroups of non-nationals. These findings might be relevant to inform knowledge-based policies dealing with the urban space, particularly those dealing with the distribution of socioeconomic vulnerability and ethnic concentration within and across the neighborhoods of the city.

1. Introduction

Contemporary cities are becoming one of the most significant mechanisms of socioeconomic stratification and fragmentation. Urban agglomerations have been progressively transformed producing the reconfiguration of both public areas and private living spaces. This highly complex dynamic has led to a growing heterogeneity of well differentiated spatial patterns of population subgroups in the cities. Therefore, the distribution of residential spaces has often been translated into deep spatial segmentation of urban contexts revealing profound socio-spatial inequalities.

Recent research shows that social segregation in European cities increased due to the substantial and consistent growth of immigration flows and the rise of socioeconomic inequalities (Andersen and van Kempen, 2003; Tammaru et al., 2016; Lymperopoulou and Finney, 2017).

Undoubtedly, socioeconomic and housing conditions of the urban placement and its surrounding places play a relevant role not only in the size of the foreign population settling there, but also in its spatial patterns of residential segregation (Marcińczak et al., 2021; Pisarevskaya et al., 2021). This is particularly true when residential segregation is understood in terms of the extent to which individuals from different groups of the population (in terms of socioeconomic status, ethnicity, etc.) inhabit and actively live different locations (Reardon and O'Sullivan, 2004).

The latest studies on this subject find a clear North-South hierarchy of urban areas in Europe within the context of growing multiculturalism and socioeconomic inequality. That is, southern urban areas holding higher levels of segregation are also those combining a weaker economy with higher degrees of social vulnerability (Benassi et al., 2020; Marcińczak et al., 2021; Benassi et al., 2022).

The objectives of this article are threefold. First, this article presents an approach to assess multiple socioeconomic vulnerability[1] -including sociodemographic, human capital, employment, and housing factors- across urban populations at a local scale. The method includes the construction of a composite index that use available indicators in different domains to define potential socioeconomic vulnerability of the residential population by census tracts at the time of the last Census (2021) from the information publicly provided by the Italian National Statistics Institute (ISTAT). This method is applied to the city of Bari, Apulia, to illustrate its usability for identifying hotspots of spatial inequalities, allowing to assess whether and where there is an uneven distribution of socioeconomic vulnerability of the population at a detailed intra-urban scale. Second, it attempts to identity the suburban geography of non-national groups in the city analyzing their spatial concentration patterns by computing and mapping Local Quotients (LQs) of residents holding a foreign nationality (non-nationals) respect to the Italian resident population. Third, measuring local spatial correlation through the estimation and interpretation of the local versions of bivariate Moran's I between the index of potential socioeconomic vulnerability and the LQs for each population subgroup considered. We focus the attention into the top five foreign-nationality population subgroups residing in Bari (Georgians, Bangladeshis, Albanians, Romanians and Chinese), which represent more than 69% of individuals holding a foreign citizenship living in the city.

Undoubtedly, results might serve as a relevant input for stakeholders and policymakers of the city to screen the extent of potential vulnerability at a very fine scale of territorial disaggregation and across national and non-national population subgroups. This is particularly important to support knowledge-based regeneration policies in disadvantaged neighborhoods.

[1] In this article we use the concept of vulnerability for the analysis of socioeconomic and ethnic disparities, and their spatial relations in the city at the sub-urban level. This concept is embraced within the broader category of inequality that most research on this subject develops.

2. Theoretical background and state of the art: a brief overview

Inequality is spatially organized, and its organization is a result of both spontaneously differences among individuals, families, and groups that manifest across space and deliberate attempts to organize the space to sustain or reinforce inequalities (Dreier et al., 2001; Galster and Sharkey, 2017). As stated by Van Kempen (2007) the undivided city is, simultaneously, a myth and a utopic ideal. Cities are divided when two situations combine, that is, if the social tissue is divided, often the urban space is also divided[2]. This division deals with the association between socioeconomic polarization and spatial segregation. But urban cities are not simply divided in two, they might by divided in many pieces (dual, triple or quartered city), with more or less connections between these pieces (Musterd and Ostendorf, 2012).

A large body of research has shown that cities are segregated along socioeconomic or ethnic lines (e.g. Musterd, 2005; Van Kempen, 2005; Bolt et al., 2008;). In general, these studies found that the socioeconomic distance between "the less advantage" and "the more advantage" tends to follow a specific spatial outcome, in terms of segregation, in which the first group is concentrated in certain parts of the city (e.g. Musterd, 2005; Van Kempen, 2005).

Research confirms the existence of the divided city model in EU countries (OECD, 2018; Benassi and Iglesias-Pascual, 2023) but some studies also show a multiple/plural city model characterised by a variety of situations (Tammaru et al., 2020).

In fact, the relationship between high levels of socioeconomic inequality and spatial segregation is not always straightforward. In fact, it has been also shown that not always pronounced socioeconomic inequalities translate into marked spatial distance of population subgroups within the city. One example is Lisbon, where localities with the highest mean earnings are also those holding the highest level of inequality (Carmo and Carvalho, 2013).

As stated previously, contemporary cities are increasingly polarized and fragmented, which emphasizes obstacles for the socioeconomic and territorial integration of foreigners in the host society (Leclerc, 2021). Simultaneously, the socioeconomic vulnerability of foreigners is expected to strongly influence their socio-territorial process of integration (Imeraj et al., 2020).

The concept of the dual/divided city has been frequently used to highlight the socio-economic inequalities in the cities (Castells and Mollenkopf, 1991) and to explain the polarized urban spaces (Fainstein, 1992).

---

[2] The following terms are frequently used as synonyms of divided cities (Fainstein et al. 1992), dual cities (Mollenkopf & Castells, 1991), polarised cities, fragmented cities and partitioned cities.

A specific strand of literature has framed the division of urban space within the context of socio-spatial segregation of large cities often measuring the differences between neighborhoods according to the resources of their residents (Maloutas and Spyrellis, 2019). This phenomenon has been investigated by different approaches mainly based on the perspective of social classes within large urban areas (Oberti and Préteceille, 2004) and on the ethno-racial differences in the occupation of urban space (Benassi et al., 2020; Yaho et al., 2019).

Recently, literature has been increasingly paying attention to the relationship between the initial socioeconomic vulnerability of the migrant populations and their socio-spatial integration (Imeraj et al., 2020). In particular, several studies highlight how the economic dimension and the ethnic and cultural background of migrants are reflected in the difficulty of accessing the residential market: process of socio-residential exclusion (Portes and Rumbaut, 2001).

Based on previous research, and considering the peculiarities of Southern urban contexts, we aim at answering following research questions:

- ✓ RQ1: Which is the degree of heterogeneity in the sub-urban distribution of potential socioeconomic vulnerability across the city?
- ✓ RQ2: Are there any differences in the territorial concentration of the first five non-national groups if compared to Italian residents?
- ✓ RQ3: Is there a spatial correlation between potential socioeconomic vulnerability and the territorial concentration of these non-national groups respect to Italians?

3. Data and methods

The empirical analyses performed in this article are based on the last available Census data for 2021 at the level of the census tracts of the city of Bari, which come from the information publicly provided by the Italian National Statistics Institute (ISTAT). More specifically, we rely on data regarding the age groups, nationalities, number of household members, level of education and non-employment status of resident population, that are merged to housing conditions drawn from the 2011 Census. We select census tracts having at least 10 residents (n=1,291) and we focus the attention on Georgians, Bangladeshis, Albanians, Romanians and Chinese, which together represent more than 69% of individuals holding a foreign citizenship living in the city.

To answer to our first research question (RQ1) we built a composite indicator to measure potential socioeconomic vulnerability using several items that cover three well differentiated dimensions. The first is sociodemographic and includes two indicators: the share of individuals over 70 among total population and the

percentage of households with more than four components among total households. The second dimension is socioeconomic and introduces measures of low human capital by gender, that is, the shares of male/female population with at most the first level of secondary education among total males/females; plus, non-employment measures by gender, specifically, the shares of not-employed males/females among total male/female population between 15 and 64 years old. The third dimension regards housing conditions incorporating the share of residential buildings in bad or very bad state of preservation among total residential buildings. We apply Principal Component Analysis (PCA) to reduce the former six indicators into three principal components (PCs) that account for 73% of data total observed variation. The resulting composite index was built up for each census tract with the PCs retained, weighted by their eigenvalues. Finally, the indicator was standardized using the min-max method to obtain a Composite Index of Potential Socioeconomic Vulnerability that varies between 0 (null potential vulnerability) and 1 (maximum potential vulnerability). The values of this index are represented in Figure 1 at the level of census tracts through a natural breaks (Jenks) map.

For the analysis of the spatial concentration patterns of non-national population subgroups (RQ2), we compute and map Local Quotients (LQs) as a ratio of ratios (Benassi and Iglesias-Pascual, 2023), where the first is the ratio between the total population of each non-national group divided by the total Italian population for the whole city, and the second regards the same numerator and denominator but it is computed for each census tract. When the LQ is minor than 1(LQ<1) the non-national group understudy is under-represented respect to Italians, instead, if the LQ is greater than 1(LQ>1) the specific non-national group is over-represented. The LQs of the top five groups are illustrated in Figure 2.

Finally, to respond to the third research question (RQ3), we estimate and map both the local versions of bivariate Moran's I between the Composite Index of Potential Socioeconomic Vulnerability and the obtained LQs for each one of the non-nationals' groups considered. We use the queen-based contiguity weights matrix and we map these results in Figure 3.

4. Results

4.1. The heterogeneity of Potential Socioeconomic Vulnerability

Figure 1 shows -using a natural breaks map- the suburban distribution of the Composite Index of Potential Socioeconomic Vulnerability in the city of Bari. According to the values that this figure illustrates, it is possible to clearly identify

significant differences across sub-municipality areas[3] regarding degrees of potential vulnerabilities. In the map, green spots represent census trats with lower levels of vulnerability, while red ones indicate those that are more potentially vulnerable in socioeconomic terms. We can also see that the representation of green and red spots follows a particular "island-type" spatial distribution. If we concentrate the attention in the red spots, the most vulnerable tracts of the city, emerges that sub-urban areas of high potential vulnerability are, simultaneously, spatially clustered and clustered-disperse. This might be interpreted as a very first sign indicating duality, given that the most vulnerable groups are spatially isolated not only in certain areas but also across several sub-municipalities of the city.

Figure 1 – *Composite Index of Potential Socioeconomic Vulnerability. Bari (2021).*

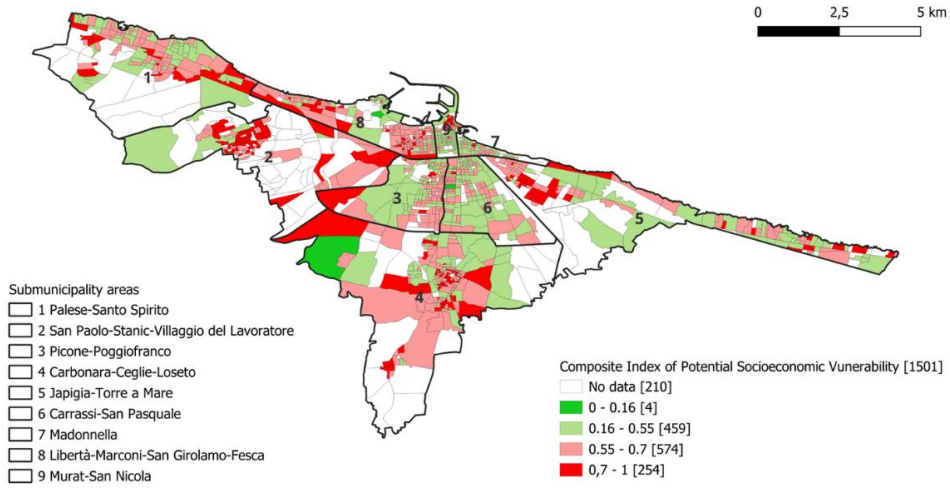


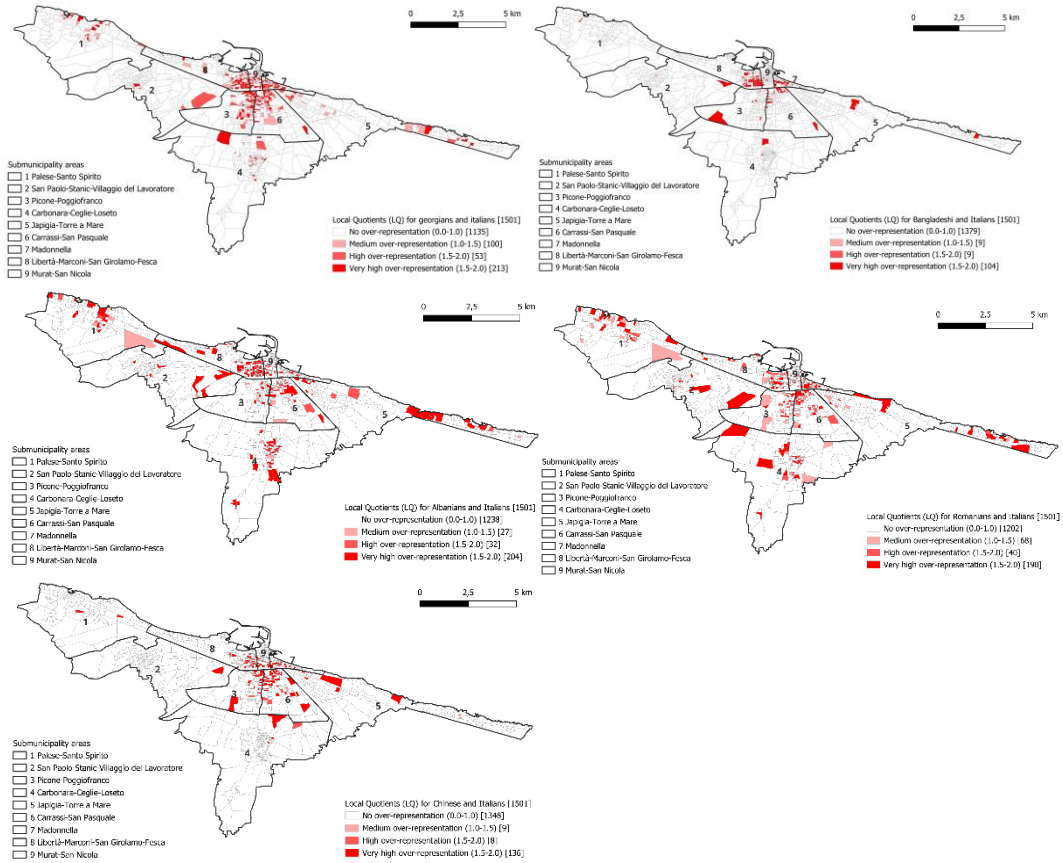
Figure notes: Classes obtained by natural breaks (Jenks) method.

4.2. Differences in the territorial concentration of non-national groups across the city

Figure 2 illustrates the LQs of each one of the top five population subgroups of non-nationals Georgians, Bangladeshis, Albanians, Romanians and Chinese, in this order.

[3] In 2014, sub-municipality areas were grouped into 5 municipalities. We believe that sub-municipality areas are more informative and less concentrated than current municipalities.

Figure 2 – *Local Quotients (LQs) for non-national population subgroups (Georgians, Bangladeshis, Albanians, Romanians and Chinese) respect to nationals (Italians). Bari (2021).*



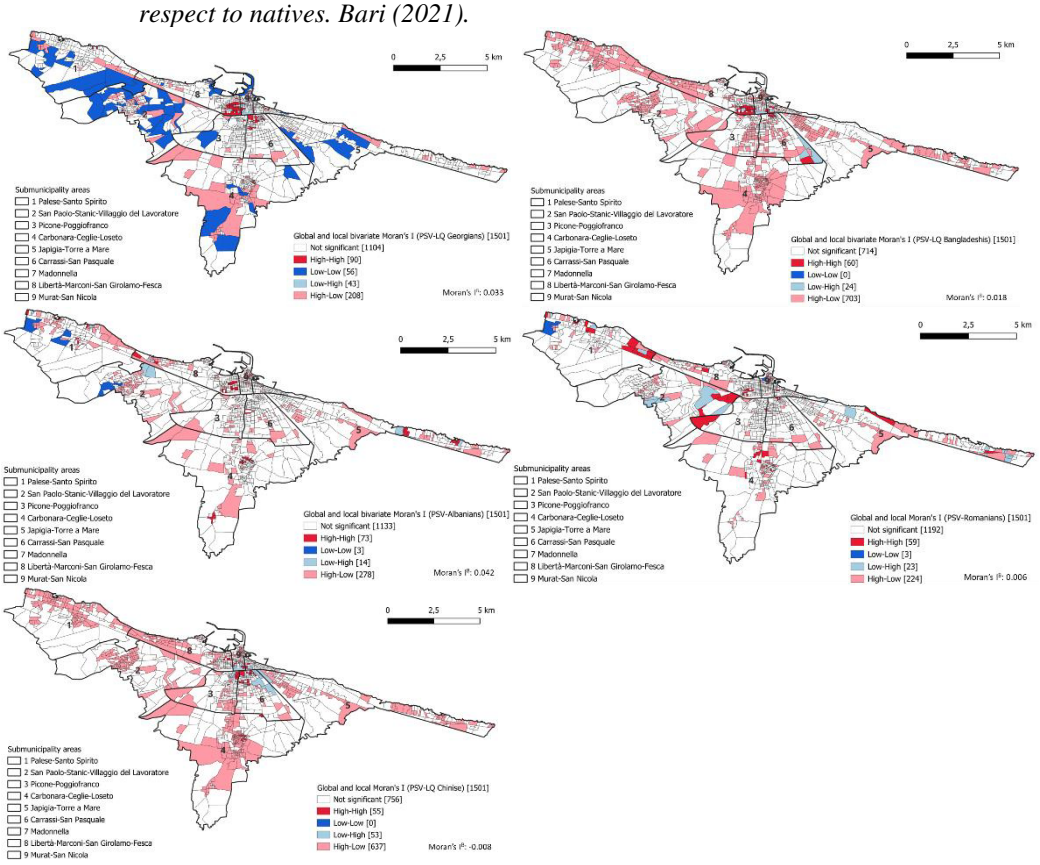
Generally speaking, all non-nationals' population groups show markedly dissimilar spatial distributions respect to the native population. However, interesting differences among groups arise and some deserve to be highlighted. For example, the territorial pattern of Georgians respect to Italians across sub-municipality areas is widely clustered-dispersed, with a very high over-representation in the city center. A spatial pattern that seems to be linked to their likelihood of employment in the care sector. In contrast, Bangladeshis display a spatially clustered pattern with very high levels of concentration in the city center (Libertà and Madonella) and very little

on the outskirts. Chinese, instead, show less areas of concentration clustered dispersed across sub-municipality areas if compared to Georgians, Albanians and Romanians. Mainly, this spatial pattern is related to the location of their economic activities.

4.3. Are Potential Socioeconomic Vulnerability and the territorial concentration of non-national groups spatially correlated?

This section is aimed at analyzing the spatial correlation between the potential socioeconomic vulnerability index and the territorial concentration of each one of the non-national groups under exam respect to Italians. Bivariate Local and Global Moran's I are represented in Figure 3.

Figure 3 – *Global and local bivariate Moran's I for selected non-national population groups respect to natives. Bari (2021).*



A general trend appears, and that is, most census tracts are in the High-Low category, in which high potential vulnerability is spatially linked to low over-representation of non-nationals groups respect to Italians. Although, again, interesting differences emerge when comparing results across the space and among population subgroups. In the case of the spatial correlation between potential vulnerability and the concentration of Georgians and Bangladeshis, sub-urban High-High areas are predominantly clustered in Libertà. For Albanians and Romanians, small and medium High-High sub-urban areas are, respectively, clustered dispersed across sub-municipalities in the city.

5. Discussion and concluding remarks

The empirical analyses performed in this article were aimed at answering the specific research questions. Regarding the first (RQ1), we find relevant differences in the degree of heterogeneity in the sub-urban distribution of potential socioeconomic vulnerability in the city of Bari. In fact, the index shows an island-type spatial distribution of both green and red spots. More specifically, sub-urban areas of high potential vulnerability are spatially clustered and clustered-disperse across the city.

About our second research question (RQ2), findings point out to significant differences in the territorial concentration of the first five non-national groups if compared to Italian residents. There are clustered-dispersed territorial patterns of high and very high concentration across the sub-municipality areas of the city for Georgians, Albanians and Romanians. There are also very high levels of concentration in Libertà and Madonella in the center of the city that are spatially clustered for Bangladeshis. Instead, emerge clear economic centered patterns for Chinese.

Finally, while answering our third research question (RQ3), we find that most census tracts with high levels of potential vulnerability are not necessarily those in which non-nationals populations subgroups are concentrated. Actually, most census tracts are those in which high potential socioeconomic vulnerability is linked to low over-representation of the non-national group respect to the native one. Although, some high-high areas emerge and merit more attention. Findings point to Libertà in the city center as the sub-municipality area where census tracts with high levels of potential vulnerability correspond to high or very high levels of concentration of Georgians and Bangladeshis.

Taken together, our results seem to be given signs of the multiple fragmentation/division of the city of Bari (Musterd and Ostendorf, 2012; Tammaru et al., 2020; Carella et al. 2024). A mosaic city within which there are also clear

traces of duality in terms of socioeconomic and ethnic vulnerability but only in the city center, more specifically, in the Libertà sub-municipality.

Acknowledgements

This presentation was conceived and realized as part of the PRIN 2022 PNRR research project "Foreign population and territory: integration processes, demographic imbalances, challenges and opportunities for the social and economic sustainability of the different local contexts (For.Pop.Ter)" [P2022 WNLM7], Funded by European Union—Next Generation EU, component M4C2, Investment 1.1. The views and opinions expressed are only those of the authors and do not necessarily reflect those of the European Union or the European Commission. Neither the European Union nor the European Commission can be held responsible for them.

References

ANDERSEN H. T., VAN KEMPEN R. 2003. New trends in urban policies in Europe: evidence from the Netherlands and Denmark. *Cities*, Vol. 20, No.2, pp. 77-86.

BENASSI F., IGLESIAS-PASCUAL R. 2023. Local-scale residential concentration and income inequalities of the main foreign-born population groups in the Spanish urban space. Reaffirming the model of a divided city, *Journal of Ethnic and Migration Studies*, Vol. 49 , No.3, pp. 673-696.

BENASSI F., NACCARATO A., IGLESIAS-PASCUAL R., SALVATI L., STROZZA S. 2022. Measuring residential segregation in multi-ethnic and unequal European cities. *International Migration*, Vol. 61, No. 2, pp. 341-361.

BENASSI F., IGLESIAS-PASCUAL R., SALVATI L. 2020. Residential segregation and social diversification: exploring spatial settlement patterns of foreign population in Southern European cities. *Habitat International*, Vol. 101: 102200.

BOLT G. VAN KEMPEN R., VAN HAM M. 2008. Minority Ethnic Groups in the Dutch Housing Market: Spatial Segregation, Relocation Dynamics and Housing Policy. *Urban Studies,* Vol. 45.

CARELLA M., GARCÍA-PEREIRO T., PATERNO A. 2024. Socioeconomic distress and foreign presence in a Southern urban context. The case of Bari. In: POLLICE A. & MARIANI P. (Eds) *Methodological and Applied Statistics and Demography I*, SIS 2024, Short Papers, Conference proceedings, Springer.

CARMO R. M. D., CARVALHO M. 2013. Multiple disparities: Earning inequalities in Lisbon. *Landscape and Geodiversity*, Vol. 1, pp. 36-45.

CASTELLS M., MOLLENKOPF J. H., 1991. *Dual City: Restructuring New York*, New York, Russell Sage Foundation.

DREIER P., MOLLENKOPF J., SWANSTROM T. 2001. *Place Matters: Metropolitics for the Twenty First Century*. Lawrence: University Press of Kansas.

FAINSTEIN S., GORDON I., HARLOE M. 1992. *Divided cities*, Cambridge, Blackwell.

GALSTER G., SHARKEY P. 2017. Spatial foundations of inequality: A conceptual model and empirical overview. *RSF: The Russell Sage Foundation Journal of the Social Sciences,* Vol. 3, No. 2, pp. 1-33.

IMERAJ L., FINNEY N., GADEYNE S. 2020. Demographic Dynamics Across Urban Settings and Implications for Ethnic Geographies. *Population Space and Place*. Article 2391.

LECLERC C. 2021. Immigrants' Earnings and Neighbourhood Economic Wealth: The Conditioning Role of Citizenship. *Journal of Ethnic and Migration Studies*.

LYMPEROPOULOU K., FINNEY N. 2017. Socio-spatial factors associated with ethnic inequalities in districts of England and Wales, 2001–2011. *Urban Studies*, Vol. 54, No.11, pp. 2540–2560.

MALOUTAS T., SPYRELLIS S.N. 2019. Segregation trends in Athens: the changing residential distribution of occupational categories during the 2000s*, Regional Studies*, Vol. 54, No.4, pp. 462-471.

MARCIŃCZAK S., MOOSES V., STRÖMGREN M., TAMMARU, T. 2021. A comparative study of immigrant-native segregation at multiple spatial scales in urban Europe. *Journal of Ethnic and Migration Studies*, pp. 1–23.

MOLLENKOPF J. H., CASTELLS, M. (Eds.). 1991. *Dual City: Restructuring New York*. Russell Sage Foundation.

MUSTERD S. 2005. Social and ethnic segregation in Europe: levels, causes, and effects. *Journal of Urban Affairs*, Vol. 27, pp. 331-348.

MUSTERD S., OSTENDORF W. 2012. *Inequalities in European Cities*, Amsterdam: Elsevier.

OBERTI M., PRÉTECEILLE E. 2004. Les classes moyennes et la ségrégation urbaine. *Éducation et sociétés, 14*(2), 135-153.

OECD. 2018. *Divided Cities: Understanding Intra-urban Inequalities*. Paris: OECD Publishing.

PORTES A., RUMBAUT R. G. 2006. *Immigrant America: A Portrait*. Berkeley: University of California Press.

PISAREVSKAYA A., SCHOLTEN P., KAŞLI, Z. 2021. Classifying the diversity of urban diversities: an inductive analysis of European cities. *Journal of International Migration and Integration*, Vol. 23, pp. 655–677.

REARDON S.F., O'SULLIVAN D. 2004. Measures of Spatial Segregation. *Sociological Methodology*, Vol. 34, 121–162.

TAMMARU T., MARCIŃCZAK S., VAN HAM M., MUSTERED, S. 2016. *Socio-economic segregation in European capital cities. East meets West*. London: Routledge.

TAMMARU T., MARCINCZAK S., AUNAP R., VAN HAM M., JANSSEN H.. 2020. Relationship Between Income Inequality and Residential Segregation of Socioeconomic Groups. *Regional Studies*, Vol. 54 , No.4, pp. 450–461.

VAN KEMPEN R. 2005. Segregation and housing conditions of immigrants in Western European cities. In: Y. KAZEPOV (Ed.) *Cities of Europe: Changing Contexts, Local Arrangements, and the Challenge to Urban Cohesion*, pp. 190-209. Oxford: Blackwell.

VAN KEMPEN R. 2007. Divided cities in the 21st century: challenging the importance of globalisation. *Journal of Housing and the Built Environment*, Vol. 22, pp. 13-31.

YAO J., WONG D. W., BAILEY N., MINTON J. 2019. Spatial Segregation Measures: A Methodological Review. *Tijdschrift voor Economische en Sociale Geografi*e, Vol. 110, pp. 235–250.

Maria CARELLA, University of Bari Aldo Moro, maria.carella1@uniba.it
Thaís GARCÍA-PEREIRO, University of Bari Aldo Moro t.garcia.pereiro@uniba.it
Anna PATERNO, University of Bari "Aldo Moro", anna.paterno@uniba.it

TERRITORIAL DISPERSION AND CONVERGENCE IN INFANT MORTALITY AND ITS COMPONENTS: ITALY 1950- 2019

Cristina Munno, Rosella Rettaroli, Francesco Scalone

Abstract. The steep decline in infant mortality is undoubtedly one of the most significant changes Italy and Europe have experienced during the last centuries. This paper focuses on the temporal and spatial evolution of survival in the first year of life, using Italian provincial data from 1950 to 2019. After World War II to the present, the decline of infant mortality risks was a process that took place with different intensities and speeds among regions and provinces. Nonetheless, the convergence process was slow even continuously in action. This work has three main objectives. First, the timing and distribution over time and by province of the drop of mortality in the first year of life are pictured. Second, we analyse the convergence process at the territorial level together with the persistence and potential concentration of inequality in survival by means of classical measures of dispersion. Third, we control the evolution of neonatal and post-neonatal mortality with a sub-national approach. To achieve these objectives, we make use of a provincial-level database that has so far been little used, and which covers 70 years, from 1950 to 2019.

After providing theoretical explanations about the emergence and the persistence of geographical inequalities in neonatal, post-neonatal and infant mortality, we will show how the geographical inequality follows the North-South gradient, and whether the process of convergence comes to an end for both the component of infant survival.

1. Introduction

In the initial decade of the 21*st* century, Italy achieved one of the world's lowest infant mortality rates. Nonetheless, studies reveal persistent and noticeable spatial variations in infant survival that have endured for a significant part of the 20*th* century (Aleotti et al., 1985; Del Panta, 1990; Pozzi 2000), mostly of whom still unexplained. Italy has a historical background of demographic inequalities, particularly in the socio-economic gap between the Northern and Southern regions, affecting various aspects such as per capita income (Daniele & Malanima, 2007; De Rose & Strozza, 2015), unemployment rates, healthcare quality, and neonatal care and infant survival (Bonati & Campi, 2005; Mazzucco et al., 2011).

Analyzed with high territorial granularity, the history of infant mortality in the country reveals unexpected patterns. In the late 19*th* century, the southern regions (Campania, Abruzzi, and Molise) exhibited lower infant mortality than the northern and central ones (Veneto, Lombardy, Emilia-Romagna, Marche, and Umbria, or rather, in some provinces of these regions) (Bellettini 1987; Del Panta 1990). The literature shows that it is primarily

mortality within the first month of life that underlies the higher risk of death during this period. The causes are likely endogenous, related to maternal health conditions and respiratory system disorders (Pozzi 2000). However, by the 1920s and 1930s, improvements attributed to increased wages and enhanced public and private hygiene in industrialized towns led to a reversal of this trend, portando le regioni meridionali a primeggiare sulle altre (Berlinguer & Terranova, 1972).

Understanding the origins and reasons behind these territorial variations is crucial (Del Panta 1990). Above all, the two components of mortality in the first year of life, neonatal and post-neonatal, may be influenced differently by territorial characteristics and vary spatially (Pozzi 2000; Scalone & Samoggia 2018; Scalone et al. 2017). Then, our focus should necessarily be on disparities between neonatal mortality (0-1 month) and post-neonatal mortality (1 month to 1 year), considering their distinct geographical influencing factors. For endogenous causes, mostly linked to neonatal mortality, the reference is to physical and biological variables of the newborns and the mother (Dalla Zuanna & Rosina 2011). Dealing with post-neonatal deaths, we will mostly refer to exogenous aspects that spatial inequalities, cultural factors, and socio-sanitarian attitudes might influence (Pozzi & Rosina 2000).

Methodologically, we start from the neonatal mortality rate (NMR), postneonatal mortality rate (PMR) and Infant mortality rate (IMR) calculated for all the Italian provinces from 1950 to 2019. The focus is on exploring spatiotemporal trends of sub-national inequalities at the provincial level to identify the existence of a plausible convergence in infant mortality until the second decade of the 21*st* century and how it has been determined by the possible different processes in neonatal and post-neonatal components. We adopted a novel approach for the Italian data to measuring national mortality convergence, making use of a simple but informative measure like the Dispersion Mortality Measure (DMM) calculated for the period from 1950 to 2021 (Moser *et al*. 2005). The DMM quantifies the degree of dispersion that exists at a given point of time in the mortality experiences of a particular country. It is calculated as the average of the absolute difference in mortality, weighted by population size, between every pair of geographical entities. From a descriptive point of view, trends in the DMM indicate global convergence and divergence of the phenomenon under study (Goli et al 2019). We have used also other simple measures of dispersion as the Coefficient of variation.

2. Italian geographical differences in mortality: the state of the art

At the National Unification of 1861, a division among the economically wealthiest and poorest regions, respectively located in the country's northern and southern parts, was already evident. However, on closer inspection, infant mortality presented a more fragmented geographical profile. On the one hand, the Alps and the Apennines Mountain zones registered lower infant mortality than others due to the better environmental conditions and pure water sources. On the other extreme, the populations living in the

marshlands and the malaria provinces experienced the highest infant mortality levels linked to the substantial incidence of gastroenteric and parasitic diseases. Moreover, these high mortality zones were seldom independently located in the country's northern or southern part of the country. (Dalla Zuanna & Rosina, 2011

The disparities in infant survival persisted also during Postwar Italy. Several studies pointed out still evident geographical inequalities both at regional and provincial levels, with the lowest Infant Mortality Ratios (IMRs) registered in northern areas and the highest ones in the more deprived southern provinces (Fantini *et al*., 2005; Lauria & De Stavola, 2003). However, in the decades following the National Unification and during most of the twentieth century, land reclamations, hygienic and sanitary interventions, improvements of the housing conditions progressively reduced the importance of exogenous determinants of infant mortality, removing the most dangerous environmental risk factors.

As research interest in the topic increases, the differences in infant mortality between provinces has also been associated with the general and long-term socioeconomic gaps between Northern and Southern Italy (De Rose & Strozza, 2015), such as wealth inequalities (Materia *et al*., 2005), higher unemployment and lower income levels (Dallolio *et al*., 2013; Lauria & De Stavola, 2003). Moreover, since scarce caregiving to mothers and their babies is one of the leading infant mortality determinants (Scioscia *et al*., 2007; Parazzini *et al*., 1992), the higher IMRs in southern provinces have also been related to delays in the development of neonatal care services (Bonati & Campi, 2005; Mazzucco *et al*., 2011).

Once the environmental and contextual factors had been reduced, one should have expected that spatial inequality in infant mortality diminished consequently with a straight convergence on territorial and spatial dimension (Gächter & Theurl, 2011; Omran, 1998). Persistent disparities in infant mortality in modern welfare states appear then as a puzzling paradox (Mackenbach, 2012). Following Vallin and Meslé (2004), during the epidemiological transition improvements in medical practices produce a first divergence between individuals who can have an immediate access to them and those who exploit this advantage only later. In our case study, geographical disparities in infant mortality could persist because some provinces lagged in introducing advanced techniques and practices in obstetric departments and neonatal intensive units.

3. Data and measures

3.1 Data

Italy represents a positive case for investigating the spatial infant mortality inequalities and convergence. Yearly data, available from the Italian National Institute of Statistics databases (ISTAT), refer to 92 provinces over 67 years (1950-2019). The number and extension of provinces changed along the time interval. Our study maintains the same administrative borders as the initial year throughout the study period. Data consists of

births and infant death counts at age 0 (before one year, before one months and between one month and eleven months) in the *s-th* province for the *t-th* year and are the basis for the computation of mortality indexes. Where data are lacking, they are calculated as averages of the previous and the following year for 1972, 1982, 1984, 1986.

3.2 Measures

As previously stated, we aim to capture whether there is a progressive convergence in provincial infant mortality and when this occurs (Congdon 2001; Congdon et al. 2004).

The mortality indexes we refer to are the Neonatal Mortality Rate (NMR), Post-Neonatal Mortality Rate (PMR), and Infant Mortality Rate (IMR)[1].

Starting from the matrixes of the three rates for 92 provinces from 1950 to 2019, we consider the Coefficient of variation and the dispersion measure of mortality (Goli et al. 2019). The DMM quantifies the degree of dispersion that exists at a given point of time in the mortality experiences of a particular area. It is calculated as the average absolute inter-province mortality difference, weighted by population size, between each pair of provinces. This approach draws on more generic mathematical work on measures of dispersion (Moser *et al*. 2005, Kendall & Stuart 1977).

Changes in the DMM over time indicate whether mortality is becoming similar across the provinces; decreases indicate convergence, while increases indicate divergence.

The formula of DMM is as follows:

$$\mathrm{DMM} = \frac{1}{2(\mathrm{W_Z})^2} \sum_{\mathrm{i}} \sum_{\mathrm{J}} (|\mathrm{M_i} - \mathrm{M_j}| * \mathrm{W_I} * \mathrm{W_J})$$

where i and j are provinces; $1 \leq i$ and $j \leq 92$. *Z* indicates the total aggregate in terms of the entire country or macro-areas when considered. M is the mortality rate, and W is the weight for whom we use the number of live births in each province. Let's either consider that $\sum iWi = \sum jWj = Wz$ where Z is equal to 1.

4. First results

Figure 1[2] represents the provincial distribution of NMR, PMR and IMR in 1950 and 2019. In 1950, the geography of survival in the first year of life is entirely determined by post-neonatal mortality, which explains more than 60% of the rate in the first year of life.

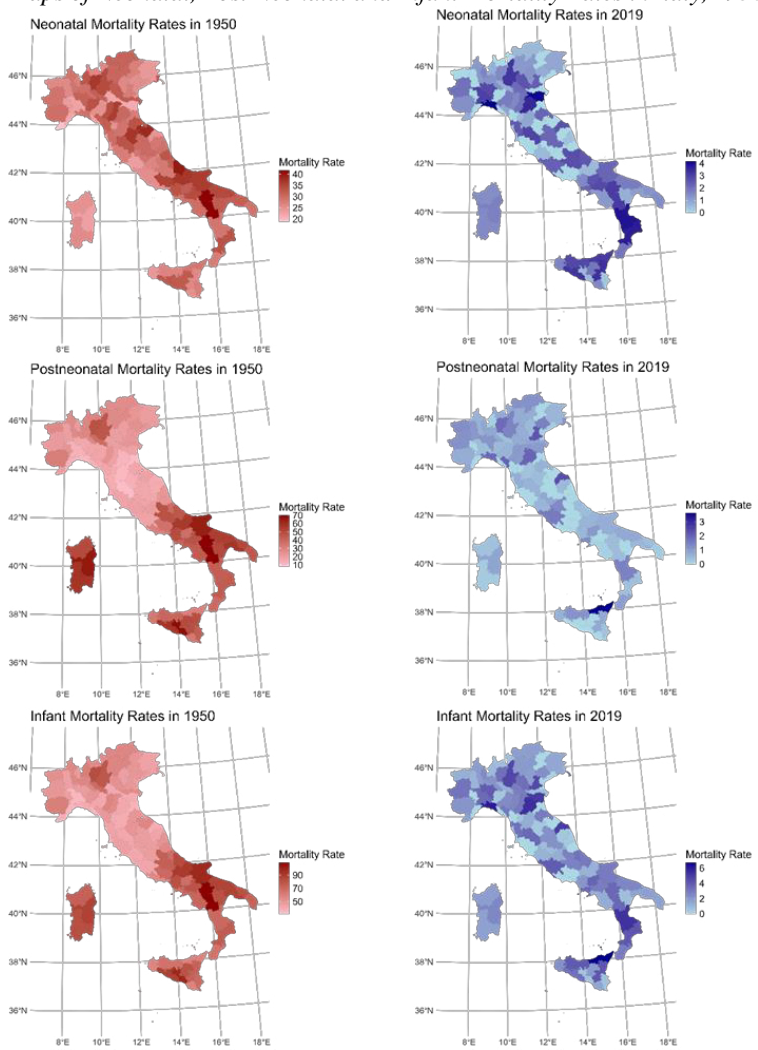
[1] NMR is the ratio between the deaths in the first month of life and the number of live births in the same year. These deaths are considered primarily caused by endogenous components such as traumatic childbirth, congenital malformations, and prematurity. PMR is the ratio of deaths between 1 and 11 months of life and the annual cohort of live births, mainly influenced by exogenous factors related to hygienic and environmental conditions causing infectious and parasitic diseases. IMR combines NMR and PMR and reflects mortality within the first year of life.

[2] In Figures 1 and 2, it is important to note that the scales of the y-axis used to represent the indices are not homogeneous, as their ranges of variation differ significantly. The chosen representations allow for a clearer visualization of the temporal evolution and the variations between provinces.

The highest values are found in the South and Islands, and Italy is clearly divided into two differentiated areas. With a national average of 30‰, values range from 41.7 in the province of Potenza (Basilicata) to 9.41 in Siena (Tuscany). This inequality is no longer visible in 2019 when with a national average of 0.67‰, the provincial distribution is puzzling, with areas of higher intensity no longer concentrated only in the South.

The NMR, on the other hand, shows a more persistent regionalization where southern provinces remain a homogeneous area with higher intensity as the rate diminished from an average around 30‰ in 1950 to 1.46‰ in 2019.

Figure 1 – *Maps of Neonatal, Post Neonatal and Infant Mortality Rates in Italy, 1950 and 2019.*



To observe the existence of a convergence process we plot NMRs, PMRs and IMRs for all provinces in Figure 2[3]. The 92 provinces are indicated by the grey watermarked lines while the solid-colored lines identify the macro-regional (North, Centre, South and Islands) and national trends. All the three panels show the progressive reduction in infant mortality with relevant differences in the speed, time, and geography of decline.

As the time of decline, a joint reading of the three panels shows three phases of evolution. The first one is the 1950-1975 interval. During this period, PMR declined more rapidly than NMR especially in the southern part of the country.

Neonatal mortality shows a slower decreasing trend and a more limited dispersion of provincial levels than PMR. The national NMR index average values reached 30‰ in 1950 and slowed to 16‰ in 1975. Up to the mid-1960s, rates ranged from a minimum of 20 to a maximum of 40‰ and only in 1974 did the South and Island go below the 20‰ level attributable to the North twenty years before. On the contrary, PMR began its intense decline in the 1950s, starting from average values of 37‰ and reaching 5‰ in 1975. In 1951, the index ranged from 87,1‰ at Potenza (Basilicata region) to 8,37 ‰ at Ravenna (in Emilia-Romagna region).

The dispersion of the provinces is at its maximum in the first years of observation, underlining extreme inequalities at a territorial level.

We can place the second period between 1975 and the beginning of the new century. This interval is characterized by the onset of the speediest decrease in NMR and the continuation of the decline in PMR. Neonatal mortality settled below 10‰ for all national areas in 1984, and again, the South with Islands came later in this transition.

PMR is already very low, no more than 2‰, while the more interesting aspect is

the reduction of dispersion, which testifies to a high level of improvement in terms of social well-being. However, the North-South divide persisted: in 1972, the PMR was already below 5‰ for the North and Center while, in the South and Islands, it reached 10,81, going below 5‰ in 1978 when the other areas were just around 2‰.

The last phase can be placed in the 2000s, when PMR has already levelled off around 1,2‰ and NMR continues to reduce. It shows values below 3‰ in 2006. Finally, it should be underlined that for NMR, the presence of dispersion around the average value is more visible than for PMR, a sign of a mortality difficult to defeat.

The general Infant Mortality rate basically is the sum of the PMR and NMR. The neonatal mortality accounted for 45% of the mortality in the first year of life at the beginning of the 1950s, its weight reached 76% in 1975 and maintained the level until more recent years.

[3] See footnote 2.

Figure 2 – *Neonatal, Post Neonatal and Infant Mortality Rates in Italy by Macro-Regions and Provinces, 1950-2019 on primary graphs and 2000-2019 on secondary graphs.*

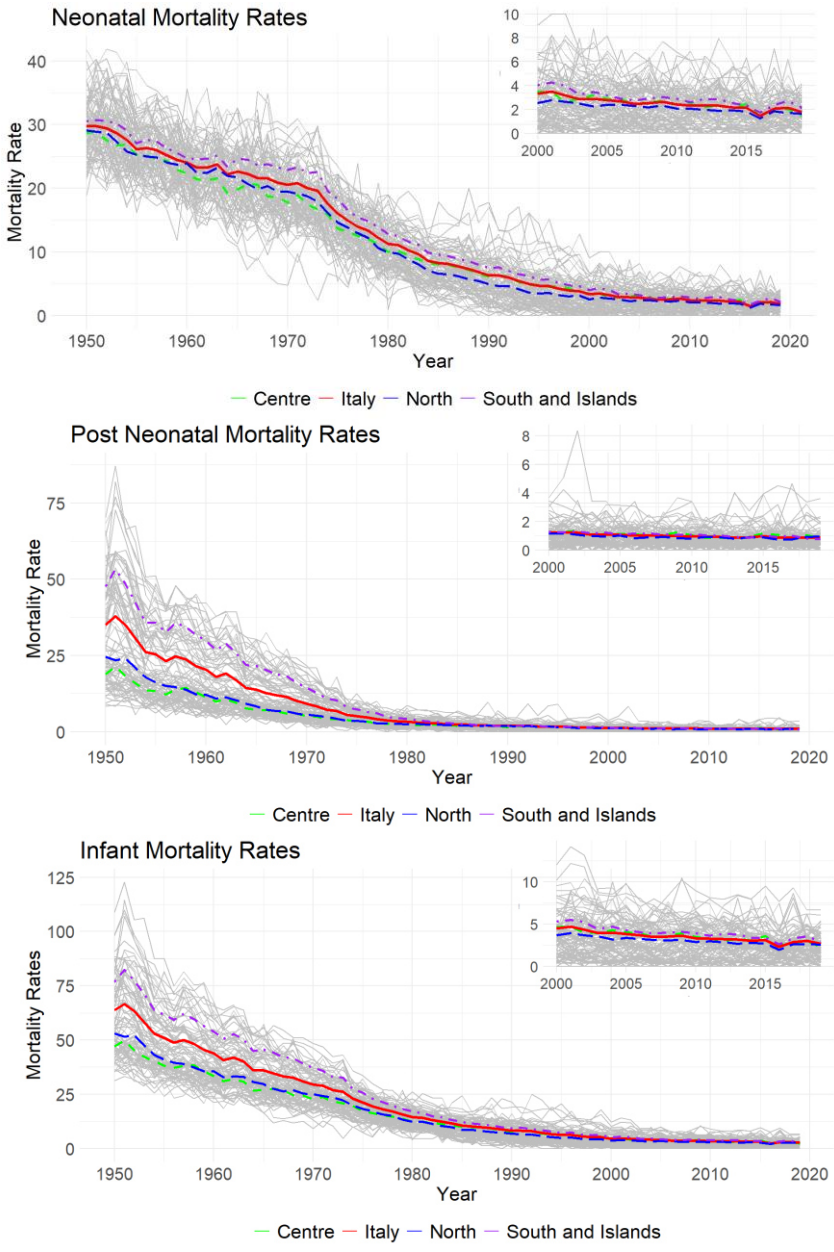


Figure 3 – *Coefficients of variation for Neonatal, Post Neonatal and Infant Mortality Rates in Italy, 1950 and 2019.*

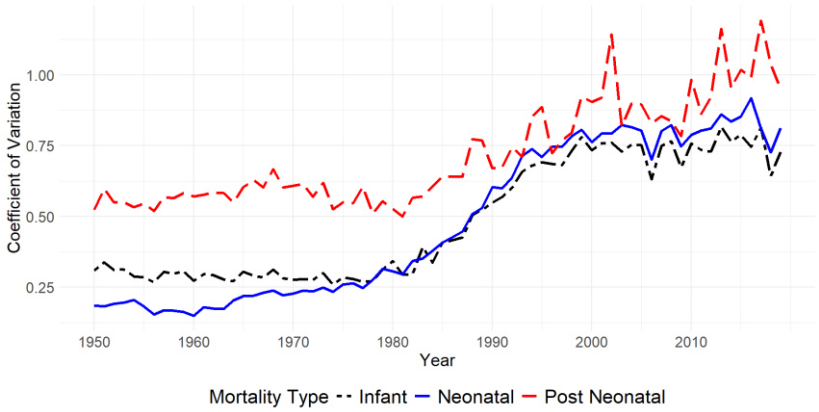
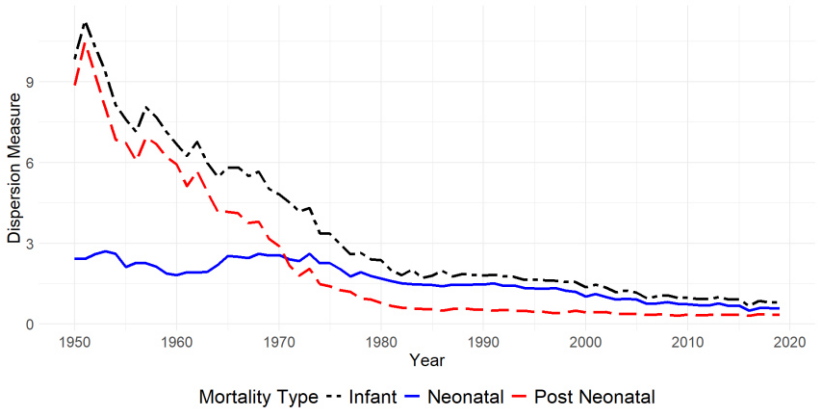


Figure 4 – *Dispersion Measures of Mortality for Neonatal, Post Neonatal and Infant Mortality Rates in Italy, 1950 and 2019.*



The Coefficient of Variation (CV)[4] shows that a higher dispersion around the mean of the post-neonatal mortality (fig. 3) should be expected. This characteristic persists throughout the period under study and, as PMR decreases, the dispersion increases, probably highlighting outliers to be identified.

[4] The coefficient of variation (CV) is the ratio of the standard deviation to the mean. The higher the CV, the greater the level of dispersion around the mean.

PMR appears to have a more significant variability until at least the early 1990s. However, there is a general increase in the coefficients of variation also in NMR.

This trend could be due to the general convergence of a growing number of provinces over time, leaving behind those territories in which aspects of health or environmental deficiencies are more difficult to eradicate.

It is also worth noting that with the decrease in the numbers of deaths and the population at risk (births), we found a more significant variability due to small numbers. That could be observe in the PNM peaks in 2002, 2010, 2013 and 2017.

The convergence process has different times per geographical area (table 1). For post-neonatal mortality the areas of the South and Islands show a greater slowness while the North and Centre accelerate already in the first evolutionary phase, up to 1975. After this date the rapprochement seems to be rapid in all the macro-areas. As for mortality in the first month of life, the central area seems to be the most dynamic in terms of convergence between 1950 and 1975. Starting from the 1980s the process speeds up everywhere, especially favouring the North.

5. Conclusions

This paper examines the evolution of exogenous and endogenous mortality in the transition from high to low infant mortality in Italy at the provincial level. The objective is to describe territorial inequality in increasing child survival and highlight the existence of a robust convergence process in the provinces.

Trends in neonatal, post-neonatal, and infant mortality were affected by a large oscillation in the ‘50s and ‘60s and remained divergent until the ‘80s.

DMM evolution shows that the convergence was rapid between 1950 and the mid 1970s, after it seemed to level and then started again to decrease from the late 1990s, even though more slowly. This trend is closely linked to the different post-neonatal and neonatal mortality trends. The first intense decrease is entirely due to post-neonatal mortality and went hand in hand with improving socio-economic and health conditions. For the neonatal component, the trend contrasts with a first initial convergence followed by a new divergence movement from the mid-1960s until the mid-1970s. A more evident provincial convergence for neonatal mortality began in the late 1990s and has continued until now.

The analysis clearly shows that provinces with the highest infant mortality rates are predominantly located in southern Italy. Given that neighboring provinces often share similar environmental, demographic, and socio-economic characteristics, these differences could be related to unequal standards of neonatal healthcare, which is generally managed locally on an infra-regional scale.

Additionally, changes in reproductive behavior have led to an increase in the age at childbirth, thereby raising the number of high-risk births and premature infants born to older mothers. Stability in these values, where present, is largely due to the different

standards of healthcare established by regional regulations. Extending the excellent medical standards of the Northern provinces to the Southern ones is a difficult mission to accomplish, even in a universal public welfare system like Italy's.

Table 1 – *Dispersion Measures of Mortality (DMM) for Neonatal, Post Neonatal and Infant Mortality Rates in Italy by Macro-Regions and Provinces, 1950-2019 (5-years intervals).*

Anni	DMM - Neonatal Mortality			DMM -Postneonatal mortality			DMM- Infant Mortality		
	North	Centre	South and I.	North	Centre	South and I.	North	Centre	South and I.
1950-54	2.26	2.40	2.54	4.50	3.23	5.24	5.56	4.21	6.62
1955-59	1.93	1.89	2.09	2.41	2.37	3.67	3.62	2.85	4.84
1960-64	1.85	1.52	1.80	1.58	1.61	3.24	2.79	2.41	4.27
1965-69	2.19	1.58	2.45	1.07	0.86	2.66	2.82	1.95	4.26
1970-74	2.06	1.47	2.43	0.88	0.69	1.53	2.70	1.80	3.68
1975-79	1.80	1.28	1.76	0.70	0.64	0.92	2.27	1.68	2.32
1980-84	1.44	1.10	1.30	0.55	0.57	0.50	1.80	1.44	1.52
1985-89	1.25	1.30	1.16	0.60	0.66	0.41	1.77	1.83	1.32
1990-94	1.18	1.60	1.14	0.55	0.57	0.41	1.59	2.03	1.38
1995-99	1.01	1.55	1.09	0.40	0.56	0.41	1.33	2.02	1.33
2000-04	0.78	1.23	0.90	0.38	0.47	0.40	1.08	1.64	1.19
2005-09	0.68	0.94	0.75	0.27	0.41	0.34	0.85	1.29	0.97
2010-14	0.59	0.84	0.65	0.32	0.36	0.34	0.83	1.09	0.85
2015-19	0.48	0.70	0.55	0.30	0.35	0.35	0.68	0.96	0.77
N. Prov.	40	20	32	40	20	32	40	20	32

Acknowledgements

This research was funded by the European Union - NextGenerationEU under the National Recovery and Resilience Plan (PNRR) - Mission 4 Education and research - Component 2 From research to business - Investment 1.1 Notice Prin 2022 – DD N. 104 del 2/2/2022, from "Weather and Climate Vulnerability in Italian Demographic History", proposal code 2022AMC93A - CUP J53D23009270006.

References

ALEOTTI P. CATALDI L., RUGGERO M., SANSONE V. 1985. *Bambini. La condizione dell'infanzia in Italia*, Milano: Federico Motta Editore.

BELLETTINI A. 1987. La transizione demografica dopo l'unificazione, in BELLETTINI A. (Ed), *La popolazione italiana. Un profilo storico*, Torino: Einaudi, pp.156-219

BERLINGUER G., TERRANOVA F. 1972. *La strage degli innocenti indagine sulla mortalità infantile in Italia*. Firenze: La Nuova Italia.

BONATI M., CAMPI R. 2005. What Can We Do to Improve Child Health in Southern Italy? *PLoS Med*, Vol.2, No. 9, e250.

CONGDON P. 2004. Modelling Trends and Inequality in Small Area Mortality. *Journal of Applied Statistics,* Vol. 31, No. 6, pp. 603-622.

CONGDON P., CAMPOS R.M., CURTIS S.E., SOUTHALL H.R., GREGORY I.N., JONES I.R. 2001. Quantifying and Explaining Changes in Geographical Inequality of Infant Mortality in England and Wales since the 1890s. *International Journal of Population Geography,* Vol. 7, pp. 35-51.

DALLA ZUANNA G., ROSINA A. 2011. An Analysis of Extremely High Nineteenth-Century Winter Neonatal Mortality in a Local Context of Northeastern Italy. *European Journal of Population*, Vol. 27, No. 1, pp. 33-55.

DALLOLIO L., LENZI J., FANTINI M.P. 2013. Temporal and geographical trends in infant, neonatal and post-neonatal mortality in Italy between 1991 and 2009. *Italian Journal of Pediatrics*, Vol. 39, No. 19.

DANIELE V., MALANIMA P. 2007. Il prodotto delle regioni e il divario Nord-Sud in Italia (1861-2004). *Rivista di Storia Economica*, Vol. 92, No. 2, pp.267-315.

DEL PANTA, L. 1990, Fattori e condizioni della mortalità tra 1800 e 1930: igiene, salute e ambiente. La situazione in Italia. In SIDES (Ed.), *Popolazione, Società e Ambiente. Temi di Demografia Storica Italiana (Secc. XVII-XIX)*, Clueb: Bologna, pp. 245- 273.

DE ROSE A., STROZZA S. (Eds.) 2015. *Rapporto sulla popolazione. L'Italia nella crisi economica*, Bologna: Il Mulino.

FANTINI M.P., STIVANELLO E., DALLOLIO L., LOGHI M., SAVOIA E. 2005. Persistent geographical disparities in infant mortality rates in Italy (1999–2001): comparison with France, England, Germany, and Portugal. *European Journal of Public Health,* Vol. 16, No. 4, pp. 429–432.

GÄCHTER M., THEURL E. 2011. Health status convergence at the local level: empirical evidence from Austria. *International Journal for Equity in Health*, Vol. 10, No. 34.

GOLI S., MODADHVAJ, CHAKRAVORTY S., RAMMOHAN A. 2019. World health status 1950-2015: Converging or diverging. *PLoS One*: e0213139

KENDALL M, STUART A. 1977. *The advanced theory of statistics.* Vol 1., 4th ed. London: Charles Griffin.

LAURIA L., DE STAVOLA B.L. 2003. A district-based analyses of stillbirth and infant mortality rates in Italy: 1989–93. *Paediatric Perinatal Epidemiology*, Vol. 17, pp. 22–23.

MACKENBACH J.P. 2012. The persistence of health inequalities in modern welfare states: The explanation of a paradox. *Social Science & Medicine*, Vol. 75, pp. 761-769.

MATERIA E., CACCIANI L., BUGARINI G., CESARONI G., DAVOLI M., MIRALE M.P., VERGINE L., BAGLIO G., SIMEONE G., PERUCCI C.A. 2005. Income

inequality and mortality in Italy. *European Journal of Public Health*, Vol.15, pp. 411–417.

MAZZUCCO W., CUSIMANO R., MACALUSO M., LA SCOLA C., FIUMANÒ G., SCONDOTTO S., CERNIGLIARO A., CORSELLO G., LA TORRE G., VITALE F. 2011. A retrospective follow up study on maternal age and infant mortality in two Sicilian districts. *BMC Public Health*, Vol 11, No 817.

MOSER K., SHKOLNIKOV V., LEON D. A. 2005. World Mortality 1950–2000: Divergence Replaces Convergence from the Late 1980s. Bulletin of the World Health Organization, 83, 202–209.

OMRAN A.R. 1998. The epidemiologic transition theory revisited thirty years later. *World Health Statistics Quarterly/Rapport trimestriel de statistiques sanitaires*, Vol. 51, No. 2-3-4, pp. 99-119.

PARAZZINI F., PIROTTA N., LA VECCHIA C., BOCCIOLONE L., FEDELE L. 1992. Determinants of perinatal and infant mortality in Italy. *Revue d'Epidémiologie et de Santé Publique,* Vol. 40, pp.15–24.

POZZI, L. 2000. *La lotta per la vita. Evoluzione e geografia della sopravvivenza in Italia fra '800 e '900*. Forum: Udine.

POZZI, L., ROSINA, A. 2000. Quando la madre lavora: industrializzazione e mortalità infantile nelle province lombarde dall'Unità alla Grande Guerra. In Pozzi, L., Tognotti, E. (Eds). *Salute e malattia fra '800 e '900 in Sardegna e nei paesi dell'Europa Mediterranea*, pp. 153-177, Sassari.

SCALONE, F., AGATI P., ANGELI, A., DONNO, A. 2017. Exploring unobserved heterogeneity in perinatal and neonatal mortality risks: The case of an Italian sharecropping community, 1900–39, *Population Studies,* 71, pp. 23 – 41.

SCALONE, F., SAMOGGIA, A., 2018. Neonatal mortality, cold weather, and socioeconomic status in two northern Italian rural parishes, 1820–1900, *Demographic Research*, Vol. 39, 18, pp. 525 – 560.

SCIOSCIA M., VIMERCATI A., MAIORANO A., DEPALO R., SELVAGGI L. 2007. A critical analysis on Italian perinatal mortality in a 50-year span. European *Journal of Obstetrics & Gynecology and Reproductive Biology*, Vol. 130, No.1, pp. 60–65.

VALKONEN T. 2004. Trends in differential mortality in European countries. In Vallin J. And Meslé F. (Eds). *Trends in mortality and differential mortality*, eds., 185–321. Strasbourg: Council of Europe Publishing.

VALLIN J., MESLÉ F. 2004. Convergences and divergences in mortality. A new approach to health transition. *Demographic Research Special Collection*, S2, pp. 11-44.

Cristina MUNNO, Università di Bologna, cristina.munno@unibo.it
Rosella RETTAROLI, Università di Bologna, rosella.rettaroli@unibo.it
Francesco SCALONE, Università di Bologna, francesco.scalone@unibo.it

VULNERABILITIES IN MIGRATION: THE CASE OF UNACCOMPANIED MIGRANT MINORS IN ITALY[1]

Paola Conigliaro, Francesca Di Patrizio, Rita Serusi

Abstract. Unaccompanied Migrant Minors (UMM) are, perhaps, the most vulnerable among migrants arriving in Europe. That requires institutions to guarantee their safety and adequate reception policies. Since 2012, the presence in Italy has more than quadrupled, raising 23 thousand UMMs at the end of 2023. During the same year, several regulatory interventions were promulgated involving UMMs' reception and placement.
This paper analyses the demographic characteristics, the migratory trajectories, the modes of arrival, the placement and the permanence of the UMMs present in Italy. It mainly refers to data from the Unaccompanied Minors Information System (SIM) managed by the Ministry of Labour and Social Policies. It also outlines the strategies implemented to meet UMMs needs. In fact, thanks to Law 47/2017, Italian legislation is considered one of the most advanced. The article briefly describes what has been achieved and what remains to do to meet the most important needs of UMMs. It is based on the assumption that the presence of UMMs in our country is no longer an exceptional phenomenon.

1. The migration experience and its influence on the life course

Each migrant has a personal history, although influenced by contextual factors affecting wider groups. Some of them need to escape from very harsh conditions (pushing factors) others are following a personal dream or pursue an improvement in their own lives (pulling factors). Most migrants enter Europe through regular channels, but these are not accessible to all. Many migrants have to travel irregularly often facing very dangerous journeys. Particularly in these cases, migration can expose people to risks, misery, exploitation and abuse. Such journeys can last a long time and be so intense emotionally as to remain strongly imprinted in those who undertake them. Children can be particularly hit by those experiences, especially if they have travelled alone or have lost their reference adults during the journey. As the journey can take years, most UMMs arrive close to adulthood but many of them left when they were children or barely teenagers. They thus face a triple transition

[1] The article is the result of the joint work of the authors. §1, 2, 6 are attributed to Paola Conigliaro, §3, 5.2, 7 are attributed to Francesca Di Patrizio and §4, 5.1 to Rita Serusi.

(Ismu Foundation, 2019): 1. from adolescence to adulthood; 2. from their origins to a new life in a different cultural and social context; 3. to overcome the traumas experienced before, during or after the journey.

Becoming adult is not necessarily a linear process. It can undergo shocks, jumps or reversals, especially when it occurs during migration. Furthermore, the passage from childhood to adolescence can take on different meanings depending on the cultural context, the social as well as the material condition at the origin. Migration can be a step towards entering into adult life, contributing to the construction of one's identity and outlining one's sense of belonging to a community. Moreover, arriving in a foreign country means learning or interpreting many codes, not only those of the verbal idiom. The effect is that these young people sometimes find themselves defining the contours of their personal identity precisely when they are subjected to conflicting stimuli. For example, the compliance with codes and rules, the definition of belonging, can be subject to antithetical stresses, becoming a further destabilising element for the minor. Therefore, to overcome the challenges of this complex transition they primarily need, while dealing with new codes, to believe in their own capabilities, to trust in others, to have a vison, a perspective for the future that allows them setting goals and expectations. On these elements they can build, or rebuild, a condition of serenity. A successful transition requires appropriate reception, opportunities for integration into the social context, and personalised support.

Also for this purpose Law 47/2017,[2] has introduced the figure of voluntary guardian that is extremely important for the development of the minor's positive life project. The law also covers some key moments, such as the first reception and the transition to majority.

2. UMMs: Definition, fundamental rights and regulations

The United Nations Convention on the Rights of the Child (1989) recognises the implicit status of children as subjects of law, and not merely as objects of protection and care. Children have general and specific rights: life, health, development, participation, a name, an identity, to be heard, informed and respected, to education, play, family relationships, non-discrimination, international protection, prevention of all forms of exploitation and abuse. The concept of the "Best interests" of the child is paramount in all regulations, decisions and actions concerning the child. According to the Convention, a child is anyone below the age of eighteen.

UNHCR defines "unaccompanied children" those children who have been separated from parents and other relatives and are not being cared for by an adult

[2] Provisions on Protective Measures for Unaccompanied Foreign Minors.

who, by law or custom, is responsible for doing so. The EU Strategy on the Rights of the Child (2021) includes an explicit reference to unaccompanied migrant minors, recognising them as particularly vulnerable due to their migrant status and the absence of parental figures. Several provisions may concern UMMs, e.g. those relating to asylum and international protection.

Italian legislation, with Law 47/2017, is considered one of the most advanced as regards protecting UMMs, addressing the various aspects that affect them in a coherent and comprehensive manner. According to Italian law, UMMs are non-EU or stateless minors who are present on Italian territory without the assistance and legal representation of their parents or other adults legally responsible for them. They cannot be rejected; they have the right to education and vocational training, health, a special residence permit, protection and placement in shelters for minors, reduced time for identification procedures. They should preferably be fostered by close relatives or a family. Article 11 provides for the appointment of trained voluntary guardians instead of institutional guardians. Article 13 defines accompanying measures to the age of majority and long-term integration measures, for instance the extension the protection system by the Juvenile court up to 21 years, new residence permit for study, work or pending employment purposes. Not all provisions of the law have been implemented due to the absence or late promulgation of some implementing regulations.

3. UMMs: Who they are, how many, how and by which routes they arrive

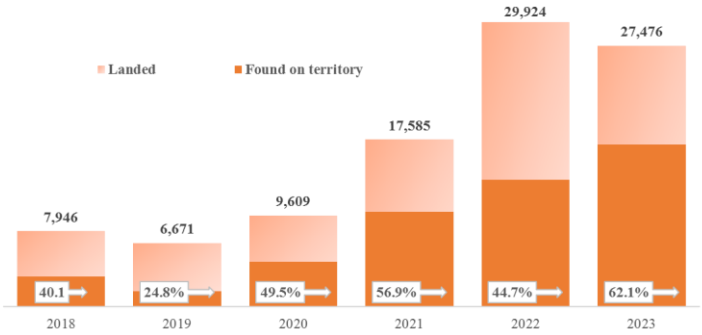
In order to provide effective interventions to support this highly vulnerable population, it is essential knowing the size and characteristics of the phenomenon. The official source referred to in this paper is the National Information System on Unaccompanied Minors (SIM), established by Law 47/2017 and managed by Ministry of Labour and Social Policies. The SIM collects information sent by police headquarters and municipalities on the personal data of minors, their mode of arrival (landed or found on territory),[3] placement and stay in Italy (Ministero del Lavoro e delle Politiche Sociali, 2023).

The presence of UMMs (stock data at December 31st) is strongly influenced by the events occurred over the years. During the period of the so-called "refugee crisis" (2016-2017) there was an increase in the presence of the UMMs (in 2017 they were over 18,000, 3 times the 2012 data), which declined sharply in the next two years, characterized by Italy-Libya agreements. During the Covid-19 pandemic, the

[3] 'Landed' means in this case that the entry is associated with a disembarkation event; 'found on territory' includes minors found in airport or port areas or on Italian territory (border crossings).

presence increase again (+73.5% in 2021 compared to the previous year). At the end of 2022 there was again a significant rise due largely to the arrival of Ukrainian minors fleeing the war that broke out on 24 February (25% of over 20,000 UMMs). On December 2023 there were 23,226 UMMs on Italian territory (a value well above that recorded in 2017), with the number of Ukrainian decreasing by about a thousand. The trend observed suggests that the presence of UMMs in Italy has become structural. It is not only linked to specific events and emergencies.

Figure 1 – *UMMs inflow, by way of access. Years 2018-2023. Absolute and percentage values.*



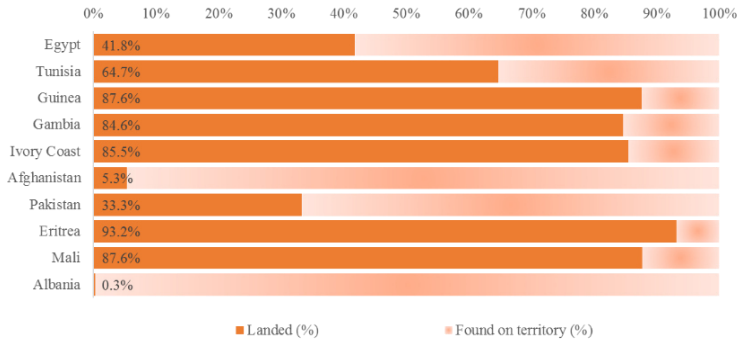
Source: Ministry of Labour and Social Policy

Analysing flow data, available as of 2018, the general trend just described is compounded by different trends depending on the mode of arrival. Figure 1 clearly shows that arrivals by sea are increasing. In the last 6 years about 100 thousand UMMs arrived; those arriving by sea were 57% in 2021 and 62% (17,000) in 2023, when they are more than five times those of 2018. In 2022, despite the increase in land arrivals of minors fleeing the war in Ukraine, landings of UMMs continue to be large (45%). When considering the total landings of migrants on Italian shores (including adults and accompanied minors), UMMs make up 11% in 2023 (since 2016 this share has always been around 13-15%, where in previous years it was around 8%). In the first five months of 2024 arrivals decreased by 41% compared to the same period of 2023, particularly among those landing by sea, even if that remains the most common mode of travel, chosen by 55% of UMMs.

Thinking about the pitfalls of clandestine sea voyages and the number of deaths recorded (Abouelhassan, 2024), even among minors, one realises the huge dangers the UMMs face. In general, UMMs have very specific demographic characteristics, being 97% male and 73% aged 16 or 17. However, considering the country of origin, it is possible to highlight some peculiarities. For example, countries such as Nigeria, Sierra Leone and Eritrea have always had a lower incidence of boys (77%, 85% and 88% respectively in 2023). Ivory Coast and Guinea, on the other hand, are the

countries where the share of younger people under 16 is higher (45.3% and 39.2%). The share of younger people is also higher among those arriving by sea than those found on territory (30.3% vs 21.8%). In 2023 the largest share (18.2%) of UMMs came from Egypt. They are quite 5,000, decreasing on respect to 2022, when they were more than 7,000. Tunisian UMMs were in first place until 2021, they are 14.7% in 2023 (around 4 thousand, +25% compared to 2022). The flow from Guinea quadrupled in a year, and reached 13% of arrivals with around 3,700 minors. Young people from Gambia and Ivory Coast also increase, tripling the former and doubling the latter, with more than 2 thousand arrivals in 2023. In general, all arrivals from other sub-Saharan countries are increasing (in particular from Benin, Burkina Faso, Mali and Sudan), albeit with less significant absolute values. The inflows from South Asian countries (Afghanistan, Pakistan and Bangladesh) continues to decrease, as does from Eastern European countries which in the past were among the first, in particular Albania. In 2022, the escape from the war brought 7,100 Ukrainian UMMs to Italy; they represent 23.8% of the total number of UMMs arriving that year, the second highest number of arrivals per country of origin. In 2023 new entries of Ukrainian minors fell to just over 200.

Figure 2 – *UMMsinflow, by way of access for each citizenship. Year 2023. Percentage.*



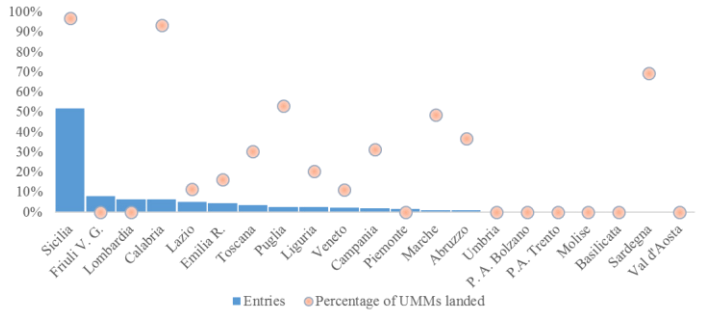
Source: Ministry of Labour and Social Policy

The large group of Egyptian minors choose to cross the Mediterranean Sea in only 42% of cases, while the majority use the Balkan route, increasingly used to enter into the European Union even for UMMs (Fig. 2). This is undoubtedly the main entry route for UMMs from Afghanistan (95% are found at the Friuli border), also chosen largely by those arriving from Pakistan (67%) and to a small extent (35%) by Tunisian minors. A particular case is that of Albanian minors who are often directly accompanied by family members and found in airport areas, seaports or on Italian land territory. Minors from sub-Saharan countries arrive by sea in 80% or more of cases.

4. Impact on the territory

Sicilia, with 13,671 new entries of UMMs in 2023, remains the region with the highest number of arrivals (51%) (Fig. 3). In particular, the region was the first landing territory for more than 80% of minors who arrived by sea in 2023. Nearly 97% of minors arriving in Sicilia were involved in landing events that occurred in several harbours in its territory, mainly in the island of Lampedusa (69% of minors landed in Sicilia), island of Pantelleria (5.4%), Messina (5.3%) and Trapani (4.9%). The main nationalities of minors arriving in Sicilia correspond to the prevailing nationalities of arrivals by sea (Guinea, Tunisia, Gambia, Ivory Coast, and Egypt).

Figure 3 - *Total UMMs entries and incidence of arrivals by sea, by region (*). Year 2023. Percentage.*



(*) The region is the region of arrival
Source: Ministry of Labour and Social Policy

The second region for number of entries of UMMs in 2023 is Friuli-Venezia Giulia (2,204, or 8%). These are always minors found on the territory and, as seen above, they mainly come from Afghanistan, Pakistan and Egypt, but also from Kosovo and Bangladesh. The third region is Lombardia with 1,892 entries (6.7%). The next regions of arrival are Calabria, with 1,690 minors (6.2%) who arrived mainly by sea (94%); Lazio (1,405 or 5.1%) and Emilia-Romagna (1,215 or 4.4%), where the majority of minors were found on the territory (88% and 84% respectively). Comparing entries in 2023 to 2022, only two regions show increasing values: Sicilia (+ 3,883 UMMs) and Friuli-Venezia Giulia (+351). Both regions are border territories: one for minors crossing the Mediterranean, the other for the UMMs crossing Europe following the Balkan route. All other regions in 2023 recorded a reduction in new entries, certainly for the northern regions, such as Lombardia, Piemonte, Liguria, and Veneto, the decrease is mainly attributable to the sharp reduction in Ukrainian minors, while the reduction in entries in Emilia-Romagna is linked to the decrease in Albanian minors. The other region that

recorded a reduction in the entry of UMMs in 2023 by almost 2 thousand is Calabria where the decrease is mainly in landings.[4]

5. Responding to UMMs' needs

5.1. Hospitality and assistance

In order to provide adequate tools for the protection of minors, in compliance with international conventions and our fundamental values, Law 47/2017 dictates specific provisions that represent the regulatory framework for the reception of UMMs and define a system that distinguishes between a first and a second reception.

The law states the establishment of governmental first reception facilities specifically for minors to meet immediate relief and protection needs. The maximum period of stay in such facilities is set at 30 days. For the continuation of the reception, it is provided that all UMMs are accommodate in second-level facilities of the Reception and Integration System (SAI). These must allow the implementation of individual integration projects and the achievement of working, social, and cultural autonomy, until the attainment of the age of majority (including in the following 6 months), unless extended until the age of 21 years to complete the integration path started. In the event of unavailability of places in the facilities of the SAI network, minors are housed in second-care facilities accredited at the regional or municipal level. The recent D.L.133/2023[5] provides, in case of momentary unavailability of reception facilities for minors, the temporary placement of the minor - who on a first analysis appears to be older than sixteen - in facilities for adults, in a specific section dedicated to minors, for a period not exceeding ninety days.[6] There is also a third form of hospitality, foster care, which consists of the service of help and support from a family or a single person: among all the different forms of hospitality, this one comes closest to the *Right of the child to a family.*[7]

In 2023, 59% of the children who entered the country were assigned a place in first reception facilities as their first placement, while 31% of minors were taken in directly by second reception (Fig. 4). In this first stage of reception, minors housed with private individuals approached 10%; in 2022, foster care placement with

[4] Presumably due to the 26 February 2023 boatwreck off the Ionian coast of Calabria (known as the Cutro disaster).

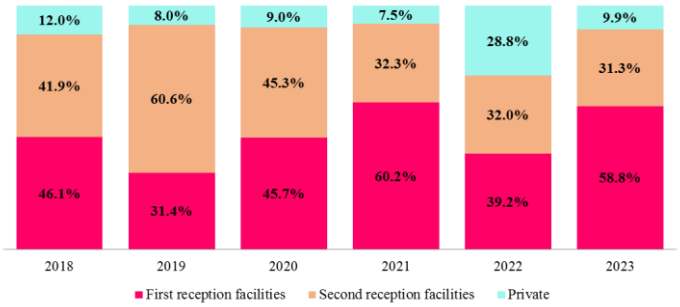
[5] "Urgent provisions on immigration and international protection, as well as for the support of security policies and the functionality of the Ministry of the Interior", converted with amendments by L.176/2023.

[6] As of July 1st 2024, 120 minors were reported to be housed in 20 adult facilities.

[7] Law n. 184/83 regulates the adoption and custody of children.

families was about 29% due to the weight of Ukrainian children who were almost all placed with families (97%). Nearly 70% of minors who arrive in Italy by sea are placed in first reception facilities, this percentage drops to 40% for minors found in the territory.

Figure 4 - *UMMs by type of reception facilities of first placement. 2018 - 2023. Percentage.*



Source: Ministry of Labour and Social Policy

The first reception system dedicated to UMMs remains fragmented in different organizational forms. Only 7% of the minors who arrived in 2023 were placed in government first reception facilities specific for minors, 7% were placed in temporary facilities activated by the Prefects while and 45% of the minors, their first home was in reception facilities accredited by municipalities and regions or in emergency and temporary facilities. In 2023, the average length of stay of minors in first reception facilities was 103 days, well beyond the maximum time stated by law.

The analysis of the placement of minors in second-care facilities also highlights some critical points. The network of the SAI, which should represent the privileged placement for the second reception of minors, despite having registered a gradual expansion in recent years, still has a limited capacity and houses a very small part of UMMs (just over 6,000 places available; Ministero dell'Interno-Anci, 2023). Most of the minors in the second reception are housed in accredited facilities at the municipal or regional level with different specializations, but those with the largest presence of minors are the Social and Educational Communities (13% of minors) and Family Communities (5%). Differently from the SAI system, these facilities often only provide the minor with room and board and just in a few cases they offer activities and services specifically dedicated to the integration of the minor. It should also be noted that in 2023, the average length of stay in second-care facilities was about 4 months. It is a very short time to implement interventions aimed at integrating and accompanying the minor in the transition to adulthood, towards his or her autonomy.

Indeed, the placement of UMMs is not grounded on a single system, but rather on an uncoordinated set of different types of reception places. This produces evident management difficulties for local institutions and has an undeniable impact on the predictability and linearity of the child's path to protection and inclusion. This undermines fairness of treatment and opportunity and have a destabilising effect on minors, operators and the institutions themselves.

5.2. Supporting roles: the figure of the voluntary guardian

Law 47/2017, in order to pursue the supreme interest of the minor more incisively, introduced the figure of the voluntary guardian. This role has so far been the prerogative of institutional figures (social worker or the Mayor of the municipality in which the child is placed). The voluntary guardian, defined as "*l'asse intorno al quale ruota l'intero sistema italiano di protezione e accoglienza dei minori stranieri non accompagnati*"[8] (Di Pascale and Cuttitta, 2019, p. 13) is a private citizen, appropriately trained and certificated, who exercises the legal representation of the minor. The guardian represents and assists the child in all his/her choices, in compliance with his/her abilities, inclinations and aspirations; ensures access to rights without any discrimination; promotes the psychophysical well-being of the child; follows the paths of education and integration; monitors the conditions of reception, safety and protection; administers any assets. The territorial distribution of voluntary guardians is uneven and not always linked to the actual presence of minors. Some regions, since the promulgation of the Law, have been more active than others in launching training courses: among them Lazio, Liguria, Tuscany, Emilia-Romagna and Campania. Training activities decreased over time, drastically reducing during the period of the Covid-19 pandemic. As of December 31st 2022, there were 3,783 voluntary guardians listed in the registers of Juvenile Courts, an increase compared to December 2018 (3,029), the first year in which voluntary guardian was established; in the last year, they grew in particular in Piemonte and Liguria (Agia, 2023).

In 2022, half of the guardians are concentrated in 5 regions: Piemonte (504), Sicilia (457), Lazio (440), Lombardia (375) and Campania (290). The highest number of matches in 2022 occurred in Sicilia and Calabria (among the regions with the highest presence of UMMs in 2022). However in these two regions, as well as in Friuli-Venezia Giulia, Emilia-Romagna and Lombardia, there is a shortage of

[8] [Our translation] The axis around which the entire Italian system of protection and reception of unaccompanied foreign minors revolves.

guardians, compared to the presence of UMMs[9]: the average number of UMMs per guardian is respectively 8.6, 11.8, 10.1, 7.9 and 7.7.

6. The relevance of the time factor for future outcomes

In 2023, 24,375 minors left the hospitality and assistance system: 47.3% due to coming of age and 41.5% due to voluntary leaving. The remaining 11.2% of exit events can be attributed to other reasons such as foster care, tracing of parents or legally responsible adults, assisted voluntary return, relocation, and return home of Ukrainian minors. Voluntary leaving occurs more frequently among those arriving by sea (48.6% vs. 32.5% those found on territory), but above all, it is at the beginning of the reception process that there is the greatest risk of UMMs voluntary leaving. The first 4 months turn out to be crucial: 73% of leaving occurred during this period are due to voluntary leaving. In case of voluntary leaving, the system loses all information about the minor and any ability to intervene in his/her support.

6.1. Coming of age

Reaching the age of majority, the most important guarantees provided for minors cease to apply: the prohibition of refoulement, the right to be placed in appropriate facilities, protection and special procedures for requesting it, education, health. Many UMMs come of age within a few months of entering the reception system. Most of them (64%), had been in the system for less than one year before coming of age, 30% for between one and two years and only 6% for more than two years. The shorter the period of reception, the more difficult it is to build a solid project for remaining in the country, as shown by research on the education and training pathways of UMMs conducted in Milan (Bonomi and Terzera, 2023). Also to overcome this hurdle, the law provides that an UMM who has reached the age of majority may pursue a personal development project until the age of 21. This option, known as "*prosieguo amministrativo*",[10] requires submitting a project assessed and approved by the Juvenile Court. From the age of 18 years of UMMs, legal guardians, whether institutional or voluntary, are no longer responsible for them. Nevertheless, they may play an important role in creating an effective support network for the young adult, both before and after his/her coming of age. Indeed, it is widely recognised that the transition to this new legal status is a delicate moment.

[9] Article 11 of Law 47/2017 states that the individual guardian may "assume guardianship of an UMM or several minors, in the maximum number of three, unless there are specific and relevant reasons".
[10] i.e. administrative continuation - Article 13 Law 47/2017.

At international level, several initiatives exist to support young adults, formerly UMMs. Some projects aim to define and train supportive figures (peers or experienced adults) to act as mentors or social guardians for young people recently of age (Bracalenti and Landi, 2023). They facilitate the creation and consolidation of meaningful relationships, compensating for the lack of social capital, supporting the recognition and development of the young adults' capabilities promoting their self-fulfilment and well-being.

In Italy, there are two National measures for the UMMs' autonomy, promoted by the Ministry of Labour and Social Policy. The first, "Percorsi", is a programme for socio-occupational integration of UMMs and young people up to 24, who have arrived as UMMs. An individual grant provides support services for the enhancement and development of skills, social and labour insertion and orientation towards autonomy. The measure includes six-month traineeships that can be extended for a further six months. Between 2016 and 2020, approximately 2,000 socio-work integration paths were completed. A new call for tenders ('Pathways 4') for 750 dowries closed in June 2024. The second is PUOI (*Protezione Unita a Obiettivo Integrazione* – i.e. protection and integration), project targeting foreign nationals, including UMMs, under international protection, in the framework of the Global Compact on Refugees. The cooperation between the reception system, companies and employment services allowed for the definition of customised integration paths, which included job orientation and a six-month traineeship, as well as additional support measures. Each integration pathway was financed by an individual grant. 3,000 projects were launched between May 2019 and May 2023.

7. Final considerations

The arrivals and the presence of UMMs in Italy have increased over the years, regardless of specific or emergency situations. In particular, arrivals by sea are increasing and are characterised by a greater presence of the youngest and of minors who leave the reception system before reaching the age of 18. On the other hand, the reception system, while showing improvements, is too often unprepared to deal with what has become a structural phenomenon. There are evident organisational and management difficulties, particularly in the areas with the highest number of UMM arrivals (Sicilia and Friuli-Venezia Giulia, but also Calabria). Even the great added value of volunteer guardians is diminished by an inadequate territorial distribution of them and a network of support services that is late in being organised. All this has an impact on the predictability and linearity of the child protection and inclusion pathway, also leading to strong inequalities between children in relation to the opportunities they have the chance to encounter. This is compounded by the urgency

to intervene competently and effectively, as the time before the child comes on age and leaves the statutory protection system is very short. Although the hosting system provided by the law is considered excellent, further efforts need to be made to achieve a functional network capable to respond to the specific and particular needs of UMMs. This, of course, requires an accurate knowledge of the phenomenon, which is useful and necessary for all stakeholders, but especially for policy makers. In order to better identify the needs of UMMs, it is necessary to use, in addition to the data available in the SIM, other data sources (e.g. the Student Register of the Ministry of Education and Merit, the Residence Permit Archive of the Ministry of the Interior) that allow a multidimensional knowledge of the phenomenon and a longitudinal reading of the pathways taken by UMMs.

References

ABOUELHASSAN, R.. 2024. *Middle East and North Africa: Migrants Deaths and Disappearances in 2023.* International Organization for Migration (IOM).

AGIA 2023. V Rapporto di monitoraggio sul sistema della tutela volontaria.

BONOMI P., TERZERA L. 2023. Terzera Learning Performances of Unaccompanied Foreign Minors: a Case Study, *Rivista Italiana di Economia Demografia e Statistica*, Vol. LXXVII No.3 Luglio-Settembre 2023.

BRACALENTI R., LANDI L. 2023. *Coming of age. Il mentoring come strumento di inclusione per giovani con background migratorio*. Torino. Fondazione Hapax, Welcome Refugees Italia, IPRS.

DI PASCALE A., CUTTITTA C. 2019. La figura del tutore volontario dei MSNA nel contesto delle iniziative dell'Unione Europea e della nuova normativa italiana. Diritto, Immigrazione e Cittadinanza Fascicolo No. 1/2019 ISSN 1972-4799, p.13.

ISMU FOUNDATION, 2019. *At a Crossroad. Unaccompanied and Separated Children in their Transition to Adulthood in Italy*. Roma: UNICEF, UNHCR and IOM. ISBN: 9788894432473.

MINISTERO DEL LAVORO E DELLE POLITICHE SOCIALI. 2023. I minori stranieri non accompagnati (MSNA) in Italia, *Rapporto di approfondimento semestrale. Dati al 31 Dicembre 2023*.

MINISTERO DELL'INTERNO-ANCI, 2023. Report annuale SAI- Ed. XXII.

Paola CONIGLIARO, Istat, paola.conigliaro@istat.it
Francesca DI PATRIZIO, Istat, dipatriz@istat.it
Rita SERUSI, Laser Srl, DG Immigrazione, MLPS, RSerusi.ext@lavoro.gov.it

SAMPLING AND CIVIL SOCIETY ENGAGEMENT IN SURVEYING HARD TO REACH POPULATIONS

Eugenia De Rosa, Francesca Inglese

Abstract. 'Hard-to-reach' is a term used to describe sub-groups of the population that may be difficult to reach or involve in research and social statistics. Examples include LGBT+ people, irregular migrants, homeless people and more in general those living in vulnerable social and economic situation and people at risk of discrimination. Invisibility and cumulative disadvantages may characterize hard-to-reach populations. These groups are difficult to identify and recruit, and their sampling frames are usually unavailable. Moreover, official statistics need to gather data that can help to design and monitor policies to combat inequalities, discrimination and disadvantages. The National Statistical Institute of Italy has a long tradition on investigating different hard-to-reach groups. This paper critically analyses these different experiences, focusing on two main aspects: a) sampling techniques and b) civil society involvement. Strengths and limitations, as well as future prospects are discussed.

1. Introduction

The term 'hard-to-reach' populations is often used to describe "underground communities whose members may be reluctant to self-identify and for whom no sampling frame is available or can be constructed" (Raifman, *et al.* 2022) such as LGBT+ people, irregular migrants, people experiencing homelessness, and more in general people in vulnerable social and economic situation and at risk of discrimination. They have different levels of visibility and social recognition related to their marginalized status. Invisibility and cumulative disadvantages may characterize hard-to-reach populations, as well as stigma associated with group membership. This can lead to reticence to participate in research, desire for anonymity (choose not to be identified) and mistrust of social research and statistics. In addition, researchers are rarely members of the community under study.

Defining hard-to-reach populations and sampling strategies are common challenges of this kind of research.

The "Human Rights-Based Approach To Data Collection" (2018) calls for the principle of self-identification: respondents must be placed in a position to choose whether or not to identify themselves as members of certain groups. Ideally, specific questions about protected grounds by international legislation such as sex, age, racial or ethnic origin, religion or belief, disability and sexual orientation should be addressed in surveys targeted to the whole population. While some self-

identification questions and their associated conceptual issues and definitions are clear and data well available in social statistics, as for the grounds of sex, age and disability, there is a need to improve the definitions and data availability for other characteristics, namely, gender identity, sexual orientation, racial or ethnic origin, religion or belief. In addition, extensions beyond the social domain should be considered when relevant, considering social class and cross equality and multiple dimensions.

In terms of sampling techniques these can be placed on a *continuum* from probabilistic to non-probabilistic. The approach most often used to recruit hard-to-reach populations is snowball but for official statistical agencies probability sampling is their preferred tool to meet information needs and make statistical inferences. Common methods for facilitating the participation in surveys, include the use of self-completed questionnaire to ensure maximum privacy of the respondents or questionnaire administered by experienced interviewers with knowledge of the specific populations/phenomena. At the same time different strategies to recruiting enough number of study participants and break down barriers are adopted such as developing partnerships with stakeholder organizations and relationships within the target population, community-engagement activities, including as researchers or surveyors' members of the target population, working with a community advisory board.

The National Statistical Institute of Italy (Istat) has a long tradition on investigating hard-to-reach groups such as homeless, LGBT+ people and other groups at risk of inequality and discrimination. Besides conceptual and methodological challenges, a deep knowledge of the groups investigated and the involvement of civil society emerge as common aspects when designing and producing official data on hard-to-reach populations.

The aim of this article is to critically analyses these different experiences focusing in particular on two main aspects: sampling techniques and civil society involvement, and the interplay between these two aspects. What are the most common samples used? At what stages of the data value chain does the civil society involvement take place? What can civil society do to contribute to the construction of the sample design? Main challenges, strengths, and limitations of designs for surveys of hard-to-reach populations, as well as future prospects are discussed.

Instead, in order to analyse the role of civile society, we start from the "Generic Statistical Business Process Model" that describes and defines the set of business processes needed to produce official statistics, namely specify needs, design, collect, analyse and evaluate. This model is integrated with the UN framework "Harnessing data by citizens for public policy and SDG monitoring" (Pratesi, 2023) that defines citizen's contribution to data as "the engagement of citizens in multiple processes in the data value chain, from specifying needs to use of the data to inform policy… is

increasingly recognized for its unique ability to help overcome many data challenges of our times" (UN, 2022, p. 2).

2. Sampling technique: representativeness and generalizability of results

For sampling purpose, surveying hard-to-reach populations occurs when (Marpsat and Razafindratsima, 2010): the population of interest has a relatively low number of people, which makes a survey of the entire general population very expensive; the members of the target population are difficult to identify; there is no sampling frame or there is only a very incomplete one that produces biased results; the persons concerned do not wish to reveal that they are members of the population of interest, because their behaviour is illicit, because it is socially stigmatised, and for other causes; the behaviour of the target population is not known, which leads to an inappropriate choice of places to interview them, or more in general, an inappropriate choice of method for recruitment. The sampling of hard-to-reach populations partly overlaps with the sampling of rare populations for which the frame is generally unavailable, incomplete or consists of general population lists.

In the latter case, an efficient sampling design that includes specific/rare populations must take into account that in order to have representative samples of these aggregates, a large number of people need to be surveyed. Representativeness may be compromised as the units to be selected is not controlled a priori, making it difficult to define the optimal sample size for the particular domain. Also, the estimates may be biased for differences in the socio-demographic distribution of the target population compared to the general population. One solution to the representativeness issue, as suggested by Kalton (2009) in defining sampling designs for rare populations, might be to start from a large sample to conduct a screening that can generate an adequate sample size for the domain of interest.

Observing hard-to-reach populations often involves a range of solutions based on quantitative and qualitative methods, with non-standard probability sampling techniques based on the locations frequented by the population (location/venue based sampling, time location sampling, centre sampling, capture-recapture) or their social network (respondent driven sampling - RDS) and non-probability sampling techniques based on social network or other (snowball, network sampling, convenience or random sampling, voluntary sampling, quota sampling, web panel, etc.).

The absence of 'lists' of people raises some important questions, primarily on how to construct a frame of reference population for the design of probability samples when possible or how to reach the population of interest through different techniques in such a way that statistical representativeness is guaranteed.

Sampling techniques based on the locations require the construction of lists: depending on the type of information available on the frame it is possible to refer to

different techniques. In the case of the homeless population, for example, an indirect sampling design (Lavallée, 2007; Deville and Lavallée, 2006) that uses the list of services provided in centres for the homeless can be used as a sampling frame. Indirect sampling strategy exploits the link that exists between the target population and services for obtaining the final weight of homeless person based on the probability of inclusion of the selected services and the total number of service links with the user. Other approaches that count homeless people in the places they frequent, such as the point-in-time census (Boeri *et a*l., 2009), can indeed provide a framework to define sampling techniques for a subsequent survey with interviews. The indirect sampling produces correct estimates, only the coverage of the part of the homeless population that does not use services may be affected. The point-in-time census does not ensure a complete and accurate count of the population for areas not covered because inaccessible or unknown (under-coverage) and the inclusion of people who are not homeless or are counted several times (over-coverage): errors in the count, and hence in the frame, will affect the final sample estimates. From an inferential point of view, the effectiveness of such approaches depends on the completeness of the locations list and the possibility of using probabilistic selection methods.

Sampling techniques, which exploit the social network of the population of interest, through a snowball type recruitment, allow to build a list from scratch or to build a larger one. These techniques move between probability and non-probability sampling depending on the type of population, the research question and objectives; also include a variety of procedures different for a series of elements, such as the methods of choosing the people who are part of the initial group/sample, the methods of recruitment and selection of the people who gradually enter the sample. RDS is an example of probability sampling that combines the snowball technique with a mathematical model that formalises the recruitment process as a Markov chain (Heckathorn, 1997, 2002; Crawford *et al*., 2018). The recruitment process evolves in waves generated by the initial recruiters, selected non-randomly on the basis of the criterion of differentiation and ability to recruit. The data collected during the sampling process are used to make inferences about the structure of the social network and to obtain unbiased estimates. The applicability of the RDS may be limited by the strict assumptions required to achieve the desired inference results that are not easily verifiable a priori. Some conditions can be verified by information obtained from respondents, such as the dimension of their social network or the reciprocity of links between recruits and recruited.

In general, these techniques are characterized by complexities linked both to the definition of the probability of inclusion of the sampling units and to the estimation phase in which the risk of multiple counting of the units must be faced, the same individuals can be indicated by different networks or frequent more places.

In order to derive conclusions about the population from the sample and to obtain generalizable results, it is necessary to assume that the sample is representative of the population of interest. In non-probability sampling - that constitutes a quick, easy and inexpensive way of obtaining data - the assumption of representativeness for the generalisation of results is a risky, as it is difficult to assess its validity. There is no way of estimating the inclusion probability of a unit and is no certainty that unit has a chance of being included, making it impossible to estimate sampling variability or identify possible bias. Statistical representativeness is an unattainable goal when using non-probability techniques, but it can also be a problem when using non-standard techniques based on places attended or social network. The representativeness can be compromised by partial coverage, e.g. when people who do not attend venues intended for the population are excluded, when using a web-based survey technique or survey techniques that are too invasive of people's privacy. Also in techniques based on social network, "the representativeness of the sample is conditioned by the way in which individuals are recruited" (Caputo 2013).

3. Non-probability vs probability sampling techniques

Probability sampling is the preferred tool adopted by statistical institutes to produce official statistics. In recent years, research on the use of data generated by non-probability sampling techniques for the production of official statistics has been increasingly explored (Kalton 2023, mainly thanks to the diffusion of big data. The use of alternative sources in official statistics has led to a paradigm shift and a change in the traditional approach to statistics. However, data from non-probability sources pose some challenges in terms of data quality, including the potential presence of participation and selection biases: data collected should be used with greater caution.

In non-probability samples, the degree to which certain forms of bias occur can greatly affect the accuracy of the results; the efficiency of inference is not guaranteed by a theoretical-mathematical basis but depends exclusively on the correct specification of models defined on untestable assumptions on the phenomenon and on the similarity between the sample and the population; the presence of selection bias makes these hypotheses dangerous. To generalise the results to the whole population, it is necessary to use probability sampling or integration techniques.

In adopting non-probability sampling techniques, specific strategies can be implemented at the sampling stage to reduce potential bias, e.g. by drawing the non-random sample from a large panel of volunteers, taking care to ensure that there is a match of characteristics between sample units and those belonging to a probability sample selected from a frame covering the same reference population.

In the data processing phase, various methods can be used to correct or reduce the effects of bias in the results, thereby making the inferential process more reliable and increasing the external validity of a survey. In general, estimation methods from

non-probability samples refer to integration techniques that use weighting or predictive approaches. Weighting approaches (calibration, propensity score adjustment, statistical matching) attempt to reduce selection bias and coverage problems by manipulating the data so that the sample comes to resemble the population in the distribution of covariates. Predictive approaches fall within the framework of super-population models. They treat the analysis variable as if it had been generated by a model specified on the basis of the data collected from the non-probability sample. The values of the auxiliary variables must be known not only for the sample units but also for those of the target population, or at least the totals. Common to the different approaches is the use of auxiliary information observed in the non-random sample, including at least the totals (or averages) in the target population, the values for each unit in the target population, and the values for each unit in a reference probability sample. Data may be obtained from official statistics or high-quality probabilistic surveys. It may be necessary to conduct parallel probabilistic surveys in order to detect more relevant variables for the integration.

4. Istat experiences: Surveying Homeless People

In Italy, research on people living in extreme poverty was carried out in 2011 and 2014 by Istat - in agreement with the Ministry of Labour and Social Policies, the Italian Federation of Organisations Working with the Homeless (fio.PSD) and Italian Caritas - and led to a national estimate of the homeless population (De Vitiis *et al*., 2014). In 2014, an experimental survey was carried out only in the city of Turin to estimate also the part of the population that does not use the services.

The surveys were based on the system of services used by homeless people. This made it possible to adopt a location sampling design referring to the theory of indirect sampling: in the national surveys the services were represented by soup kitchens, lunch and dinner places, and night shelters, while in the experimental survey conducted in Turin in 2014, they were services provided in public spaces by street units that carry out rescue and support activities for people in a state of social marginality (Inglese and Masi, 2019). The information on services were collected through censuses carried out prior to the implementation of the surveys, which provided the necessary information base for the development of the indirect sampling methodology. Starting from existing archives, the complete mapping of services was carried out using the snowball method, through a survey network selected by fio.PSD and composed mainly of operators in the sector. The list of street unit services was updated in 2014 from the previous complete mapping of services through interviews conducted with street unit managers. The censuses made it possible to build up a picture of the system of services provided by private and public organisations to people living in a state of social marginality, including the structures that operate "on the street". The definitions of "street unit" and "home service"

(services/support action distributed by street units in public spaces at the same time) provided the basis for applying the same methodology used in the national survey. For the city of Turin it was possible to obtain an overall estimate of homelessness.

In 2023, Istat provided support for the implementation of a survey of the homeless people in the city of Rome, in collaboration with Roma Capitale. The "Notte della solidarietà survey" (a point in time survey) was carried out on the evening of 20 April 2024, and counted people sleeping in the overnight shelters and on the streets, by means of a short web questionnaire that captured some of their basic characteristics. Difficulties in measuring homelessness lay in how to reach them but also in the lack of a definition on which living conditions may lead to consider a person as a homeless. More than 1700 volunteer surveyors (from associations, universities and citizens) participated in the night survey. Volunteers, organized in teams, were in charge of conducting the survey on the street, while the survey in the night shelters was carried out by the people in charge of running these facilities. The pilot survey (2023) showed how in point-in-time approach to investigate homelessness, training of non-professional surveyors is fundamental in approaching homeless people but also a critical issue, to guarantee the quality of data. Therefore, for the finale survey, a more targeted training on the questionnaire was designed for a more professional approach, and an increased care in the team composition by providing for each team at least one student, always keeping a gender balance. The involvement of civil society was crucial, also in terms of socio-cultural impact on the representation and knowledge of homeless people (Table 1).

Table 1 – *Sampling strategies and civil society involvement in the Istat and Istat-Roma Capitale surveys on homeless people (2011, 2014, 2024).*

Target	Sampling	Civil Society Engagement
Homeless people who frequent services (soup kitchens, night shelters) (2011, 2014)	Non standard probabilistic **Design**	▪ Fio.PSD, the Italian Caritas and surveyors from services **Collect**
Homeless people in Rome (2024) sleeping rough and in overnight shelters	Homeless Census – Point in Time **Collect**	▪100 associations and entities, 6 Universities and citizens ▪ 1,700 volunteers and state workers spend the night walking the streets of Rome to make a count/survey **Disseminate and Trust**

In 2024, Istat launched a project for the continuous monitoring of extreme poverty, which involves numerous research activities and types of surveys. The survey on homelessness in the 14 metropolitan areas of Italy is currently being carried out. The approach used is the point-in-time census (shelter and street night)

followed by a sample survey with in-depth thematic interviews. Istat investigated also the severe housing exclusion of Roma people within a project carried out in collaboration with the National Antidiscrimination Office (Unar), during the period 2018-2023 (Di Leo and Nur, 2023).

5. Istat experiences: Surveying Group at risk of discrimination

To date, Istat adopted two main strategies to investigate the condition of groups at risk of discrimination, by introducing self-identification questions into (a) Discrimination surveys targeted to the whole population and (b) Surveys targeted to specific population such as LGBT+ people.

In 2011, Istat addressed for the first time issues related to diversity in terms of sexual orientation and gender identity with the "Survey on Discriminations by Gender, Sexual Orientation and Ethnic Origin" (Istat, 2013). The survey, CAPI (mandatory) and with an optional paper self-administered questionnaire, included questions on sexual orientation which allowed to provide a first estimate of the homosexual and bisexual population in Italy. However the limited sample size (7,725 individuals aged between 18 and 74) did not allow for estimates on some specific groups at risk of discrimination as for transgender people or bisexual man and women. In view of the new edition of the Discrimination Survey (2025), the mode technique was redesigned as well as the sample size of the whole population - about 50 thousand people. At the same time updated and more self-identification questions have been introduced. This opens up an interesting scenario in terms of estimation possibilities as well as corrections of results from non-probabilistic sample surveys.

In general, the involvement of civil society was on the questionnaire design of the first edition of the survey. In 2018, Istat dealt with these issues again in the framework of a collaboration agreement signed with Unar to fill an information gap on LGBT+ populations. The Istat-Unar project "Labour discrimination against LGBT+ people and diversity policies" (2018-2023) is characterized by a mixed method approach (probabilistic and non-probability sampling technique; qualitative and quantitative tools), multiple perspective approach (LGBT+ people, employers, stakeholders) as well as a participatory approach with the interaction of experts, academics and LGBT+ associations (De Rosa and Inglese, 2018). It included the direct collection of information from LGBT+ people and from employers, particularly enterprises, and the main stakeholders. Three CAWI surveys based on a web self-completed questionnaire were carried out on three different target groups of LGBT+ people (people in civil union, LGB people not in civil union, trans and non-binary people) using different sampling strategies. The first two surveys mainly focused on aspects related to sexual orientation; the third focuses on gender identity issues. Self-identification of respondents as LGBT+ was a key principle adopted.

SOGIESC (sexual orientation, gender identity and expression and intersexuality) indicators were gradually tested and introduced into the three surveys.

The project included surveys both with standard and non-standard sampling techniques. The most robust survey was on People in Civil Union or formerly in union because a list was available. A second survey, addressed to LGB people who have never been in Civil Union, was carried out in 2022 with a snowball technique, the web-RDS. Fifty LGBT+ associations throughout the national territory identified first respondents ("seeds") belonging to the population target, and respondents played an active role in recruiting (at least 4 people). After an established time passed from the beginning of the survey, there was evidence that the RDS snowball technique was not working properly. In order to go on with the work, the option of a convenience sample was considered since it could anyway provide interesting and qualitative information on the target population of homosexual and bisexual persons. Finally, a survey on "Labour Discrimination against Trans and Non-binary people", based on a convenience sampling, was carried out in 2023. Questions on gender identity allow to identify the target population. Table 2 shows LGB participant distributions in Istat-Unar surveys and EU FRA LGBT II survey 2019 for Italy.

Table 2 – *Main LGB target profiles.*

Survey	Lesbian	Gay	Bisexual Women	Bisexual Men
Istat-Unar 2020-2021	5,828	13,162	847	352
LGB in Civil Union	(28.9%)	(65.2%)	(4.2%)	(1.7%)
Istat-Unar 2022	282	640	166	71
LGB not in Civil Union	(24.3%)	(55.2%)	(14.3%)	(6.1%)
FRA 2019	1,853	4,789	1,481	627
LGB Sample size (unweighted)	(21.2%)	(54.7%)	(16.9%)	(7.2%)

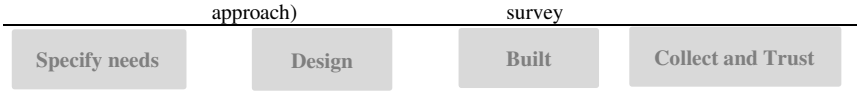
Definitions and indicators provided in the questionnaire where discussed and shared with LGBT+ associations and LGBT+ people but also with experts, academics and other stakeholders (e.g. enterprises' associations, trade unions, networks of LGBT+ workers etc….) were also involved (design phase). Self-identification questions were developed consultation with civil society. Civil society was involved in different stages of the surveys and its role was crucial in defining-recruiting-data collection operations (Table 3).

The engagement was also in the build phase: associations and other civil society actors tested and gave feedback on the questionnaires developed for the different project surveys. Another contribution came from respondents' remarks in open questions within the surveys. In this sense a participatory approach increased the validity of data. Regarding the collection phase, in all three surveys civil society foster the participation of target populations and create a climate of trust in official

statistics. In addition, for the survey with RDS technique respondents played a crucial role in recruitment.

Table 3 – *Sampling strategies and civil society in the Istat-Unar project "Labour discrimination against LGBT+ people and diversity policies" (2018-2023).*

Target	Sampling	Civil Society Engagement
People in Civil Union or formerly in Union	Census over 21,000 respondents aged 18 and over ▪Self-identification questions on sexual orientation	▪Working groups with stakeholder, LGBT+ associations, experts and consultation with LGBT+ people
LGB People who have never been in Civil Union	▪ 1,159 respondents aged 18 and over ▪ Self-identification questions on sexual orientation and (testing) gender identity	▪Working groups ▪Associations and respondents: recruiting and dissemination of the survey
Trans e no-binary people	▪Self-identification questions on gender identity (2 step approach)	▪Working groups ▪Associations: dissemination of the survey



However, this experience showed the importance to qualitative approaches in order to deepen the contextual knowledge about the network of the population (more formative study). At the same time the involvement of association and civil society was not enough to ensure the participation of well-connected members of the target population to serve as initial participants or aid rapport-building to increase the likelihood of people participating in the study.

6. Future prospects and conclusions

At European level, the EC calls for a national strategy for equality data and, at the same time, Eurostat is working on equality and non-discrimination statistics toward a harmonization of concepts and classifications. The introduction of self-identification questions about sex/gender, racial or ethnic origin, religion or belief, disability, age and sexual orientation in surveys with large samples is the ideal for investigating groups at risk of discrimination. This is not always possible, and in addition, this is not appropriate for specific groups such as Roma and homeless People that require ad hoc sampling strategies and surveys.

The Istat' tradition in surveying hard-to-reach groups underlines that integration techniques and other ad hoc solutions need to be found to obtain in-depth information on the target group of the population. Quantitative and qualitative methods, which can respond to different research needs, should be able to go together, and probability sampling can help correct various forms of bias (potential presence of participation and selection biases) that affect non-probability sampling. Data from non-probability sampling pose some challenges in terms of data quality, the accuracy and generalisation of the results to the whole target population, need to adopt integration

techniques based on the use of auxiliary information observed in the non-random sample and in high-quality probabilistic surveys, or know from censuses, administrative or demographic sources and others official statistics. Parallel surveys to detect variables relevant for integration may need to be conducted.

More generally, the design of surveys on groups at risk of discrimination could benefit from programming discrimination survey design for correcting estimates of subsequent surveys on specific groups (such as LGBT+) based on non-probability sample (integration techniques); using longitudinal big datasets to follow the same group of people over time or asking the same questions to representative groups of different people over time (i.e., panel studies - non-representative sample, but generalizable results tank to the possibility of identifying the temporal order of the variables); programming dedicated surveys to reach small groups; defining a good recruitment strategy and variables/indicators and paradata useful for the explanation of the specific group' survey participation.

The participation of civil society often serves as a bridge to define sampling strategies, but its role is not limited to this phase. Istat' experiences show how the involvement of civil society can cover different steps such as specify needs and questionnaire design, organizational aspects and research infrastructure, data collection and dissemination. Even citizens can be surveyors as in the case of homelessness surveys. This leads to pushing the methodological debate more systematically in analysing wow does a participatory approach affect the quality of data, considering the different step of the process needed to produce official statistics. The exchange of experiences between countries and the provision of tools to evaluate and monitoring such aspects would be very useful, keeping in mind also how civil society can use these data to foster social change, disseminate socio-cultural meanings supporting alternative narratives of the social reality (Milan and van der Velden, 2016, p. 67).

References

CRAWFORD F. W., WU J., HEIMER R. 2018. Hidden population size estimation from respondent-driven sampling: a network approach, *J Am Stat Assoc*. Vol. 113, No. 522, pp. 755–766. doi:10.1080/01621459.2017.1285775

BOERI T., BRAGA M., CORNO L. 2009. L'economia invisibile dei senza casa. in GNOCCHI R. (a cura di), *Homelessness e dialogo interdisciplinare. Analisi a confronto tra modelli diversi*, Roma: Carocci.

DEVILLE J.C., LAVALLÉE P. 2006. Indirect Sampling: The Foundation of the Generalized Weight Share method, *Survey Methodology*, Vol. 32, No. 2

DE ROSA E., INGLESE F. 2018. Diseguaglianze e discriminazioni nei confronti delle persone LGBT: quale contributo della statistica ufficiale?, *RIEDS,* Vol. LXXII, No. 4, pp.77-88.

EU LGBTI Survey II. 2019. https://fra.europa.eu/en/project/2018/eu-lgbti-survey-ii
HECKATHORN D. D. 1997. Respondent-Driven Sampling: A New Approach to the Study of Hidden Populations, *Social Problems*, Vol. 44, No. 2, 1 pp. 174–199.
HECKATHORN D. D. 2002. Respondent-Driven Sampling II: Deriving Valid Population Estimates from Chain-Referral Samples of Hidden Populations, *Social Problems,* Vol. 49, No. 1, pp. 11-34. Oxford University Press.
INGLESE F., MASI A. 2019. Una metodologia per la stima della homelessness attraverso le Unità di strada: il caso della città di Torino, *IWP*, N. 5.
ISTAT. 2014. Indagine sulle discriminazioni. Anno 2011.
ISTAT. 2021. Abitare in transizione.
ISTAT-UNAR. 2022. Survey on Labour Discrimination toward LGBT+ People (in Civil Union or formerly in union). Year 2020- 2021.
ISTAT. 2022. Pilot Survey on Discrimination (2022-2023).
ISTAT-UNAR. 2023. L'indagine sulle discriminazioni lavorative nei confronti delle persone lgbt+ (non in unione civile o già in unione). Anno 2022.
ISTAT, COMUNE DI ROMA. 2024. I senza tetto a Roma, press release.
KALTON G. 2009. Methods for oversampling rare subpopulations in social surveys. *Survey methodology*, Vol. 35, No.2, pp. 125-141.
KALTON G. 2023, Probability vs. Nonprobability Sampling: From the Birth of Survey Sampling to the Present Day, Statistics in transition new series, Vol. 24, No. 3, pp. 1–22, https://doi.org/10.59170/stattrans-2023-029
LAVALLÉE P. 2007. *Indirect Sampling*. New York: Springer.
MARPSAT M., RAZAFINDRATSIMA N. 2010. Survey methods for hard-to-reach populations: introduction to the special issue, *Meth. Innovations Online*, 5(2).
MILAN S., VAN DER VELDEN L. 2016. The Alternative Epistemologies of Data Activism, *Digital Culture & Society*, Vol. 2, No. 1. pp. 57-74.
NUR N., DI LEO F. 2024. Reaching the unreachable. Innovative strategies to approach hard-to-reach populations, *RIEDS*, Vol. 78, No. 2, pp. 41-51.
PRATESI M. 2023. Towards A Framework To Harness Data By Citizens: The Istat Experience, presentation 64th ISI World Statistics Congress - Ottawa, Canada.
RAIFMAN S., DEVOST M.A., DIGITALE J.C. 2022. Respondent-Driven Sampling: a Sampling Method for Hard-to-Reach Populations and Beyond, *Curr Epidemiol Rep*, Vol. 9, pp. 38–47.
UN Office of the High Commissioner for Human Rights. 2018. A human rights-based approach to data

---

Eugenia DE ROSA, Istat, eugenia.derosa@istat.it
Francesca INGLESE, Istat, fringles@istat.it

LABOUR MARKET PARTICIPATION OF SECOND-GENERATION YOUTH IN ITALY

Ivana Fellini, Francesca Megna

Abstract. As second-generation youth are just beginning to enter the labour market in Italy, there is a significant knowledge gap on their labour market outcomes. As regards participation, an important dimension of economic and social integration of youth, second generations might be affected by the same widespread discouragement experienced by youth with no migratory background, even worsened by a more difficult access to employment and/or discrimination. Conversely, they could develop a strong labour market attachment due to ethnic disadvantage in accessing higher education and/or different expectations and aspirations.
Using the "decimal generations" framework to define second generations, the article explores the differences in the composition of youth with and with no migratory background by labour market status, focusing on being a student as a special condition of youth inactivity and on being active in the labour market.
The analysis builds on the ISTAT Labour Force Survey that since 2021 has released information on the country of birth of the respondent's parents thus allowing the identification of second generations both in the strict, i.e. the country-born children to at least one foreign-born parent, and extended sense, i.e. the foreign-born who arrived in Italy as children, while previous studies have mainly used respondents' citizenship. Multivariate models are run to control for socio-demographic composition effects and results show that country-born second generations have outcomes similar to those of the youth with no migratory background. In contrast, the 'in-between' generations -the foreign-born who migrated as children or young adolescents- are less likely to be students but are more likely to be active in the labour market than youth with no migratory background. The analysis then highlights a clear-cut difference between the country-born and the foreign-born children of immigrants.

1. Second generations[1] in the Italian labour market: an opening area of study

Research across Europe has shown that young people frequently face labour market exclusion, experiencing unemployment and periods of not being in employment, education, or training (NEET). Low youth participation is a structural feature of the Italian and other Southern European labour markets (for a review, see Unt et al., 2021). However, little is known about the labour market participation of second generations and, more generally, about their insertion into the Italian labour market as it represents an opening area of study. While a growing body of studies on second generations' presence and performance in the school system is developing also in Italy (for a review, see Ambrosini and Pozzi, 2018), their outcomes in the labour market are still understudied (Gabrielli and Impicciatore, 2022). This dearth of literature is primarily due to "historical" reasons. Contemporary migration to Italy is a relatively "recent" phenomenon that differs significantly from the previous waves of migration to Northern and Continental European countries. In a rapid transition, Italy, like the other Southern European countries, transformed from an emigration country into a major destination country (King et al., 2000). Only in recent years, the numbers of second-generation youth entering the labour market have become notable. This modest presence of second generations in the Italian labour market is also characterised by a strong prevalence of boys and girls of very young age (ISTAT, 2020). Moreover, data shortcomings have made it difficult so far to identify properly second generations as information on the country of birth of both individuals and their parents is needed but it is rarely available.

If the classical assimilation theory holds true, the ethnic penalty experienced by first-generation migrants should not extend to second generations (Park, 1950: Alba and Nee, 1997) since intra and intergenerational mobility should occur with time (Chiswick, 1977). However, the segmented assimilation hypothesis stresses that the interactions between the characteristics of immigrant groups and the conditions of the receiving context (the socioeconomic context, social networks, and discrimination) may shape divergent and paradoxical paths with only partial or segmented assimilation (Portes and Zhou, 1993)[2].

It is difficult to advance hypotheses on the Italian case but the empirical evidence for Western European receiving countries suggests that, among the "children of immigrants", assimilation is not complete, and penalization persists. Evidence on Central and Northern "older" receiving countries has found that while first-

[1] The term second generations -in a plural noun- includes both country-born youth with one or both migrant parents and foreign-born youth who migrated as children or adolescents (Demarie and Molina, 2004)

[2] The full cultural assimilation could result in a lack of economic incorporation, and conversely, a lack of cultural assimilation - and the preservation of ethnic identities - could lead to full economic incorporation and success (Portes and Rumbaut, 2001; Portes and Zhou, 1993).

generation migrants face significant disadvantages, second generations do achieve better labour market outcomes than first generations (Heath and Cheung, 2007; Heath et al., 2008) but they still experience notable penalization when compared to individuals with no migratory background (Drouhot and Nee, 2019). The scarcer and partial evidence on Southern European countries has found, for Spain, a possible assimilation process for the foreign-born second generations as the labour market outcomes of immigrants who moved as children are better than those of first-generation immigrants (Muñoz-Comet and Arcarons, 2022). In Italy, a recent analysis has found that second generations experience an ethnic penalty in the labour market, but those born in the country from one immigrant and one country-born parent perform similarly to the youth with no migratory background (Piccitto, 2023).

In this article, we explore second generations' outcomes in the labour market, focusing on participation, a relevant dimension of labour market integration which is of special relevance in a country with high levels of youth inactivity (ISTAT, 2024). The article explores the differences in the composition of youth with and with no migratory background by labour market status, focusing on being a student as a special condition of youth inactivity and on being active in the labour market (when not student). Two are the main research questions: do second generations participate in the labour market as youth with no migratory background or, rather, do they exhibit a different and specific pattern of participation? Are there relevant differences across migratory generations (i.e. country-born vs foreign-born from immigrant parents)?

The article is structured as follows: the first section addresses the definition of second generations. The subsequent section outlines data and the methodology, followed by a section devoted to the empirical findings. The final section summarises the key results.

2. A theoretical and empirical issue: the definition of second generations

Defining the second generations is more complex and less straightforward than it may seem due to its inherent complexity and wide range of diverse conditions within this category as it comprises individuals for whom both the migratory experience and the socialisation processes are very different (Rumbaut 2004). Indeed, the "children of immigrants" are both young people born and grown up in the receiving country from immigrant parents and who have not directly experienced migration. Second generations also include the foreign-born who moved to the destination country at an early stage of their life course, being children or young adolescents, with a direct experience of migration and with a socialisation process that started in the origin country.

In the literature, the “decimal generations" framework takes account of this complexity and defines a continuum of conditions to consider the different experiences of migration and socialisation of the “children of immigrants” (Rumbaut, 2004). In particular, the country of birth and the phase of the life course define different groups of second generations, which capture the conflicts and challenges that arise from cultural disparities or early uprooting, with implications for interactions with the host country's context. According to the “decimal generations" framework, the first relevant difference is among the country-born and the foreign-born second generations who have, as mentioned, a different migratory experience and are exposed to different socialisation processes. For the foreign-born children of immigrants three life stages under which migration occurs are distinguished: early childhood (arrived at 0-5 years old, G1.75), middle childhood (arrived at 6-12 years old, G1.50) and adolescence (arrived at 13-17 years old, G1.25) (Rumbaut, 1997, 2004; Hermansen, 2017). For the country-born children of immigrants, the key difference is whether they have one or both parents born abroad (G2.5 and G2.0, respectively). Children with one country-born parent (G2.5) should be less likely to identify with the foreign heritage of their immigrant parent, and less likely to become proficient in or use that parent's native language. On the other hand, those with two foreign-born parents (G2.0) tend to be more influenced by growing up in an immigrant family, which can affect both their self-identification and their connection to their parents' language as they reach adulthood (Rumbaut, 2004).

Most research on European receiving countries has used partial definitions of second generations without systematically accounting for generational differentiation (Schneider, 2016). With some exceptions (Piccitto, 2023), the few previous studies on the Italian labour market have only partially considered the heterogeneity of second generations or have approximately defined the second generations due to lack of adequate data. Indeed, in lack of the information on the parents’ country of birth, second generations could only be defined considering the country-born with a foreign citizenship and the foreign-born arrived as children or adolescents (Buonomo et al., 2023). Since 2021, however, the ISTAT Labour Force Survey releases the information on parents’ country of birth – Italy vs a foreign country – of the respondents, allowing the identification of the second generations in the strict sense (i.e. those born in the country from two foreign-born parents or at least one, G2.0 and G2.5 respectively), in addition to the foreign-born who migrated as children or young adolescents which could already be identified.

3. Data and Methods

We use the ISTAT Labour Force Survey (LFS) 2021-2022 (pooled)[3] yearly data, focusing on a subsample of respondents aged 15-29 (N=130,148) and categorize second generations using the decimal generations, however aggregating some groups, we define the following migratory backgrounds:

- G2.5 are the country-born (c-b) with one foreign-born (f-b) parent and one c-b;
- G2.0 are c-b with both f-b parents;
- [G1.75+1.50] are the f-b who arrived in Italy between ages 0-12;
- [G1.25+G1.0] are the f-b who arrived after 13 years old;
- the country-born (c-b) from both country-born (c-b) parents[4].

To simplify the classification, G1.75 (arrived by 0-5 years old) was aggregated with G1.50 (arrived by 6-12 years old), and G1.25 (arrived by 13-17) was aggregated with G1.0 (arrived after 18 years old).

To study labour market participation, we consider three possible statuses: active, student, and inactive. Active include both the employed and the unemployed. According to the conventional definition, employed individuals are those aged 15-89 who have carried out at least one hour of paid work during the survey reference week (or are temporarily absent from their job). Unemployed are instead those aged 15-74 without work during the reference week, who have actively sought employment in the previous four weeks and are available to start work within the next two weeks (for a detailed description, see Eurostat, 2024).

Table 1 – *Youth by migratory background and labour market conditions (15-29 years old).*

Generations	Active			Student			Inactive		
	N	Pop.	%	N	Pop.	%	N	Pop.	%
G2.5	2,568	176	4.9	5,066	297	7.2	709	49	4.8
G2.0	1,031	78	2.2	3,508	219	5.3	316	21	2.0
G1.75+1.50	2,926	203	5.7	3,078	182	4.4	764	53	5.1
G1.25+1.0	3,379	256	7.2	707	43	1.0	1,842	134	12.9
c-b to c-b parents	38,237	2,824	79.8	55,680	3,407	82.1	10,337	774	75.0
Total	48,141	3,538	100	68,039	4,150	100	13,968	1,031	100

N= sample size; Population= weighted sample; % = % on the weighted sample
Source: Authors' elaboration on ISTAT LFS

Since a large share of young people are inactive – that is neither employed nor actively looking for a job – because they are students, we consider being a student

[3] Robustness checks were conducted to ensure that pooling the data from both years does not distort the results.
[4] The f-b from both c-b parents are excluded from the study due to the small size of the group.

as an autonomous condition, different from being inactive, the condition under which students are instead conventionally classified. We define the student by their self-reported condition using the declared main activity status. Table 1 shows our sample by migratory background and labour market condition.

The first step of the analysis is to explore the raw differences in the labour market condition of the groups with different ethnic background. In the second step, we estimate the probability of being student and the probability to be active accounting for composition effects by two logistic regressions. The dependent variables are: a) the likelihood of being a student (1=student; 0=active or inactive), and b) the likelihood of being active (1=active; 0=inactive), excluding students who, as mentioned, represent a very peculiar case of inactivity for young people. The logit models control for age, sex, territorial area (North, Centre, South), civil status, type of family, role in the family. The second logistic regression additionally controls for education (low, medium, high). Unfortunately, data do not allow distinguishing by country of origin, a very relevant factor of heterogeneity also for second generations.

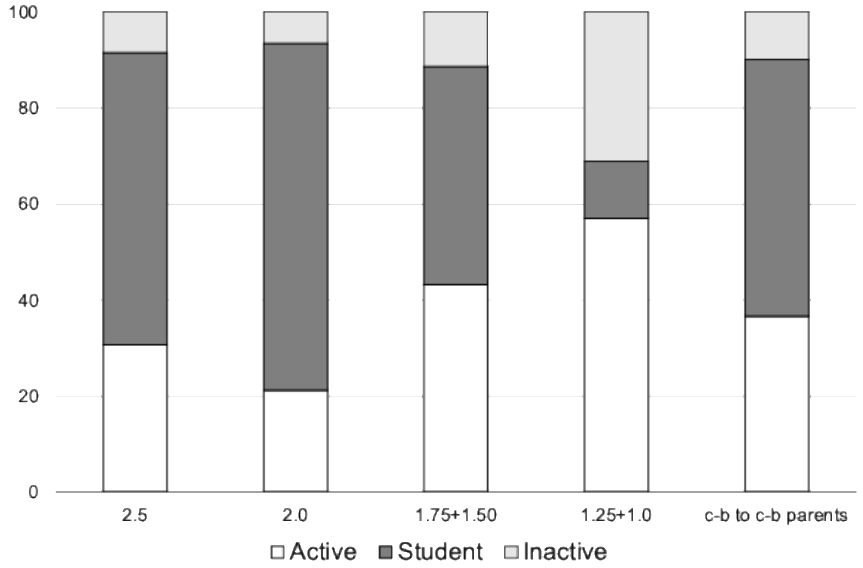
4. Results

Figure 1 illustrates the labour market condition by migratory background, showing relevant differences across groups. Notably, G2.5 and G2.0 have the largest proportion of students, at 61% and 72%, respectively, with fewer active (31% and 21%) and a small percentage of inactive individuals (8% and 7%). [G1.75+1.50] and c-b to c-b parents also show a significant but less notable student presence, at 45% and 53%, and a more relevant share of active (43% and 37%) while inactivity rates are relatively low (11% and 10%). In stark contrast, [G1.25+1.0] stand out with the lowest student share (12%), and the highest rates of active (57%) and inactive individuals (31%).

Differences largely stem from the varying age structure of the different groups. The box plot in Figure 2 provides a detailed view of the age distribution within each group, displaying the interquartile range (IQR)[5], median, and outliers. C-b to c-b parents, [G1.75+1.50], and G2.5 have a balanced age distribution, with a median age of around 20. G2.0 shows a narrower IQR and a median age of 18, reflecting a concentration of younger individuals, which aligns with their high proportion of students and low numbers of active or inactive. In contrast, [G1.25+1.0] have a median age of 26, indicating a much older group.

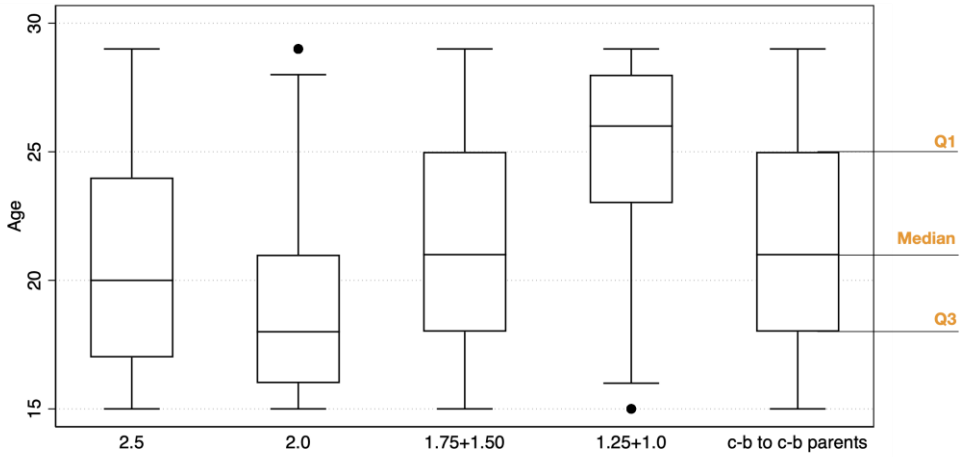
[5] The IQR represents the length of the box: the range between the first quartile (Q1) and the third quartile (Q3). Values outside this range are considered outliers and are plotted as individual points.

Figure 1 – *Youth condition by migratory background.*



Source: Authors' elaboration on ISTAT LFS

Figure 2 – *Age distribution by migratory background.*

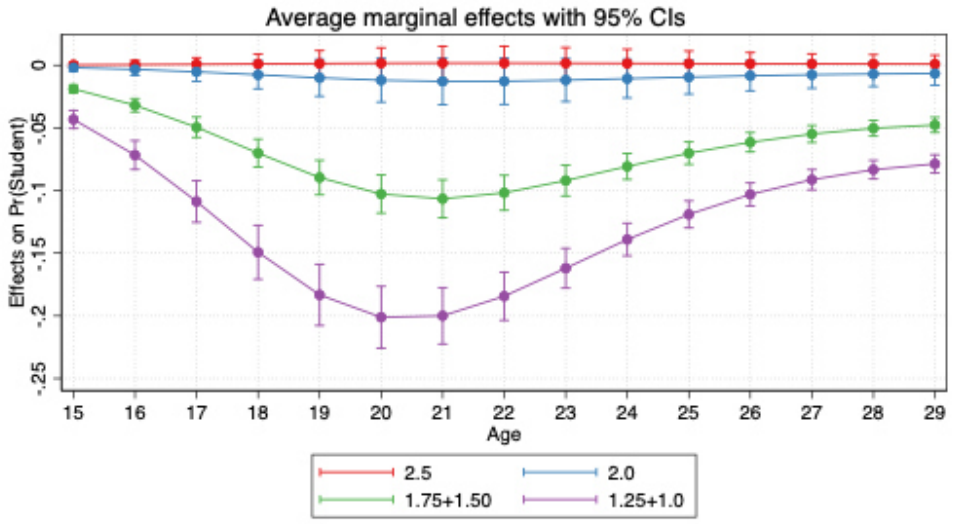


Source: Authors' elaboration on Istat LFS

The first logistic model estimates the probability of being a student compared to being in another condition (Figure 3). The average marginal effects (AME) of the migratory background on the probability of being a student across different ages,

with 95% confidence intervals, shows for G2.5 no significant differences from youth with no migratory background, suggesting that their likelihood of being students is similar to that of this group at every age. Looking at Figure 1, G2.0 appears to have a higher probability of being in education compared to all other groups. However, after introducing controls for age and other individual characteristics, the association becomes slightly negative, indicating a lower probability of being in education than youth with no migratory background (Figure 3).
[G1.75+1.50] shows a pattern similar to [G1.25+1.0], with both groups exhibiting lower probabilities of being students relative to youth with no migratory background. The negative gap widens with age, especially after age 17. [G1.25+1.0] shows the steepest decline, particularly between ages 19 and 23, with this group displaying the lowest likelihood of being students across all ages.

Figure 3 – *Likelihood of being student: AMEs of migratory background (ref. category: c-b to c-b parents) at different age.*

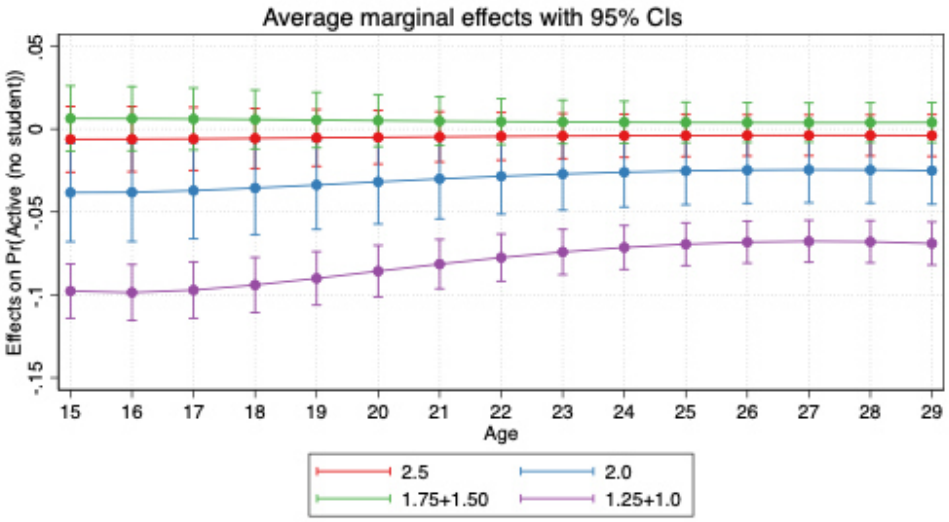


Notes: Estimates controlled for sex, age, age², territorial area (North, Centre, South), civil status, type of family, role in the family. N=129,965; Pseudo R-sq=0,38; 95% confidence intervals. Source: Authors' elaboration on Istat LFS.

The second logistic model estimates the probability of being active versus inactive, excluding the student status (figure 4). The AMEs of the migratory background on the probability of being active across different ages, with 95% confidence intervals, show, for G2.5 and [G1.75+1.50] no statistically significant differences from youth with no migratory background in their probabilities of being

active. G2.0 consistently shows slightly lower probabilities of being active compared to youth with no migratory background, though this difference is modest. In contrast, [G1.25+1.0] exhibits a higher level of inactivity, which is not related to student status. This pattern contrasts with the other groups, where inactivity is more likely explained by student status.

Figure 4 – *Likelihood of being active: AMEs of migratory background (ref. category: c-b to c-b parents) at different age levels.*



Notes: The results are reported after controlling for sex, age, age², education level (low, medium, high), territorial area (North, Centre, South), civil status, type of family, role in the family. N=61,943; Pseudo R-sq=0,13; 95% confidence intervals. Source: Authors' elaboration on ISTAT LFS.

5. Conclusions

This study explores labour market participation of the 15 to 29-year-old population in Italy, distinguishing youth migratory background and focusing of the condition of student, active and inactive (net of students). The analysis builds on the ISTAT LFS data, which allows for the identification of the decimal generations through the information on respondents' and their parents' country of birth.

Following the main research questions, the analysis has shown that once controlling for main individual characteristics, second generations participate to the labour market differently from youth with no migratory background but participation

behaviours are not the same for the different decimal generations. Country-born second generations (G2.0 and G2.5) have a participation profile similar to that of youth with no migratory background, consistently with an assimilation process, while first-generation immigrants [G1.25 + G1.0] are penalised with respect to both the probability of being student and the probability of being active, thus experiencing some ethnic penalty.

In deeper detail, not negligible differences in the composition of the different youth groups by labour market condition emerged. G2.5 and G2.0 have the highest student proportions, while [G1.25+1.0] shows the lowest share of students but has the highest active and inactive rates. [G1.75+1.50] and youth with no migratory background present a more balanced distribution of students and active individuals. The very different age profiles of the groups partially account for the different labour market condition since G2.5, G2.0, and [G1.75+1.50] have much younger age profile, leading to higher student rates, whereas [G1.25+1.0] have an older demographic profile, resulting in higher active and inactive rates.

However, some differences persist even when controlling for main socio-demographic characteristics. Indeed, the study highlights a marked distinction between the second-generations born in Italy (G2.5 and G2.0) and those born abroad [G1.75+1.50]. The former show the same probabilities of being students as youth with no migratory background but, when focusing on the active status (excluding students), G2.0 appear to be the slightly penalised. Conversely, the foreign-born second generations [G1.75+1.50], those who are born abroad but migrated as children, show the lowest probability of being students but the highest probability of being active, taking some relevant distance from the participation behaviour of both youth with no migratory background and the second-generations born in Italy.

These findings, however, have some limitations to be recalled. First, the sample size restricts our chances to account for the specific geographic origins of foreign-born individuals, a relevant dimension of heterogeneity. Furthermore, the socio-economic backgrounds of the youth could significantly affect both educational and labour market choices.

Acknowledgments

We acknowledge funding from MUR for the project ‘The children of immigrants have grown up. The transition to adulthood for youth with a migratory background’ [PRIN 2022, Grant No. 2022PFL7ZB]. We thank the anonymous referee for useful comments and suggestions.

References

ALBA, R., NEE, V. 1997. Rethinking Assimilation Theory for a New Era of Immigration, *International Migration Review*, Vol.31, No.4, pp. 826-874.

AMBROSINI, M., POZZI, S. 2018. *Italiani ma non troppo? Lo stato dell'arte della ricerca sui figli degli immigrati in Italia*. Genova: Centro studi Medí-Migrazioni nel mediterraneo.

BUONOMO, A., GABRIELLI, G., GATTI, R., STROZZA, S. 2023. Occupational Characteristics and Trajectories of Young Immigrants' Descendants in Italy. Rivista Italiana di Economia Demografia e Statistica. Vol. LXXVII No.4

CHISWICK, B. R. 1977. Sons of Immigrants: Are They at an Earnings Disadvantage? American Economic Review, No.67, pp. 376-380

DEMARIE, M., MOLINA, S. 2004. Introduzione. Le seconde generazioni. Spunti per il dibattito Italiano. In AMBROSINI, M. AND MOLINA, S. (Eds.), *Seconde generazioni. Un'introduzione al future dell'immigrazione in Italia.* Edizioni Fondazione Giovanni Agnelli. IX-XXIII.

DROUHOT, L. G., NEE, V. 2019. Assimilation and the Second Generation in Europe and America: Blending and Segregating Social Dynamics Between Immigrants and Natives. *Annual Review of Sociology*, Vol.*45*, No.1, pp. 177–199.

EUROSTAT. 2024. EU Labour Force Survey - new methodology from 2021 onwards. Eurostat Statistics Explained. Retrieved October 26, 2024, from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=EU_Labour_Force_Survey_-_new_methodology_from_2021_onwards

GABRIELLI, G., IMPICCIATORE, R. 2022. Breaking down the barriers: Educational paths, labour market outcomes and wellbeing of children of immigrants. *Journal of Ethnic and Migration Studies*, Vol.48, No.10, pp. 2305–2323.

HEATH, A. F., ROTHON, C., KILPI, E. 2008. The Second Generation in Western Europe: Education, Unemployment, and Occupational Attainment. *Annual Review of Sociology*, Vol.34, No.1, pp. 211–235.

HEATH, A., CHEUNG, S. Y. 2007. *Unequal Chances: Ethnic Minorities in Western Labour Markets*. London: British Academy.

HERMANSEN, A. S. 2017. Age at Arrival and Life Chances Among Childhood Immigrants. Demography, Vol.54, No.1, pp. 201–229.

ISTAT. 2020. *Identità e percorsi di integrazione delle seconde generazioni in Italia*. Roma: Istat.

ISTAT. 2024. *Rapporto annuale 2024: La situazione del Paese*. Roma: Istat.

KING, R., LAZARIDIS, G., TSARDANIDĒS, C. G. 2000. *Eldorado or fortress?: Migration in Southern Europe*. St. Martin's Press.

MUÑOZ-COMET, J., ARCARONS, A. F. 2022. The occupational attainment and job security of immigrant children in Spain. *Journal of Ethnic and Migration Studies*, Vol.48, No.10, pp. 2396–2414.

PARK, R. E. 1950. *Race and culture*. Free Press.

PICCITTO, G. 2023. The later, the better? The ethnic penalty on labor market achievement by migrant generation: evidence from Italy. *Sociologia del lavoro*, No.166, pp. 79–101.

PORTES, A., RUMBAUT, R. G. 2001. *Legacies: The story of the immigrant second generation*. University of California Press.

PORTES, A., ZHOU, M. 1993. The New Second Generation: Segmented Assimilation and Its Variants. *The ANNALS of the American Academy of Political and Social Science*, No.530, pp.74–96.

RUMBAUT, R. G. 1997. Assimilation and Its Discontents: Between Rhetoric and Reality. *The International Migration Review*, Vol.31, No.4, pp. 923–960.

RUMBAUT, R. G. 2004. Ages, Life Stages, and Generational Cohorts: Decomposing the Immigrant First and Second Generations in the United States. *International Migration Review*, Vol.38, No.3, pp. 1160–1205.

SCHNEIDER, J. 2016. First/Second Generation Immigrants. *NESET II ad hoc question IMIS*, No. 4.

UNT, M., GEBEL, M., BERTOLINI, S., DELIYANNI-KOUIMTZI, V., HOFÄCKER, D. 2021. *Social Exclusion of Youth in Europe: The Multifaceted Consequences of Labour Market Insecurity.* Bristol: Bristol University Press.

Ivana FELLINI, University of Milano-Bicocca, ivana.fellini@unimib.it
Francesca MEGNA, University of Milano-Bicocca, f.megna2@campus.unimib.it

KIDULTS IN THE MAKING? HOW DOES THE PARENT-CHILD RELATIONSHIP QUALITY IMPACT HOME-LEAVING DECISION: INSIGHTS FROM GRAPHICAL MODELS

Gabriele Dore

Abstract. This longitudinal analysis investigates the impact of the quality of the mother-child and father-child relationship on the home-leaving decision. Leveraging retrospective data from the 2017 Wave 7 of *SHARELIFE*, we conceived two plausible causal mechanisms for the two dyads via *Directed Acyclic Graphs* (DAGs). We applied the *Backdoor Criterion* to select control variables and employed *Discrete-Time Survival Analysis* to estimate the effect of the mother-child and father-child relationship quality on the decision to leave the parental nest for individuals aged between 15-49 years old.
Results reveal significant differences in the impact of mother-child and father-child relationship quality on the transition to independent living. Constructive mother-child relationships may not lead to delayed launching, and the probability of nest leaving increases as the relationship quality decreases. Conversely, the father-child relationship does not appear to be central in terms of effect size and significance. These results led us to hypothesise a *transition-specific impact* of the mother-child relationship on home-leaving dynamics.

1. Introduction

Within a context of growing uncertainty and tenuous institutional support, the transition to adulthood is becoming "*late, protracted, and complex*" compared to the dominant patterns observed in the 1950s and 1960s (Billari and Liefbroer, 2010). A striking feature of these evolving patterns is represented by the attainment of residential independence (Seiffge-Krenke, 2013). Current estimates highlight an increase in the age at home-leaving in 1970-1979 cohorts compared to earlier cohorts (Billari and Liefbroer, 2010) and a rise in the proportion of nesters in Europe by 0.33 percentage points yearly between 2011 and 2019 (Sompolska-Rzechuła and Kurdyś-Kujawska, 2022). These current trends have ignited the disciplinary and public debate on the societal and family burden deriving from the "*cluttered nest effect*" and "*delayed launching*" of young adults. Terms such as *bamboccioni* in Italy, *kidults*, or *boomerang kids* in the UK utterly emphasise young adults' responsibility in the delayed launching[1]. However, delayed launching may be a concrete response

[1] "Early" and "late leaving" describe moving out before or after the country's cultural age deadlines and norms (Aassve et al., 2013).

to the protraction of educational careers, escalating economic uncertainty, and hindered access to the housing market (South and Lei, 2015; Mulder and Clark, 2002). Hence, co-residing with parents may be considered a rational investment and a safety net against poverty and substandard dwellings. On the other hand, leaving home late is associated with greater dependence on parents and generally detrimental effects on adulthood outcomes (Billari and Tabellini, 2011).

This context of protracted co-residence underscores the central role played by parents in shaping young adults' life course outcomes (King *et al*., 2018). Constructive parent-child relationships may favour autonomy, independence, and distancing, providing young adults with a set of competencies to face the challenges of transitioning to adulthood (Gillespie *et al*., 2020; Seiffge-Krenke, 2006). Thus, the parent-child relationship is expected to be associated with the decision to leave the nest (Işık Akın *et al*., 2020). Nevertheless, the literature on the impact of parent-child relationships on home-leaving remains scant and porous. Contributions are limited to the estimation of associations of the overall parent-child relationship rather than capturing differences in the relationship with the mother and the father and addressing whether causal effects could be identifiable. In this regard, this longitudinal study elucidates how early life interactions with parents shape young adults' trajectories out of the nest. By employing *Directed Acyclic Graphs* (DAGs), we identified a plausible causal mechanism and by applying the *Backdoor Criterion* and *Survival Analysis* we selected control variables and estimated the effect of the parent-child relationship on the probability of leaving the nest separately for the two dyads.

Our study highlights the importance of understanding how early life family interactions affect young adults' life outcomes, particularly in a context where parents are overburdened with providing support to emerging adults and finding an adequate balance between involvement in their children's development and their occupational careers.

2. Home-leaving determinants

Notable diversity in home-leaving patterns was observed across Europe (Iacovou, 2010). Individuals in Northern/Central Europe leave the parental home earlier than in Southern/Eastern Europe (Iacovou, 2010). Currently, despite a stable EU average exit age (26.4 years in 2024 vs. 26.5 in 2012), national differences persist: Croatia (33.4), Slovakia (30.8), Greece (30.7), Bulgaria, Spain (30.3), Malta (30.1), and Italy (30.0) show the highest averages, while Finland (21.3), Sweden (21.4), Denmark (21.7), and Estonia (22.7) have the lowest (Eurostat, 2024). These variations reflect differences in institutional, cultural, and economic factors, with familistic and weak welfare regimes countries showing delayed transitions (Iacovou, 2010).

Economic conditions also impact home-leaving: a higher personal income facilitates earlier moves since it enables individuals to afford living expenses (Mulder and Clark, 2002). However, the increasing proportion of employed young adults living in the nest highlights the importance of family support in the act of leaving. In fact, parental resources may act both as facilitating and hindering factors. Direct resource transfers increase the likelihood of moving out (Angelini and Laferrère, 2012), while "*non-transferable resources"* like housing conditions, consumption patterns, or homeownership rights can influence the attractiveness of the parental dwelling, encouraging individuals to stay rather than leave (Gierveld *et al*., 1991).

Family structure may also influence the decision to leave. In disrupted and stepfamilies, Aquilino (1991) argued that children may develop more rapidly an independent sense of the "*self*" separated from the family, prompting the transition to adulthood. Explanations stem from the deterioration of psycho-social well-being, reduced financial resources after dissolution, frictions deriving from the poor quality relationship with the stepfather to higher expectations of premarital residential living which are, indeed, associated with premature leaving of the nest (Aquilino, 1991).

3. Parent-child relationship quality and home-leaving

Severing co-residence with parents enables individuals to progressively engage in adult behaviours, fostering an escalating sense of responsibility (Branje *et al*., 2021). As they navigate this critical juncture, young adults undergo processes of self-discovery, identity formation, and career exploration, laying the fundamental elements of future well-being and ultimately symbolising the attainment of personal autonomy and self-sufficiency (Branje *et al*., 2021). In this process, parents have the complex task of balancing closeness and autonomy and parental practices must be adjusted according to the evolving needs of the child. This is achieved by the gradual relinquishment of some parental power at the cost of increased conflicts and a temporary decline in support and closeness (De Goede *et al*., 2009). Between childhood and adolescence, however, the relationship between parents and the child gradually becomes more egalitarian; before leaving the parental nest, parents encourage autonomy, and support stabilises for males while increasing for females (Seiffge-Krenke, 2006; De Goede *et al*., 2009). Despite this, relatively less attention has been devoted to the household's psychosocial well-being and early parent-child relationship in the analysis of home-leaving determinants. In this regard, as summarised by Isik Akin *et al*. (2020), prospective studies show that growing up and developing in a constructive parent-child relationship is likely to delay the home-leaving decision (Gierveld *et al*., 1991; Seiffge-Krenke, 2006; South and Lei, 2015) while studies adopting retrospective design indicate how adults that left home earlier

where exposed to conflictual parent-child relationships during adolescence (Cherlin *et al*., 1995). Recent findings confirm that individuals who have experienced a good relationship between childhood and adolescence, particularly by developing a strong bond with their mother, tend to be less motivated to leave the original family nucleus (South and Lei, 2015). In this vein, Gillespie (2020) has underscored how consistent interactions among family members (e.g., family activities) tend to decrease the probability of leaving the nest. However, the author has also highlighted how a good parent-child relationship leads to leaving the family nucleus earlier as an initial attempt at independence.

4. Data and Empirical Strategy

We sourced data from Wave 7 of *SHARELIFE*, a retrospective wave of the *Survey of Health, Ageing, and Retirement in Europe* that provides information about the life histories of individuals aged 50 or older from 26 Continental EU Member States, in addition to Switzerland and Israel.

Our initial sample included 63,228 individuals. We opted to omit individuals who declared they had not lived with the mother or the father and those who had not provided any information regarding the past relationship with both parents. Additionally, we excluded missing and implausible values reported for the year of establishment of an independent household. Our initial sample was then comprised of 62,082 individuals, with a mean age of 67.42 (SD=10.01). The dataset was then adjusted to perform a *discrete-time survival analysis*. We opted to establish a plausible risk set, ranging from 15 to 49 years old, in order to avoid implausible early and late home-leaving and mechanical age effects. This operation entails that an individual is included in the risk set until either moving out of the nest or reaching a maximum year at risk of 34 years. Subsequently, we generated a dichotomous variable *event* using a single question "*In which year did you start to live on your own or establish your household*". Answers were recoded into two levels: 0= *never established own household*; 1= *established own household*. We then corrected the dependent variable according to the proposed risk set: if the sum of the year of birth, year at risk, and the age at entry in the risk set (15) is lower than the actual year of household establishment, then the variable takes value 0; otherwise, 1 if the sum is higher or equal to the year at home-leaving. We then dropped missing observations for the variable event and observations for individuals with ages lower than 15 and higher than 49. Our final dataset comprised 529,432 person-year observations corresponding to 59,466 individuals.

Regarding the covariates, the quality of the parent-child relationship was assessed separately for the two dyads through the *SHARELIFE* retrospective questions: *"How would you rate the relationship with your mother/father or the woman/man who*

raised you before 17?". Replies were measured on a 5-point scale ranging from 1= Excellent, 2= Very good, 3= Good, 4 = Fair, and 5= Poor. The questions enable us to analyse the overall rate of the relationships before age 17 separately for mother and father. Table 1 provides key descriptive statistics on the self-reported relationship with parents.

Table 1 – *Descriptive statistics for the self-reported rate of the parent-child relationship quality at the time of the interview.*

Variable	**Overall** N = 59,466	**Male** N = 25,426	**Female** N = 34,040
Relationship Mother			
Excellent	19,146 (32)	8,060 (32)	11,086 (33)
Very Good	19,666 (33)	8,721 (34)	10,945 (32)
Good	15,210 (26)	6,772 (27)	8,438 (25)
Fair	3,931 (6.5)	1,368 (5.4)	2,563 (7.6)
Poor	1,198 (2.0)	362 (1.4)	836 (2.5)
Relationship Father			
Excellent	14,574 (26)	5,687 (23)	8,887 (27)
Very Good	17,454 (31)	7,546 (31)	9,908 (30)
Good	17,245 (30)	7,849 (32)	9,396 (29)
Fair	5,456 (9.6)	2,419 (9.9)	3,037 (9.3)
Poor	2,379 (4.2)	958 (3.9)	1,421 (4.4)

The responses are shown both in absolute numbers and in parenthesis as percentages of the total in each group.

We selected a series of control variables: age, gender, cohort; country, area, and type of residence (Type) at 10 years old, importance of religion before age 17, reported physical violence before age 17; enrolled in full time-education, full-time employed, cohabiting, married and number of children as time-varying covariates. Additionally, we selected variables regarding the family structure and household size (HouseSize) at 10; family financial status before age 16, and number of books in the house at 10 as a proxy of family socio-cultural and economic background.

4.1. Empirical strategy

The analysis aimed to estimate the effect of the quality of the mother-child and father-child relationship on the decision to leave the nest. We employed *discrete-time survival analysis* to estimate how different self-reported qualities of the relationships impact the probability of leaving the nest. In order to achieve this goal, we first opted to employ *Structural Causal Models* (SCM) (Pearl, 2009) to identify the causal structure regulating the phenomenon of interest in the dataset. The SCMs

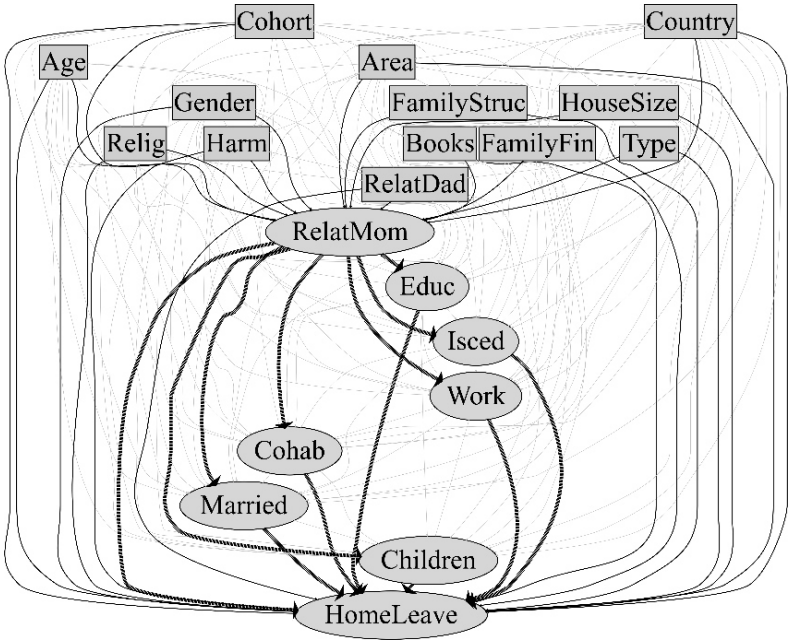
were represented through *Directed Acyclic Graphs* which consist of a set of *nodes* (*vertices/variables*) and *directed edges* (*arrows*) that reflect causal relationships. A direct edge between two variables, say *Relationship* → *Home-Leaving* entails direct causality while a series of edges, such as in the case of a *chain*, say *Relationship* → *Working* → *Home-Leaving,* entail an indirect causal relation mediated via the central node of the chain (working). Two additional path structures are particularly relevant for *confounding*: *forks* and *inverted forks*. A forked path is represented by variables that share a common cause; to clarify: *Relationship* ← *Age* → *Home-Leaving*. Inverted forks are represented by two arrowheads meeting a node: *Relationship* → *Education* ← *Country of residence*. While forks can transmit associations; inverted forks can not, therefore they should not be controlled in the analysis.

The acyclicity represents a fundamental assumption in a DAG: a variable cannot causally affect itself either directly or via feedback loops. This assumption was particularly hard to meet in our case due to the cycle present between Mother-Child and Father-Child relationships: *Rel-Mother* → *Rel-Father* → *Rel-Mother*. One possible solution was represented by creating a new variable that describes the overall rate of the relationship with parents at the cost of not distinguishing between the two relationships. We did not consider this approach feasible, so we opted to conceive two distinct DAGs for the Mother-Child and Father-Child relationships. In Figure 1, a plausible DAG for the mother-child relationship is represented, where the father-child relationship is shown as a *confounder*. Due to space constraints, we do not represent the specific DAG for the father-child relationship, which differs only in the direction of the edge with the variable Rate Relationship Mother-Child. Consequently, we estimated two distinct models in which one of the two relationships represents the exposure and home-leaving the outcome.

As a second step of the analysis, we identified the backdoor paths in both DAGs. A *backdoor path* is represented by a series of arrows that start with an edge pointing to the independent variable and end with an edge pointing to the dependent one. This indicates a shared cause, or confounder, that affects both the treatment and the outcome. When the paths are opened, non-causal associations are transmitted. In order to estimate the effect of interest in an observational setting, holding the assumption that our DAGs capture the correct causal web, we must block all backdoor paths. When the criterion's conditions are satisfied, then the causal effect is identifiable.

For the effect of the relationship with the mother and home-leaving, we identified the following adjustment set: Age, Area, Books, Cohort, Country, FamilyFin, FamilyStruc, Gender, HouseSize, Harm, RelatDad, Relig, Type. For the relationship with the father, the only difference is represented by the confounder RelatMom, which was included in the adjustment set instead of RelatDad.

Figure 1 – *Plausible Directed Acyclic Graph for the Mother-Child Relationship.*



Confounding variables and paths are represented with boxes and solid black (main biasing paths) and grey lines, respectively; Mediating variables and causal paths in ellipses and bold dashed black lines, respectively.

Data were first analysed using life tables with actuarial adjustment to correct the downward bias in the estimation of the hazard, assuming that the event or censoring occurred at the mid-time point in each interval.

The baseline hazard was then estimated and a series of period dummies were included in a piecewise-constant fashion. Finally, we estimated the total causal effect via the following logit model in which we included the covariates of the adjustment set:

$$log\left[\frac{p_{ti}}{1-p_{ti}}\right] = \alpha \boldsymbol{d_{ti}} + \beta \boldsymbol{x_{ti}} \quad (1)$$

p_{ti} represents the probability of an event during interval t, d_{ti} is a vector of functions of the cumulative duration by interval t with coefficients α and x_{ti} is a vector of covariates with coefficients β.

5. Results

Descriptive results from the life table estimation show that half of the sample of interest experience the transition to independent living at 22/23 years old, corresponding to the median age at home-leaving. Women tend to leave the nest earlier than men, the median age at the transition is indeed 21 years for the former and 24 years for the latter group. Survival curves for the relationship with the mother show that individuals with a poor relationship tend to complete the transition earlier; the same applies to the relationship with the father. Results from the baseline hazard model indicate that the odds ratios increase rapidly in the first years at risk, reaching a peak at the 10^{th} year (25 years old) and then decreasing as age increases. Covariates included in the adjustment set were progressively controlled in the model to estimate the effect of interest. Table 2 reports the results of the multivariate discrete-time final model for the quality of the relationship with the mother. Estimates indicate that as the relationship with the mother worsens, an increased probability of departure from the parental home is observed. Particularly surprising for their significance and magnitude of effects are the estimates for negative relationships.

Table 2 – *Estimate of the causal effect of Mother-Child Relationship quality on home-leaving.*

Coeff.	Odds ratios	SE	z	Pr(>|z|)
RelatMom				
Very Good	1.033252	.0143722	2.35	0.019
Good	1.063641	.0163363	4.02	0.000
Fair	1.173831	.0273379	6.88	0.000
Poor	1.326193	.0535378	6.99	0.000
_cons	.0138734	.0006088	-97.48	0.000

Control variables: RelatDad, Age, Area, Books, Cohort, Country, FamilyFin, FamilyStruc, Gender, HouseSize, Harm, Relig, Type(residence).

An outstanding example is the relationship classified as 'poor', which shows a 32.6% increase in the probability of home leaving compared to those with an excellent relationship. This could imply an abrupt departure from the family nucleus, driven by poor relational well-being between childhood and adolescence. Instead, for “very good”, “good”, and “fair”, the probability of leaving is increased by 3.3%, 6.3% and 17.4% compared to the reference category, respectively.

Moving to the father-child relationship, the step-by-step inclusion of covariates highlighted how the addition of the 'relationship with mother' covariate drastically reduces the effect size and significance of the relationship with the father. This could confirm the confounding effect of the mother-child relationship between the

exposure and the outcome. Surprisingly enough, estimates reported in Table 3 indicate that different levels of relationship quality do not show significant differences in the probability of family nucleus abandonment compared to the reference category. Only a 'very good' relationship shows a slight probability increase (2.8%), but the result is not significant. Similarly, for worse self-reported relationship quality, there is no evidence of a significant effect on the probability of parental nest leave.

Table 3 – *Estimate of the causal effect of Father-Child Relationship quality on home-leaving*

Coeff.	Odds ratios	SE	z	Pr(>|z|)
RelatDad				
Very Good	1.028165	. 0154001	1.85	0.064
Good	1.007986	.015906	0.50	0.614
Fair	.9817236	.0205893	-0.88	0.379
Poor	1.037681	.0306867	1.25	0.211
_cons	.0138734	.0006088	-97.48	0.000

Control variables: RelatDad, Age, Area, Books, Cohort, Country, FamilyFin, FamilyStruc, Gender, HouseSize, Harm, RelatMom, Relig, Type(residence)

In summary, the results suggest that the quality of the relationship with the mother has a significant impact on the probability of leaving the parental nest, with less positive relationships significantly increasing this probability. Conversely, father-child relationship quality does not have a significant impact on the home-leaving decision. We may hypothesise a "*transition-specific effect"* of the relationship with the mother on the home-leaving decision. This points in the direction of the predominance of mother-child interaction quality between childhood and adolescence on the decision to leave the nest.

6. Conclusions

In this study, we elucidated how early-life parent-child interactions impact young adults' trajectories to independent living. Unlike previous studies, we distinguished between the two dyads using a retrospective overall assessment for each relationship and *Structural Causal Models* to test the causal mechanism regulating the phenomenon, unveiling a *maternal transition-specific impact*.

Our estimates show that a positive relationship with the mother has a moderate effect on the decision to leave the nest. This result aligns with recent studies by Gillespie et al. (2020) and Seiffge-Krenke (2006), which confirm that a strong bond with the maternal figure tends to equip young adults with a set of emotional and behavioural competencies that facilitate the transition to autonomy. Contrary to the idea that positive relationships encourage remaining in the family home, as shown

by Isik Akin et al. (2020) and South and Lei (2015), our estimates indicate that the quality of the maternal relationship does not necessarily result in prolonged residence in the parental home. Similarly, strained maternal relationships significantly increase the probability of leaving the family home. This result is consistent with previous studies (Cherlin et al., 1995) that show how young adults leave the home as a coping strategy to escape conflictual and stressful cohabitation. However, this partially diverges from Isik Akin et al. (2020), who found no clear link between conflict and home-leaving, except in father-child relationships.

The estimates regarding the paternal relationship are the most surprising. Our analysis found no significant impact on home-leaving at different quality levels once the maternal relationship was controlled for. This result contrasts with the findings of Isik Akin et al. (2020) and Gillespie et al. (2020), who demonstrated that parental warmth, closeness, and attentiveness are associated with premature departure from the family home. One explanation could be derived by considering the phenomenon from a mother-father-child triangular point of view: mother-father relationship quality may impact how fathers interact with the child. In this respect, Pekel-Uludağlı (2023) highlights that mothers may exert *maternal gate-closing*, limiting fathers' parental involvement without them viewing this behaviour as negative. This dynamic may have been more common in earlier cohorts, such as those born before 1953, as they compose the majority in our sample, compared to more recent cohorts where father-child interactions could play a more significant role (Pekel-Uludağlı, 2023).

Our approach has certain limitations. The measurement of relationships is time-invariant and spans a 17 years-period, making it challenging to capture how relationships evolve from childhood to adolescence. Additionally, assessing relationships later in life may introduce recall bias.

In summary, this study offers new insights into how family relationships influence the transition to adulthood, raising important questions about how early dysfunctional parent-child interactions can shape the path toward residential independence and adulthood.

References

AKIN R.I., BREEMAN L.D., MEEUS W., BRANJE S. 2020. Parent-adolescent relationship quality as a predictor of leaving home, *Journal of Adolescence*, Vol. 79, No. 1, pp. 81-90.

ANGELINI V., LAFERRÈRE A. 2013. Parental altruism and nest leaving in Europe: Evidence from a retrospective survey, *Review of Economics of the Household*, Vol. 11, No. 3, pp. 393-420.

AQUILINO W.S.1991. Family Structure and Home-Leaving: A Further Specification of the Relationship, *Journal of Marriage and Family,* Vol. 53, No.4, pp. 999-1010.

ASSAVE A., ARPINO B., BILLARI F.C. 2013. Age Norms on Leaving Home: Multilevel Evidence from the European Social Survey, *Environment and Planning A: Economy and Space,* Vol. 45, No.2, pp. 283-401.

BILLARI F.C., LIEFBROER A.C. 2010. Towards a new pattern of transition to adulthood?, *Advances in Life Course Research*, Vol. 15, No. 2-3, pp. 59-75.

BILLARI F.C., TABELLINI G. 2011. Italians are late: does it matter?. In JOHN B. SHOVEN, *Demography and Economy,* Chicago: University of Chicago Press, pp. 37-412.

BRANJE S., DE MOOR EL., SPITZER J., BECHT AI. 2021. Dynamics of Identity Development in Adolescence: A Decade in Review, *Journal of Research on Adolescence*, Vol. 31, pp. 908-927.

CHERLIN A.J., KIERNAN K.E., CHASE-LANSDALE P.L. 1995. Parental Divorce in Childhood and Demographic Outcomes in Young Adulthood, *Demography*, Vol. 32, No. 3, pp. 299-318.

DE GOEDE I.H., BRANJE S.J., DELSING M.J., MEEUS W.H.J. 2009. Developmental Changes in Adolescents' Perceptions of Relationships with Their Parents., *Journal of Youth and Adolescence*, Vol. 38, pp. 75-88.

Eurostat. Available online: https://ec.europa.eu (accessed on 10 October 2024).

GIERVELD J.D.D, LIEFBROER A.C., BEEKINK E. 1991. The effect of parental resources on patterns of leaving home among young adults in the Netherlands, *European Sociological Review*, Vol. 7, No. 1, pp. 55-71.

GILLESPIE B.J. 2020. Adolescent intergenerational relationship dynamics and leaving and returning to the parental home, *Journal of Marriage and Family*, Vol. 82, pp. 997-1014.

IACOVOU M. 2010. Leaving home: Independence, togetherness and income, *Advances in Life Course Research*, Vol. 15, No. 4, pp. 147-160.

IŞIK AKIN R., BREEMAN L.D., MEEUS W., BRANJE S. 2020. Parent-adolescent relationship quality as a predictor of leaving home, *Journal of Adolescence*, Vol. 79, pp. 81-90.

KING V., BOYD L.M., PRAGG B. 2018. Parent–Adolescent Closeness, Family Belonging, and Adolescent Well-Being Across Family Structures, *Journal of Family Issues*, Vol. 39, No. 7, pp. 2007-2036.

MULDER C.H., CLARK W.A.V. 2002. Leaving home for college and gaining independence, *Environment and Planning A: Economy and Space*, Vol. 34, No. 6, pp. 981-999.

PEARL J. 2009. *Causality. Models, Reasoning and Inference*. Cambridge, Cambridge University Press.

Pekel-Uludağlı N. 2023. The role of the father involvement in child development: the relationships with maternal, paternal, and child characteristics, *Curr psychol,* Vol. 43, pp. 4085-4097

SEIFFGE-KRENKE I. 2013. "She's Leaving Home . . .": Antecedents, Consequences, and Cultural Patterns in the Leaving Home Process, *Emerging Adulthood*, Vol. 1, No. 2, pp. 114-124.

SEIFFGE-KRENKE. 2006. Leaving home or still in the nest? Parent-child relationships and psychological health as predictors of different leaving home patterns, *Developmental Psychology,* Vol. 42, No. 5, pp. 864-876.

SHARE-ERIC 2024. Survey of Health, Ageing and Retirement in Europe (SHARE) Wave 7. Release version: 9.0.0. SHARE-ERIC. Data set. DOI: 10.6103/SHARE.w7.900

SOMPOLSKA-RZECHUŁA A., KURDYŚ-KUJAWSKA A. 2022. Generation of young adults living with their parents in European Union countries, *Sustainability*, Vol. 14, No. 7, pp. 4272.

SOUTH S.J., LEI L. 2015. Failures-to-launch and boomerang kids: Contemporary determinants of leaving and returning to the parental home, *Social Forces*, Vol. 94, No. 2, pp. 863-89.

Gabriele DORE, University of Florence, Dipartimento di Statistica, Informatica, Applicazioni "G. Parenti" (DiSIA), gabriele.dore@unifi.it

RESPONSE BEHAVIOR PATTERNS AMONG YOUTH[1]

Sabrina Barcherini, Serena Liani, Silvia Pecora, Simona Rosati

Abstract. In 2023, the Italian National Institute of Statistics conducted the second edition of the survey on behaviours, attitudes and future plans of children and young people, addressed to 107,635 boys and girls, between 11 and 19 years old, resident in Italy. Building on the previous experience, innovations were fielded in the data collection methods, including improvements in the questionnaire's design. To meet the needs of young respondents, a streamlined, short, easy to answer, and responsive questionnaire was designed. We analysed data on sampling units who accessed and submitted the questionnaire and those who accessed but did not submit it to identify different response behaviour patterns among youth. First, we analysed how many times the sampling units tried to access the questionnaire, by which device and mode (by scanning the QR Code or entering the website address), and where they stopped filling in the questionnaire. Then, we studied partial non responses to non-mandatory questions – i.e. if respondents preferred not to answer when they were not obliged to do it. Finally, we applied a logistic regression model to identify the determinants of the youngers propensity to submit the questionnaire. The findings provided useful insights on the design of web questionnaires targeting young respondents.

1. Background

In 2023 the Italian National Institute of Statistics conducted the second edition of the survey on behaviours, attitudes and future plans of children and young people. The aim was to collect information on daily lives and future plans directly from boys and girls, aged between 11 and 19 years old, and resident in Italy.

The data collection ran from 2 October to 20 December and involved a random sample of 107,635 children and young people, drawn from the Individuals Basic Register, i.e. a statistical register obtained by integrating several administrative data sources (Ascari *et al*., 2023). The sampling design allowed the thematic experts to make estimates at a regional level both for the young Italians and the young people

[1]This article is the result of the collaboration between the authors. In particular: paragraphs 1 and 7 have been written by Simona Rosati, paragraph 2 and 5 have been written by Serena Liani, paragraphs 4, 8 and 9 have been written by Sabrina Barcherini, paragraphs 3 and 6 have been written by Silvia Pecora.

of the five largest groups of foreigners in Italy (Romanians, Albanians, Ukrainians, Chinese, and Moroccans). A total of 38,872 sampling units actually submitted the questionnaire (36.1 percent response rate).

Since the younger generations are 'digital natives', the survey design focused on mobile devices, Internet and social media (Conti *et al*., 2024). First, a questionnaire to be administered via Computer Assisted Web Interview was designed. To encourage participation in the survey, the questionnaire was designed to adapt to filling in not only from personal computer, but also from mobile devices.

Unlike the previous edition, schools did not support Istat in promoting the survey but an effective communication campaign also based on social media was run. The sampling units received an advance letter containing information on the survey and how to access the web questionnaire; the advance letter was addressed directly to the sampling units, if over 18, or to their parents if they were minors.

To foster the participation of young foreigners, the advance letter was translated and made available in the Istat website in ten languages other than italian, and the web questionnaire could be compiled in nine languages (Albanian, Arabic, Chinese, French, English, Romanian, Spanish, German and Ukrainian).

Section two describes the questionnaire design strategies intended for reducing response burden and improving both the submission rate and the quality of responses obtained; in sections three to eight, the methods and results of some analyses carried out to study the questionnaire completion behaviors of young people and their perception of the statistical burden are finally reported.

2. The questionnaire design

The questionnaire was structured in seven thematic sections and a final evaluation section of the questionnaire. The survey questions were few and simple, and gathered information on: family, housing environment, school, citizenship, relationships with friends and family, educational poverty, leisure, expectations for the future, opinions on gender stereotypes, and informations on filling experience.

As the questionnaire had to be self-administered by young respondents, without being supported by an interviewer, it had to be easy to access and fill out. Thus, we designed some measures to increase the response rate, reduce the response error, and prevent the chance of questionnaire's breakoffs.

Firstly, to facilitate the access to the web questionnaire we gave respondents the opportunity to scan an individual QR Code, printed on the advance letter, in addition to type the web address and enter the passcode. Indeed, scannig a QR Code is more straightforward for smartphones, which we thought could be the devices most used by young people to fill in the questionnaire. As discussed in Section seven, this has

proven to be successful as over two thirds of respondents who submitted the questionnaire said they accessed via QR Code.

Always considering the specific target of respondents and the general confidence of young people with mobile devices, it was important to design a questionnaire easy to fill in not only on desktop or laptop computer, but also on smartphones and tablets. Therefore, we developed the web questionnaire with LimeSurvey, an open-source software tool that enables scholars to develop mobile responsive questionnaires. In particular, it allows to develop questionnaires whose display automatically adapts to the device, avoiding horizontal scrolling on mobile ones; furthermore, on mobile device screens it convert a matrix question in a set of single-choice questions that fit to the width of the screen.

Particular attention was then paid to the design of effective questions that could be appropriate for the specific target and could avoid satisficing behaviour (Krosnick, 1991). We strive to reduce the cognitive effort of the respondents by designing short questions, with a straightforward syntax and few response options. The language was tailored to the youths, by chosing unambiguous terms, and replacing unknown terms to them with more familiar ones. Finally complex structures that could burden the still-developing cognitive capacities of young respondents were avoided wherever possible (Bell, 2007).

3. Methods

We studied the response behaviour patterns among sampling units who accessed the web questionnaire, analyzing how many times they tried to access, how many of them completed and submitted the questionnaire and how many did not.

We then focused on data quality issues, analyzing the number of missing answers to non-mandatory questions and the answers to the questions of the last section on any problems the respondents encountered in filling it.

We ran descriptive analyses using frequency distributions and contingency tables, and multivariate analyses using logistic regression models.

4. Finding on questionnaire accesses

Of the 107,635 young people in the sample, 43,546 accessed the questionnaire at least once, i.e. 40 percent of the theoretical sample. Almost all of them (38,290, i.e. 87.9%) have accessed the web questionnaire once (Table 1). Among those who tried to access and fill in the questionnaire more than once, few sampling units have made more than two accesses anyway (2.3%).

Those who made more than one access are mostly younger people: 13.1 percent among boys and girls aged 11 to 14 compared with 10.6 percent among those aged 15 to 19. The difference is even larger when citizenship is taken into account: for the foreigners, the percentage of those who made more than one access is twice as high (16.0%) as for italians (8.1%) (Table 1).

Table 1 – *Sampling units who accessed the questionnaire by number of accesses, age and citizenship. Year 2023 (percentage and absolute values).*

	1 access	2 or more accesses	Total
AGE			
11-14	86.9	13.1	25,139
15-19	89.4	10.6	18,407
CITIZENSHIP			
Italians	91.9	8.1	21,968
Foreigners	84.0	16.0	21,578
Total (%)	87.9	12.1	100.0
Total (n)	38,290	5,256	43,546

Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

5. Findings on submissions and break-offs

Data on sampling units who completed and submitted the questionnaire and those who accessed but did not submit it were then compared. Among sampling units who accessed the questionnaire, 38,872 completed and submitted it (89.3%), while only 10.7 percent definitely stopped compiling[2] (Figure 1).

78.9 percent of the questionnaire's submissions were made via smartphones or tablets, confirming the confidence of young people with the mobile devices.

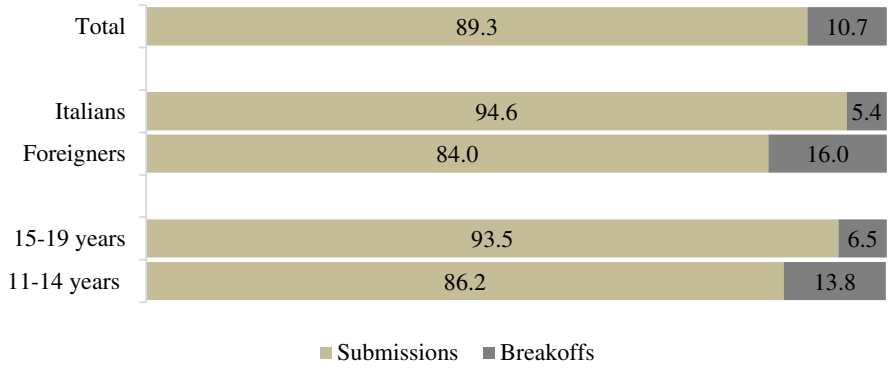
Those who accessed the questionnaire but did not submit it stopped at the first sections: over 85 percent of those who definitively stopped did not pass the third section, and more than half did not even pass the first. The choice of whether or not to continue thus does not seem to depend on fatigue or on response burden, but on a lack of engagement, an aspect on which further work needs to be done. Perhaps the questionnaire's access through QR Code may have encouraged young people to access out of curiosity without any real intention of continuing the compilation.

[2] Among the 43,546 sampling units that accessed the web questionnaire at least once, 342 sampling units completed it but never submitted it.

Due to the lack of survey information for young people who stopped filling in the questionnaire, little is known about their socio-demographic characteristics, with the exception of gender, age and citizenship[3].

With regard to gender, we found no association with the propensity to submit or not submit the questionnaire, whereas this seems to be associated with citizenship (Figure 1). As can be seen below, the breakoff rate is higher among young people (13.8% for 11-14 year olds vs. 6.5% for 15-19 year olds) and foreigners (16.0% for foreigners vs. 5.4% for Italians) (Figure 1).

Figure 1 – *Submissions and breakoffs by citizenship and age. Year 2023 (percentage values).*



Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

6. Findings on partial non responses

We analyzed partial non responses to non-mandatory questions as a measure of data quality. In fact, if some survey questions are left unanswered, this may introduce a bias (Groves *et al*. 1991).

Unlike the other sections of the questionnaire, the last two included questions for which the respondents were not obliged to answer: one concerning their opinions on women and men (section G)[4] and the other one about their experience with filling in the questionnaire (section H). Only the questions in these two sections could be left unanswered without preventing respondents from submitting the questionnaire.

[3] Information on gender, age and citizenship was drawn from administrative records.
[4] Note that this section included four Likert scales: the first one was administered to everyone, while the others were administered only to the respondents over 13 years old.

Partial non-response rates to questions in both sections are very low: in section G the question with the highest non-response percentage reaches 5.3 percent, while in H reaches 1.7 percent. Furthermore, data show that few young respondents skipped both G and H sections: only 0.2 percent of those who submitted the questionnaire did not answer any questions of them[5].

Note that, for confidentiality reasons, at the beginning of the section G a message explicitly informed the respondents of the possibility of not answering, while no such message was included in section H. Furthermore, unlike the questions in section H, those in section G asked about sensitive topics and had a matrix format that could be burdensome for some young respondents. All these factors could have effect young people's propensity to answer.

Indeed, 4.9 percent of respondents who submitted the questionnaire did not answer any of the questions in G (Table 2), while only 0.4 percent of them failed to answer the whole H section. Furthermore, 4.7 percent of respondents who did not answer any questions in G then answered some questions in H section.

Foreigners show higher values of partial non responses: 6.0 percent of foreigners did not answer any questions in section G compared to 3.9 percent of Italians (Table 2). As expected, the difference in partial non response rate depending on device was not that relevant since the questionnaire was responsive: 5.1 percent for respondents who submitted the questionnaire via smartphone or tablet vs 4.2 percent of those who used the PC.

Table 2 – *Answers and no answers to section G by citizenship and device. Year 2023 (percentage and absolute values).*

	No answer in section G	At least one answer in section G	Total
CITIZENSHIP			
Italians	3.9	96.1	20,421
Foreigners	6.0	94.0	18,451
DEVICE			
Smartphone/Tablet	5.1	94.9	30,670
Pc	4.2	95.8	8,202
Total	4.9	95.1	100.0
	1,914	36,958	38,872

Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

[5] Partial non response rates were calculated by dividing the number of respondents who answered a question by the number of respondents who were eligible to answer it.

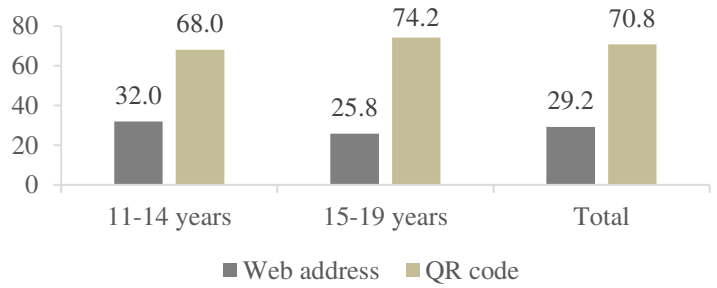
7. Findings on questionnaire filling experience

The last section of the questionnaire asked respondents information about the device used, any need for assistance in accessing the questionnaire, the difficulties in viewing the questions, and the questionnaire's aspects to be changed according to the respondents. Collecting feedbacks from respondents could in fact suggest to further simplify the structure of the questionnaire or to improve the usability of the tool (Barcherini *et al*., 2022).

The data described in this section refers to the sampling units who completed and submitted the questionnaire.

The respondents appreciated the possibility of accessing the questionnaire via QR code: 70.8 percent of those who submitted the questionnaire used this method to access the web questionnaire rather than typing the web address provided in the advance letter (Figure 2). Furthermore, those aged 15 and older used QR Code more often than the youngers (74.2% vs. 68.0%).

Figure 2 – *Questionnaire access method by age. Year 2023 (percentage values).*

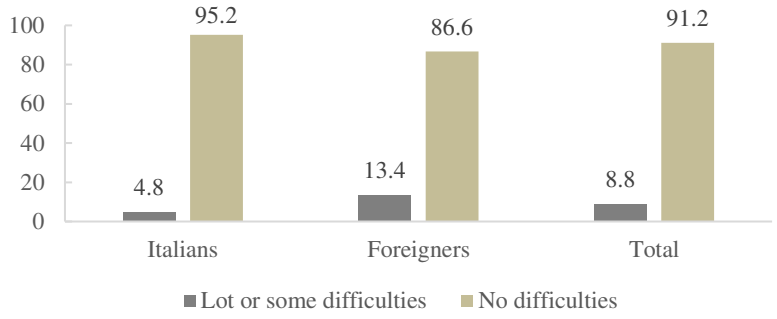


Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

Most of the respondents had no difficulty accessing the questionnaire: only 11.1 percent reported needing help to access. In particular, those who used a personal computer needed more support than those who used smartphones or tablets (18.8% vs. 9.0 %). Both for the choice of access method and for the need for support, there is no relevant association with citizenship.

Concerning the display of the screens, only 8.8 percent of respondents reported having had many or some difficulties in viewing them. Note that foreigners reported viewing difficulties more often than their Italian peers (13.4% vs. 4.8%) (Figure 3).

Figure 3 – *Questionnaire viewing difficulties by citizenship. Year 2023 (percentage values).*



Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

Finally, respondents were asked to indicate up to 3 aspects of the questionnaire that they would have changed. The most significant data is that almost two thirds of those who submitted the questionnaire would not change anything (64.4%), confirming the validity of the choice made in designing the questionnaire, based on the characteristics of this specific target of population (Table 3).

Table 3 – *Respondents by questionnaire aspects that would change. Year 2023 (percentage and absolute values).*

	Respondents	
Suggestions	(n)	(%)
I would not change anything	24,612	64.4
Length	8,522	22.3
Wording	2,736	7.2
Graphic layout	3,084	8.1
Pages loading speed	1,689	4.4
Question display	1,653	4.3
Navigation buttons position	1,228	3.2
Error warning display	969	2.5

Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

At the same time, some respondents still highlighted areas for improvement in which to invest for future editions of the survey. Among those who indicated aspects to be modified, the main issue was the length of the questionnaire (22.3%), followed by the layout (8.1%) and the questions wording (7.2%). Some changes can still be made to streamline the structure of the questionnaire and further adapt the wording of the questions to this specific target. Finally, less than 5 percent of young people

report some aspects that could be improved from a usability point of view, such as web pages loading speed (4.4%), the position of the navigation buttons (3.2%) and the display of error warning (2.5%).

8. A multivariate approach: the logistic model

Logistic regression models were used to support the descriptive analysis (Hosmer *et al.*, 2013).

A first model was applied to examine the interaction between the number of questionnaire's accesses and some background information of respondents. The indipendent variables were age, citizenship, household economic condition, dropping out of school, having friends to confide in, reading book in the past twelve months, being satisfied with relationships with friends or family, to be hyper connected to Internet (more than 4 hours a day), need help to access the questionnaire, difficulty viewing the questions and the device used for filling in. The dependent variable was having made one access or more than one access, setting as a reference the risk of doing more than one access. A stepwise method was employed to select the most representative variables, with a significance level of 0.05 for both entering and retaining variables in the model. The percentage of pairs of observations in which model predictions agree with observed responses is 59.4%, indicating that the model demonstrates a good ability to correctly predict the classes.

The risk of multiple accesses before submitting the questionnaire was mainly related to citizenship, but also to having had difficulty viewing the questions, device used, age, difficulty of access, and being hyper connected to Internet (Table 4).

Foreigners had more than twice the risk of making multiple accesses than Italians.

Those who had difficulty viewing the questions had a risk of doing multiple accesses one and a half times higher than those who viewed the questions without problems.

Those who filled in via smartphones or tablets had a one and a half times higher risk than those who used the personal computer: probably smartphones imply more breaks in filling in the questionnaire because of notifications, messages, and calls that require respondents to stop and exit the questionnaire.

Table 4 - *Probability of doing more accesses to the questionnaire. Year 2023.*

	Analysis of Maximum Likelihood Estimates			Odds Ratio Estimates		
Parameter	Estimate	Standard Error	P-value	Point Estimate	95% Wald Confidence Limits	
Intercept	-3.4508	0.0893	<.0001			
Under 14 years old (ref. 15-19 years)	0.2001	0.0334	<.0001	1.222	1.144	1.304
Foreigner	0.7275	0.0334	<.0001	2.070	1.939	2.210
Connected more than 4 hours a day	0.0402	0.0200	0.0444	1.084	1.002	1.172
Need help to access the questionnaire	0.1672	0.0500	0.0008	1.182	1.072	1.304
Difficulty viewing the questions	0.4612	0.0488	<.0001	1.586	1.441	1.745
Smartphone/tablet (to submit the questionnaire)	0.4573	0.0449	<.0001	1.580	1.447	1.725

Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

Another model was applied using the need help to access the questionnaire as the dependent variable. The most representative variables were selected again using a stepwise method, with a significance level of 0.05 for both entry and retention in the model. In this second model, the predictive ability is improved; specifically, we observe a percentage of pairs of observations in which the model's predictions align with the observed responses of 69.4%.

In this case, the most important variable is the age: children under 14 years old were almost five times more likely than the older ones to need support to access the questionnaire (Table 5).

Those who filled in via personal computer have 2.3 times higher risk of having difficulty accessing than those who filled in via mobile devices.

Unlike the previous model, proxy variables of a distress attitude such as dropping out of school, not having trusted friends, having a perception that one's own family has financial distress, and not reading books were significant. All these factors slightly increased the risk of needing help in access.

The amount of time spent on Internet was another difference compared to the previous model: being less connected in fact increased the risk of needing help in access.

Table 5 - *Probability of the need help to access the questionnaire. Year 2023.*

	Analysis of Maximum Likelihood Estimates			Odds Ratio Estimates		
Parameter	Estimate	Standard Error	P-value	*Point Estimate*	95% Wald Confidence Limits	
Intercept	-3.4730	0.07550	<.0001			
Make more accesses	0.2830	0.04820	<.0001	1.327	1.207	1.459
Under 14 years old (ref. 15-19 years)	1.5980	0.04490	<.0001	4.943	4.526	5.399
Household economic condition not good	0.2911	0.04900	<.0001	1.338	1.215	1.473
Dropping out of school	0.4449	0.07790	<.0001	1.560	1.339	1.818
Not having friends	0.3064	0.04280	<.0001	1.359	1.249	1.477
Connected less than 4 hours a day	0.1430	0.02380	<.0001	1.331	1.212	1.461
Not being satisfied with relationships with friends	0.2243	0.08650	0.0095	1.251	1.056	1.483
Being satisfied with relationships with household	0.1242	0.06140	0.0430	1.282	1.008	1.631
Not having read books in the past year	0.2661	0.03660	<.0001	1.305	1.215	1.402
PC (to submit the questionnaire)	0.4165	0.01800	<.0001	2.300	2.143	2.469

Elaboration on Istat data on behaviours, attitudes and future plans of children and young people

9. Conclusions

Innovations in questionnaire design led to good results in terms of submissions even with a hard-to-survey target as young people. Of the young people who accessed the questionnaire, nine in ten were finally able to submit it; and in most cases they filled in and submitted it at one time. In addition, those respondents who submitted the questionnaire did not seem to have encountered any problems in filling in it: they reported few difficulties in viewing the questions, and most of them answered they did not need help to access it.

In conclusion, having taken into account the specificities of young respondents in designing a short questionnaire, responsive to mobile devices and easy to access (via QR Code) facilitated responents in compiling and submitting it, thus increasing participation in the survey.

Further improvements are still possible, especially for enocuraging the youngers (11-14 years old) and foreigners to access and submit the questionnaire. Some changes in the questionnaire design in terms of length and layout can help make it

more appealing to these targets, but also other interventions in the data collection methods will be needed to reach and motivate them to fill in the questionnaire.

References

ASCARI G., BRANCATO G., BRUNI A., DADDI S., DI BELLA G., GIAVANTE S., ROCCI F., SANZO R., SGAMBA A.M., SIMEONI G., SPIRITO S. 2023. Monitoring and Evaluating the Quality of the Integrated System of Registers. *Working Papers 7*, Rome, Istat.

BARCHERINI S., BONTEMPI K., FAZZI G., LIANI S., LORÈ B., PIETROPAOLI S., ROSATI S. 2002. The respondent as the focus of the questionnaire design. In *UNECE Expert Meeting on Statistical Data Collection – Towards a New Normal?*, October, Rome, Italy.

BELL A. 2007. Designing and testing questionnaires for children, *Journal of Research in Nursing*, Vol. 12, No. 5, pp. 461-469.

CONTI C., FANFONI F., FAZZI G. 2024. Giving children and young people a voice: the experience of the sample survey on children and young people in Italy. *Working paper* 1, Geneva, UNECE.

GROVES R. M. 1991. *Measurement errors across the disciplines*. In P. BIEMER et al. (Eds.), Measurement errors in surveys. New York: John Wiley & Sons.

HOSMER JR D. W., LEMESHOW S., STURDIVANT R. X. 2013. *Applied logistic regression*. Hoboken: John Wiley & Sons

KROSNICK J.A. 1991. Response strategies for coping with the cognitive demands of attitude measures in surveys, *Applied Cognitive Psychology*, Vol. 5, pp. 213–236.

Sabrina BARCHERINI, Italian National Institute of Statistics, sabrina.barcherini@istat.it
Serena LIANI, Italian National Institute of Statistics, serena.liani@istat.it
Silvia PECORA, Italian National Institute of Statistics, silvia.pecora@istat.it
Simona ROSATI, Italian National Institute of Statistics, srosati@istat.it

ESTIMATION MODELS USED IN 2021 PERMANENT POPULATION CENSUS: CURRENT ACTIVITY STATUS, OCCUPATION, INDUSTRY AND STATUS IN EMPLOYMENT[1]

Diego Chianella, Carolina Ciccaglioni, Dario Ercolani

Abstract. Every year, Istat is involved in Census estimates production, which is obtained by integrating sample data with information from administrative sources. As regards the production of labour estimates, Istat produces Current activity status estimates for Italian dissemination. In 2023, in addition to these estimates, to comply with EU regulations, referred to the year 2021, estimates for Occupation, Industry and Status in employment were also produced. The estimation process for Employed/Not Employed is already well documented. For this reason, the procedure for estimating the Unemployed and Outside the labour force (students, retired people, housewives, other) and the variables related to Occupation, Industry and Status in employment will be here described. The estimates of these variables were produced at municipal level. The estimation models were implemented in R software through the 'multinom' function included in the 'nnet' package which allows to fit multinomial log-linear models using neural networks. The article aims to describe the different estimation models and the procedures used for choosing and defining the auxiliary variables included in the models. The administrative sources used were mainly social welfare and income sources and they allowed to identify 'work signs' of each individual.

1. Context and objectives

The transition from the traditional Census to the Permanent Census has required a total overhaul, both conceptual and methodological, of the estimation process of the census hypercubes. In detail, this evolution was made possible by the arrangement and use of administrative archives. This method provides up-to-date information on the population by integrating survey data with administrative data. A description of this process was provided in D'Alò et al. (2017) and Brogi et al. (2018). As a consequence, it was necessary to implement new estimation strategies to produce reliable estimates at given territorial levels (municipal and provincial).

One of the aims of the Italian Permanent Population and Housing Census is providing estimates of occupational, non-occupational status and so on. Following

[1] Although the document is the result of a joint effort of the authors, D. Chianella realized sections 3, 5, 7, C. Ciccaglioni sections 1, 4, 6 and D. Ercolani section 2. The views expressed in this article are those of the author and do not necessarily represent the views of Istat.

the Commission Regulation (EU) 2017/712 of 20 April 2017 about the production of census hypercubes, we computed estimates of *current activity status*, *occupation*, *industry* and *status in employment*. These variables are part of several census hypercubes. Below a description of the census variables related to the work topics and their breakdowns in accordance with the Commission Implementing Regulation (EU) 2017/543 of 22 March 2017:

- 'Current activity status' is the current relationship of a person to economic activity, based on a reference period of one week; his classification is shown in Table 1.
- 'Occupation' variable refers to the type of work done in a job (Table 2).
- 'Industry' (branch of economic activity) topic refers to the kind of production or activity of the establishment or similar unit in which the job of an employed person is locate (Table 3).
- 'Status in employment' classification is shown in Table 4.

Table 1 – *Current activity status classification.*

		Current activity status categories
1	Labour force	
	1.1	Employed
	1.2	Unemployed
2	Outside of the labour force	
	2.1	Persons below the national minimum age for economic activity
	2.2	Pension or capital income recipients
	2.3	Students
	2.4	Others

Table 2 – *Occupation variable classification.*

	Occupation categories
1	Managers
2	Professionals
3	Technicians and associate professionals
4	Clerical support workers
5	Service and sales workers
6	Skilled agricultural, forestry, and fishery workers
7	Craft and related trades workers
8	Plant and machine operators, and assemblers
9	Elementary occupations
10	Armed forces occupations

Table 3 – *Industry classification.*

	Industry categories
1	Agriculture, forestry and fishing
2	Mining and quarrying
3	Manufacturing
4	Electricity, gas, steam and air conditioning supply
5	Water supply; sewerage, waste management and remediation activities
6	Construction
7	Wholesale and retail trade, repair of motor vehicles and motorcycles
8	Transportation and storage
9	Accommodation and food service activities
10	Information and communication
11	Financial and insurance activities
12	Real estate activities
13	Professional, scientific and technical activities
14	Administrative and support service activities
15	Public administration, defence; compulsory social security
16	Education
17	Human health and social work activities
18	Arts, entertainment and recreation
19	Other service activities
20	Activities of households as employers; undifferentiated goods- and services producing activities of households for own use
21	Activities of extraterritorial organisations and bodies

Table 4 – *Status in employment classification.*

	Status in employment categories
1	Employees
2	Employers
3	Own-account workers
4	Other employed persons

An ‘employee’ is a person who works in a ‘paid employment’ job, that is a job where the explicit or implicit contract of employment gives the incumbent a basic remuneration, which is independent of the revenue of the unit for which he/ she works (this unit may be a corporation, a non-profit institution, government unit or a household).

An ‘employer’ is a person who, working on his or her own account or with a small number of partners, holds a ‘self- employment’ job and, in this capacity, on a continuous basis (including the reference week) has engaged one or more persons to work for him/her as ‘employees’.

An ‘own-account worker’ is a person who, working on his/her own account or with one or a few partners, holds a ‘self- employment job’ and has not engaged, on

a continuous basis (including the reference week), any ‘employees’.

‘Other employed persons’ includes persons who are ‘contributing family workers’ and ‘members of producers’ cooperatives'.

2. Focus on available data sources and variables created

The Census is the only survey that allows the dissemination of data on employed people, people seeking employment and the inactive up to municipal detail. With the new system, census data on the labour and non-labour force no longer derive from exhaustive field surveys, but from the integration of information from administrative sources with that collected on a sample of families. To support the estimate process of census topics we selected the information available from the archives considered to be the most correlated with the professional and non-professional status. Specifically, with reference to all the units included in the Population Register (RBI), an information structure has been created extending its contents by integrating data regarding both employment and income, as well as social areas (pensions, subsidies and monetary grants). The information on employment contained in administrative sources is of fundamental importance for the purposes of measuring employment. The administrative content that will be exposed consists of an extension of the RBI through an individual archive called Prevalent Occupation Base (BOP), derived from the study of the Labour Register (RL), and through the integration of social and income information (several variables of the realized dataset are on Table 5). The RL is configured as a system of micro data at the basis of a series of internal processes of the Institute - that is, usable by various internal users - able to increase coherence between the processes themselves, reduce redundancies and unify the statistical treatment of the available archives on employed persons, their job, contributions and salaries. The information present in the RL is used as input for two other registers: 1) employment data based on Business Enterprise Registry (Asia); 2) annual register on wages, hours and individual Labour costs, aimed at producing and analysing the remuneration variables and the work input from the worker side starting from the employment relationship linking the worker to the economic unit. The different sources used were ordered in a hierarchical way on the basis of the study conducted on the quality of the sources, in terms of consistency and completeness of the information and are obviously different for each subgroup of workers. For the "private employees" component, supplies were used: UNIEMENS INPS source that represents the main source both in terms of coverage (approximately 90% of job positions come from this source) and in terms of information content; employees in agricultural sector INPS and CIG. The priority criterion between sources allows to create intermediate versions of the register even

in the absence of one or more sources; these versions in fact allow to produce timely and accurate output to support other processes. As previously reported, starting from the identification codes in the RBI, which consistently align with the survey data, a data structure was created consisting of administrative information regarding the following fields.

Occupational field. With reference to the activities on the Labour Register, a database has been set up to allow the main occupation of the employed to be defined (BOP). This activity can be summarized in the deterministic identification, the investigation among all the work positions, observed through RL, of the individual and his main work activity, his work characteristics, connected to the ILO definitions, from which the specifications of the Labour Force survey (FOL) and Census Surveys are derived.

The reference population of the BOP consists in all the subjects identified in at least one of the administrative sources on employment available in Istat identified within RL. The aim is to identify, for each subject in at least one of the administrative sources on occupation acquired by the Istat and available for the reference year, his main work activity in a specific period of the year, limited to the month.

The basic definitional aspects applied to the data sources analysed are connected to the administrative information, from which the aim is to extract characteristics similar to the work definitions dictated by the International Labour Organization (ILO). Therefore, the classifications of work characteristics used in the FOL survey and in the Population Census were identified through administrative data.

The choice of the main work activity depends on criteria linked to the information power of the individual sources and on the comparison between different sources. Main sources: RL – Employed employment; INPS – Domestic work; INPS – Voucher; INPS – Parasubordinate Collaborators; INPS - Parasubordinate Freelancers; INPGI - Collaborators; INPGI - Freelancers; INPS - Artisans and traders; INPS - Autonomous Agriculture; INPS Ex Enpals – Self-employed workers; ASIA Enterprises – Individual VAT numbers with positive turnover. Auxiliary sources: Chamber of Commerce - Business Persons Archive; Chamber of Commerce - Shareholder Archive of joint-stock companies; ASIA Active and non-active companies.

Income aspects. The availability of fiscal sources acquired by the Ministry of Finance and the Revenue Agency has allowed the reconstruction of income from work, pensions and capital.

For the residents observed in RBI and their family characteristics, the individual indicator called equivalent income was calculated according to criteria defined by the OECD.

Social spheres. From the Population Register, information on educational qualifications and attendance at educational courses was extracted and partly

reclassified, as well as the types of pension (source of origin: INPS Social Security Source) such as old-age, indemnity and welfare pensions, disability and survivors. The possibility of having the source on non-pension monetary treatments has made it possible to associate with each individual in RBI the possible sums paid by INPS and the related types of benefits regarding social unemployment benefits, family allowance for workers, household allowance family member for families with economic difficulties, maternity or sickness allowances, student subsidies.

Among the reconstructed information, the available variables, which can be used as covariates, are: personal data (sex and age); residence and citizenship; annual incomes; presence of pension; enrolment in study courses; type of administrative information about work.

The following table summarises the variables used and the way they were build.

Table 5 – *Several variables used and reconstructed in this work on employment estimation.*

Source		Individuals type	Variable
Labour Register (LR)	Employees – Social Security of Private and Public sector (INPS-UNIMENS)	Employees	- Work distance - Distance from last work signal in terms of months - Work signals in terms of yearly weeks - Continuity of administrative work signals presence - Qualify classification of Employees - Main job classification of Not-Employees
	Domestic sector Social Security	Employees	
	Journalism Social Security	Employees	
	Agricultural Autonomus Social Security	Not-Employees	
	Artisans and traders Social Security	Not-Employees	
	Freelance Employer Coordinated Social Security	Not-Employees	
	Freelance Self Employed Social Security	Not-Employees	
ASIA Business Register (VAT Self-employed)		Not-Employees	
ASIA Business Register (Enterprises)		Work charateristics	Work activity sector (NACE)
Individuals Register (RBI)		Students	Course of study frequency (0,1)
		Registry personal data	Gender / Age / Citizenship
Social Security Source (INPS)		Work retired persons	Retirement allowance (0,1)
Not Social Security Benefits source (INPS)		Unemployed persons	Unemployment benefit indicator
Income source (Agenzia Entrate – Ministero Economia e Finanze)		Income data	Earnings from employment (OECD)

3. Estimation Methodology

As mentioned in section 1, traditional decennial census was replaced by continuous data collection integrating survey and administrative data.

The sampling design used to draw the census sample involves a two-stage stratified approach: municipalities and households/individuals. Larger municipalities are surveyed every year, while smaller municipalities rotate annually, covering all municipalities over a five-year cycle. This ensures comprehensive data collection, even though not all municipalities are surveyed each year.

To produce estimates on professional and work conditions at the municipality level for 2021 (covering all the Italian municipalities), we used logistic multinomial models (Agresti, 2013) implemented in R with the "multinom" function from the nnet package, except for the estimation of employed individuals, which is carried out through latent class models (Boeschoten et al., 2021). It is important to note that individuals estimated as employed through latent class models were excluded from the units on which the multinomial models were applied. The models were run separately for each region. These models are designed to fit multinomial log-linear relationships using neural networks, allowing for accurate estimation of categorical responses.

The estimation process uses a variety of administrative data sources, including ISTAT thematic registers on labour, the statistical register on enterprises for self-employed workers and ISTAT base individual register for demographic data. Additional data sources provide specific information such as education records and pension benefits.

The response variable, representing the specific category j of interest (e.g., employment status), is observed in the census sample data, while the predictors include a rich set of individual and area-level variables. Individual-level predictors, derived from administrative data might include age, sex, citizenship, and employment history, while area-level predictors might encompass regional unemployment rates derived from the labour-force survey and geographical classifications.

For each individual i (excluding those under 15 years old and individuals estimated as employed through latent class models) in RBI, probabilities of belonging to different categories (j) are calculated based on the predictor values X, where X_i represents the vector of covariates for individual *i*:

$$log(P(Y_i = j\,|X_i)/P(Y_i = k\,|X_i)) = X_i\beta_j; \quad for\, j = 1, \dots, k-1,$$

where β_j represents the set of regression coefficients associated with the predictors for category j and k is the reference category in the model. From this

relationship, we can derive the probability of belonging to each category j for individual i:

$$\hat{P}_{ij} = \hat{P}(Y_i = j \,|X_i) = \; exp\big(X_i\hat{\beta}_j\big)/\big(1 + \sum_{l=1}^{k-1} exp\big(X_i\hat{\beta}_l\big)\big).$$

Summing these probabilities within a specific domain, such as a municipality (M), provides the estimated number of individuals in each category j:

$$\hat{Y}_j^M = \sum_{i\in M} \hat{P}_{ij} = \sum_{i\in M} \hat{P}(Y_i = j \,|X_i).$$

The β parameters are estimated using maximum likelihood estimation (MLE). The nnet package internally sets up the likelihood equations and uses optimization techniques to find the parameter estimates that maximize the likelihood of the observing given data. This involves solving the following optimization problem:

$$\hat{\beta} = \arg max_\beta \sum_{i=1}^{n}\sum_{j=1}^{k} I(Y_i = j) \log P(Y_i = j \,|X_i, \beta),$$

where $I(Y_i = j)$ equals to 1 if the response variable for the individual i is in the category j, and 0 otherwise.

Variable selection for the models was carried out using Classification and Regression Trees (CART) models (Breiman et al., 1984), with model comparisons based on the Akaike Information Criterion (AIC) (Akaike, 1973) and the Bayesian Information Criterion (BIC). The BIC consistently favored simpler, more parsimonious models compared to the AIC, balancing model fit and complexity.

In addition, to select the best model, confusion matrices were generated for different models and their accuracy was evaluated. These confusion matrices were calculated on the test dataset, which was not used during the model training phase, following a standard cross-validation procedure. This approach ensures a more realistic assessment of the model performance and generalization capability.

Some covariates included in the model were grouped into classes to reduce model complexity, prevent overfitting, and increase computational efficiency. With a high number of categories, it was observed that some profiles had few or no observations, leading to potentially unstable or inaccurate estimates. By grouping categories, the number of observations per class increases, improving the stability of the estimates.

This methodology allows ISTAT to provide detailed and accurate estimates that inform policy-making, economic planning, and social services delivery at both national and municipal levels.

To produce a measure of accuracy associated with the municipal-level estimates, experiments are recently being conducted (Chianella et al. 2024) to account for both

sampling error and model error. This experimentation is based on a previously introduced generic measure of global uncertainty (GMSE) (Alleva et al. 2021).

4. Current activity Status

Referring to the categories described in Table 1, the 'labour force' category (1) comprises all persons who fulfil the requirements for inclusion among the employed or the unemployed. 'Employed' category (1.1) was estimated through latent class model (as mentioned in section 3) and it is out of scope for this work.

'Persons below the national minimum age (15 years old) for economic activity category' (2.1) were derived from RBI and therefore is not part of the estimation process.

The remaining categories in Table 1 (1.2, 2.2, 2.3, and 2.4) were estimated using a multinomial logistic model (as describe in section 3).

The categories of the target variable, recorded in the census sample and used as the response variable in the model, has a broader classification: 'unemployed' (1.2) individuals are divided into 'person seeking for first employment' and 'person seeking for new employment'; 'others' category (2.4) comprises 'housewife' and 'other condition'.

The variables found to be significant in the model are both individual and municipal level variables:

- Individual level variables: gender, age group, citizenship, attendance of a course of study by RBI, distance from the last work signal (in classes), continuity pattern of administrative work signals (in classes), retirement indicator from labour statistical register, unemployment benefit indicator and labour income (in classes).
- Area level variables: provincial unemployment rate, target variables municipal level estimates from previous census and inner areas (urban, suburban, and rural).

5. Occupation

Referring to Table 2, the classification is effective for both employees and non-employees. The categories of the response variable 'Occupation' recorded in the census sample and used in the multinomial model align with those required by European regulations.

The predictor variables (X_i) used in the models include both individual level and area level variables:

- Individual level variables: gender, age group, citizenship, education level, main job classification of non-employees and qualify classification of Employees.
- Area level variables: provincial unemployment rate from the Labour Force Survey, estimates from the previous census and inner areas (urban, suburban, rural).

The covariates "Main job classification of non-employees" and "Classification of employees" are derived from the BOP database described in the previous paragraphs. The main data sources for defining these variables are detailed in Table 5.

The most significant covariate was found to be the Qualify classification of Employees. The categories for this variable are: Manual Worker, Office Worker, Middle Manager, Apprentice, Senior Manager and Other Employee. Unfortunately, this was the most detailed reconstruction possible from the administrative data. It was not possible to create a covariate matching the response variable more closely, which would have allowed for a higher model accuracy.

6. Industry

For the Industry variable, some individual values were directly derived from the register, while the residual part was estimated using a model based on administrative and survey data. It was not possible to link the administrative data on the type of enterprise for about 30% of the estimated employed people. In particular, for this portion of individuals, the model was fitted on the subset of the census sample without administrative signals on industry. In fact, the auxiliary variables were related to individual demographic characteristics (gender, age group, and citizenship), educational level and territorial features (urbanization degree, coastal areas).

For each individual the industry value was generated by means of random draws based on the estimated probabilities.

Model selection was carried out on the basis of AIC and p-values of regression coefficient analysis comparison.

7. Status in Employment

The variable Status in Employment, represents the type of employment status held by individuals and is categorized into specific types as required by EU regulations (Table 4).

The categories of the variable of interest, recorded in the census sample and used as the response variable in the multinomial model, follow a different classification system: Employee (1), Continuous collaboration worker (2), Occasional worker (3), Entrepreneur (4), Freelancer (5), Self-employed worker (6), Member of a cooperative (7), Contributing family worker (8).

The predictors (X_i) used in the model include both individual- and area level variables:

- Individual level variables: gender, age group, citizenship, education level, presence of income from self-employment, presence of income from employment and main job classification of non-employees.
- Area level variables: the same area-level variables used for the Occupation estimation are applied here.

The most correlated variable with the Status in Employment is "Main job classification of non-employees". The categories for this variable are: Contributing family worker (1), Collaborator (2), Entrepreneur (3), Freelancer with employees from census sample (4), Freelancer without employees from census sample (5), Own-account worker with employees from census sample (6), Own-account worker without employees from census sample (7), Member of a cooperative (8).

It is evident that the categories required by European regulations, those recorded in the census sample, and those of the covariates differ from each other. Consequently, a mapping operation was carried out to align the categories of this covariate with those required in the census sample and those mandated by the regulation (Table 6). For example, individuals who responded in the census sample as "Entrepreneur", along with "Freelancer" and "Own-account worker" and who also declared having employees in the census sample, were assigned to category 2 (employers). Following these mapping procedures, the multinomial model was run using the reclassified variable from the census sample with its four categories instead of eight. This alignment ensures consistency and compliance with the regulatory requirements while improving the accuracy and reliability of the estimates.

Table 6 – *Mapping Operation between European Regulation Classification of the "Status in Employment", Values Recorded in the census sample, and the Main Covariate Used in the Estimation Model.*

No	Status in Employment (Eurostat)	Status in Employment (census sample)	Main job classification of non-employees
1	Employees	1	Null + Cond[2]=Employee
2	Employers	4 + (5+6)*Employees	3+4+6
3	Own-account workers	2+3+ (5+6)*Not Employees	2+5+7+9
4	Other employed person	7+8	1+8

[2] "Cond" is another variable contained in BOP: it indicates whether the worker is an employee or not.

References

AGRESTI A. 2013. *Categorical data analysis (3rd edition)*. John Wiley& Sons, Hoboken NJ.

AKAIKE H. 1973. Information theory and an extension of the maximum likelihood principle. In *Proceedings of the 2nd International Symposium on Information Theory*, Budapest: Petrov, B.N., Csáki, F. (eds) Akadémia Kiadó, pp. 267–281.

ALLEVA G., PETRARCA F., FALORSI P. D., RIGHI P. 2021. Measuring the Accuracy of Aggregates Computed from a Statistical Register. *Journal of Official Statistics*, Vol. 37, No. 2, pp. 481-503.

BOESCHOTEN L., FILIPPONI D., VARRIALE R. 2021. Combining multiple imputation and hidden markov modelling to obtain consistent estimates of employment status. *Journal of Survey Statistics and Methodology*, Vol. 9, No.3, pp. 549–573.

BREIMAN L., FRIEDMAN J., OLSHEN R., STONE C. 1984. *Classification and Regression Trees*, Wadsworth and Brooks, Monterey CA.

BROGI F., CICCAGLIONI C., FALORSI S., FASULO A., QUONDAMSTEFANO V., SOLARI F. 2018. Preliminary experimental: results on the Italian Population and Housing Census estimation methods. In *Proceedings of Twentieth Meeting of UNECE Group of Experts on Population and Housing Censuses*, Geneva.

CHIANELLA D., DELIU N., DI ZIO M., FALORSI P.D., FALORSI S., ROCCI F., SIMEONI G. 2024. Process and output quality evaluation measures for Istat Integrated System of Statistical Registers. In *Proceedings of the Seventh International Conference on Establishment Statistics (ICES VII),* Glasgow.

D'ALO' M., FALORSI S., FASULO A., SOLARI F. 2017. Estimation strategies combining different sources of data. In *Proceedings of 61st World Statistics Congress ISI 2017*, Marrakech.

Diego CHIANELLA, Istat, chianella@istat.it
Carolina CICCAGLIONI, Istat, ciccaglioni@istat.it
Dario ERCOLANI, Istat, ercolani@istat.it

TERRITORIAL AGGREGATION OF MEDIUM SIZE CITIES AND THEIR GRAVITATIONAL TERRITORY FOR EFFECTIVE COHESION POLICIES[1]

Pietro Barbera, Alberto Dolce, Rosario Milazzo, Ornella Pucci

Abstract: The Unitary Cohesion Policy in the previous programming cycle (2014-2020) focused on Urban and Inner Areas, but in the current cycle (2021-2027), the approach has expanded to larger territories. This approach targets local development policies, encompassing metropolitan and medium-sized urban areas, inner areas, and other intermediate territorial systems based on internal functional connections. However, the lack of a clear definition for "intermediate" territories makes it challenging for statistics to identify suitable areas for public intervention. Consequently, some territories characterized by economic, cultural, and social centres with significant demographic decline and rapid aging may lack adequate public policies. The Regional Programme ERDF in Sicily for 2021-2027 has been designed to be geographically structured in a way that best addresses the needs and challenges expressed by the entire Sicilian territory. This includes the goal of countering demographic decline and population aging.

To plan and implement effective public policies aligned with the cohesion objectives for 2021-2027, the first step is to define territorial systems based on strict criteria of functionality and internal homogeneity. In this context, a new representation of the Sicilian territory has been developed. It involves dividing the regional territory into "urban" areas (Functional Urban Areas-FUA) and "non-urban" areas (Inner Areas-AI) based on established criteria (OCSE/Eurostat, SNAI). Given the absence of a clear definition for "medium-sized cities" and their associated territories, the authors have identified Urban Rank Inter-Municipal Systems (SIRU) as territories sharing similar characteristics that can contribute to regional-level impacts through place-based strategies. This method involves considering commuting flows of Local Labour Systems (SLL) and local services to identify territories characterized by shared anthropic pressure factors and underutilized resources and attractors. The method yielded the following outcomes, as the selection of a group of medium-sized cities based on demographic and territorial dimensions, functions, and services for a wider area, and past cooperation for local development, the identification of other municipalities with similar specializations and urban criticalities and the framing of inter-municipal systems of urban rank in the "Area Vasta (large)" including a network of poles of attractiveness and relevant functional connections to enhance potentials through infrastructure interventions and

[1] Cap. 1 Alberto Dolce e Ornella Pucci, Cap. 2 Pietro barbera e Ornella Pucci, Cap. 3 Rosario Milazzo e Alberto Dolce.

standards of services provided by the FESR intervention.

1. The programmatic and implementation context

Over the last decade, there has been a noteworthy shift in European and national public policies towards territorial issues. This change reflects a growing interest in non-traditional territorial forms in response to factors such as rapid urbanization, demographic changes, environmental challenges, and the pursuit of sustainable development objectives more effectively. This evolution combines objectives of small municipality reorganization with strategies for local development in the country's most vulnerable areas. The EU played a crucial role in consolidating this shift during the 2014-2020 programming cycle, addressing challenges in both urban and inner regions and promoting connections between urban and rural areas (Partnership Agreement Italia 2014-2020, 2014). With the commencement of the 2021-2027 Cohesion Policy programming cycle, the centrality of the "functionality" criterion (OECD, 2021) was further reinforced in the identification of homogeneous urban areas for the planning and implementation of policies aimed at revitalizing economic development and enhancing urban attractiveness.

In Sicily, the 2021-2027 programming cycle aimed to develop an efficient and responsive strategy to address the diverse needs and challenges of the entire territory. Following European and national guidelines (Regulations UE 1060 and 1058, 2021), Sicily's 391 municipalities were restructured into three homogeneous geographic areas: 9 Functional Urban Areas (FUA), 12 Inner Areas (AI), and 8 Urban Inter-municipal Systems (SIRU) (PO FESR 21-27 Sicily). This aggregation relied on official statistical data for transparency and reliability, adhering to functionality and internal homogeneity criteria to optimize program management and resource allocation.

This holistic approach fosters synergies, optimizes public resource allocation, and addresses socio-economic and environmental challenges beyond individual municipalities, encompassing broader zones of influence. Intermediate territories exist between the FUA and AI, showcasing diverse and distinct areas that lack uniform definitions. Medium-sized cities, crucial for well-being, public services, and cooperation, lack a universally accepted definition. Various authors use demographic size as the primary criterion (ISTAT, 2020), while others emphasize different factors. Medium-sized cities serve as urban centres with a higher quality of life but limited service capacity compared to larger cities. They play a significant role in decompressing challenges faced by larger urban areas. The FESR Sicily 2021-2027 Program identified these territories as Urban Inter-municipal Systems, covering a substantial portion of the region's municipalities, population, and land. The challenge lies in addressing economic issues and enhancing infrastructure and services to align with urban standards.

2. Aims and methods

The territorial reading of the regional context aimed at characterizing and determining the Inter-municipal Systems mentioned in the 2021-2027 Partnership Agreement had to be conducted within a research scenario where two types of territorial systems were previously identified based on specific aggregation criteria: density and gravitational influence (commuting) for Functional Urban Areas (FUAs), and marginality and depopulation for Inner Areas. In light of these premises, the remaining regional territory - and the areas that could potentially be subsequently aggregated - were characterized as generally intermediate due to their residual determination compared to the identification of systems with maximum and minimum urban rank.

An initial analysis of the group of municipalities not included in FUAs and Inner Areas was carried out to define the most conducive analytical hypotheses according to the strategic framework of the Partnership Agreement. According to this framework, the implementation of policies at the territorial level, in addition to having local impacts, must significantly contribute to achieving impacts at the regional level. Within this perspective, the objective of defining strategically relevant Inter-municipal Systems translated into the operational search for urban rank characteristics that appeared present in the territory left from previous aggregations, with greater empirical evidence compared to those more typical of marginal areas.

Subsequent analytical investigations then focused on:

a) The attributes of urbanity, such as demographic and territorial dimensions, the presence of functions and services for a wider inter-municipal area, and the existence of previous experiences in urban development planning and cooperation.

b) The critical combination, typically urban, between factors of concentration related to the vocations/specializations of certain contexts and the pressure factors triggered by them on the environment, services, and overall liveability.

c) The relationships/connections that allowed the aggregation of other municipalities to those that were more characterized according to the two previous criteria, leading to the definition of coalitions/projects that go beyond the perimeter of individual municipalities, starting from the reference to their Local Labor Systems (SLLs), adopted as a comprehensive approach for the territorial analysis of the ERDF Regional Programme.

Through a multi-stage process, an armor of regional Medium-Sized Cities emerged, for which the application of an articulated set of indicators and descriptors, in addition to the typical complexity of the urban dimension, highlighted certain specificities of the regional scenario that, even more than the rest of the South of Italy, is characterized by a clear asymmetry between the aspects of dimensional growth (population and land consumption, primarily) and the actual qualitative

growth of the urban rank (advanced functions and services, opportunities, and quality of life, etc.).

In a preliminary analysis phase, a demographic consistency threshold was set at 30,000 inhabitants, also following the historical regional programming, where, in previous cycles, this class of urban centres was entrusted with the role of promoting and inter-municipal aggregation in local development plans.

The function of being the centroid of their own SLL and the presence of supra-municipal level service centres/facilities (healthcare, social and judicial services) were considered indicative of a medium urban rank of the municipalities in which they were observed. The subsequent Table 1 lists the nine municipalities with a population exceeding the identified threshold value and their corresponding descriptors of urban rank as previously explained.

Table 1 - *Municipalities with a population exceeding 30,000 inhabitants (in the regional territory outside FUAs and Inner Areas) and indicative descriptors of the "medium" urban rank for supra-municipal service areas.*

Municipality	Population	SLL Centroid	Social-Health District	Hospital Facility	Court	Local Development
Alcamo	45.025	**X**	**X**	**X**	*	
Augusta	34.657	**X**	**X**	**X**	*	
Barcellona	40.499	**X**	**X**	**X**	*	PISU 2007 – 2013*
Canicattì	34.697	**X**	**X**	**X**	*	
Comiso	30.509	**X**	**-**	**X**	**-**	
Licata	35.496	**X**	**X**	**X**	*	
Partinico	30.917	**X**	**X**	**X**	*	
Paternò	46.202	**X**	**X**	**X**	*	PISU 2007 - 2013
Sciacca	39.246	**X**	**X**	**X**	**X**	

*Piano Integrato di Sviluppo Urbano

Below the first dimensional threshold adopted of 30,000 inhabitants, medium-sized urban systems have also emerged, particularly centred on district capitals (administrative area abolished with the reform of the provinces in 1927) and characterized by i) the presence of supra-municipal service functions/centres, similar to the preeminent centres identified in the first phase of analysis based on dimensional thresholds; ii) a significant specialization and/or evident concentration related to a qualifying production asset of the entire regional system, primarily the tourism-hospitality sector, which results in a concomitant concentration of pressure factors on the environment, services, and overall liveability; iii) the growth trends of tourism-hospitality flows at the municipal level, besides highlighting an increasing presence of medium-sized urban systems, have led to issues of over-tourism that, in systems with greater and more enduring hospitality specialization, are rapidly

evolving into phenomena of saturation, with growing challenges related to environmental sustainability and the well-being of residents. The subsequent Table 2 lists the "medium" municipalities identified based on the selection criteria adopted in the second phase of territorial analysis.

Table 2 - *Medium-sized urban centres (with a population of less than 30,000 inhabitants) with characteristics of specialization/vocation in production and supra-municipal service areas.*

Municipality	SLL Centroid	Social-Health District	Hospital Facility	Court	Local Development
Cefalù	X	X	X	*	
Giarre	X	X	X	*	
Milazzo	X	X	X	-	PISU 2007 - 2013
Noto	X	X	X	-	
Patti	X	X	X	X	
Piazza Armerina	X	X	X	-	
Taormina	X	X	X	*	
Termini Imerese	X	X	X	X	PISU 2007 - 2013

Based on the methodology and results of the territorial analysis of the ERDF ROP 2021-2027, the third phase of the analysis aimed to verify the presence of a "second-level functionality" characterized by:

- Commuting flows and specialization of the Local Labor Systems (SLL).
- The establishment of functions and services complementary to the attractivity factors of the Medium-Sized Urban Centres/Gateways.
- A noticeable function of integration and diversification (i.e., proximity offering) concerning the more mature Tourist Hubs, which can act to mitigate pressure factors.
- Elements of continuity/spatial aggregation (cluster effect or territorial corridor) attributable to the widespread presence of underutilized territorial resources and attractors.

The analysis revealed an aggregate of municipalities that, due to their geographical location and functional complementarity with respect to the "medium" urban centres, would make a significant contribution to achieving regional-level impacts of implemented policies.

In the aggregate of municipalities presented in Table 3, a correlation was observed in several cases between specialization/attractiveness, economic performance, and

conditions or risks of incipient saturation, similar to what was previously verified in the reference urban centers. Besides the observable influx of people, there is an influx of settlements that cannot be read in terms of official residents: the incidence of built structures and seasonal overpopulation results in these municipalities having a demand for services that is quantitatively and qualitatively urban and generally unmet. Others share underutilized attractivity factors with the reference urban center, which are not adequately valued in a strictly municipal dimension and perspective, including in communication.

Table 3 - *Inter-municipal aggregations among municipalities with high accommodation capacity and/or attractiveness of flows and/or settlement pressure and medium-sized urban reference centers.*

Attractive-Settlement Poles	Medium-Sized Urban Centers
Campofelice di Roccella	Cefalù, Termini Imerese
Capo d'Orlando, Furnari, Gioiosa Marea, Terme Vigliatore, Tripi	Barcellona Pozzo di Gotto, Milazzo, Patti
Giardini-Naxos, Letojanni	Taormina
Linguaglossa, Mascali, Milo, Piedimonte Etneo, Sant'Alfio, Nicolosi, Zafferana Etnea	Giarre
Chiaramonte Gulfi, Pachino, Palazzolo Acreide, Ispica	Noto, Comiso
Calatafimi – Segesta, Gibellina, San Vito Lo Capo	Alcamo, Partinico, Sciacca
Aidone, Palma di Montechiaro	Licata, Canicattì, Piazza Armerina

The elements of "intermunicipality" emerging and highlighted in the distribution of Table 3 are not only traceable in the proximity or geographical contiguity of the territories but also in the presence of functional relationships and connections.

From the geographical distribution of the intermunicipal areas illustrated above, the location and role of four urban centres stand out, where physical access infrastructures such as airports and ports with traffic movements, even at the international level, are situated. In addition to the growing traffic flows, their complementarity with those located in FUAs, with which they are associated in terms of management, is also remarkable.

Of these Gateway Cities, three have already been qualified as medium-sized cities based on the preliminary criteria applied (Augusta, Comiso, and Termini Imerese), while the fourth (Pozzallo) can be considered for the presence of transboundary flows, constantly intensifying, to and from Malta.

Among the first intermunicipal aggregations present in Table 3, supported by more immediate geographical and functional connections, two medium-sized cities

stand out for which their dimensional consistency does not correspond to an evident attractive and relational capacity even in terms of contiguity.

The first city (Paternò), despite being the largest in population among those in the first aggregate of regional medium-sized cities and, in general, among those with the greatest territorial extension, shows a kind of functional "self-containment" evident even from its attraction capacity limited to the sole municipality of Ragalna, with a population equal to one-tenth of the centroid.

The second case is represented by a medium-sized city (Augusta), which, due to the capacity and types of port traffic, represents the largest Gateway City among those identified and also expresses the most striking dilemma about the possibility of maintaining its historical productive and functional characterization in the future.

3. Results

The outcomes of the analysis have led to the identification of a total of 123 municipalities, with a population of 1,130,532 residents, and the establishment of eight Inter-municipal Systems defined as "Urban Rank" since they are aggregated and clearly characterized by Medium-Sized Cities, Gateway Cities, and the main accommodation and attraction Hubs in the portion of the regional territory that was not originally classified as Functional Urban Area or Inner Area.

The eight Urban Rank Inter-municipal Systems (SIRUs) were constructed, as specified above, through various analysis steps supported by the implementation and analysis of over fifty indicators at the municipal level. These indicators allowed us to trace the main socioeconomic, demographic, environmental, and some essential service characteristics of the territorial systems. Particular attention was also given to the construction of second-level urban functionality indicators (commuting, services complementary to the attractiveness of Medium-Sized Cities, and densification from tourist attractiveness - ADP 21-27).

Through the analysis of the unifying characteristics of the Urban Rank Inter-municipal Systems (SIRUs) (common strengths and weaknesses), it was possible to identify the specific potential and needs of each territory in terms of infrastructure, services, and support for economic activities, and therefore, the most suitable public policies for their development. In doing so, the presence of Inter-municipal Systems that play a specific role, which we can define as intermediate, between the Urban and Inner territories of Sicily, has been highlighted.

More specifically, these Urban Rank Inter-municipal Systems, due to their identified peculiarities and needs, represent a specificity of urban areas that are not represented by metropolitan Functional Urban Areas (FUAs), medium-sized urban areas, or even coalitions of inner areas in the Sicilian territory.

Figure 1 - *Classification of the Urban Rank Inter-municipal Systems in Sicily.*

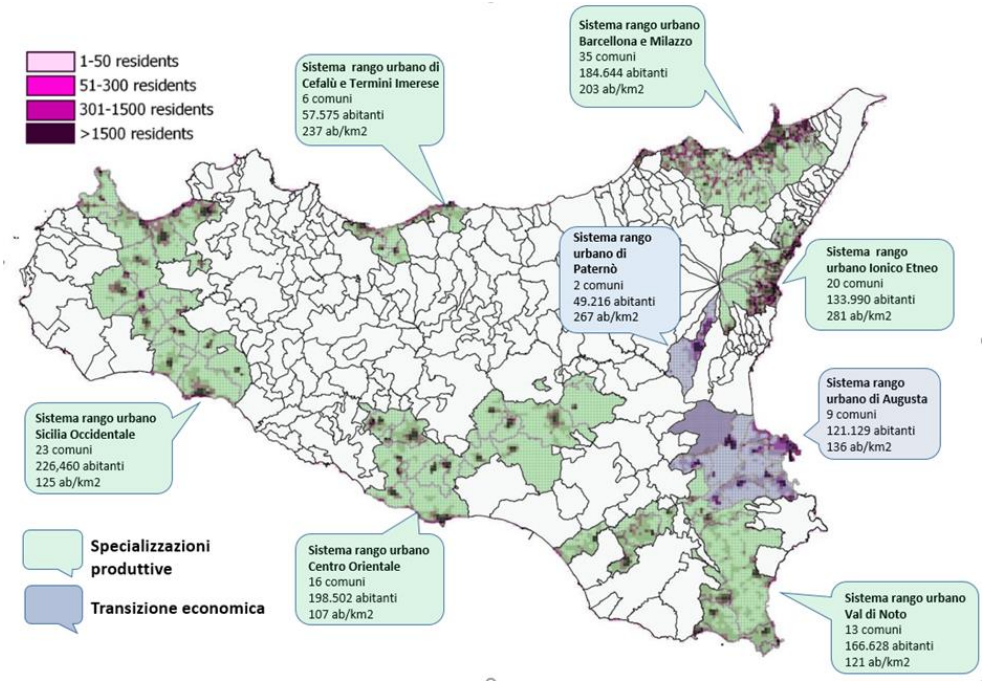
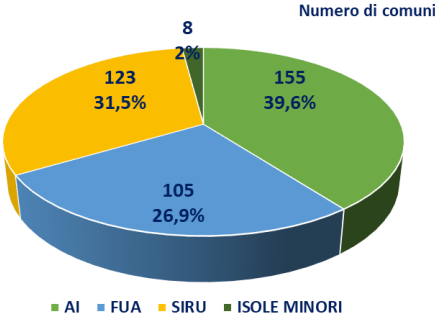
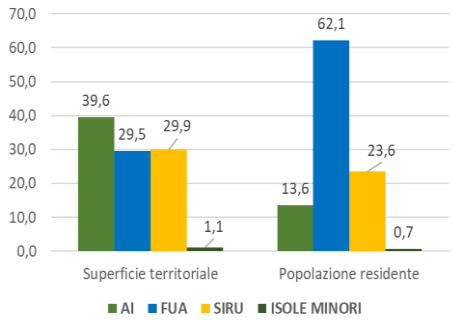


Figure 2 - *Comuni per macro aree - Anno 2022 (valori assoluti e percentuali).*



Fonte: elaborazioni su dati Istat

Figure 3 - *Superficie e popolazione per macro aree – Anno 2022 (valori percentuali).*



Fonte: elaborazioni su dati Istat

The table below shows a selection of indicators that have been used in the methodology both to identify the Urban Rank Inter-municipal Systems (Medium-Sized Cities) with particular attention to the main intervention sectors of the

Cohesion Policy 21-27, and to determine the positioning of individual SIRUs relative to Functional Urban Areas and Inner Areas. The results of the selected indicators demonstrate a perfectly intermediate dimension in the continuum between urban areas (FUAs) characterized by high density and demographic concentration, as well as functional relationships between the various aggregated administrative units, and the Inner Areas (AIs) characterized by demographic and economic decline and poor accessibility.

Table 4 – *Indicators for Inter-municipal Systems and Macro Areas - Various years*[2].

SIRU	Ind.1	Ind.2	Ind.3	Ind.4	Ind.5	Ind.6	Ind.7	Ind.8	Ind.9	Ind.10
Centro orientale	-9,4	170	10,6	47,8	10.302	4,7	23,8	1,3	2,2	1,2
Sicilia occidentale	-4,8	190	14,6	54,9	9.637	6,3	25,6	1,3	10,2	1,8
Tirreno sud orientale	-5,8	194	17,7	56,0	2.288	8,2	36,7	1,8	17,1	1,4
Val di Noto	-0,6	151	13,2	51,1	1.814	7,8	26,1	1,3	6,1	0,5
Tirreno sud occidentale	-2,7	188	19,4	66,3	2.754	10,2	30,2	1,3	44,6	5,3
Paternò	-4,5	131	12,7	48,7	-	7,2	30,6	1,4	0,9	0,8
Ionico etneo	-3,4	176	17,1	63,8	49.171	9,1	50,8	1,7	51,3	1,4
Augusta	-6,2	189	19,9	43,5	148	9,1	37,5	1,1	3,0	2,9
MACRO AREE										
FUA	-2,4	159	18,2	57,3	13.476	10,4	24,1	1,1	13,0	3,7
SIRU	***-5,1***	***176***	***15,4***	***54,5***	***8.377***	***6,9***	***31,8***	***1,4***	***10,7***	***1,6***
AI	-9,5	198	12,1	49,5	949	3,2	32,8	1,8	1,4	1,8
ISOLE MINORI	+3,3	183	21,1	81,7	6.103	6,8	5,3	2,1	56,2	0,9
SICILIA	**-4,0**	**168**	**16,7**	**55,7**	**9.322**	**6,5**	**26,9**	**1,3**	**8,2**	**2,9**

Fonte: elaborazioni su dati Istat, Ispra, Miur; Mibact, Ministero della salute

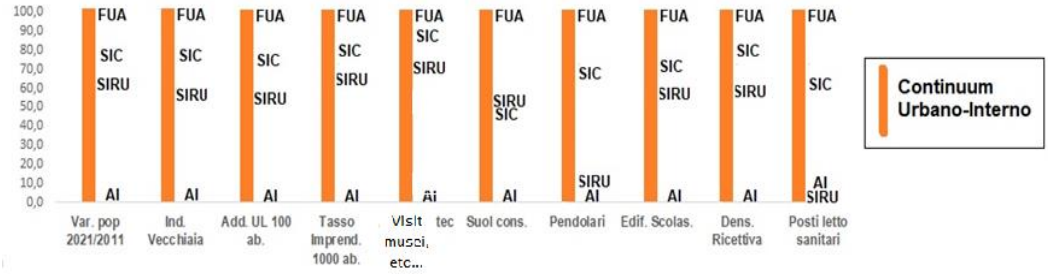
The results in the table show, for almost all the examined indicators, the intermediate positioning of the SIRUs with respect to both macro urban and non-urban areas. The exception is the indicator of hospital beds per thousand inhabitants, where the value of the SIRUs is lower than both FUAs and AIs. This positioning is likely to be explained by the territorial logics and organizational models of the regional healthcare system.

After the descriptive analysis of the indicators and the identification of their

[2] Ind.1: % Population Variation (2011-2021) ; Ind.2: Dependency Ratio (2021) ; Ind.3: Employees in Local Units per 100 Inhabitants (2019) ; Ind.4: Entrepreneurship Rate (Enterprises per Population) per 1,000 Inhabitants (2019) ; Ind.5: Average Visitors to Museums, Galleries, Archaeological Sites, and Monuments ; Ind.6: Land Consumption Rate per 100 Hectares (2020) ; Ind.7: Incidence of Commuters Outside the Municipality (2020) ; Ind.8: School Buildings per 1,000 Inhabitants (2021) ; Ind.9: Accommodation Density Index - Bed Places per Square Kilometer (2020) ; Ind.10: Bed Places in Healthcare Facilities per 1,000 Inhabitants (2019) ;

intermediate positioning with respect to the two-macro areas, in order to confirm this specificity, it was decided to apply a methodology to synthesize the indicators and verify the results obtained. To this end, after standardizing the selected indicators for the 3 territorial macro areas (SIRUs, FUAs, and AIs), the method of difference between the mean and mean squared deviation of individual indicators multiplied by their coefficient of variation was applied. This method was chosen for both its ease of calculation and its ability to identify the statistical behaviour of the individual indicators contributing to the intermediate positioning of the SIRUs in the landscape of Urban and Non-urban coalitions in Sicily. The results of the methodology are synthetically represented in Fig. 4.

Figure 4 - *Positioning and distance of the Urban Rank Inter-municipal Systems on the Urban-Inner continuum.*



4. Some concluding remarks

The identification of homogeneous territories, achieved through appropriate criteria such as aggregations of municipalities with specific characteristics, serves as a fundamental step in fostering their active involvement in both Italian and international political agendas. While it may appear relatively straightforward to direct public policies and allocate resources towards either densely populated urban areas or economically disadvantaged rural regions, which represent the two extremes of the territorial continuum, it is indeed more intricate to address the needs of territories falling outside these well-defined categories.

In this context, medium-sized cities and their surrounding areas emerge as pivotal components of the Italian and Sicilian territorial landscape. Despite their importance, these territories present challenges when it comes to their precise identification and understanding of their role within the overall planning and political context. However, for the 2021-2027 programming cycle, Sicily has successfully developed a meticulous and well-structured approach to define and recognize these intermediate territories. The primary goal is to establish relevant criteria for the allocation of economic resources, while simultaneously acquiring in-depth

knowledge essential for planning and executing development policies, particularly in territories of vast significance and complexity, characterized by distinct challenges and unique issues.
The process of identifying these intermediate territories is grounded on several key criteria: the characterization of Local Labor Systems (SLL), which carefully examines the dimensions and degree of specialization of the centroid municipality and the surrounding municipalities within their scope. This approach facilitates a comprehensive understanding of the territories' economic dynamics and employment patterns; the identification of complementary functions and services that are intricately linked to the territories' specialization and attractiveness factors. These may include Medium-Sized Cities, Gateway Cities, mature or saturated Tourist Hubs, and regions with high attractivity. Recognizing and enhancing these features contribute significantly to the overall development strategy; the emphasis on fostering a growing and discernible function of integration and diversification of offerings, often referred to as "proximity offerings." This strategic approach aims to alleviate settlement pressures and mitigate the demands for services caused by excessive concentration, both in terms of location and seasonality. Lastly, the consideration of the function of complementarity and/or continuity of territorial offerings within and between the territorial strategies of the Inter-municipal Systems. This approach ensures effective coordination of territorial resources and activates previously underutilized attractors through targeted regional-level actions.
By applying these rigorous criteria, Sicily has achieved considerable success in identifying homogeneous territories that share common characteristics. This comprehensive approach has not only provided them with access to vital resources for territorial development but also empowered them to address the ever-increasing and multifaceted challenges they encounter in their quest for sustainable progress. The coherent and strategic pursuit of these objectives has ushered in a new era of territorial governance that is more responsive, inclusive, and forward-thinking.

Acknowledgements

A special thanks is extended to the "Interdepartmental Group for Territorial Policies 2021-2027 for Sicily," comprised of experts from the "Evaluation and Verification Unit for Public Investments in Sicily" and officials from the “Area 8 Planning and Management for Urban and Territorial Development Policies” of the Department of Planning of the Sicilian Region. Through their rigorous reviewing and verification activities, they have provided valuable contributions to enhance the conceptual and methodological contents of this work and have helped create an extensive reference bibliography.

References

ANCI-IFEL. 2013. L'Italia delle città medie. In *i Comuni – Quaderni di analisi* from Centro Documentazione e Studi Comuni Italiani

CONSIGLIO ITALIANO PER LE SCIENZE SOCIALI. 2011. *Società e territori da ricomporre Libro bianco sul governo delle città italiane*

DE DONNO M, TUBERTINI C. 2020. Frammentazione comunale e contrasto allo spopolamento. In *Istituzioni e Federalismo*

FORMEZ. 2021. *Dossier regionale -Regione Autonoma Sicilia, programmazione 2021-2027*

ISTAT. 2020. *Rapporto sul territorio 2020 - Ambiente, Economia e Società.*

REGOLAMENTO DISPOSIZIONI COMUNI (RDC) UE 1060 del 2021 e Regolamento UE FESR1058 del 2021

THE EUROPEAN COMMISSION, UNITED NATIONS HUMAN SETTLEMENTS PROGRAMME. 2021. *OECD Regional Development Studies Applying the Degree of Urbanisation A Methodological Manual to Define Cities, Towns and Rural Areas for International Comparisons: A Methodological Manual to Define Cities, Towns and Rural Areas for International Comparisons*. OECD Publishing.

Pietro BARBERA, Nucleo Valutazione e Verifica Investimenti Pubblici Regione Siciliana, pb.barbera@gmail.com

Alberto DOLCE, Istituto Nazionale di Statistica, dolce@istat.it

Rosario MILAZZO, Istituto Nazionale di Statistica, milazzo@istat.it

Ornella PUCCI, Nucleo Valutazione e Verifica Investimenti Pubblici, Regione Siciliana, ornellapucci1@gmail.com

HOW DEEP IS THE IMPACT OF DEEP TRADE AGREEMENTS? AN EMPIRICAL ANALYSIS ON A LARGE SAMPLE

Elisa Borghi, Rodolfo Helg, Lucia Tajoli

Abstract. The actual impact on trade flows of preferential trade agreements (PTAs) has been debated for a long time. In light of the "deepening" occurring in PTAs, increasingly including beyond-the-border measures and non-economic goals, we reassess their effects by estimating a gravity model of trade including a large set of countries, and specifically treating the EU as a unique entity. We control for the depth of the agreements using different sets of measures. Our results confirm the positive impact of PTAs on bilateral trade flows, but also show that the larger and more complex the included provisions, the weaker is the marginal effect on trade.

1. Introduction

Since their diffusion after World War II, Preferential Trade Agreements (PTAs) among countries stirred a debate on their effectiveness and their actual impact on international trade, and whether they are "building blocs or stumbling blocs" for trade liberalization (Bhagwati, 1991; Baldwin and Seghezza, 2010). While most of the empirical evidence suggests that PTAs increase trade among partner countries, a renewed assessment of their effects is appropriate in light of the changing nature of PTAs over time. Initially, these were agreements mainly based on the elimination of border trade barriers, first of all tariffs, but more recently they developed into agreements that seek a "deep integration" and include a large set of behind-the-border policies, and often include also non-economic objectives.

The aim of this paper is to assess the impact of PTAs including deep provisions on bilateral trade flows. In order to do so, we introduce variables that capture different depths of the agreements and group provisions together on the basis of their characteristics. Even if these deals include provisions of different kinds, aimed for example at protecting the environment or the safety of consumers, in principle, they should still be aimed at liberalizing trade. Therefore, we want to test the impact they have on the main variable that should be affected: trade flows.

PTAs, and especially "deep" agreements, have proliferated during the last ten years, also because of the growing skepticism toward globalization and toward the multilateral system built by the WTO. In a world economy formed by an expanding group of relevant different players, reaching consensus on complex policies affecting trade in a multilateral setting has proven to be very difficult. Therefore, countries

preferred to resort to agreements within smaller groups of (often like-minded) countries. This interest in PTAs as means to spread their own rules and a given view on the functioning of world markets was displayed also by the largest world economies. The EU signed a very large number of such agreements with many countries around the world, and from 2013 to 2016 the EU and the US negotiated the Transatlantic Trade and Investment Partnership (TTIP), potentially one of the most important bilateral trade initiatives ever negotiated. This agreement would have been relevant also because of its potential global reach in setting an example for future agreements and setting new (much needed) standards for international trade.

Differently from the literature, we consider the EU as a single country to fully include the potential scale effects of its deep trade agreements, and to ensure that the high degree of EU internal integration is not affecting the overall results. Our analysis suggests, in line with the literature, that PTAs enhance international trade among countries. However, when we consider the depth of PTAs, we find that there is a non-linear relationship between PTAs' depth and international trade: beyond a certain complexity, the agreement reduces international trade. Similarly, when we split the policy areas covered by PTAs in terms of their economic relevance, we find that non-core policy areas (related mainly to non-trade objectives) don't have any positive impact on trade flows.

2. The empirical analysis of the role of PTAs

Starting with Tinbergen (1962) the gravity model has been a workhorse for empirical analysis in international trade generating results that fit the data remarkably well. Tinbergen's gravity equation has some analogy with Newton's law of gravitation:

$$Trade_{ij} = constant \times GDP_i^{a1} \times GDP_j^{a2} \times Distance_{ij}^{-1} \quad (1)$$

Using logarithmic transformation and with some additional covariates controlling for barriers - "resistances"- to bilateral trade flows, the equation's coefficients can be easily estimated with OLS and generated a large empirical literature (for surveys: Yotov, 2022; De Benedictis and Taglioni, 2011).

For a long period, the gravity equation remained without solid theoretical foundation. However, in the last 20 years, it has been shown (Anderson and van Wincoop, 2003; Arkolakis *et al.*, 2012) that a slightly modified version of equation 1 is consistent with a wide range of canonical trade models: the gravity equation is a reduced form for many theories. Nonetheless these theories impose some constraints on the correct specification.

The gravity model has been adopted to analyse various topics. The largest number of contributions has concentrated on quantifying the impact on trade of

various determinants and policies: distance, international economic integration and PTAs (the focus of this paper), currency unions, tariffs and non-tariffs measures, colonial ties, common language and others.

The large empirical literature on the economic effects of PTAs has commonly found that trade agreements have a positive effect on international trade flows (*e.g.* Baier *et al.*, 2019; Larch and Yotov, 2014). However, the estimates of the PTAs impact on trade flows have changed across authors and over time. This can be explained by two facts. First, the increasing availability of panel data samples has allowed the adoption of important methodological contributions (see next section) that generate more precise estimates of the coefficients of interest. Second, the nature of PTAs has changed over time, with a considerable increase of their depth (Hofmann *et al.*, 2017).

3. Methodology and data

3.1 Empirical specification

In this paper a structural gravity model is adopted to quantify the impact of trade agreements and their depth on international trade flows. We rely on the latest developments on the theoretical side and follow the most recent contributions on the estimation and data fronts (*e.g.*, Larch and Yotov, 2024). Our econometric model has the following baseline specification:

$$X_{ij,t} = exp\left\{\beta_1 PTA_{ij,t} + \beta_2 WTO_{ij,t} + \gamma_{ij} + \varphi_{it} + \theta_{jt}\right\} + \epsilon_{ij,t} \quad (2)$$

Our sample is a panel with i=exporter country, j=importer country and t=year. It covers 156 countries from 1980 to 2018.

$X_{ij,t}$ is the nominal value of good exports from country i to country j at time t. It includes both international and intra-national trade flows (domestic sales). All theoretical micro-foundations of the gravity equation require market clearing and these conditions include domestic sales. This inclusion is not only theory consistent but allows the identification of non-discriminatory trade policies (otherwise wiped out by the inclusion of country-time fixed effects as in equation (2)) (Yotov, 2022).

$PTA_{ij,t}$ is our variable of interest. It is a dummy variable with value 1 if i and j have a preferential trade agreement in force. In some of our specifications we will substitute $PTA_{ij,t}$ with a vector of variables including PTA and other measures of the agreement depth.

$WTO_{ij,t}$ is a dummy variable with value 1 if both countries are World Trade Organization (WTO) members.

Exporter-year ($\varphi_{i,t}$) and importer-year ($\theta_{j,t}$) fixed effects are utilized to eliminate the omitted variable bias due to not properly accounting for multilateral resistance terms (MRT) (which are country specific and vary overtime). Anderson and van

Wincoop (2003) have shown that equation 1 is misspecified because it accounts only for bilateral resistance terms (distance and other covariates) and not for MRT (barriers to trade that a country has with all partners, capturing the general equilibrium effects associated with barriers to trade that each country faces with all its trading partners). The inclusion of these directional country-time fixed effect wipes out also the two GDP variables that appear in equation (1).

Asymmetric (or directional) country-pair fixed effects ($\gamma_{i,j}$) are included to control for bilateral time invariant variables. Some of these might be measured (for example, distance, common language, common border), but many others not. This allows us to control for omitted variable bias generated by observable and unobservable bilateral time invariant determinants of international trade. Moreover, including country-pair fixed effects allow us to handle the endogeneity bias linked to the fact the probability of signing a trade agreement is influenced by the same determinants of trade flows. The identifying assumption is that this problem is generated by time-invariant non measured variables (Larch and Yotov, 2024). This has been the leading approach in the literature to handle the endogeneity problem. As an additional control for endogeneity, we will also include leads of the PTA variable to measure the anticipation effects of future agreements. The asymmetricity of the fixed effects allows for the possibility that a PTA might not affect trade of a given pair of country in the same way (Baier *et al*., 2019).

The inclusion of all these fixed effects wipes out some of the variables that traditionally entered the gravity equation: country pairs GDP and distance. These are not variables of interest in this paper. However, we control for their effect, but we do not identify their specific impact on trade flows.

Equation (2) is estimated using the Poisson pseudo maximum likelihood (PPML) estimator proposed and discussed by Santos Silva and Tenreyro (2006). This estimator solves two weaknesses of the OLS estimator utilized with a logarithmic transformation of eq 2: inconsistency of the estimates due to heteroscedasticity and the problem of dealing with the many zero trade flows due to the logarithmic transformation. PPML estimator does not require any logarithmic transformation and the gravity equation is estimated in multiplicative form.

Equation (2) contains dummy variables whose number depends on how many countries are included in the sample. This might generate an incidental parameter problem: in general, it is not possible to obtain consistent estimates when the number of parameters depends on sample size (Santos Silva and Tenreyro, 2022). Weiner and Zylkin (2021) have shown that in a three-way panel gravity equation like ours, the PPML estimator is still consistent, but asymptotically biased and propose an analytical bias correction. We follow their suggested procedure.

We exploit all the information contained in our panel data set using consecutive years rather than time-averaged or time-interval data as done by part of the empirical

literature. Egger *et al.* (2022) have convincingly argued against the use of time-interval data based on the fact that this practice might lead to biased estimates of both short and long-run effects of PTA on trade flows, that selection of the interval length is arbitrary and that discarding data generates less efficient estimates. To capture the dynamic adjustments (phase-in and phase-out) of trade flows to PTA we will introduce leads and lags in the PTA variable.

3.2 Data sources

To estimate the model in equation (2) we consider a panel of 156 exporters and importers from 1980 to 2018. As mentioned, the European Union (EU) is treated as a single country due to its common trade policy, implying that PTAs are negotiated and signed by the EU and not by individual member countries, and the significance of the Single Market as a deeply integrated area. The EU is built dynamically, with individual countries appearing in our dataset as such prior to access and then incorporated in the Union.

Export flows from origin to destination are sourced from the CEPII Trade and Production database (TradeProd). This database combines data on international and domestic trade flows at the bilateral level combining trade data from Comtrade and production data from UNIDO (Mayer *et al.*, 2023).

Gravity variables, including information on the existence and the type of regional trade agreements (PTAs) and WTO membership are sourced from the CEPII Gravity Database (Conte *et al.*, 2022). The database reports information not only on the participation of countries in PTAs, but also on the type of PTA, distinguishing Partial Scope Agreements (PSA), Free Trade Agreements (FTA), Customs Union (CU) and Economic Integration Agreements (EIA).

Finally, to introduce a more refined measure of the depth of regional trade agreements, we take advantage of the World Bank's Deep Trade Agreements database (Hofmann *et al.*, 2017). This dataset maps the coverage of 52 policy areas in the PTAs notified at WTO signed between 1958 and 2023, including information not only on the policy areas included but also on their legal enforceability, providing a measure of the extensive margin of the content of deep trade agreements.

4. Results

4.1 Baseline results

Our baseline specification considers the (simultaneous and lagged) impact of PTAs on bilateral trade flows, taking into account the type of agreement. Estimates for our baseline specification in equation (2), are presented in Table 1.

Table 1 – *Trade effects of PTAs.*

	(1)	(2)	(3)	(4)
PTA	0.250***	0.200***	-0.007	
	(0.088)	(0.059)	(0.025)	
WTO	0.240***	0.255***	0.226**	0.144
	(0.095)	(0.067)	(0.096)	(0.123)
PTA_{+4}			0.132***	
			(0.041)	
PTA_{+2}			0.042*	
			(0.022)	
PTA_{-2}			0.068***	
			(0.020)	
PTA_{-4}			0.049**	
			(0.025)	
PTA_{-6}			0.0300	
			(0.028)	
PTA_{-8}			-0.002	
			(0.030)	
PTA_{-10}			0.085*	
			(0.045)	
FTA				0.404***
				(0.071)
CU				0.296*
				(0.177)
EIA				-0.557***
				(0.144)
PSA				0.382***
				(0.138)
Tot. PTA			0.376***	
			(0.096)	
F.E. ($\varphi_{it}\,\theta_{j,t}\,\gamma_{i,j}$)	Yes	Yes	Yes	Yes
Pseudo R^2	0.998	0.998	0.998	0.998
Observations	615742	615742	615742	615742

Table note: in column 2 we use the Stata code ppmlhdfe developed by Correia et al (2020) that improves on the routine proposed by Santos and Tenreyro (2006) by finding solutions for those cases in which the pseudo loglikelihood function does not have a maximum. In the remaining columns we use the Stata code ppml_fe_bias created by Weidner and Zylkin (2021) that corrects for asymptotic bias.

In column 1 and 2 are reported the estimates for our baseline specification (equation 2) with and without correction for asymptotic bias. PTA has a positive and significant effect on trade flows in both cases and the two estimated coefficients have similar dimension. An estimated coefficient of 0,25 implies that an international trade agreement between two countries increases trade flows by 28,4%. This result is in line with the most recent literature (Larch and Yotov, 2024). This is only the direct or partial equilibrium effect on trade. It doesn't consider indirect effects induced by third countries adjustments that could be computed in a general

equilibrium framework. As expected, also WTO participation has a positive and significant effect on trade flows. Also in this case the estimated point estimate has a dimension in line with the recent empirical literature (Larch and Yotov, 2024)[1].

International trade reacts slowly to changes in trade barriers; therefore it is appropriate to allow for anticipation and phasing-in effects of an international agreement. Anticipation effects are due to firms that start adjusting their internationalization strategies when the agreement is announced or to some trade costs that start falling before the agreement is signed. Phasing-in effects are motivated by stepwise reduction in trade barriers designed by the PTA. To allow for these dynamic effects, we introduce in the baseline equation leads of the PTA variable for anticipation effects and lags of PTA for phase-in effects.

We follow the empirical literature (for example, Egger *et al.,* 2022) in assuming that anticipation effects are spread over a shorter number of years than phase in effects: for the former we go back four years and for the latter we have leads up to the tenth year. In Table 1 column 2, we add 2-year lags and leads of PTA variable[2]. With the introduction of leads and lags the contemporaneous effect of PTA disappears. However, various leads and lags are positively significant, a signal of the relevance of anticipation and phase-in effects and the importance of including them into the specification. The cumulative effect of PTA (calculated as the sum of the significantly different from zero leads and lags coefficients) is 0,376 (significantly different from zero), implying a 45,6% increase in trade flows.

The WTO distinguishes different types of PTAs. In column 4 of Table 1, the PTA variable has been substituted by indicator variables for four types of agreements. The most common type is the Foreign Trade Agreement (FTA) in which member countries eliminate completely all tariffs among them. Our results show that it has the largest impact on trade flows (it increases international trade by 49,8%). Custom Unions (CU) are a form of agreement deeper than FTA: in addition to complete good trade liberalization, members of a CU adopt a common trade policy. CU has a positive and significant impact on trade flows, even if lower that FTA. Partial Scope Agreements (PSA), which covers only certain products, have a positively significant impact on trade flows stronger than FTA. This result has also been obtained by Larch and Yotov (2024). One possible explanation is that these agreements being narrowly focused on specific products are very effective in liberalizing and increasing trade flows. Finally, the result for Economic Integration Agreements (EIA), which liberalize trade in services, is puzzling: the estimated coefficient is significantly negative, suggesting a negative correlation between better access to service markets

[1] As a goodness-of-fit measure we use the Pseudo R^2 generated as the squared simple correlation between observed and predicted values of the dependent variable.

[2] We have also estimated a specification with year-on-year responses to the creation of an PTA obtaining similar results.

and trade in goods. Certainly, crossed effects of economic agreements between countries on different types of flows do exist and the sign is not always positive (see for example, Heid and Vozzo, 2020). Therefore, it is possible that a sort of crowding-out effect occurs also between services and goods.

4.2 The depth of trade agreements

The baseline estimates confirm that PTAs' trade effects differ by type of agreement, as expected. Here we focus on how the depth of an agreement impacts international trade flows. Since the early '90s there has been a large increase in the number of PTAs. These new agreements are considered "deep", in contrast to old PTAs considered as "shallow". Shallow agreements were mainly concerned with reducing tariffs on industrial and agricultural goods (border policies). The new wave of agreements has extended the commitments to non-tariff border measures and a large set of behind the border measures (for example, intellectual property rights and standards). Hofmann et al (2017) show that deep integration has gained momentum since the '90s: PTA signed between 1990 and 1994 covered around 15 policy areas and between 2010 and 2015 on average 23.

According to many authors (for example, Mattoo *et al*., 2020) deep trade agreements (DTA) are expected to increase trade flows among member countries more than a comparable shallow agreement. One argument is based on the larger reduction in trade costs due to the increased number of policy areas included in DTAs. However, it is reasonable to expect that some provisions included in DTAs might have a negative effect on trade flows between members. Some of the new policy areas covered by DTAs aim to improve various non-trade objectives (NTOs) such as labour and environmental standards (these two policy areas are covered by around 20% of all PTAs, Mattoo *et al*., 2020). In this case, recent DTAs that include trade-restrictive environmental provisions might allow countries to promote "green protectionism" and therefore reduce international trade (Brandi and Morin, 2023). There is also empirical evidence at the level of single policy area showing that some provisions have a negative impact on international trade (Winters, 2023).

In this section we keep our focus on the aggregate trade effects of PTAs and try to explicitly allow for their heterogeneity in the depth dimension. We generate various measures of PTAs' depth exploiting the number of policy areas included in the trade agreement available in The World Bank's Deep Trade Agreements database (Hofmann *et al.*, 2017). The total number of policy areas is 52 and we create count variables differentiating by type of provisions.

The first two variables are *totac* (the number of policy areas included in the PTA) and *totle* (the number of policy areas included with legally enforceable provisions). The latter is our baseline measure for PTAs' depth. A provision is defined legally enforceable if the language used is sufficiently precise and binding (our variable

aggregates what in the WB database is defined as weakly and strong legally enforceable). Estimation method and specification are the same as for results in Table 1 and the PTA dummy is replaced with the relevant depth variables.

Results in column (1) and (3) of Table 2a show that PTA's depth increases international trade: estimated coefficients for depth variables are positively significant and very similar in dimension (a new legally enforceable policy area included in the PTA increases trade by 7,6%). WTO membership is also positively significant. In column (2) and (4) we introduce also the squared term for the relevant depth variable. The non-linear term is negatively significant for the specification including only legally enforceable provisions. This is an important result, suggesting that PTA depth has a positive impact on international trade up to a certain level of complexity (i.e. number of policy areas covered), beyond which any additional policy area covered with legally enforceable provisions generates negative effect on international trade.

Table 2a – *Trade effects of PTAs' depth: total and legally enforceable.*

Variable	(1)	(2)	(3)	(4)
totac	0.012***	0.026**		
	(0.003)	(0.011)		
totac^2		-0.001		
		(0.000)		
totle			0.013***	0.033***
			(0.005)	(0.011)
totle^2				-0.001**
				(0.0004)
wto	0.251***	0.238**	0.251***	0.251***
	(0.096)	(0.099)	(0.094)	(0.094)
F. E. (φ_{it} $\theta_{j,t}$ $\gamma_{i,j}$)	Yes	Yes	Yes	Yes
Pseudo R^2	0.998	0.998	0.998	0.998
Observations	615742	615742	615742	615742

Table note: we use the Stata code ppml_fe_bias by Weidner and Zylkin (2021).

The 52 policy areas of the WB database can be divided into two groups: 14 areas covered by the current mandate of WTO (WTO+ areas) and 38 areas not currently regulated by the WTO (WTO-X areas). WTO-X areas include many policies with NTOs (for example, environmental laws, labour market regulations, health laws – for a detailed description Hofmann *et al.*, 2017). Descriptive evidence in Hofmann *et al.* 2017, shows that only a few WTO-X policy areas are both included and legally enforceable in a relevant number of PTAs. We distinguish between the two provision groups, as the cost of implementing them might be quite different. When provisions become complex and not standard for exporting firms, as it might happen

especially with WTO-X provisions, access to a given market can become more costly, even if border barriers are removed.

We create two count variables: wtoplus_ac and wtox_ac. We also measure those policy areas which are legally enforceable: wtoplus_le and wtox_le. Results are presented in Table 2b. The results in column 1 and 2, show that on average only WTO+ areas (legally enforceable or not) have a positive and significant effect on trade flows. Areas that are beyond the current WTO mandate included in PTAs don't have on average a significant effect.

Table 2b – *Trade effects of PTAs' depth: other dimensions.*

Variable	(1)	(2)	(3)	(4)
wtoplus_ac	0.034***			
	(0.012)			
wtox_ac	-0.009			
	(0.009)			
wtoplus_le		0.037***		
		(0.011)		
wtox_le		-0.017		
		(0.011)		
core_ac			0.020**	
			(0.009)	
noncore_ac			-0.002	
			(0.010)	
core_le				0.024***
				(0.007)
noncore_le				-0.015
				(0.013)
wto	0.234**	0.250**	0.246**	0.266***
	(0.098)	(0.099)	(0.098)	(0.098)
F. E. ($\varphi_{it}\,\theta_{j,t}\,\gamma_{i,j}$)	Yes	Yes	Yes	Yes
Pseudo R^2	0.998	0.998	0.998	0.998
Obs.	615742	615742	615742	615742

Table note: we use the Stata code ppml_fe_bias by Weidner and Zylkin (2021).

Similar results are obtained classifying the policy area covered by PTAs in terms of their economic relevance. Core policy areas are those considered by the literature as more important from an economic point of view. In the WB database core policy areas are the 14 WTO+ areas and four additional WTO-X areas: competition policy, investment, movement of capital and intellectual property rights protection. Non-core policies areas are the remaining WTO-X areas. For each PTA we create four additional count variables on the basis of relevant policy areas covered: core_ac (core areas), noncore_ac (non-core areas), core_le (legally enforceable areas) and noncore_le (legally enforceable non-core areas).

5. Conclusions

In this paper we use the gravity equation to estimate the effects of PTAs and their depth on trade flows for a panel of 156 countries during the period 1980-2018. EU is considered as a single country due to its common trade policy and high level of domestic economic integration. Our baseline results show that signing a PTA has an average cumulative impact on international trade flows of 45,6% after allowing for phase-in and anticipation effects. We have also shown that PTAs have heterogenous effects on trade flows both in terms of type of institutional agreement and of their depth. A novel result is that the depth of PTAs has a nonlinear impact on trade flows: up to a certain number of policy areas containing legally enforceable provisions trade increases with the depth of the agreement and beyond that level trade starts declining. Measuring PTAs depth in terms of policy areas included in the WTO mandate or in terms of core economic policy areas covered by the agreement increases trade. However, the deepening of agreements in the direction of covering more non-core policy areas (having mainly NTOs) doesn't have a positive impact on trade.

These results suggest that policymakers proposing deep trade agreements, as well as firms and consumers affected by it, should take into account that the boost in trade flows can be limited or even negative, as the agreements' provisions often have different targets than trade, and indeed might introduce new costs.

References

ANDERSON J., VAN WINCOOP E. 2003. Gravity with Gravitas: A Solution to the Border Puzzle, *American Economic Review*, Vol. 93, No.1, pp. 170-192.

ARKOLAKIS C., COSTINOT A., RODRIGUEZ-CLARE A. 2012. New Trade Models, Same Old Gains?, *American Economic Review*, Vol. 102, No. 1, pp.94-130.

BHAGWATI J. 1991. *The World Trading System at Risk*. Princeton, NJ: Princeton University Press.

BAIER, S.L., YOTOV, Y.V., ZYLKIN, T. 2019. On the Widely Differing Effects of Free Trade Agreements: Lessons from Twenty Years of Trade Integration, *Journal of International Economics*, Vol. 116, pp.206–226.

BALDWIN, R. E., SEGHEZZA E. 2010. Are Trade Blocs Building or Stumbling Blocs?, *Journal of Economic Integration*, Vol. 25, No. 2, pp. 276–97.

BRANDI C., MORIN J.F. 2023. *Trade and the Environment*. Elements in Earth System Governance, Cambridge University Press.

CONTE M., COTTERLAZ P., MAYER T. 2022. "The CEPII Gravity Database". *CEPII Working Paper N°2022-05*, July 2022.

CORREIA S., GUIMARÃES P., ZYLKIN T. 2020. Fast Poisson Estimation with High-dimensional Fixed Effects, *Stata Journal*, Vol. 20, No. 1, pp. 95–115.

DE BENEDICTIS L., TAGLIONI D. 2011. The Gravity Model in International Trade. In DE BENEDICTIS L. and SALVATICI L. (Eds.), *The Trade Impact of European Union Preferential Policies*, 2011, Springer.

EGGER P., LARCH M., YOTOV Y. V. 2022. Gravity Estimations with Interval Data: Revisiting the Impact of Free Trade Agreements, *Economica*, Vol. 89, No. 353, pp. 44-61.

HEID, B., VOZZO, I. 2020. The International Trade Effects of Bilateral Investment Treaties, *Economics Letters*, Vol. 196:109569.

HOFMANN C., OSNAGO A., RUTA M. 2017. Horizontal Depth: A New Database on the Content of Preferential Trade Agreements. *Policy Research Working Paper*; *no. 7981*. Washington, D.C: World Bank Group.

LARCH M., YOTOV Y.V. 2024. Estimating the Effects of Trade Agreements: Lessons from 60 Years of Methods and Data, *The World Economy*, Vol. 47, pp. 1771-1799.

MATTOO A., ROCHA N., RUTA M. 2020. The Evolution of Deep Trade Agreements. *Policy Research Working Paper; no. 9283*. Washington, D.C: WB.

MAYER T., SANTONI G., VICARD, V. 2023. The CEPII Trade and Production Database, *CEPII Working Paper 2023- 01*, January 2023, CEPII.

SANTOS SILVA J. M. C., TENREYRO S. 2006. The Log of Gravity, *The Review of Economics and Statistics*, Vol. 88, No. 4, pp. 641–658.

SANTOS SILVA J. M. C., TENREYRO S. 2022. The Log of Gravity at 15, *Portuguese Economic Journal*, Vol. 21, No. 3, pp. 423–437.

TINBERGEN J. 1962. *Shaping the World Economy*. New York: The Twentieth Century Fund.

WEIDNER M., ZYLKIN T. 2021. Bias and Consistency in Three-way Gravity Models, *Journal of International Economics*, Vol. 132: 103513.

WINTERS, L. A. 2023. Trade Agreements and Non-Trade Objectives: a Cautionary Note. In FERNANDES, A, ROCHA N., RUTA M. (Eds.), *Beyond Trade: How Deep Trade Agreements Shape Non-Trade Outcomes*, CEPR Press.

YOTOV Y.V. 2022. On the Role of Domestic Trade Flows for Estimating the Gravity Model of Trade, *Contemporary Economic Policy,* Vol. 40, pp. 526-540.

Elisa BORGHI, Università Bocconi, elisa-borghi@unibocconi.it
Rodolfo HELG, Università C. Cattaneo-LIUC, rhelg@liuc.it
Lucia TAJOLI, Politecnico di Milano, lucia.tajoli@polimi.it

DO INNOVATING ENTERPRISES PERFORM BETTER? NEW EVIDENCE FROM FRAME SBS AND CIS DATA INTEGRATION

Valeria Tomeo, Valeria Mastrostefano

Abstract. Most of economic literature has insisted on the role of business investments in innovation as one of the key drivers of productivity and economic growth. Nowadays policymakers through the ambitious National Recovery and Resilience Plan (PNRR), have also emphasized the importance of innovation in enhancing enterprises' competitiveness and productivity as well as in supporting the twin green and digital transformation and in building enterprises' resilience. The aim of this study is twofold. It investigates the relationships between the enterprises' economic performances – measured through the statistical information system for estimating structural economic variables (FRAME SBS) - and enterprises' innovation activeness, as resulted by the European CIS survey. The second aim of this study is to give some evidence about the characteristics and performances of eco-innovators. The results from the special module on eco-innovation of the CIS 2020 confirm a strong attitude of innovators towards the introduction of new products and processes leading to less environmental impact. To integrate the two sources of business data – FRAME SBS and CIS - the calibration estimator methodology was applied. It is the same methodology adopted for the CIS estimates, but the proposed set of indicators exploits the information derived from the interaction between the two sources in substantial consistency with both. From our analysis a clear picture emerges: the innovation active enterprises showed better economic results in the COVID-19 pandemic' context too. Italian enterprises' productivity and profitability are strictly linked to the type and quality of innovation activities carried out. The findings also confirm that better economic performances are strongly associated with R&D-driven innovation attitude. Finally, the study suggests that better profitability and productivity are found in eco-innovators that chose business strategies aimed at implementing environmental sustainable models in the innovation process.

1. Introduction

It is well known that innovation drives productivity which in turn promotes economic growth. There is an extensive theoretical as well as empirical literature on the relationship between innovation and productivity that specifically recognizes innovation as one of the most important sources of multifactor productivity growth (Oecd, 2010). In particular, the impact of Research and Development (R&D) – a type of innovation investments aimed at producing new knowledge - on the productivity growth has been established by many quantitative studies (Guellec and Pilat, 2008). Besides, there is a long-standing view that innovation can have a

positive effect on profitability. Product innovations favorably affect a firm's market position while process innovations, strengthening its internal capabilities, makes the enterprise more flexible and adaptable and thus more capable in dealing with market pressures than a non-innovator (Geroski *et al.*, 1993). Understanding the impact of innovation on enterprise's economic performances (and vice versa) is crucial for (re)designing, monitoring and evaluating the results of economic policy. However, the complexity of the interactions between firms' innovative capabilities and its economic performances has led to a variety of results, reaching different (sometimes opposite) conclusions. In this sense, new empirical evidence is required for better understanding how innovation fosters productivity and if an inverse relationship between them exists, if there is a strict correlation between innovation and profitability, how the relationship between innovation and exports really works.

The aim of this work is to produce a set of indicators able to give new empirical insights on the close relationship between the structural characteristics of firms, their propensity to innovate (and different innovation modes) and their economic performances. To this aim, we integrated the information gathered both by a sampling (CIS) and exhaustive (FRAME SBS) sources and combining CIS qualitative indicators and FRAME economic variables through a method that qualified the results in terms of comparability and consistency according to the Istat statistical standards. This exercise allowed to add "hard" information (i.e. quantitative economic indicators) to the qualitative and more subjective information from innovation survey, without increasing response burden and producing estimates representative of the Italian population of enterprises.

The paper is structured as follows: Section 2 describes the main features of FRAME SBS. Section 3 focuses on the CIS approach in the measurement of innovation. Section 4 presents the list of innovation indicators chosen for data integration. Section 5 describes the data integration's methodology. Section 6 discusses the results obtained. Attention was also give to the economic performances of eco-innovators, given the growing importance of the issues of sustainable growth and green transition in the design of industrial policies. Section 7 presents the conclusions and some suggestions for future analyses.

2. The FRAME SBS system

Statistical production methodologies, in response to the need to fully capture the factors of economic competitiveness, have focused on constructing relevant, high-quality and coherent microdata with macroeconomic aggregates, such as those provided by National Accounts. The information system adopted by ISTAT for the annual production of business economic account estimates, the FRAME SBS system, addresses these needs (Seri *et al.*, 2016). The FRAME SBS is an integrated system of administrative and statistical data, produced annually by ISTAT to

estimate the economic results of businesses, based on the units (approximately 4.4 million) included in the Statistical Archive of Active Enterprises (ASIA), the statistical business register produced annually by ISTAT according to European Business Register regulations. The FRAME SBS is integrated with ASIA both in terms of the list of units and the identifying characteristics of the businesses (economic activity, legal form, number of employees, revenue class, location). The system, produced from the economic results of 2012 onwards, uses innovative methodologies to integrate administrative data from Chamber of Commerce sources (financial statements), tax data (Sector Studies, IRAP - Regional Tax on Productive Activities, Unico model), and social security data (monthly declarations related to employees from UniEmens, which feed the Annual Register of Labor Costs in Enterprises – RACLI, produced by Istat) and data from structural business surveys (Survey on Small and Medium Enterprises - PMI, sample survey on enterprises with up to 250 persons employed, and Survey on the system of enterprise accounts - SCI, a census survey on enterprises with 250 or more persons employed). The FRAME SBS is regularly used to produce structural business statistics (SBS), both for submission to Eurostat and for national dissemination through Istat's institutional channels, and was also designed as a data input register for National Accounts (NA) estimates, used as an information source starting from the 2014 general revision of economic accounts (Arnaldi *et al.*, 2020).

The FRAME SBS includes information on structural characteristics (size, sector, location) and key economic account items (turnover, value added, operating margin, personnel costs). This dataset offers multiple advantages: it ensures full coherence between official estimates of structural variables and National Accounts aggregates at the sectoral level; the dataset serves as a platform for further integration with other sources of statistical and administrative microdata; finally, it becomes the reference structure for the convergence and coherence of numerous surveys on specific aspects of the Italian economy and for multipurpose surveys on the main factors of business competitiveness, ensuring coherence over time.

3. The CIS approach in measuring innovation.

Innovation is a broader concept than R&D. Firstly, because R&D is just an innovation input. Then, innovation is an activity that may be combined with R&D or not: non R&D-based innovation is of growing importance. A need of new survey to complement R&D data has arisen at the end of last century to measure innovation outputs and non-R&D innovation inputs. This is why the EU launched the Community Innovation Survey (CIS) in 1992[1]. The main challenges of the CIS are:

[1] For details: The Community innovation survey 2020 (CIS2020) (europa.eu) Community Innovation Survey – New features

to detect any sorts of informal innovation that traditional indicators such as R&D expenditure or patents are not able to capture; to take into account the variety of innovation patterns and the diversity in innovation strategies, activities and performances of enterprises in EU; to detect the external drivers and enablers of innovation and the factors hampering innovation. Such information provides an important tool to support policy makers in developing and monitoring policy and evaluating the results of the policy. Indeed, the CIS produces policy-relevant indicators widely used in EU and national policy reports, such as the European Innovation Scoreboard[2], as well as in the SDGs report, BES report and Rapporto sulla competitività[3]. Since 1992, the CIS has evolved into the largest innovation survey in the world. Since its launch, the CIS is complied with the conceptual and methodological criteria defined within the framework of the OECD and Eurostat: the OECD Oslo Manual[4] and the Eu Regulation 2152/2019 on European Business Statistics (EBS)[5]. The CIS measures innovation in business enterprises during a 3-year period[6]. In order to ensure a sound comparability across countries, all the CIS waves have a harmonized survey questionnaire, composed of standard modules and focused (rotational) questions. It takes place every two years and it is a sample survey (more precisely, it is a combination of sampling for firms with 10-249 number of persons employed - NPEs - and census survey for units with 250+ NPEs). Final data are weighted and calibration estimators methodology is used for the estimation process[7]. The response rate in the CIS2020 was 62.3%, that is about 25,000 of respondents, of which about 23,000 active in 2020 and representative of the whole population of enterprises with at least 10 number of persons employed.

[2] European innovation scoreboard - European Commission (europa.eu)

[3] Publications – Istat

4 The Oslo Manual is the international reference guide for collecting and using data on innovation. It in continuous evolution. The first version was published in 1992. It has been revised on three occasions and we are now at the 4th edition.

[5] Along with the Regulation, an Implementing Act dedicated to the topic 'business innovation' is adopted in order to produce internationally comparable statistics and indicators: Regulation - 2019/2152 - EN - EUR-Lex (europa.eu)

[6] According to both the Oslo Manual and the CIS, an innovation is: a new or improved product or process (or combination thereof), introduced on the market or brought into use by the firm; it can be simply new or improved to the firm; it could have been originally developed by other enterprises or organisations. There are two types of innovation: product innovations (including changes to product design) and business process innovations (for one or more business functions related to both the core activity of producing and delivering products for sale, and other supporting operations characterizing the most advanced services activities - administrative, ICT and marketing activity). The CIS covers all the firms active in the economic Nace sections from B to M. Regarding the CIS 2020, the reference period is from the beginning of 2018 to the end of 2020, even if questions on expenditures and turnover from innovative products refer just to the last year of the period (2020).

[7] Better information on target population, sampling design, data collection and data treatment, weights calculation method, dissemination of the data is available in the Report published at every survey's edition. The last one is available at the following website: L'innovazione nelle imprese. Anni 2018-2020

4. Research aims and methodology adopted in the CIS indicators chosen.

In this context, although we had to limit the analysis to a small set of innovation indicators, we chose both traditional indicators and new, more complex, indicators.

A first group is composed of indicators measuring the propensity to innovate and the attitude to do it through R&D investments (Table 1). These indicators are widely known and commonly used in the international context to measure the relations between innovation and competitiveness.

However, the CIS allows to build innovation indicators that can differentiate between modes of innovation and can thus provide a clear picture of innovation within different firms, economies, and countries (European Commission, 2024). Over time the CIS data have indeed revealed the presence of a great variety across innovation strategies and processes of Italian enterprises (Evangelista and Mastrostefano, 2006; OECD, 2009). Innovation profiling can differentiate innovators in several groups and hence allows to explore empirically the concept of variety in innovation, taking into account the complex and multidimensional nature of innovation[8]. Using variables related to different innovation dimensions - knowledge, novelty, implementation - and combining them in non-overlapping categories, a second group of CIS indicators made possible to identify five different innovation profiles. Additionally, we decided to include some indicators for environmental innovation, given the new challenges for achieving sustainable growth and the growing importance of policies for green transition. Among the eco-innovators, particular attention was given to R&D performers. Finally, we took a look at those eco-innovators that undertake innovation aimed at reducing energy use.

5. Methodology for the construction of the final indicators

The aim of this paper is to integrate data from an exhaustive source (FRAME SBS) and a sample survey (CIS) by combining economic variables and qualitative indicators. The methodology used was tested in ISTAT by applying it to the integration with the ICT survey data (Nurra *et al.*, 2024) and guarantees comparable and consistent results according to ISTAT statistical standards. New statistics and indicators from this work could produce additional insight into the enterprises' strategies and performances and suggests new views for economic analysis and support for policy making. This work exploits past experiences and Italian best practices for the implementation of microdata integration from different sources.
The FRAME SBS represents the central data source for microdata integration.

[8] Full information is available in the following document: Innovation profiling – first results

Table 1 – *CIS indicators chosen for data integration with the FRAME – SBS.*

Propensity to innovation/R&D
1. **Innovation-active** enterprises (e. with innovation activities) (% on total enterprises) *of which:* o **R&D** performers (e. that undertook in-house or contracted out R&D activities) (% on total enterprises) 2. **Non innovative** enterprises (e. without innovation activities) (% on total enterprises)
Innovation Profiles (IPs)
1. **In-house product innovators with market novelties**: enterprises that develop with own substantial capabilities and introduce into the market original product innovations (% on total enterprises) 2. **In-house product innovators without market novelties**: enterprises that develop in-house and introduce into the market other product innovations (% on total enterprises) 3. **In-house business process innovators**: enterprises that produce in-house and brought into use only process innovations (% on total enterprises) 4. **Innovators that do not develop innovations themselves**: enterprises that acquired innovations outside (% on total enterprises) 5. **Innovation-active enterprises**: enterprises that worked on innovations but didn't implement them (% on total enterprises)
Green innovation
1. **Eco-innovators**: innovators generating environmental benefits (% of total innovators) *of which:* o With R&D/No R&D o Innovation aimed at reducing energy use 2. **Innovators not oriented to environmental issues**: innovators that do not generate environmental benefits (% of total innovators)

Among different strategies, the calibration estimators approach was deemed the most appropriate for integrating data from the FRAME SBS with the CIS survey. This method leverages the interplay between a comprehensive register and sample data to generate economic indicators (Seri *et al.*, 2016).

The calibration estimates methodology is the same used in the estimation process of the CIS sample survey. However, the initially proposed set of indicators does not duplicate published estimates, whether directly or indirectly. Instead, it takes advantage of the data derived from combining the two sources, ensuring substantial or complete consistency with both.

The differences between the application of the two methodologies are shown below:

- The statistical archives for estimates is FRAME SBS referred to year t. The sampling of the CIS is carried out from ASIA referred to the year t-1 while the final CIS estimates are calculated from ASIA referred to the year t.

- The FRAME SBS doesn't cover the section K.
- A small number of enterprises that reported innovation activities in the CIS survey were removed from ASIA (and FRAME SBS) for the year t for various reasons, including changes in the number of persons employed, changes in the NACE code, and demographic events that redefined the target population. Despite these adjustments, more than 96% of the CIS sample remained eligible for the analysis.
- About overlapping information, the FRAME SBS source was privileged.
- With regards to the model used for the calibration of the weights in the CIS survey (totals for the variables Number of enterprises and Number of persons employed by NACE), the use of FRAME SBS was crucial to consider within the known totals those related to Value Added and Turnover.

The methodological framework employed is structurally identical to that of the CIS survey. Consequently, the same criteria used for the currently published estimates can be applied to evaluate the accuracy and precision of the produced estimates. The analysis was conducted using the ReGenesees software (Zardetto, 2015), which implements methods commonly used by ISTAT for economic surveys.

Additionally, the adopted strategy produces microdata files with a weighting system that represents the entire population, similar to the survey, so it was possible to reproduce the CIS indicator estimates, though replicating these estimates is not the aim of this work. These estimates are entirely consistent with the published ones, ensuring the reliability of the results (consistency with FRAME SBS is assured by design in the new estimation domains). However, it is crucial to emphasize that the goal of this work was to create a series of indicator tables that integrate information from both FRAME SBS and the CIS survey.

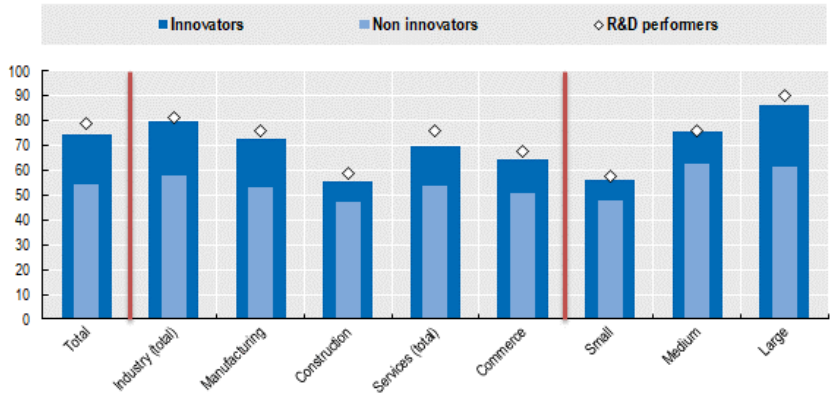
6. Empirical insights from data integration.

In 2018-2020 period, 50.9% of industrial and service enterprises with 10 or more NPEs carried out innovation activities, with a fall of about 5 percentage points compared to the previous period (2016-2018). The health emergency was one of the main causes of the reduction of innovation active enterprises, mentioned by 64.8% of them[9]. The industrial sector showed the highest propensity to innovation: 58.5% versus 47.2% of services and the propensity to innovate increases with firms' size: among small enterprises (10-49 employees) one half was active in innovation while in large enterprises three fourth were engaged in innovation activities. R&D is the

[9] An innovation active enterprise is an enterprise that has carried out innovation activities. An innovator is the enterprise that has carried out successfully innovation activities leading to the introduction of a product innovation on the market or a process innovation internally. So, an innovation active enterprise is just a potential innovator.

main component of innovation expenditures, representing 50.6% of total. Results from the ad-hoc module of the CIS on eco-innovation confirm the tendency of adopting product and process innovations with lower environmental impact. During the 2018-2020 period, 40.3% of innovators reported having introduced one or more eco-sustainable innovations, and 25.4% introduced innovations that led to greater energy efficiency[10]. From data integration with the FRAME SBS, it is confirmed what showed in most empirical literature: innovation leads to an increase of productivity. In 2020, despite the pandemic crisis and its economic impact, innovators had better economic performances than those oriented to more cautious and conservative competitive strategies (Figure 1). Innovation-active enterprises have higher levels of labor productivity than non-innovative ones, both as total and in each class. Additionally, enterprises active in R&D show on average higher productivity values than the other innovation active enterprises, reaching the highest value in large enterprises.

Figure 1 – *Labour productivity (value added per employee) of Italian enterprises by economic activity, size class and type of enterprises. Year 2020 (thousands of Euro).*



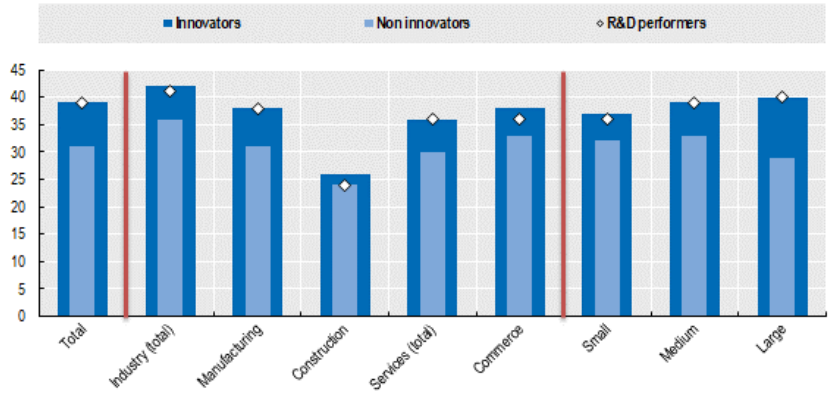
Authors'elaborations on Istat data

It is thus confirmed the association between innovation and profitability: innovation-active enterprises are the enterprises with the highest profits (Figure 2). Specifically, R&D performers show better economic performances, both as a whole and in the enterprises of the same average size. Among innovators, large enterprises and those operating in the manufacture experienced the highest profitability margins than reported by non-innovative enterprises in the same classes. More complex indicators, able to capture different dimensions of innovation at the same time - both

[10] Further details are available at the following website: L'innovazione nelle imprese. Anni 2018-2020

from input and output side, about firms' strategies and innovation processes and modalities, allow to define a variety of innovation profiles and to improve significantly the explanatory power of CIS indicators (European Commission, 2023).

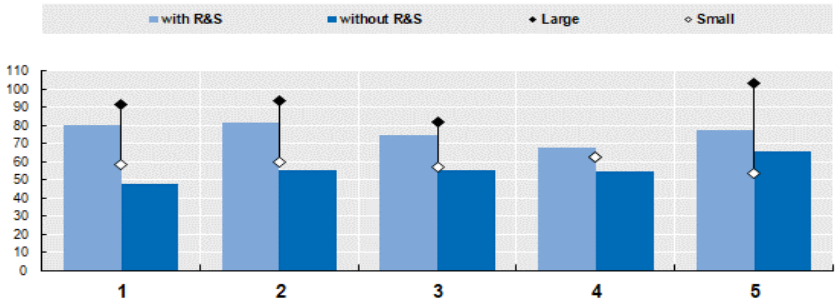
Figure 2 – *Profitability (operating margin per value added) of Italian enterprises by economic activity, size class and type of enterprises. Year 2020 (%).*



Authors'elaborations on Istat data

From profiling innovators, a clear-cut result has arisen. Innovators are characterized by different productivity levels, varying in relation to the firms' innovation choices: more sophisticated innovators, that is enterprises oriented towards more complex, diversified and pro-active strategies, are those with greater productivity levels (Figure 3).

Figure 3 – *Labour productivity of Italian enterprises by innovation profile and firm's size. Year 2020 (value added per employee).*

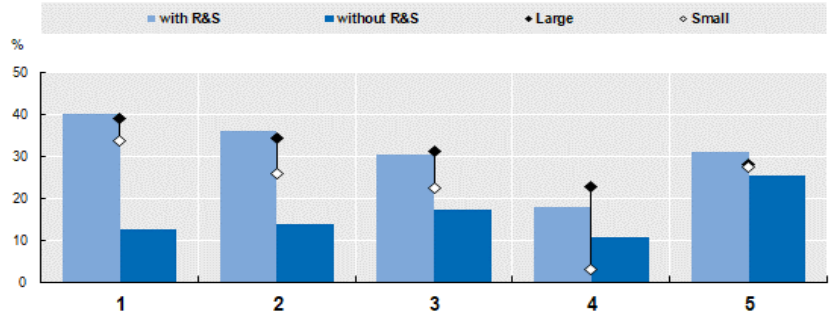


1. In-house product innovators with market novelties; 2. Other in-house product innovators; 3. In-house process innovators; 4. Innovators that do not develop innovations themselves; 5. Innovation-active enterprises

Authors'elaborations on Istat data

Looking at the presence of innovators in foreign markets, a close association between the high level of innovation and the propensity to exports results from integration (Figure 4). More export-oriented enterprises are the most sophisticated innovators: better exports' performances are associated to more complex strategies based on investments in R&D and on the development of new products for their reference markets.

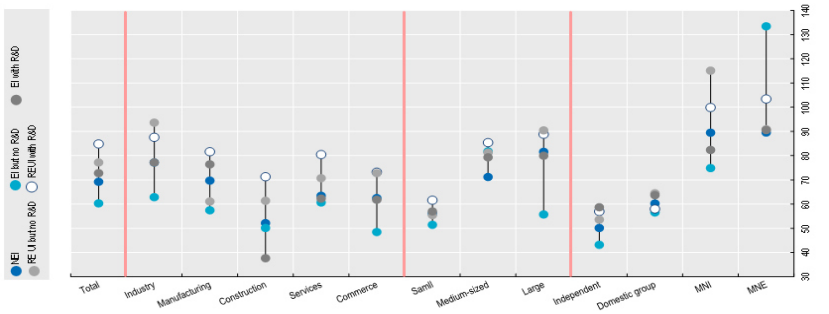
Figure 4 – *Exports of Italian enterprises by innovation profile and firms' size. Year 2020 (% on revenues).*



1. In-house product innovators with market novelties; 2. Other in-house product innovators; 3. In-house process innovators; 4. Innovators that do not develop innovations themselves; 5. Innovation-active enterprises
Authors'elaborations on Istat data

Turning to the green innovation, during the period 2018-2020 enterprises that implemented eco-sustainable measures, particularly in energy efficiency, are those with better economic results among innovators. In general, enterprises that adopted eco-sustainable innovative measures did not record better performance than enterprises less sensitive to environmental issues, except for foreign-controlled multinationals and medium-sized enterprises (Figure 5).

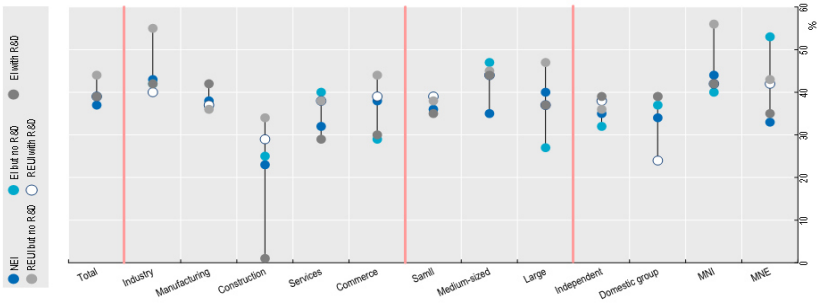
Figure 5 – *Labour productivity of innovation active enterprises by economic activity, size class, corporate control and innovation profile. Year 2020 (thousands of Euro).*



NEI: no environmental innovation; EI: environmental innovation; REUI: innovation aimed at reducing energy use
Authors'elaborations on Istat data

However, enterprises that invested in innovative low-energy consumption technologies, especially if their investments had a R&D component, show a significant productivity gap compared to those that innovated without considering environmental issues. The profitability analysis also reflects a similar general trend: eco-sustainable innovative choices correspond to higher profitability levels, although at the level of firms' categories, the resulting picture is not always clear-cut, and the indicators do not always show consistent directions (Figure 6).

Figure 6 – *Labour productivity of innovation active enterprises by economic activity, size class, corporate control and innovation profile. Year 2020 (thousands of Euro).*



NEI: no environmental innovation; EI: environmental innovation; REUI: innovation aimed at reducing energy use
Authors' elaborations on Istat data

7. Conclusion

Data integration is a cost efficient way to improve and diversify existing statistics. Specifically, this integration's work may represent a significant potential in gathering new statistical evidence without increasing the burden placed on respondents and producing at the same time estimates representative of total population. However, some drawbacks exist and must be dealt with in the future. Firstly, there is no convergence at regional level: estimates obtained from this data integration's exercise cannot be used in regional analyses. If we want to replicate this work for analyzing how different are innovators across regions, we need to build another system of weights. Otherwise, we must look for alternative methodological solutions. Secondly, from this exercise we haven't got any information on the cause-and-effect relationships between innovation and economic performances, but we can provide just some basic clues about their associations. In the future, we should repeat this work according to a dynamic perspective, that is by integrating both CIS and FRAME SBS earlier data going back as many years as possible, in order to explore how successful innovation impacts on the economic performances in the longer run

and if there are inverse relationships between economic and innovation variables, since causation can run in the opposite direction.

References

ARNALDI S., AURELI P., CARUCCI A., CURATOLO S., DI FRANCESCANTONIO T., FARAMONDI A., FILIPPELLO R., NARDECCHIA R., PUGGIONI A., REGANO A., RIZZI R., SACCO R., SANZO R., SASSAROLI P. 2020. Il trattamento delle fonti amministrative per la costruzione del sistema informativo sui risultati economici delle imprese italiane (Frame SBS), *Istat Working Papers 6*, Istat.

EVANGELISTA R., MASTROSTEFANO V. 2006, Firm size, sectors and countries as sources of variety in innovation. In *Economics of Innovation and New Technology*, Vol. 15, No. 3, pp. 247-270.

GEROSKI P., MACHIN S., VAN REENEN J. 1993. The Profitability of Innovating Firms. *RAND Journal of Economics*, Vol. 24, No. 2, pp. 198-211.

GUELLEC D., PILAT D. 2008. Productivity growth and innovation in OECD. In OECD Eds. *Productivity measurement and analysis*, pp. 41-59.

NURRA A., SERI G., TOMEO V. 2024. Integration between data from register and sample surveys: enterprises classified by use of ICT and economic indicators, *Italian Journal of Economic, Demographic and Statistical Studies*, Vol. LXXVIII-1, pp.77-87.

OECD. 2009. *Innovation in Firms: A Microeconomic Perspective*. Paris: OECD Publishing.

OECD. 2010. *The OECD innovation strategy. Getting a head start on tomorrow*, Paris: OECD Publishing.

OECD. 2018. *Oslo Manual 2018: Guidelines for Collecting, Reporting and Using Data on Innovation, 4th Edition, The Measurement of Scientific, Technological and Innovation Activities*, Paris: OECD Publishing.

SERI G., ICHIM D., LUCHETTI F., COSTA S., NURRA A., MASTROSTEFANO V., SALAMONE S., PASCUCCI C., ORSINI D. 2016. Integrazione del Frame con altre indagini e fonti amministrative ai fini della produzione di indicatori complessi, *Istat Working Papers 17*, Istat.

ZARDETTO D. 2015. ReGenesees: an Advanced R System for Calibration, Estimation and Sampling Error Assessment in Complex Sample Surveys, *Journal of Official Statistics*, Vol. 31, No 2, pp.177-203.

Valeria TOMEO, Istat, tomeo@istat.it
Valeria MASTROSTEFANO, Istat, mastrost@istat.it

EVOLUTION AND CHANGE OF WINTER TOURISM: HOW SEASONALITY AFFECTS THE ECONOMY OF LOMBARDY'S MOUNTAIN COMMUNITIES ON THE OLYMPIC ROAD (MILANO-CORTINA 2026)

Gianpaolo Caprino, Antonio Dal Bianco

Abstract. Using municipal data on tourist overnight stays, this paper examines tourist seasonality of Lombardy's Mountain Communities (CCMM) over the last 15 years. In detail, based on the geographical location proximity on the Olympic Road of Milano-Cortina 2026 winter edition, twelve Mountain Communities have been selected. Using widely known statistical indexes, the seasonality of the selected mountain communities was represented. The analyses confirm the presence of two types of seasonality in Lombardy: a growing summer seasonality driven by the lakes and a bi-seasonal one, which appears mostly in the Alpine and pre-Alpine areas, characterized by declining winter tourism flows relatively to the rest of the year. Exploiting the legacy of Milano Cortina 2026 Olympic event, this study intends to offer a contribution to the deseasonalization policies to be implemented in mountain areas.

1. Mountain Tourism during Climate change and Sustainability

In recent decades, with the exacerbation of climate change, scholars have questioned the necessity of measuring sustainable tourism, considering its promotion of sustainable well-being from the mere market and statistical perspective of the consumer, to highlight the awareness and engagement of the host communities (Crabolu et al., 2023). As confirmed by the Copernicus Monitoring Services in the Global Climate Highlights 2022 report, 2022 has been the driest and hottest year in Italy (the second in Europe) of the last two centuries, and it has been confirmed that temperature in mountainous areas is increasing more than double the average, even causing the suspension of several ski world cup races due to lack of snow in the same year (Nevediversa, 2023). On this matter, the World Meteorological Organization predicts that by the next 14 years, snow will be too watery even beyond 3000m altitude, facing the risk of impracticability even for well-known ski tracks as "Cortina d'Ampezzo", moreover, daily observations of ground's snow depth in the Alpine area over the last 50 years showed that in addition to the thickness, the duration of the snow has also reduced, decreasing on average by 34 days at altitudes between 1000m and 2000m (Crespi et al., 2021).

Overall, the ski industry has been hit by an irreversible crisis due to the increase in temperatures and the decrease in snowfalls (Mariani and Scalise, 2022), to the point that some scholars, such as Professor Claudio Visentin declared that "[..] winter sports season has no future" (Nevediversa 2024:3).

The ski industry's crise is a challenging mountain tourism economy, which has been historically generated on its economies of scale and currently found it very difficult to build tourism conversion on new products and services. However, as explained by Professor Riccardo Beltrame, areas that can combine both winter offers and summer seasons will enjoy a competitive advantage compared to those that stick to a single product destination market (Nevediversa 2024:107). Despite these warnings, Italy is an alpine country where artificial snow is mostly widespread (90%) (Nevediversa, 2023), even though it results in a very costly adaptation practice in terms of land, water, energy, and money consumption (Willibald et al., 2021; Steiger, 2019), and there are still some discrepancies between the national ministry's climate goals and the actual regional policies. Thus, to study the evolution of winter tourism in Lombardy and its seasonality, this study has been conducted on Lombardy's mountain communities (from now on CCMM), introduced in the following paragraph, as the geographical granularity level for the statistical analysis of tourist overnight stays (TOS), presented later in the second chapter.

1.1. Mountain Communities of Lombardy

Mountain areas are characterized by peculiar attractive drivers, such as a favorable summer climate, suitable for enjoying walks in nature, the geological slope, and winter snow that, if well exploited, can guarantee a strong tourism flow (Macchiavelli, 2006). In fact, thanks to breathtaking panoramas, food and wine culture and the increasingly varied sporting attractions, together with seaside areas, places near mountains are increasingly frequented by Italian and foreign tourists; but how is mountain tourism defined exactly? There is no universally accepted definition, even though the World Tourism Organization (UNWTO) provides an international understanding, which refers to tourism activities conducted in open-air spaces such as hills or mountains, occurring in specific geographical areas characterized by unique landscapes, topography, climate, biodiversity, and local communities, driven by a desire to connect with nature during leisure time. Nevertheless, it is crucial to consider the multiple facets of mountain tourism that, depending on the point of view and the goal to be achieved, drastically change the way it is understood. Indeed, for the statistical purposes of this study, it has been adopted different perspectives of mountain tourism according to administrative definitions, among which draw on geographical and territorial outlook – law n.

991/1952 – in terms of altitude (above 600m), municipalities are categorized in three categories, "totally mountainous," "partially mountainous" and "non-mountainous"; then, a more tourist perspective, has been detected from the Italian Institute of Statistics (ISTAT) – following law n. 77 of July 17, 2020 – establishing a new classification for Italian municipalities based on tourism vocation, which considers both the potential for tourism development and the existing level of tourist activity in each location. The latter includes 501 municipalities classified as "municipalities with a mountain vocation" at national level (mostly located in Northern Italy), and 240 municipalities which are classified as "municipalities with mountain and cultural- historical-artistic-landscape vocation". A final socio-economic balanced view was provided by Lombardy Regional Law 19/2008, where mountain tourism is expressed through the so-called "Mountain Communities" (CCMM), such as local territorial public institutions, organized in "homogeneous areas", established for the promotion and valorization of mountain tourism, for the exercise of conferred functions and the associated exercise of municipal functions (Regional law 19/2008, art. 1, comma 2), from which the Lombardy Region recognizes and allocates an economic contribution every year[1].

Lombardy has 23 CCMM[2] that differ in terms of territorial extension, number of belonging municipalities, and geographical location. This characteristic, together with other factors, such as the availability of hotels and ski lifts, influences the ability of territories to be attractive to visitors, which, in terms of tourism flows, the situation of CCMM appears extremely different. For instance, Alto Garda Bresciano and Alta Valtellina represent a destination that counts over 3 million TOS per year, while others, such as Scalve and Valle Trompia, have much smaller numbers with less than thirty thousand TOS per year (Dal Bianco, Caprino, 2023).

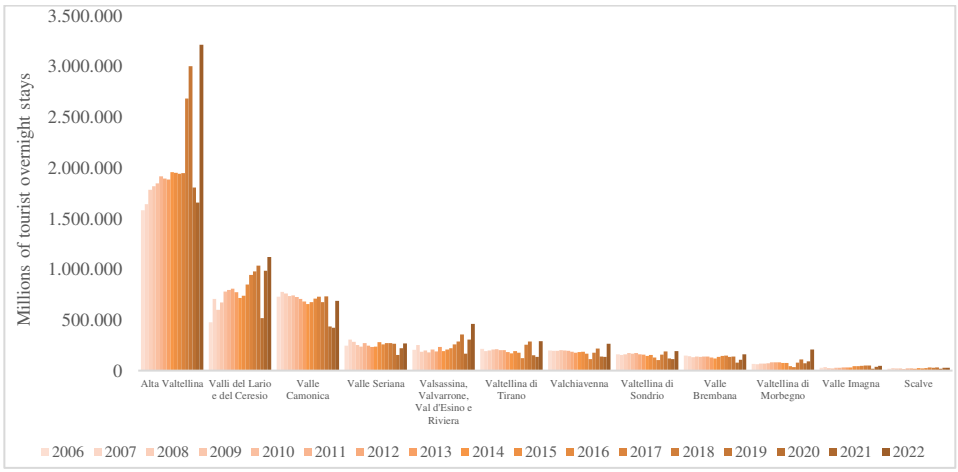
Considering the heterogeneity of CCMM and their different territorial extensions, in this study, particular attention will be focused on 12 selected CCMM localized on the Olympic Road of Milano-Cortina 2026 winter edition as the geographical granularity level for the statistical analysis of TOS (see Chapter 2). Following this method of identification, through the seasonality analysis of ISTAT municipality data on TOS from 2006 to 2022, the study will offer an interpretation aimed at identifying policies for mountain tourism promotion.

Therefore, as showed in Figure 1, CCMM selected for this study are the following, ordered by the average number of TOS recorded between 2006 and 2022. Even among this group, the sample included 232 municipalities categorized into nine typologies according to the ISTAT tourism vocation criteria, and 78 municipalities (30%) represented the mountain vocation degree, highlighting a significant difference between attractiveness and accommodation preferences.

[1] In 2023, the contribution is 11.5 million euros (dgr 7817 of 01/23/2023) (Regione Lombardia, 2023).
[2] List available at *Le Comunità Montane della Lombardia* (Regione Lombardia, 16/06/2023).

In addition, 26 municipalities (11%) represent the lake tourism vocation, and Valli del Lario e del Ceresio is the mountain community (CM) with the highest lake tourism prevalence (67.86%) (Dal Bianco, Caprino, 2023).

Figure 1 - *TOS growth of the selected twelve Lombardy's CCMM on the Olympic Road '26 (years: 2006 -2022).*



Polis Lombardia – ISTAT data elaboration

Therefore, different models of tourist attractiveness reflect the diverse capacity of territories to develop a diversifies tourist offer, intercepting flows in every season of the year; hence, as recalled in Figure 1, tourist offer increased heterogeneously over 15 years, rising from 4 to almost 7 million TOS. Climate has always played a fundamental role in influencing the concentration of TOS and available activities, depending on the weather conditions (Baum and Hagen, 1999). In recent years, with the increase in temperatures and the consequent decrease in snowfall, tourists are increasingly encouraged to enjoy attractions at high altitudes even in summer, as ski lifts - the main mountain infrastructure–are exploited all year and not just for skying (Macchiavelli, 2022). However, not all CCMM are well equipped, and some are particularly threatened by the risks associated with climate change; on the other hand, festivities and institutional events also appear to be a fundamental factor, as it can influence the availability of free time of tourists (Nadal et al., 2004). To better understand this aspect, in the following section, the seasonality of CCMM tourist flows is analyzed.

2. Seasonality in CCMM of Lombardy

Seasonality is often an inevitable phenomenon that involves the concentration of peaks in tourist intensity in a certain territory and period of the year. It is often caused by a favorable climate, but also by other factors such as the coexistence of other tourism, proximity to national borders or creating demand centers, and foreign tourism (Candela and Figini, 2010). Even though at the national level, the greatest tourism flow is generated by seaside locations and, therefore, the most relevant season is typically concentrated in the summer months from June to September (Candela et al., 2007), there is a second type of seasonality, typical of mountain tourism, which is characterized by its concentration in two specific periods of the year: winter for the ski season and summer for natural excursions (Baum and Lundtorp, 2001). It is generally recognized that tourism can bring various benefits to the local economy, such as increased sales of goods and services, profits, income, tax revenues, or creation of new jobs (Nadal et al., 2004). However, when the phenomenon is concentrated in concise periods, negative effects tend to emerge, such as increasing inflation and the crowding-outeffect[3], as well as externalities that impact the environment, such as degradation and pollution (Donato, 2007).

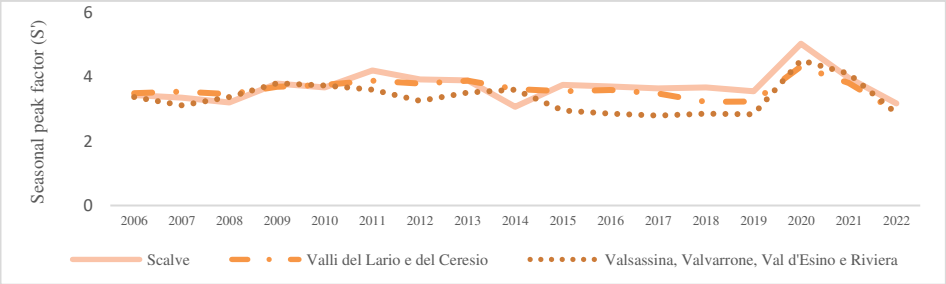
In particular, the UNWTO defines the phenomenon of overtourism as the detrimental effects of excessive tourism on a destination, significantly diminishing residents' perceived quality of life and overall visitor experience. Thus, seasonal tourism forces tourism operators to minimize management costs to alleviate the temporary season loss effect, negatively impact employment, and discourage investments (Butler, 1994). Statistically, the seasonality of Lombardy's CCMM can be represented by different indices; three of them have been selected because of their wide use in the literature (Ciccarelli, 2018). The first adopted index is the seasonality rate, which is based on the simple ratio between the maximum and minimum TOS recorded in a year and can represent the disparity of TOS of a given area in one year.

$$\text{Seasonality rate} = \frac{\text{Max } Overnight\ Stays}{Min\ Overnight\ Stays}$$

This index does not consider the relative size of tourist flows; therefore, it risks being excessively affected by periods in which attendance is minimal – typical trend of mountain's tourism. Indeed, in statistical terms, to adjust this denominator's instability, it is recommended that the seasonal peak factor (S'), an index that relies on the average TOS in the whole year (Figure 2).

[3] By crowding-out effect it is meant the possibility that tourism becomes an activity capable of making the other economic activities of the area, no longer competitive, causing an economic monoculture (Costa, 2001).

Figure 2 – *Top three Lombardy's CCMM on the Olympic Road '26, based on seasonality peak factor (S'), (years: 2006-2022).*



Polis Lombardia – ISTAT data elaboration

However, because of their different extensions and tourist flows, it is more appropriate to analyse the seasonality of CCMM in relative terms as a percentage of the annual total, allowing a more accurate comparison of seasonal patterns.

$$\text{Seasonality peak factor (S')} = \frac{\text{Max } Overnight\ Stays}{Average\ Overnight\ Stays}$$

Furthermore, for some CCMM, it is necessary to calculate the tourist concentration in both the winter and summer. In this regard, it is possible to use the Gini index, which is more precise for calculating the inequality of distributions and comparing it with the curve of perfect equality and Lorenz Curve (Duro, 2016). The formula can be expressed as follows as done in Lundtorp (2001)[4].

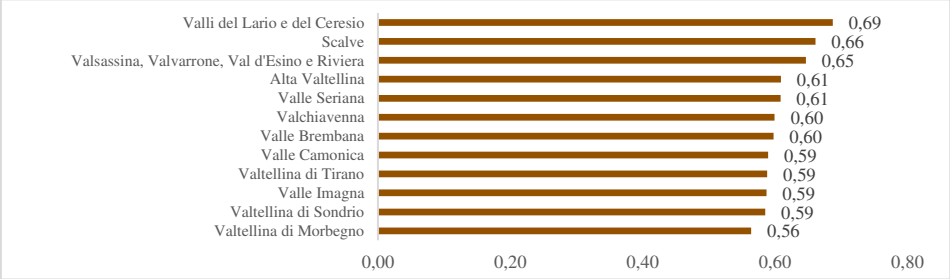
$$\text{Gini Index} = \frac{2}{n}\sum_{i=1}^{n}(xi - yi)$$

To show the seasonality of the selected CCMM, as generally applied at the regional level, municipalities' analyses were collected within their CM. S' shows the top three CCMM with the greatest tourist concentration during the selected years: Valli del Lario e del Ceresio (3,70) and Valsassina, Valvarrone, Val d'Esino e Riviera (3,60), both located near lakes, because they mainly attract tourists in summer. On the other hand, Scalve (3,36) does not seem to have a great source of tourist attraction, maintaining a modest TOS mainly in two peaks of the year (Figure 1 and 2). Similarly, adopting the Gini Index, Valli del Lario e del Ceresio was confirmed to be the CM with the highest average concentration of tourist flows (Gini Index:

[4] Gini Index:
n = the number of fractiles, months, weeks, days or other units
xi = the rank of fractiles, for example 1/12, 2/12… when using months, or when using weeks 1/52, 2/52…, or days 1/365, 2/365… etc.
xi = i/n
yi = the cumulated fractiles in the Lorenz curve

0.69), followed by Scalve (Gini Index: 0.66) and Valsassina, Valvarrone, Val d'Esino, and Riviera (Gini Index: 0,65) (Figure 3).

Figure 3 - *Ranking of twelve Lombardy's CCMM on the Olympic Road '26, based on the average GINI Index, (years: 2006-2022).*



Polis Lombardia - ISTAT data elaboration.

Since the definition and measurement of seasonality has been presented, in the following paragraph, the evolution of seasonality curves of CCMM will be observed, representing two different clusters and focusing on the relative monthly distribution of TOS (in annual percentage).

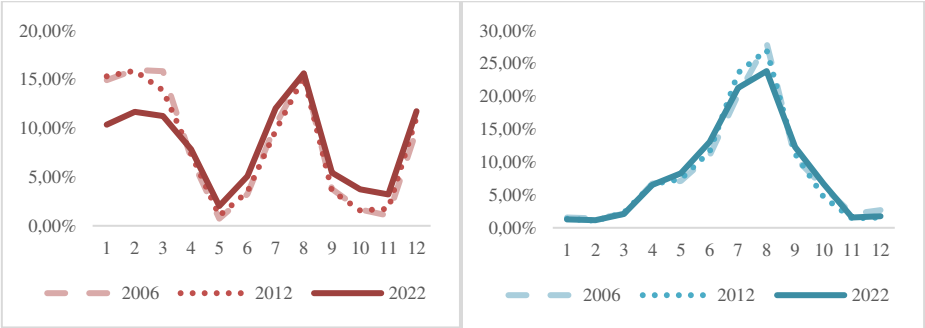
2.1. Evolution of seasonal tourism in Lombardy's CCMM

As already mentioned at the beginning of chapter 2, it is commonly believed that mountain areas benefit of tourist flows in two periods of the year however, analyzing the seasonality curves of CCMM, it is possible to classify them in two distinct groups: a "Bi-Seasonality" cluster (two peaks), which appears mostly in the Alpine and pre-Alpine areas (Figures 4-left) and a "Summer seasonality" cluster (one peak), which mostly occurs in areas close to lakes (Figure 4-right). Taking Alta Valtellina's peaks as an example of the "bi-seasonality" cluster (Figure 4-left), and Valsassina Valvarrone Val d'Esino and Riviera for "summer seasonality" (Figure 4-right), it is clear that in the former case, the seasonality curve rose in spring (April and May), summer (June–August), and autumn months (September–December) compared to the previous years, while in winter months (January–March), the curve decreased, resulting in two high points.

On the other hand, for the second case, the seasonality curve rose in spring and autumn months belonging Valsassina Valvarrone Val d'Esino and Riviera in "summer seasonality" cluster, due to the exclusively and visible increase in those periods. Hence, especially in the former case of Alta Valtellina it is possible to

imagine a better distribution of TOS over the year and therefore, a possible de-seasonalization phenomenon in progress. Thus, if TOS increased over the last 15 years in absolute terms, how did seasonal TOS evolve relative to the rest of the year? To offer a correct reading of the relative data, it is necessary to adopt a climate change perspective. Consequently, in meteorological terms, we can assume that the winter and autumn seasons will shrink, with the increasing risk of some CCMM losing skiing tourists. Similarly, with rising temperatures, it is reasonable to imagine that visitors will start to enjoy mountain areas, even in spring and autumn, bringing more tourists as a new trend.

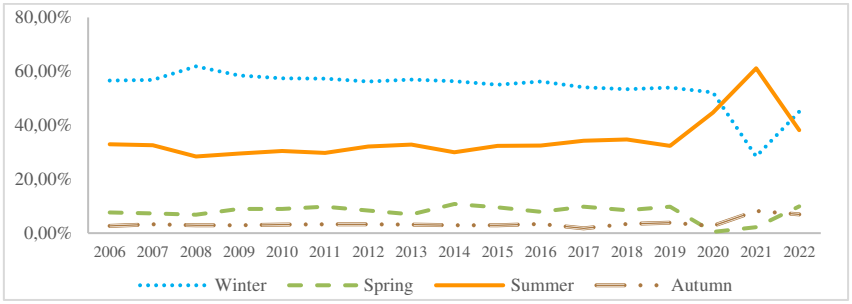
Figure 4 - *Seasonality curves in Alta Valtellina (left) and Valsassina, Valvarrone, Val d'Esino e Riviera (right.).*



Polis Lombardia - ISTAT data elaboration

From this perspective, the following analyses rely on an alternative division of seasons by gathering months as follows: December, January, February, and March to identify winter and June, July, August, and September for the summer season. Afterwards, the spring season was shortened, including only April and May, as well as for the autumn season, with October and November (Figure 5).

Figure 5 - *Evolution of tourism overnight stays (% of the year) – Alta Valtellina.*



Polis Lombardia - ISTAT data elaboration

Adopting this criterion, it is notable that for CCMM belonging to "Bi-seasonal" cluster (two peaks), such as Alta Valtellina (Figure 5), summer and winter remain the most important seasons in terms of tourist flow, with a reverse trend recorded in the last three years, probably influenced by mobility restrictions during covid pandemic emergency. Furthermore, new growing spring and autumn tourist trends have also appeared.

3. Conclusions and final remarks

Tourist attractiveness models of Lombardy's CCMM is different because of geographic location, weather conditions and many other factors. Analysis of tourist flow data during the study period between 2006 and 2022 of the selected 12 CCMM located on the Olympic Road confirmed an increase in absolute numbers of TOS from 4 million in 2006 to over 6, 5 million in 2022. Then, observing the seasonality curves, the presence of two typologies is demonstrated: a "Bi-seasonal" cluster (two peaks) mainly present in Alpine areas and a "Summer" cluster (one peak), typical of CCMM located near lakes, both characterized by an ongoing deseasonalisation phenomenon. However, in relative terms, a decreasing winter attendance trend has been shown, together with a stable growth in summer and an emerging growth in spring and autumn. This leads to the belief that identifying the causes that characterize the seasonality of mountain tourism is essential to understand whether and how to control this phenomenon, implement policies to deseasonalize tourist flows, lengthen the winter season and live with climate change.

In general, seasonalization adjustment interventions are based on the increase in tourist demand beyond the main season, and these include, among others, the diversification in the destination of the tourist product with the valorization of other tourist resources, the extension of the high season times, applying a consumer-oriented marketing strategy, targeting their free time as a resource to dedicate for tourism purposes during all periods of the year (Candela et al., 2007; Macchiavelli, 2004), or even offering alternative attractions exploiting specific events, such as impacting and private organized events, such as Floating Piers in Iseo Lake in 2016.

Historically built on the ski-tourism environment, mountain tourism has been particularly affected by climate change, which currently represents the main challenge and unfortunately, artificial snow is becoming a very expensive adaptation strategy that does not allow all ski areas to lengthen the ski season.

Certainly, the remote geographical location and difficult accessibility of some mountain areas represent one of the most influential elements for seasonality, however, although it is not possible to seek a definitive solution to the problem, there

are deseasonalization strategies that, if applied, would bring significant socio-economic and environmental benefits, such as the diversification of tourist service, followed by the optimization of school, liturgical, and job calendars, as well as the exploitation of large attractive drivers, such as big events and festivals.

Although this study only focused on the tourist demand side, the literature suggests that to better understand the dynamics of seasonality and to precisely identify effective and targeted deseasonalization policies, it is necessary to integrate analyses from the tourist supply side (for example, it is widespread to adopt the occupancy rate of tourist facilities (Morrison, 1998; Jeffrey et al., 2002).

However, it is also appropriate to point out that in addition to the classic empirical evidence, based on objective criteria, it has proven to be fundamental also to adopt innovative and subjective analyses, measures and evaluations of performances, often based on the direct opinion of the hospitality facilities' business owners, whose approaches, behaviors and perceptions in contrasting seasonality, often find to be highly heterogeneous. Therefore, capturing such information means being able to cluster and map such diversity and therefore avoid concerns that *may lead to ill-focused broad-brush strategies and consequent misallocations of resources*, and above all, being able to report to policy makers, where it is necessary to implement general support, such as training in marketing and management skills, especially for entrepreneurs who find difficulties as they do not know how to counteract the phenomenon of seasonality (Koenig-Lewis & Bischoff, 2010).

In addition, as mentioned in this study, sporting and cultural events organized at the local, national, or international level are catalysts of both positive factors - especially at the economic level - and negative factors, such as overtourism and a trend of degrowth after the event, especially if the initiatives of innovation and maintenance are not implemented. Thus, it suggests thinking about policies not only in favor of the local economy, but above all to a situation of constant socio-economic well-being, considering not only the purely tourist aspect but also the local and climate. Even when considering overcrowding phenomena, in the literature is demonstrated that stakeholder behavior and engagement directly impact the perceived sustainability of major events. Consequently, by understanding these perceptions, the challenges of overtourism can be better addressed (Gon et al., 2019).

Along these lines, Milan-Cortina 2026 Olympic Winter Games legacy, together with the international fame of Lombardy's mountains, could represent an unmissable opportunity to relaunch mountain tourism in Lombardy and focus deseasonalization policies aimed at Lombardy region growth. In this context, policymakers should also pay attention to successful initiatives that can be adopted to overcome overtourism in host destinations for mega sports events, for example as adopted by UK Government during London 2012 Olympic year, leveraging stakeholder advance thinking, spreading domestic tourism, showcasing destinations outside the host city

and promoting regional collaboration (Mhanna et al., 2019). In conclusion, in future studies, authors suggest to investigate the correlation between temperature trends, snowfall levels, and seasonal TOS over time to study the relationship between climate change and winter tourism in Lombardy. It would provide further evidence for the implementation of deseasonalization policies, focusing on the diversification, adaptation, and extension of tourism offerings beyond traditional winter sports, towards emerging tourism demands, as in Ponte di Legno Tonale and Madesimo ski areas are attempting through snowkiting experiencies.

References

BAUM, T., HAGEN, L. 1999. Responses to seasonality: the experiences of peripheral destinations. *International journal of tourism research*, Vol.1, No.5: pp. 299–312.

BAUM, T., LUNDTORP, S. 2001. *Seasonality in tourism: An introduction. Seasonality in tourism*, Vol. 4.

BUTLER, R. 1994. *Seasonality in tourism. issues and problems: Tourism. the state of art*, pp.332–339.

CANDELA, G., FIGINI, P. 2010. *Economia del turismo e delle destinazioni.* Mac-Graw-Hill.

CANDELA, G., GIANNERINI, S., SCORCU, A. E. 2007. Rimini. le caratteristiche strutturali di una destinazione balneare matura. *Economia dei Servizi*, Vol. 2, No.1:pp.123–146.

CICCARELLI, M. 2018. Analisi statistica della stagionalità nelle regioni italiane: come la distribuzione annua delle presenze influenza l'economia della destinazione turistica.

COSTA, P. 2001. La sostenibilità e il turismo, *Politica economica del turismo*, Milano.

CRABOLU, G., FONT, X., MILLER, G. 2023. The Hidden Power of Sustainable Tourism Indicator Schemes: Have We Been Measuring Their Effectiveness All Wrong? *Journal of travel research.*

CRESPI, A., MATIU, M., BERTOLDI, G., BERRO, D. C., CIANFARRA, P., MAJONE, B., VALT, M. 2021. Il primo archivio di osservazioni giornaliere di altezza neve al suolo nell'arco alpino: analisi delle tendenze dal 1971 al 2019. Nimbus.

DAL BIANCO, A., CAPRINO, G. 2023. Analisi della stagionalità del turismo nelle comunità montane della Lombardia. In *MILeS2023: Milano-Impresa, lavoro e società*, pp. 1-18.

DONATO, C. 2007. *Turismo rurale, agriturismo ed ecoturismo quali esperienze di un percorso sostenibile*. EUT Edizioni Università di Trieste.

GON, M., GRASSETTI, L., MARANGON, F., RIZZI, L., TROIANO, S. 2019. Between seasonality and overtourism in seaside destinations: Multi-stakeholder perceptions of hosting music events during summer season. In *Overtourism*. Routledge, pp. 135-148

JEFFREY, D., BARDEN, R.R.D., BUCKLEY, P.J., HUBBARD, N.J. 2002. What makes a successful hotel? Insights on hotel management following 15 years of hotel occupancy analysis in England, *The Service Industries Journal*, Vol. 22, No.2, pp. 73–88.

KOENIG-LEWIS, N., BISCHOFF, E. E. 2010. Developing Effective Strategies for Tackling Seasonality in the Tourism Industry. *Tourism and Hospitality Planning & Development*, Vol.7, No. 4, pp. 395–413.

MACCHIAVELLI, A. 2006. *Il turismo montano tra continuità e cambiamento*, Vol. 4. FrancoAngeli.

MARIANI, G. M., SCALISE, D. 2022. Climate change and winter tourism: evidence from Italy. *Bank of Italy Occasional Paper*, No. 743.

MHANNA, R., BLAKE, A., JONES, I. 2019. Spreading tourists around host countries of mega sport events: A strategy to overcome overtourism in host cities. Worldwide hospitality and tourism themes, Vol. 11, No.5, pp.611-626.

MORRISON, A. 1998. Small firm statistics: a hotel sector focus, Service Industries Journal, Vo. 18, No. 1, pp. 132–42.

NADAL, J. R., FONT, A. R., ROSSELLO, A. S. 2004. The economic determinants of seasonal patterns. Annals of Tourism Research, Vol. 31, No.3, pp.697–711.

NEVEDIVERSA. 2023. *Il turismo invernale nell'era della crisi climatica. Rapporto annuale Legambiente. Anno 2023*.

NEVEDIVERSA. 2024. *Il turismo della neve nelle montagne senza neve. Rapporto annuale Legambiente. Anno 2024*.

WILLIBALD, F., KOTLARSKI, S., EBNER, P. P., BAVAY, M., MARTY, C., TRENTINI, F. V., GRÊT-REGAMEY, A. 2021. Vulnerability of ski tourism towards internal climate variability and climate change in the Swiss Alps. *Science of the Total Environment*, Vol. 784:147054.

Gianpaolo CAPRINO, Università Carlo Cattaneo - LIUC, gcaprino@liuc.it
Antonio DAL BIANCO, Polis Lombardia, antonio.dal.bianco@polis.lombardia.it

NEW INDICATORS FOR ROAD ACCIDENTS ANALYSIS: THE "COLLISION MATRIX" AND ROAD USERS' RISK PROFILES[1]

Marco Broccoli, Silvia Bruzzone

Abstract. Road accidents are a complex issue, and for a comprehensive analysis of the data, it is often recommended to use new indicators and innovative approaches rather than relying solely on traditional methods.
In order to study the different features of all road users and their interactions, it is very important to relate the specific risk elements of the connections between users and vehicles on the road. The paper presents the new collision matrices, with reference to killed or injured involved, the information on the vehicle in collision with they had the crash, and the method used to build the new indicators.

1. Introduction

Today, an information bias persists due to the selection of appropriate denominators for calculating road accident rates. Analysts often use resident population or vehicle fleet size as a common proxy for those at risk, but these choices are not always suitable.

The adoption of the new collision matrices contributes to fill in a gap about the road accidents analysis and to provide a new point of view for the investigation.

The presented study, besides, helps to outline elements for road safety performance too, measured with the support of the Key Performance Indicators, provided by the 2030 Agenda, for the European Union Countries. The new method offers a multidimensional approach to the subject, with roads, vehicles and the human behaviours as key elements.

In addition, to more traditional mortality and injury rates and even with respect to the length of the roads, also new in the Istat dissemination product, the new "collision matrices" introduces an innovative element of the project.

They use an accurate technique designed to connect those killed (within 30 days) or injured in road accidents, whether drivers, passengers, or pedestrians, with the type of vehicle responsible for the collision during the crash.

[1] Marco Broccoli and Silvia Bruzzone edited paragraph 1; Silvia Bruzzone edited paragraphs 2 and 3; Marco Broccoli edited paragraphs 4 and 5, Marco Broccoli and Silvia Bruzzone edited paragraph 6.

2. The road accidents resulting in death or injuries survey

The survey on road accidents resulting in death (within 30 day) or injury carried out by the Italian National Institute of Statistics (Istat), with the cooperation of ACI (Automobile Club of Italy) and other local organisations, is an exhaustive and monthly based data collection, included in the National Statistical Programme. The Police authorities verbalise for administrative reason and collects for Istat and statistical purpose all road accidents involving at least a vehicle circulating on the national road net, resulting in death or injury (Council Decision n. 704 of 1993, of 30 November 1993)[2].

The detection unit is the single road accident resulting in death or injury; the period when the accident occurred refers to all information collected.

As regards the data flow, Istat adopted a flexible model, through the subscription of a Memorandum of understanding or special agreements signed with regions (NUTS2 level) and provinces (NUTS3 level). Main information collected are: date, time and location of the accident, type of road and surface, signals, weather conditions, type of accident (collision, investment, etc.), type of vehicles involved, causes of the accident.

3. The road accidents in Italy and in Europe: an overview on recent data

During 2023, a stabilization in mobility occurs, if compared to 2022, a year in which there was a clear increase in noticed movements compared to the most acute phases of the pandemic. Concerning road accidents, 2023 shows a small improvement in the number of fatalities compared to the previous year; however, there is an upward trend in accidents and injuries, although slightly.

In 2023, we count 3,039 deaths in road accidents in Italy (-3.8% compared to the previous year), 224,634 injuries (+0.5%), and 166,525 road accidents (+0.4%). The values are slightly higher than 2022 for accidents and injuries, but lower for fatalities. There is still a decrease compared to 2019 for accidents, fatalities, and injuries (respectively -3.3%, -4.2%, and -6.9% (Figure 1 and Table 1).

In 2023, fatalities increased for drivers of e-scooters, bicycles, and electric bicycles, they are stable for pedestrians, and decreased for other users. There were 1,332 fatalities among car occupants (-3.1%), 734 among motorcyclists (-6.0%), 68 among moped riders (-2.9%), 485 among pedestrians (0.0%). Among truck occupants, 112 deaths were recorded (-32.5%), while for bicycles and electric bicycles, the fatalities were 212, an increase compared to 2022 when there were 205 (+3.4%). Injuries also increased among users of electric scooters (counted since 2020): road accidents involving them rose from

[2] Link to Decision EC 704/93

2,929 in 2022 to 3,365 in 2023, injuries from 2,787 to 3,195, while deaths (within 30 days) were 21 (in 2022 there were 16).

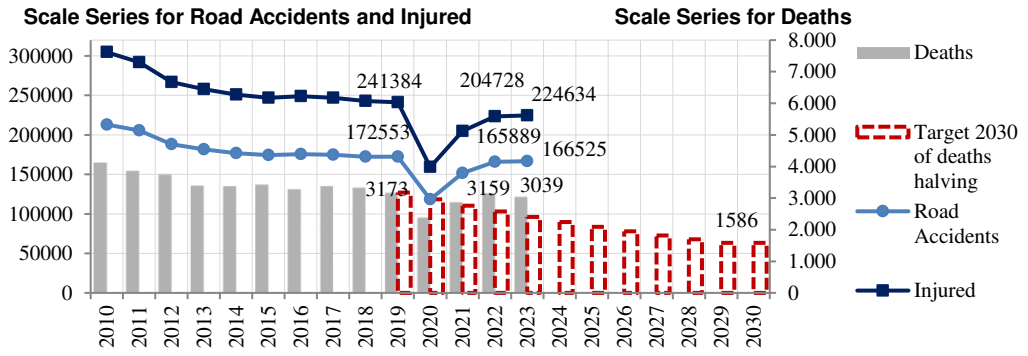
On urban roads, motorways and rural roads, road accidents and injuries are slightly up or stable compared to 2022, with values still all falling compared to the reference year 2019. The number of fatalities fell in comparison with 2022 in all road areas, with a substantial drop, in particular, on motorways (-19.0 per cent); on urban roads, the decrease was 0.3 per cent, on rural roads 3.9 per cent.

The most frequent types of incorrect driving behaviour are distraction, failure to yield right of way and speeding. The three groups together account for 36.5% of cases (80,057), a value that has remained stable over time.

Driving too fast is the most sanctioned behaviour after prohibited stop, parking, and accounts for 37% of all traffic offences. Sanctions for failure to use seat belts and child restraint systems fell slightly, while those for failure to wear a helmet rose sharply. The number of penalties for improper use of devices in the car remains high, and penalties for driving under the influence of alcohol are on the rise, especially the high proportion from local police forces.

The car market shows a growth in 2023: first registrations of passenger's cars increased by 18.4 % compared to 2022. On the motorway network, the annual average vehicle journeys shows a growth of 3.8% compared to 2022 and an increase compared to 2019, recording a maximum, in absolute terms for total journeys, which exceed 86.7 billion vehicles per km.

Figure 1 – *Road Accidents resulting in death or injury, deaths and injured. Years 2010-2023. (Absolute values).*



Source: Istat Survey on Road Accidents resulting in death or injury.

Table 1 - *Road accidents, deaths and injured persons. Years 2001, 2010-2023 (absolute values, deaths per million and percentage change).*

YEARS	**Road accidents** (a)	**Deaths**	**Injured**	**Deaths per million inhabitants** (b)	**Deaths yearly % change**	**Deaths % change vs 2001** (c)	**Deaths % change vs 2010** (c)
2001	263,100	7,096	373,286	124.5	-	-	-
2010	212,997	4,114	304,720	68.8	-	-42.0	-
2011	205,638	3,860	292,019	64.3	-6.2	-45.6	-6.2
2012	188,228	3,753	266,864	62.4	-2.8	-47.1	-8.8
2013	181,660	3,401	258,093	56.4	-9.4	-52.1	-17.3
2014	177,031	3,381	251,147	56.1	-0.6	-52.4	-17.8
2015	174,539	3,428	246,920	56.9	+1.4	-51.7	-16.7
2016	175,791	3,283	249,175	54.6	-4.2	-53.7	-20.2
2017	174,933	3,378	246,750	56.3	+2.9	-52.4	-17.9
2018	172,553	3,334	242.919	55.7	-1.3	-53.0	-19.0
2019	172,183	3,173	241,384	53.1	-4.8	-55.3	-22.9
2020	118,298	2,395	159,249	40.3	-24.5	-66.2	-41.8
2021	151,875	2,875	204,728	48.6	+20,0	-59.5	-30.1
2022	165,889	3,159	223,475	53.6	+9.9	-55.5	-23.2
2023	**166,525**	**3,039**	**224,634**	**51.5**	**-3.8**	**-57.2**	**-26.1**

(a) Road accident resulting in deaths (within the 30th day) or injuries represent the event that involves at least a vehicle circulating on the national road net.
(b) Deaths out of resident population (per 1,000,000).
(c) The percentage changes of the number of deaths is calculated as $((D^{t}/D^{t-1 \text{ or } 2001 \text{ or } 2010}) - 1)*100$

There were 20,365 fatalities on the roads of the EU27 in 2023, compared to 20,685 in 2022, 22,761 in 2019 and about 30,000 in 2010. The decrease in 2023 was very small and amounted to -1.5% on the previous year, while there was a decrease of 10.5% compared to 2019.

For the decade 2021-2030, the European targets on road safety recommend the halving the number of deaths and serious injuries by 2030 compared to the benchmark year (2019) and the monitoring of specific performance indicators, Key Performance Indicators[3]. The road death rate (deaths per million inhabitants) stands at 45.4 in the EU27 and 51.5 in Italy. Our country remains in 19th place in the European ranking, tied with Poland (European Transport Safety Council, 2024).

[3] The European Commission is in charge of coordinating the work of the EU27 countries for the production of the key performance indicators (8 different indicators on the topics: infrastructure, vehicles, road infrastructure, post-accident care). Each country will provide between one and eight national KPIs, comparable and with the minimum methodological requirements decreed by the European Commission (TRENDLINE project).

4. Collision Matrices: the methodology used

The "collision matrices" represent the original element of the project, calculated by road type and other crucial features. The matrix structure consist in an accurate technique, aimed to put in connections all persons killed (within 30 days) or injured in road accidents, drivers and passengers, or pedestrian and the vehicle type, responsible of the collision during the crash.

The road accident indicators based on collision matrices make it possible to outline risk profiles for road users and to highlight differences by type of road, urban and rural, by geographical zone of accident event and by gender and age of users involved.

The project was born following a format used by the European Commission[4], implementing a national variation. The Italian research provides, in fact, an updated and enriched version, in respect to the European Commission proposal.

The Collision Matrix proposed by EU include data with coverage of fatalities in single-vehicle crashes and crashes involving one or more traffic units. For most fatal crashes, only one other vehicle is involved in the crash. For multi-vehicle crashes, the "main vehicle" is the heaviest of the vehicles involved, as this tends to be responsible for the most serious consequences. As results, the figures in each column likely underestimate the number of cases a particular vehicle was involved in a crash (Source: EU CARE Database).

Concerning the Italian version, the values within the cells of the matrix represent, as an added value, a partition of total cases (killed or injured), developing an algorithm combining and permuting all vehicles involved in the accidents and all the crashing interaction between vehicles and other vehicles or pedestrians. Another customisation implemented by the Italian researchers, in the matrix Italian version is the introduction of two new types of vehicle: E-bike and E-scooters.

The algorithm used to build the collision matrix includes the implementation of an iterative process that considers in sequence some steps:

1) Road accidents involving a single vehicle (single vehicle and all pedestrians);

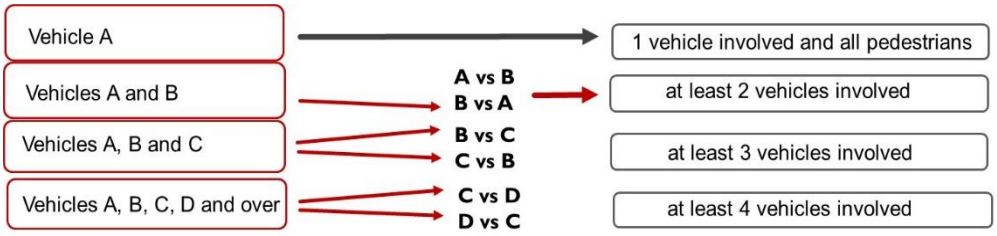
2) Road accidents involving at least two vehicles (vehicle A and B), making comparisons between the first two vehicles A vs B and B vs A;

3) Road accidents involving at least three vehicles (vehicles A, B and C), making comparisons between vehicles B vs C and C vs B, considering that the comparisons vs vehicle A have already been done.

The next steps follow, in an iterative mode, the same process (Figure 2).

[4] European Commission: 2023 figures show stalling progress in reducing road fatalities in too many countries - European Commission (europa.eu)

Figure 2 - *General scheme of the iterative procedure for collision matrices processing.*



Source: Istat processing

5. Collision Matrices: main results

The collision matrices produced contain data for a set of years, in time series, considering the main benchmarks years for the last road safety decades (2001, 2010 and 2019) and the most recent data too (2022 and 2023)[5].

They refer to fatalities and injuries for drivers, passengers or pedestrians and detailed for urban and rural areas. The collision matrix includes, as an innovative analysis element, the information on the mortality or harmfulness risk (as a proxy) for the different user's categories. The tables contain the absolute number for the cross-referencing of the matrix cells, the row percentage values and the column percentage values. The reading key, by the percentage values information too, is useful to understand immediately the weight of each category out of the total.

The analysis of the main and most recent data for 2023 shows interesting results.

Concerning mortality data, for the most vulnerable users, the drivers of electric bicycles and scooters collide mainly against passenger cars or they are involved in single vehicles accidents. Powered two-wheelers have a high number of fatal accidents in collisions with passenger cars, light commercial vehicles and as single vehicles too. Pedestrians present a higher mortality risk than other users when they collide with passenger cars or with heavy good vehicles. Passenger's cars users crashes mainly with other cars or as single vehicles. Heavy Good Vehicles collide against other heavy good vehicles, passenger's cars, and in single vehicle accidents (Table 2, 3 and 4).

[5] Istat Road accidents in Italy. Year 2023 (Appendices) https://www.istat.it/en/press-release/road-accidents-2023/

Table 2 - *Collision matrix for road accidents fatalities by road user and other vehicles involved. Year 2023 (absolute values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	4	2	0	4	33	353	37	28	14	10	0	**485**
Bicycles	6	0	0	0	9	116	18	14	4	7	26	**200**
E-bikes	0	0	0	1	1	7	1	0	0	0	2	**12**
E-scooters	0	0	0	0	2	6	0	1	0	0	12	**21**
Mopeds	0	0	0	3	2	29	4	1	0	4	25	**68**
Motor-bikes	2	0	1	0	33	375	50	23	6	4	240	**734**
Passengers cars	1	0	0	4	4	532	68	123	15	21	564	**1,332**
Lorries (< 3,5 t)	0	0	0	0	0	9	5	8	2	0	18	**42**
Heavy Good Vehicles (> 3,5 t)	0	0	0	0	0	11	2	27	5	0	25	**70**
Buses or Coach	0	0	0	0	0	0	0	5	0	0	23	**28**
Other vehicles	0	0	0	0	1	20	3	9	0	0	14	**47**
Total	**13**	**2**	**1**	**12**	**85**	**1,458**	**188**	**239**	**46**	**46**	**949**	**3,039**

Table 3 - *Collision matrix for road accidents fatalities by road user and other vehicles involved. Year 2023 (Row percentage values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	0.8	0.4	0.0	0.8	6.8	73.0	7.6	5.6	2.9	2.1	0.0	100.0
Bicycles	3.0	0.0	0.0	0.0	4.5	58.0	8.5	7.5	2.0	3.5	13.0	100.0
E-bikes	0.0	0.0	0.0	8.3	8.3	58.3	8.3	0.0	0.0	0.0	16.8	100.0
E-scooters	0.0	0.0	0.0	0.0	9.5	28.6	0.0	4.8	0.0	0.0	57.1	100.0
Mopeds	0.0	0.0	0.0	4.4	2.9	42.6	5.9	1.5	0.0	5.9	36.8	100.0
Motor-bikes	0.3	0.0	0.1	0.0	4.5	51.1	6.8	3.1	0.8	0.5	32.8	100.0
Passengers cars	0.1	0.0	0.0	0.3	0.3	39.9	5.1	9.2	1.1	1.6	42.4	100.0
Lorries (< 3,5 t)	0.0	0.0	0.0	0.0	0.0	21.4	11.9	19.0	4.8	0.0	42.9	100.0
Heavy Good Vehicles (> 3,5 t)	0.0	0.0	0.0	0.0	0.0	15.7	2.9	38.6	7.1	0.0	35.7	100.0
Buses or Coach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	17.9	0.0	0.0	82.1	100.0
Other vehicles	0.0	0.0	0.0	0.0	2.1	42.6	6.4	19.1	0.0	0.0	29.8	100.0
Total	0.4	0.1	0.0	0.4	2.8	48.0	6.2	7.9	1.5	1.5	31.2	100.0

Table 4 - *Collision matrix for road accidents fatalities by road user and other vehicles involved. Year 2023 (Column percentage values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	30.8	100.	0.0	33.3	38.8	24.2	19.7	11.7	30.4	21.7	0.0	16.0
Bicycles	46.2	0.0	0.0	0.0	10.6	8.0	9.6	5.9	8.7	15.2	2.7	6.6
E-bikes	0.0	0.0	0.0	8.3	1.2	0.5	0.5	0.0	0.0	0.0	0.2	0.4
E-scooters	0.0	0.0	0.0	0.0	2.4	0.4	0.0	0.4	0.0	0.0	1.3	0.7
Mopeds	0.0	0.0	0.0	25.0	2.4	2.0	2.1	0.4	0.0	8.7	2.6	2.2
Motor-bikes	15.4	0.0	100.	0.0	38.7	25.7	26.6	9.6	13.0	8.7	25.3	24.2
Passengers cars	7.6	0.0	0.0	33.2	4.7	36.4	36.1	51.5	32.7	45.7	59.5	43.8
Lorries (< 3,5 t)	0.0	0.0	0.0	0.0	0.0	0.6	2.7	3.3	4.3	0.0	1.9	1.4
Heavy Good Vehicles (> 3,5 t)	0.0	0.0	0.0	0.0	0.0	0.8	1.1	11.3	10.9	0.0	2.6	2.3
Buses or Coach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.1	0.0	0.0	2.4	0.9
Other vehicles	0.0	0.0	0.0	0.0	1.2	1.4	1.6	3.8	0.0	0.0	1.5	1.5
Total	100	100	100	100	100	100	100	100	100	100	100	100

As regards the vehicles involved in the collision, passengers' cars drivers are responsible, in total, mainly for other car occupants' deaths (36.4%), motorcyclists' fatalities (25.7%), and pedestrians (24.2%, 39% in urban area). Motorcyclists, instead, kill mainly, pedestrians (38.8%) and other motorcyclists (38.7%) (Table 4).

The analysis of collision matrices data for fatalities within urban areas shows a slightly different profile for users and the type of vehicles in collision with them enter during the crash, if compared with the total data or with rural roads information.

Cyclists, in fact, reach a percentage of collision with passengers' cars of 64.2%, while the value is 58% as whole and 51.1% on rural roads. Concerning e-scooters, the collision is more frequent within urban roads (14 deaths in 2023) than outside the built up areas (7 deaths in 2023). The collision outside the cities is mainly with passengers' cars (57.1%); inside the urban roads, the percentage is highest for accidents as single vehicles due to the loosing of control of the means of transportation (78.6%). A possible cause could be the condition of the surface of the road or the distraction or the misuse of the vehicle, without the respect of the rules of use. For motorcyclists, ever for crashes with passengers' cars, the percentage of collision rises to 54.1% from 51.1% as whole and 48.3 outside built up areas (Table 5, 6 and 7).

Table 5 - *Collision matrix for road accidents fatalities, within urban areas, by road user and other vehicles involved. Year 2023 (absolute values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	4	2	0	4	32	283	27	17	13	7	0	389
Bicycles	3	0	0	0	1	68	9	8	2	2	13	106
E-bikes	0	0	0	0	1	5	0	0	0	0	1	7
E-scooters	0	0	0	0	1	2	0	0	0	0	11	14
Mopeds	0	0	0	2	1	15	1	1	0	3	16	39
Motor-bikes	0	0	1	0	10	193	29	4	3	1	116	357
Passengers cars	1	0	0	1	2	149	16	9	6	4	203	391
Lorries (< 3,5 t)	0	0	0	0	0	2	1	0	1	0	5	9
Heavy Good Vehicles (> 3,5 t)	0	0	0	0	0	2	1	0	0	0	3	6
Buses or Coach	0	0	0	0	0	0	0	1	0	0	1	2
Other vehicles	0	0	0	0	1	6	1	0	0	0	1	9
Total	8	2	1	7	49	725	85	40	25	17	370	1,329

Table 6 - *Collision matrix for road accidents fatalities, within urban areas, by road user and other vehicles involved. Year 2023 (Row percentage values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	1.0	0.5	0.0	1.0	8.2	72.8	6.9	4.4	3.3	1.8	0.0	100.0
Bicycles	2.8	0.0	0.0	0.0	0.9	64.2	8.5	7.5	1.9	1.9	12.3	100.0
E-bikes	0.0	0.0	0.0	0.0	14.3	71.4	0.0	0.0	0.0	0.0	14.3	100.0
E-scooters	0.0	0.0	0.0	0.0	7.1	14.3	0.0	0.0	0.0	0.0	78.6	100.0
Mopeds	0.0	0.0	0.0	5.1	2.6	38.5	2.6	2.6	0.0	7.7	41.0	100.0
Motor-bikes	0.0	0.0	0.3	0.0	2.8	54.1	8.1	1.1	0.8	0.3	32.5	100.0
Passengers cars	0.3	0.0	0.0	0.3	0.5	38.1	4.1	2.3	1.5	1.0	51.9	100.0
Lorries (< 3,5 t)	0.0	0.0	0.0	0.0	0.0	22.2	11.1	0.0	11.1	0.0	55.6	100.0
Heavy Good Vehicles (> 3,5 t)	0.0	0.0	0.0	0.0	0.0	33.3	16.7	0.0	0.0	0.0	50.0	100.0
Buses or Coach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	50.0	0.0	0.0	50.0	100.0
Other vehicles	0.0	0.0	0.0	0.0	11.1	66.7	11.1	0.0	0.0	0.0	11.1	100.0
Total	0.6	0.2	0.1	0.5	3.7	54.6	6.4	3.0	1.9	1.3	27.8	100.0

Table 7 - *Collision matrix for road accidents fatalities, within urban areas, by road user and other vehicles involved. Year 2023 (Column percentage values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	50.0	100.	0.0	57.1	65.3	39.0	31.8	42.5	52.0	41.2	0.0	29.3
Bicycles	37.5	0.0	0.0	0.0	2.0	9.4	10.6	20.0	8.0	11.8	3.5	8.0
E-bikes	0.0	0.0	0.0	0.0	2.0	0.7	0.0	0.0	0.0	0.0	0.3	0.5
E-scooters	0.0	0.0	0.0	0.0	2.0	0.3	0.0	0.0	0.0	0.0	3.0	1.1
Mopeds	0.0	0.0	0.0	28.6	2.0	2.1	1.2	2.5	0.0	17.6	4.3	2.9
Motor-bikes	0.0	0.0	100.	0.0	20.4	26.6	34.1	10.0	12.0	5.9	31.4	26.9
Passengers cars	12.5	0.0	0.0	14.3	4.1	20.6	18.8	22.5	24.0	23.5	54.9	29.4
Lorries (< 3,5 t)	0.0	0.0	0.0	0.0	0.0	0.3	1.2	0.0	4.0	0.0	1.4	0.7
Heavy Good Vehicles (> 3,5 t)	0.0	0.0	0.0	0.0	0.0	0.3	1.2	0.0	0.0	0.0	0.8	0.5
Buses or Coach	0.0	0.0	0.0	0.0	0.0	0.0	0.0	2.5	0.0	0.0	0.3	0.2
Other vehicles	0.0	0.0	0.0	0.0	2.0	0.8	1.2	0.0	0.0	0.0	0.3	0.7
Total	100	100	100	100	100	100	100	100	100	100	100	100

Injuries matrices shows similar results and profiles within and outside urban areas.

Finally, an interesting comparison consists in the time series collision matrices analysis too.

One of the most evidence emerged, for instance, is the increasing of the percentage of single vehicles accidents, in particular within built up areas. The percentage rises, in fact, since 38.3% in 2001 (Table 9) to 51.9% in 2023 (Table 6). In addition, drivers of lorries, classified as light commercial vehicles, shows a strong increase of single vehicle accidents, from 34.8% to 55.6%.

The specific increase could partly result from distractions caused by using smartphones or devices while driving, along with bad road conditions or speeding. Some studies (Matthews *et al.* 2019) deal with the strong connection between fatigue and distraction driving too, or between other activities done while driving, such as eating or drinking, and texting (Choudhary *et al.*, 2017; Gariazzo *et al.*, 2018)). The rise in distractions often leads to road accidents for lorry drivers as well, especially in recent years, with the growing spread of e-commerce and delivery networks.

Table 8 - *Collision matrix for road accidents fatalities, within urban areas, by road user and other vehicles involved. Year 2001 (absolute values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	5	-	-	72	73	578	42	41	17	8	-	836
Bicycles	-	-	-	3	13	147	23	29	2	4	25	246
E-bikes	-	-	-	-	-	-	-	-	-	-	-	-
E-scooters	-	-	-	-	-	-	-	-	-	-	-	-
Mopeds	2	-	-	17	16	192	21	30	7	3	87	375
Motor-bikes	5	-	-	2	14	284	27	30	2	4	131	499
Passengers cars	6	-	-	15	18	560	78	85	25	8	494	1.289
Lorries (< 3,5 t)	-	-	-	1	1	17	3	8	-	-	16	46
Heavy Good Vehicles (> 3,5 t)	-	-	-	-	-	1	1	6	-	-	7	15
Buses or Coach	-	-	-	-	1	3	-	-	1	-	6	11
Other vehicles	-	-	-	-	1	21	1	2	-	-	9	34
Total	18	-	-	110	137	1.803	196	231	54	27	775	3.351

Table 9 - *Collision matrix for road accidents fatalities, within urban areas, by road user and other vehicles involved. Year 2001 (Row percentage values).*

	IN COLLISION WITH											
FATALITIES BY USER TYPE	**Bi-cycles**	**E-bikes**	**E-scooters**	**Mopeds**	**Motorbikes**	**Passengers cars**	**Lorries (< 3,5 t)**	**Heavy Good Vehicles (> 3,5 t)**	**Buses or Coach**	**Other vehicles**	**No other vehicle involved**	**Total**
Pedestrians	0,6	-	-	8,6	8,7	69,1	5,0	4,9	2,0	1,0	0,0	100,0
Bicycles	0,0	-	-	1,2	5,3	59,8	9,3	11,8	0,8	1,6	10,2	100,0
E-bikes	-	-	-	-	-	-	-	-	-	-	-	-
E-scooters	-	-	-	-	-	-	-	-	-	-	-	-
Mopeds	0,5	-	-	4,5	4,3	51,2	5,6	8,0	1,9	0,8	23,2	100,0
Motor-bikes	1,0	-	-	0,4	2,8	56,9	5,4	6,0	0,4	0,8	26,3	100,0
Passengers cars	0,5	-	-	1,2	1,4	43,4	6,1	6,6	1,9	0,6	38,3	100,0
Lorries (< 3,5 t)	0,0	-	-	2,2	2,2	37,0	6,5	17,4	0,0	0,0	34,8	100,0
Heavy Good Vehicles (> 3,5 t)	0,0	-	-	0,0	0,0	6,7	6,7	40,0	0,0	0,0	46,7	100,0
Buses or Coach	0,0	-	-	0,0	9,1	27,3	0,0	0,0	9,1	0,0	54,5	100,0
Other vehicles	0,0	-	-	0,0	2,9	61,8	2,9	5,9	0,0	0,0	26,5	100,0
Total	0,5	-	-	3,3	4,1	53,8	5,8	6,9	1,6	0,8	23,1	100,0

6. Conclusions

Collision matrices represent a new tool for analysing road accident data, allowing for the study of connections between road users—whether injured, killed, or hurt—and the vehicles they collided with, which are often responsible for the accident. The scientific community particularly values the analysis using two-way tables because it explains data clearly and straightforwardly, filling an existing information gap in the available tools. The generalization of collision matrices for the Italian model introduces two innovations: the inclusion of electric scooters and electric bicycles, and the calculation that allows for a data partitioning in the table, with marginal distributions that include all recorded cases of deaths and injuries, not just those involving the first two vehicles, as proposed by the European Commission.

References

CHOUDHARY P., Velaga N.R. 2017. Modelling driver distraction effects due to mobile phone use on reaction time, *Transportation Research Part C: Emerging Technologies,* Vol. 77, pp. 351-365.

ETSC (European Transport Safety Council). 2024. Ranking EU progress on road safety 18th Road Safety Performance Index (PIN) Report

EUROPEAN COMMISSION. 2024. (Collision Matrices) 2023 figures show stalling progress in reducing road fatalities in too many countries - European Commission (europa.eu).

GARIAZZO, C., STAFOGGIA, M., BRUZZONE, S., PELLICCIONI, A. and FORASTIERE, F. 2018. Association between mobile phone traffic volume and road crash fatalities: A population-based case-crossover study. *Accident; analysis and prevention,* Vol. 115*,* pp. 25-33.

ISTAT. 2024, Road accidents in Italy. Year 2023 (2024), (Appendices), Road accidents 2023 – Istat.

MATTHEWS G., NEUBAUER C., SAXBY D.J., WOHLEBER R.W., LIN J. 2019. Dangerous intersections? A review of studies of fatigue and distraction in the automated vehicle, *Accident Analysis and Prevention*, Vol. 126, pp. 85-94.

Marco BROCCOLI, Istat, Directorate for Methodology and Statistical Process Design broccoli@istat.it

Silvia BRUZZONE, Istat, Directorate for Social Statistics and Welfare bruzzone@istat.it

LITIGANTS' ATTITUDES TOWARD CIVIL JUSTICE IN ITALY

Claudio Caterino, Isabella Latini, Maria Giuseppina Muratore, Sante Orsini

Abstract. The functioning of civil justice represents an essential aspect of the citizens' quality of life and affects their trust in an institution that is one of the pillars of civil society. Citizens resort to civil justice when they believe their rights have been violated or they want to resolve a dispute. When dealing with "justice", its evaluation and the citizens' opinions about it are essential. Policies in the field of justice aim to improve the efficiency of the justice system but also the citizens' satisfaction with it. Data from the recent 2023 wave of the sample survey "Aspects of Daily Life (A.V.Q.)" provide an opportunity to analyse citizens' experiences with civil justice. In this study, we analysed the answers given by the interviewees using non-parametric tests, regression models, and correspondence analysis, taking into account the interviewees' characteristics and some structural characteristics of the trial. By doing so, we intend to identify the determinants of citizens' satisfaction in civil suits. The overall results highlighted the citizens' experiences with the judicial process, the problems they perceive, their attitudes, and their opinions towards justice. This analysis represents the first step in checking the outcomes of recent changes in the organisation of civil justice in Italy. It would be the basis for monitoring the effect of alternative dispute resolutions (ADR), which are expected to expand justice efficiency and citizens' satisfaction.

1. Introduction: satisfaction with civil justice and trust in the institutions

Italian civil justice has been long criticised for its alleged inefficiency and as an impediment to foreign companies' investments in the country's economy (Lorizio and Gurrieri, 2014). However, this has concerned more private corporate law than civil law as a whole.

As a matter of fact, civil justice, in general, concerns all citizens in their daily interactions in social life. Anyone who resorts to the civil justice system to resolve a dispute would derive from this experience a sense of satisfaction or dissatisfaction, which influences, in turn, his/her level of trust in the justice system and the institutions in general.

An approach to the degree of satisfaction associated with being involved in a civil suit requires a multidimensional analysis, embracing psychological, legal, and social aspects. Several factors can influence the litigants' satisfaction. Post-lawsuit

satisfaction is affected not only by the final verdict but also by the entire judicial process, including the quality of communication between lawyers and clients, the perceptions of procedural fairness, and the judges' behaviour (Tyler, 1988; Relis, 2002).

Empirical studies conducted in countries with civil law systems, such as Italy and France, have shown that the trial's length and the procedures' complexity significantly affect litigants' satisfaction. The tardiness of Italian courts and the inadequate use of technologies have often been mentioned as a source of the citizens' dissatisfaction (Fabri, 2009)**.** The role of legal support in building trust and satisfying litigants also seems crucial. Good legal counselling, which includes effective communication, a clear explanation of (procedural) complexities and transparency of the economic costs, can increase litigants' trust in the justice system, leading to greater overall satisfaction (Verzelloni, 2016).

Judges' attitudes and their way of managing the hearings also play a crucial role. Judges who adopt a more interactive and transparent approach tend to foster greater satisfaction for the litigants (Genn, 2008). Clear explanations of decisions and greater accessibility of the judge help mitigate the sense of alienation often associated with formal court procedures.

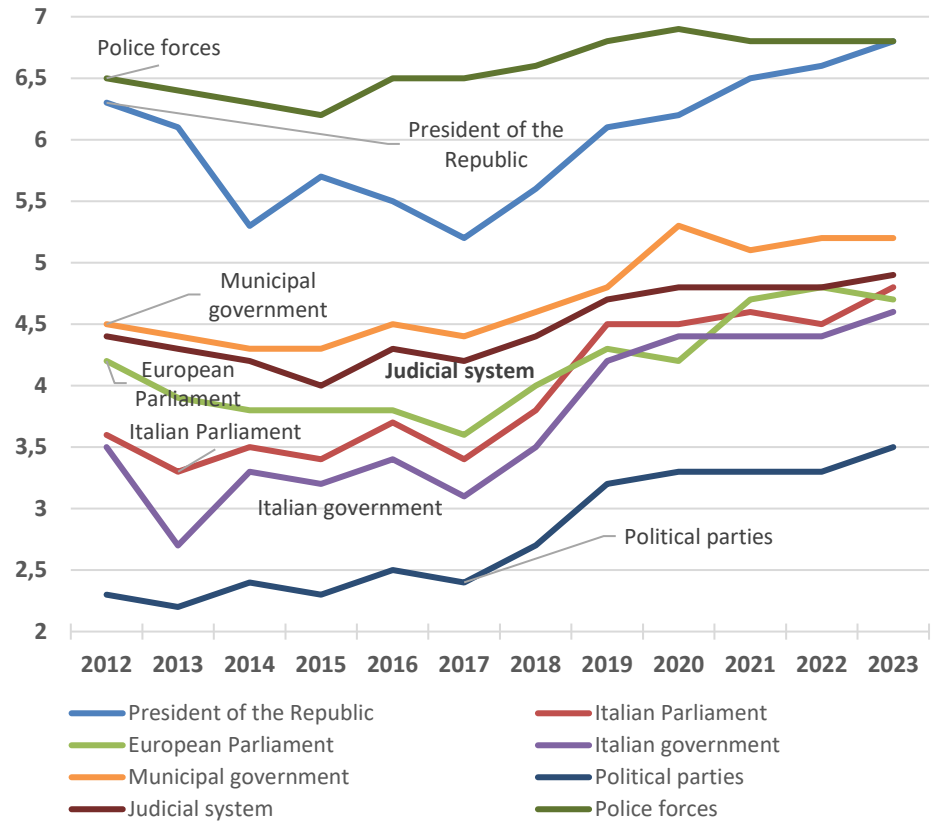
Procedural justice theory emphasises that litigants feel more satisfied when they perceive the process as fair and transparent, even if the outcome is not in their favour. **(**Thibaut and Walker, 1975; Tyler, 2016). According to this theory, trust in justice is a key mediator between the perception of the procedure and the final satisfaction. Perception of procedural fairness, namely the feeling that the trial was fair and impartial, increases trust in judicial institutions. This trust, in turn, improves litigants' overall satisfaction (Hulst J.E. *et al.,* 2017). Trust in the judicial institutions is a fundamental element influencing litigants' satisfaction with the civil law system. This trust is fuelled by the perception of procedural fairness, transparency and competence, all contributing to a better judicial experience for citizens.

Trust in judicial institutions varies significantly across countries. For example, in countries where judicial institutions are perceived as more corrupt or inefficient, citizens tend to show lower satisfaction with the judicial process. A transparent and accountable justice system is fundamental to maintaining citizens' trust (Siegrist, 2010).

Figure 1 shows the evolution over time of the average degree of trust in the institutions in Italy, as measured by scores ranging from zero to ten.

Political parties get low scores. However, it is interesting to note the relative increase in scores in recent years for all institutions. This trend has also influenced trust in justice, which attains an intermediate position.

Figure 1 – *Evolution of trust in the Institutions in Italy. Years 2012-2023. Yearly average of scores.*



The Italian government introduced some changes to improve the efficiency of civil justice, simplify and rationalise the civil process, and reduce the judicial offices' workloads (Vendramini, 2022). Among them is the Alternative Dispute Resolution (hereafter ADR) (Fornari, 2013). ADRs (i.e. mediation, arbitration, etc.) are less formal, less expensive, and less time-consuming. Therefore, they are considered a positive innovation since they resolve civil legal disputes between the parties outside of the traditional courtroom setting. However, it is a matter of discussion if ADRs represent a form of privatisation of justice and jeopardize the rule of law (Kamilovska, 2020; Waters, 2022). Certainly, it is difficult to predict the citizens' satisfaction when there has been a civil process in courtroom after a failed ADR. In

these cases, the citizens' satisfaction is expected to change in the future according to improvements in the justice system's organization.

2. Data and methods

This study used data from the Questionnaire-Form No. 20 of an Istat sample survey entitled "Aspects of Daily Life". This survey is part of an integrated system of social surveys – multipurpose surveys on families – and collects information relating to the daily lives of individuals and families. Since 1993, the survey has been carried out every year. The information collected allows us to understand citizens' habits, their daily problems and whether they are satisfied with the functioning of those public utility services that contribute to improving the quality of life.

The responses are collected using a mixed technique: an online questionnaire self-compiled by the respondents (CAWI - Computer-Assisted Web Interviewing technique) or a direct interview with an electronic and paper questionnaire administered by an interviewer (CAPI/PAPI - Computer-Assisted Personal Interviewing and Paper and Pencil Interviewing). Weighted estimates are significant down to the regional level.

This study used responses to the module dedicated to civil justice, a module intermittently added to the survey, to analyse the determinants of satisfaction. Respondents are 18-year-old individuals who declared having been involved in a civil suit at least once. In the 2023 survey, they amounted to almost 6 million (corresponding to over 4,700 individuals in the sample).

The satisfaction of those who concluded a civil suit will be used here to monitor the effects of the organisational and procedural changes in civil justice that are being recently implemented and are expected to produce their effects shortly.

Firstly, we intend to verify the association between the satisfaction of the respondents involved in a civil suit and some of their personal characteristics as well as some characteristics of the civil suit.

As for the characteristics of the lawsuit, we will use the information provided by the survey. They regard the matter of the most recent civil suit in which the respondent was involved; whether the lawyer had provided a cost estimation; the duration of the lawsuit; the outcome of the concluded lawsuit; the cost incurred versus the expected one; and the respondent's suggestions on how to improve the civil justice system. Information regarding the Economic cost and the Outcome only concerned concluded lawsuits; other information (Satisfaction, Existence of a cost estimation) also concerned ongoing lawsuits.

Finally, we used a mixed logistic regression model to measure the impact of the interviewees' socioeconomic features on their satisfaction with the civil justice

system as well as the random effects based on the territorial units (Italian regions). We hypothesize a hierarchical structure of the data with unmeasured sources of variance affecting individuals according to their territorial units. These unmeasured sources might consist, for instance, in differences between the various courts. The current survey, unfortunately, didn't identify the court that dealt with the lawsuit.

3. Results

Firstly, let us check whether we can reject the null hypothesis (H0) of independence between citizens' satisfaction with their civil suits and the abovementioned characteristics.

Table 1 – *Satisfaction with one's own civil suit and trust in the judicial system, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Trust in the judicial system			
	Low	Medium	High	**Total**
Dissatisfied	53.1	37.4	26.3	**45.8**
Satisfied	46.9	62.6	73.7	**54.2**
N = 4274; Pearson : F= 2.178 P=0.0696				

We cannot reject the hypothesis of no association between satisfaction and trust in the judicial system unless we accept a 7% error probability. Litigants' satisfaction is associated with their "Gender" (Table 2), as well as with their "Education" and Marital Status (tables not shown).

Table 2 – *Satisfaction with one's own civil suit and gender of the litigants, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Gender		
	Female	Male	**Total**
Dissatisfied	42.3	50.3	**45.8**
Satisfied	59.5	49.7	**54.2**
N = 4274; Pearson : F= 32.277 P=0.0000			

Other characteristics of the litigants, such as "Work status", "Geographical area", and "City type", are not associated with satisfaction (tables not shown).
The number of civil suits the respondents have been involved in during their lives is not associated with their satisfaction (table not shown). Respondents were asked to

focus on detailed informations only about their most recent lawsuit. This outcome suggests that different lawsuits can lead to different experiences. As expected, "Duration" (Table 3), "Outcome" (Table 4) and "Cost of lawsuit compared to expected cost" (Table 5) are closely associated with satisfaction. There is also an association between satisfaction and "Economic Status" but it is not linear: Low status = 50.1% satisfied, Medium st. = 57.9%, High st. = 55.2% (table not shown).

Table 3 – *Satisfaction with one's own civil suit concluded and suit duration, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Lawsuit duration				
	0-1 year	2-5 years	6-10 years	> 10 years	**Total**
Dissatisfied	31.6	51.0	66.9	75.0	**45.8**
Satisfied	68.4	49.0	33.2	25.0	**54.2**
N = 4231; Pearson : F= 96.079 P=0.0000					

Table 4 – *Satisfaction with one's own civil suit and suit outcome, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Lawsuits outcome				
	Negative verdict	Mixed verdict	Positive verdict	No verdict yet	**Total**
Dissatisfied	87.2	49.0	21.1	70.4	**45.8**
Satisfied	12.8	51.0	78.9	29.6	**54.2**
N = 4274; Pearson : F= 252.135 P = 0.0000					

Table 5 – *Satisfaction with one's own civil suit and suit costs vs the expected ones, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Lawsuit costs vs the expected costs			
	Lower costs	Fair costs	Higher costs	**Total**
Dissatisfied	26.0	30.0	67.7	**41.2**
Satisfied	74.0	70.0	32.3	**58.8**
N = 4274; Pearson : F = 168.566 P = 0.0000				

A cost estimation leads to greater satisfaction (68.1% of the litigants were satisfied when there was an estimation and 48.8% when the estimation was lacking: table not shown). All the respondents provided at least one suggestion to improve the justice system, but many "hints" were associated with more dissatisfaction.

Table 6 – *Satisfaction with one's own civil suit and the number of hints provided by the respondent, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Number of hints				
	1 hint	2-3 hints	4-7 hints	>7 hints	**Total**
Dissatisfied	30.1	40.2	54.8	71.3	**45.8**
Satisfied	69.9	59.8	45.2	28.7	**54.2**
N = 4274; Pearson : F = 90.036 P = 0.0000					

The most frequent litigations concern "Family" (separation and divorces, child support, adoption, and inheritance) and "Labour" lawsuits, involving more than 4.5 million people; the item "Other" includes further types of lawsuits (neighbourhood disputes, road accidents, customer-supplier disputes, etc.); "Not specified" refers to lawsuits of an undetermined type (Table 7).

Table 7 – *Satisfaction with one's own civil suit and type of most recent suit, Chi^2 Pearson test. (Percentages from calculations on weighted values).*

Satisfaction with lawsuit	Type of most recent lawsuit				
	Family	Labour	Other	Not specified	Total
Dissatisfied	34.8	53.0	56.2	50.7	**45.8**
Satisfied	65.2	47.0	43.8	49.3	**54.2**
N = 4274; Pearson : F = 34.115 P = 0.0000					

With a logistic regression model, we check the direction and strength of the relationships between "satisfaction" and each of the explanatory variables controlling for the others. The model (Table 8) shows the large impact on satisfaction made in particular by the explanatory variables measuring the lawsuit's duration, outcome, benefit, and costs. It also emerges the close association between the litigants' satisfaction with their lawsuits and their trust in general in the justice system. The results regarding the random effects show that the territorial dimension taken into consideration does not significantly contribute to the model variance.

Table 8 – *Mixed Logistic regression model of satisfaction with one's own civil suit on main socioeconomic variables and random effects based on regions.*

Variable/Modality	**Coefficient**	**Robust Std error**	**z value**	**P>|z|**
Gender				
Male	1			
Female	0.20	0 .12	1.77	0.077
Trust in the judicial system				
Low	1			
Medium	0.45	0.07	6.46	0.000
High	1.17	0.15	7.83	0.000
Education				
Primary	1			
Lower secondary	–0.21	0.10	–2.04	0.041
Higher secondary	–0.35	0.08	–4.42	0.000
Degree	–0.53	0.19	–2.81	0.005
Type of last lawsuit				
Other lawsuit	1			
Family lawsuit	0.71	0.09	8.22	0.000
Labour lawsuit	0.02	0.14	0.16	0.875
Not specified lawsuit	0.12	0.41	0.29	0.769
Lawsuit duration				
0-1 years	1			
2-5 years	–0.63	0.06	–10.50	0.000
6-10 years	–1.01	0.08	–12.28	0.000
over 10 years	–1.53	0.13	–11.58	0.000
Lawsuit outcome				
negative verdict	1			
mixed verdict	1.42	0.34	4.12	0.000
positive verdict	2.53	0.26	9.70	0.000
No verdict yet	0.74	0.33	2.21	0.027
Lawsuit costs				
Lower costs	1			
Fair costs	–0.11	0.10	–1.16	0.246
Higher costs	–1.11	0.15	–7.40	0.000
Perceived benefit				
Perceived benefit no	1			
Perceived benefit_yes	0.70	0.04	17.51	0.000

Table 8 (cont.)– *Mixed Logistic regression model of satisfaction with one's own civil suit on main socioeconomic variables and random effects based on regions.*

Variable/Modality	**Coefficient**	**Robust Std error**	**z value**	**P>|z|**
Number of hints				
1 hint	1			
2-3 hints	–0.25	0.14	–1.82	0.069
4-7 hints	–0.66	0.14	–4.79	0.000
>7 hints	–1.31	0.15	–8.46	0.000
Satisfaction with one's Economic Status (SES)				
Low-satisfaction	1			
Middle-satisfaction	0.34	0.06	6.05	0.000
High-satisfaction	0.17	0.23	0.75	0.453
Constant	–0.91	0.24	–3.78	0.000
Regions				
Constant	0.002	0.006	0.005	1.446
N=4231 Number of regions = 21; Obs per group: min = 74; avg = 201.5; max = 412				

Figure 2 shows the relationships between the categories through a Multiple Correspondence Analysis (MCA). The model captured almost 93% of the total inertia in a two-dimensional space. It is patent, along the vertical axis, the cluster of the categories most associated with dissatisfaction: "negative outcome", "long duration" (6-10 years and more than 10 years), "high cost" of the lawsuit, more than seven hints about how to improve the justice system. Close to the other end of the axis, we find the categories associated with satisfaction: "positive outcome", "low duration", and "fair or low cost" of the lawsuit. The horizontal axis clearly marks, in particular, the separation between the categories regarding the lawsuit type.

Figure 2 - *Multiple Correspondence Analysis (MCA), Joint method, Standard normalization.*

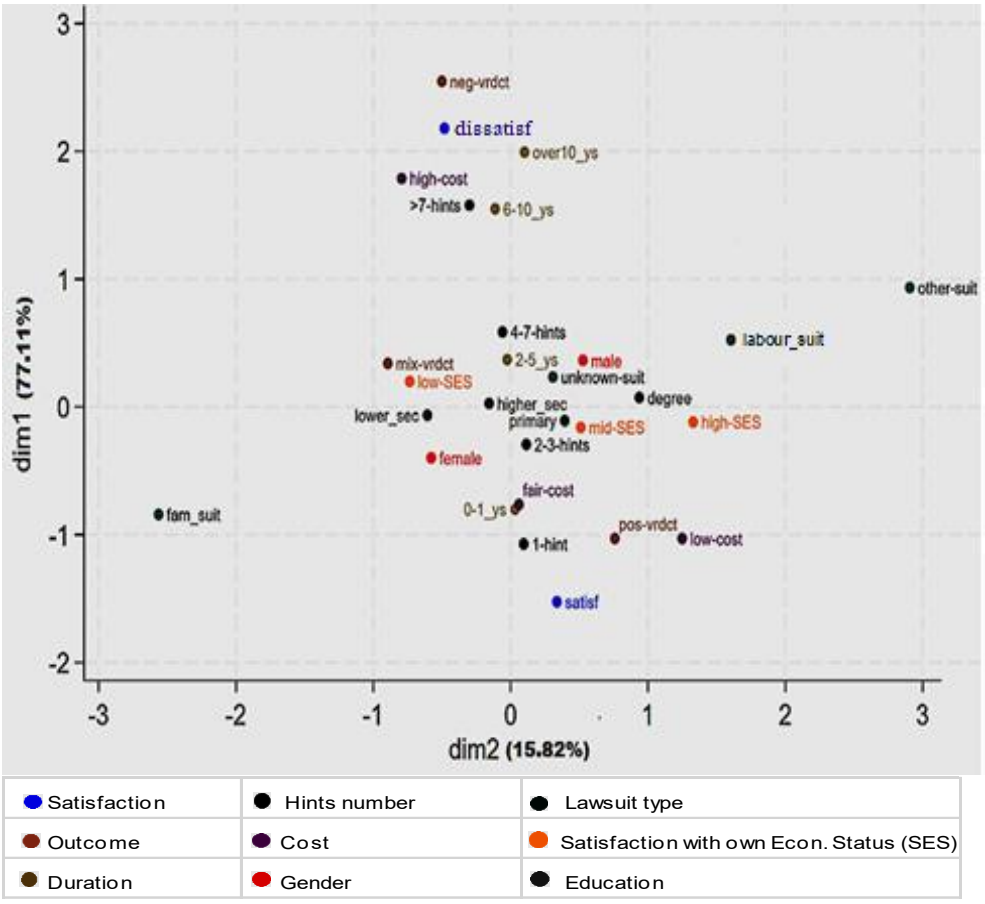
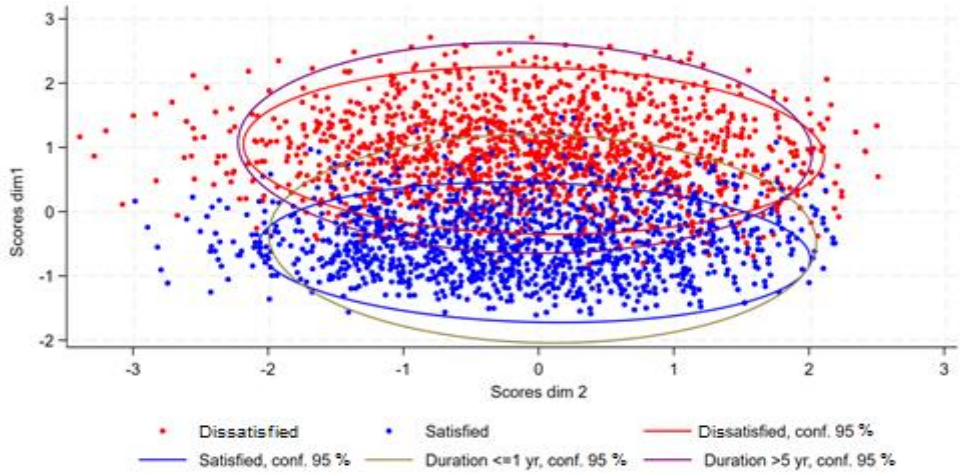


Figure 3 shows the positions of the individuals of the sample under examination according to the two dimensions of the MCA. The ellipses constructed on the sample correspond to a 95% confidence level. Satisfied litigants (blue points and the corresponding blue ellipse) and dissatisfied litigants (red points and the corresponding red ellipse) position themselves along the first dimension with limited overlapping. Variability in the individuals' positions also stretches across the second dimension. The ellipses corresponding to individuals with a "0-1 year" lawsuit duration (grey ellipse) and to individuals with a "more than 5 years" lawsuit (purple ellipse) are very close to the ellipses corresponding to individuals respectively satisfied and dissatisfied with their civil suit.

Figure 3 – *MCA with individuals (Satisfied/Dissatisfied; <=1 year/>5years Duration (95% confidence ellipses).*



4. Conclusion and future developments

This analysis represents the first step in checking the outcomes of changes in the civil justice organisation, designed to improve citizens' quality of life, and introduced after the launching of the National Recovery and Resilience Plan (PNRR). In addition to the associations with satisfaction given by the duration of a lawsuit, its cost, and the type of verdict the mixed effect regression model allowed us to measure the contribution to variance by the territorial units. The findings do not support the hypothesis of the hierarchical structure of the data.

Future steps would regard:

- Checking the effects of the increasing use of ADRs. Since 2022, it is mandatory to make recourse to an ADR before starting a civil suit regarding labour and employment disputes. ADRs have a fixed duration. Therefore, in the future, the duration of the lawsuit will be less important as a determinant of the litigants' satisfaction. ADRs are also expected to reduce costs, another satisfaction determinant and could also improve the relationship between the litigants thanks to expressly trained mediators, positively influencing litigants' satisfaction.
- Checking the effects of the introduction of family courts in 2023. These courts were designed to deal with only family lawsuits, the most frequent type of civil suit. Trials should be leaner and faster, and together with the increasing use of mediation, should reduce conflict and increase litigants' satisfaction.

Acknowledgements

The authors express their gratitude to Prof. Luigi M. Solivetti for his advice and feedback. They also thank the RIEDS Reviewers for their valuable suggestions.

References

LORIZIO M., GURRIERI A.R. 2014. Efficiency of Justice and Economic Systems, *Procedia Economics and Finance*, Vol. 17, pp. 104–112.

HULST J.E., VAN DEN BOS K., AKKERMANS A.J., LIND E.A. 2017. On the psychology of perceived procedural justice. *Frontiers in Psychological and Behavioral Science*, Vol. 6, No 1, pp. 1–12.

TYLER T.R. 2016. *Why People Obey the Law*. Prinston, N.J.: Princeton Un. Press.

SIEGRIST M., 2010. Trust and Confidence. *Risk Analysis: An International Journal*, 2010, Vol. 30, No 7, pp. 1022–1024.

GENN H.G. 2008. *Judging Civil Justice*. Cambridge: Cambridge Un. Press.

RELIS T. 2002. Civil Litigation From Litigants' Perspectives. *Studies in Law, Politics and Society*, Vol. 25, pp. 151–212.

TYLER T.R. 1988. What is procedural justice? *Law & Society Review,* Vol. 22, No 1, pp. 103–135.

FABRI M. 2009. The Italian style of e-justice in a comparative perspective. In CERRILLO A., FABRA P. (Eds.) *E-Justice*. Hershey, PA: IGI Global, pp. 1–19.

VERZELLONI L. 2016. *Gli avvocati nella giustizia civile.* Roma: Carocci.

THIBAUT J.W. 1975. *Procedural justice: a psychological analysis*. Hillsdale, N.J., Lawrence Erlbaum.

FORNARI A. (edited by), 2013. *ADRITALIA*, Vol. 1. Padova: Primiceri Editore.

VENDRAMINI C. (edited by), 2022. *La mediazione familiare nella riforma Cartabia*. Milano: Wolters Kluwer.

KAMILOVSKA T.Z. 2020. Privatisation of Civil Justice, *Access to Justice in Eastern Europe*, Vol. 6, No 1, pp. 34–45.

WATERS B. 2022. Alternative Dispute Resolution and Civil Justice, *The International Journal of Arbitration, Mediation and Dispute Management*, Vol. 88, No 1, pp. 3–33.

Claudio CATERINO, Istat - Istituto Nazionale di Statistica, caterino@istat.it
Isabella LATINI, Istat - Istituto Nazionale di Statistica, isabella.latini@istat.it
Maria G. MURATORE, Istat - Istituto Nazionale di Statistica, muratore@istat.it
Sante ORSINI, Istat - Istituto Nazionale di Statistica, orsini@istat.it

DIFFERENTIAL BENEFITS OF QUESTIONNAIRE REDESIGN: IMPLICATIONS FOR DATA QUALITY AND STATISTICAL BURDEN ACROSS DIFFERENT RESPONDENT PROFILES[1]

Sabrina Barcherini, Barbara M.R. Lorè, Valeria Mastrostefano, Simona Rosati

Abstract. The aim of this paper is to show how different respondents benefit differently from methodological improvements in the questionnaire design.
When dealing with questionnaires, respondents differ in both the type and number of difficulties they face, depending on structural characteristics, core variables, and response strategies. This leads to differences in completion performance, with some respondents more likely to introduce inaccuracies, especially in quantitative information.
If the questionnaire is one of the main sources of non-sampling error, a good questionnaire design is a primary tool for maximizing accuracy. Data from the survey on Research and Development in business enterprises (RS1), collected before and after major changes to the questionnaire design, have been compared to explore differences in completion behaviour. Both descriptive and logistic model analysis, carried out to assess the impact of design changes intended to facilitate and improve the use of the unit of measurement in expenditure questions, along with the analysis of burden indicators, have shown the existence of different sub-populations, both in terms of accuracy and perceived burden. Profiling respondents has provided valuable insights into further opportunities for improvement.

1. Introduction

A careful design of a questionnaire positively impacts the quality of the data collected and reduces the statistical burden. These effects can vary depending on the respondents' profiles and can influence both response behaviour and perceived burden.

In business surveys, completing a questionnaire can be particularly challenging for a variety of reasons (Willimack *et al.*, 2001). The information necessary to answer the questions has to be retrieved from archives and business documents that are not necessarily interconnected or freely accessible to everyone in the organisation. Enterprises data is not always readily available in the format required by the questionnaire, which must align with the definitions and classifications established in the regulations. Consequently, it often needs to be processed before

[1] This article is the result of the collaboration between the authors. In particular: paragraphs 1 and 4.1 have been written by Simona Rosati, paragraphs 2 and 4 have been written by Valeria Mastrostefano, paragraphs 3 and 4.3 have been written by Sabrina Barcherini, paragraphs 4.2 and 5 have been written by Barbara M. R. Lorè.

the questionnaire is completed, and more than one person may be necessary to perform these operations. Finally, all data entered into the questionnaire must be internally consistent and adhere to quality checks.

The following paragraphs describe the case study of the survey on Research and Development in business enterprises. The analysis performed aims to understand the impact of significant measures implemented during the questionnaire redesign on data quality and statistical burden.

2. Background

Research and Development (R&D) is universally recognised as an engine of economic growth and societal challenges. However, to be a powerful force for socio-economic development, it needs effective policies based on reliable indicators of R&D inputs, namely personnel and expenditure. To this aim, Istat has conducted yearly surveys on R&D since the 1960s, in compliance with the Frascati Manual (OECD, 2015)[2]. The Italian survey provides data on expenditure and personnel involved in R&D activities at time t, as well as preliminary data at time t+1 and t+2. As a census-based survey, the target population comprises around 39,000 Italian active enterprises that could potentially perform R&D[3]. Data is collected through an online self-completed questionnaire, available on the Istat Business Statistical Portal.

The survey's key variables are the personnel and expenditure[4] involved in R&D activities performed within a reporting unit (i.e. intramural activity). Additionally, the survey captures other expenditure aspects such as R&D funding, the functional distribution of R&D resources (basic research versus applied research and experimental development), the industries likely to be making use of the R&D results, and extramural R&D expenditure (R&D performed outside the statistical unit). The measurement of R&D personnel involves two key sets of variables: number of persons involved in R&D in headcounts and in full-time equivalent, since R&D may be a part-time activity and not necessarily involve R&D personnel on a full-time basis[5]. In recent years, the survey has faced significant issues:

- a progressively decreasing response rate;

[2] The Frascati Manual has evolved through seven editions since its initial publication and it is nowadays the de facto R&D reference document across countries at different stages of economic development.

[3] The main statistical sources used to define the potential R&D performers are the official Italian business Register and the inventory of the enterprises claiming tax relief for R&D activities and projects (from the Italian Agency for fiscal revenues of the Ministry of Economy).

[4] Intramural R&D expenditures are all current expenditures (including labour and other costs) plus gross fixed capital expenditures (such as for land, buildings, machinery and equipment) for R&D performed within a statistical unit during a specific reference period, whatever the source of funds" (Frascati Manual, 2015).

[5] The survey covers both persons employed and external R&D personnel.

- several sources of inaccuracy, including routing errors, inconsistencies, and outliers. The most concerning issue in recent years has been the misuse of the unit of measurement in the R&D expenditure report, where euros were used instead of thousands of euro;
- a growing response burden, due to an excessively long and demanding questionnaire. Quantitative variables and complex concepts behind the survey make the core questionnaire overly burdensome for respondents, especially for the large and more complex enterprises.

To handle these issues, a huge questionnaire redesign was undertaken.

3. Innovations in the questionnaire design

In 2023, a major redesign of the questionnaire was implemented to address the problem of declining response rates and increasing dropout observed in recent years, as well as to enhance the quality of the data collected. Substantial changes were made to shorten the questionnaire and enhance its user-friendliness. To minimise incorrect responses in quantitative questions, the totals of the main distributions, which are automatically computed, are now submitted to the respondents for validation (Figure 1).

Figure 1 – *Example of quantitative question and validation question from the 2023 questionnaire.*


B1.1 - Nel 2021 qual è stata la spesa in migliaia di Euro sostenuta dall'impresa per attività di R&S *INTRA-MUROS* per le seguenti voci economiche?

Indicare zero per le spese non sostenute.
Indicare la spesa arrotondata alla cifra intera (esempio: per 135.543 euro inserire 136; per 135.473 euro inserire 135)

VOCE ECONOMICA	SPESA 2021 in migliaia di Euro
Spese per personale interno impegnato in R&S	
1. Ricercatori	50
2. Tecnici	75
3. Altro personale	0
Spese per il personale esterno	
4. Consulenti	0
10. Software	0
11. Diritti di brevetto industriale e diritti di sfruttamento di opere dell'ingegno	0
TOTALE	125

Il totale delle spese sostenute dall'impresa nel 2021 per le attività di R&S *INTRA-MUROS* risulta pari a 125.000 Euro. Lo conferma?

- ○ Confermo
- ○ Non confermo

Source: RS1 questionnaire. Year 2023.

Requesting an informed response helps reduce mistakes (Barcherini and Lorè, 2022). When data are confirmed as correct, they are captured by the questionnaire and used to populate auto-filled text, which is used as a reminder, and placed within or immediately below the subsequent questions. One of the most challenging issues with the questionnaire is the request for respondents to provide information on expenditure related to intramural R&D activities in thousands of euros, as mandated by EU regulation. In 2019 two versions of the questionnaire were created: one, requiring expenditure in euros, to facilitate the task for units with low economic performance, and another requiring expenditure to be reported in thousands of euros for those expected to have accounting records in thousands (Ceccarelli *et al.*, 2022). However, inconsistent data continued to be reported, with the most prevalent error being the use of euros instead of thousands. Consequently, in the 2023 another innovation was introduced to reduce mistakes in the unit of measurement usage. To make the respondents more aware of their responses, the total submitted to the respondent for validation now includes an auto-filled text that gives the total in full (in euros), even if the data entry is requested in thousands. In this way, any error in the use of the unit of measurement can be immediately identified by the respondent and corrected before continuing with the completion (Figure 1).

4. Assessing the impact of the questionnaire redesign

Descriptive analyses have been conducted to explore the relative variation from 2022 to 2023, in order to understand the impact of major measures implemented during the questionnaire redesign on data quality, completion behaviour, and respondents' perception of statistical burden. Different categories defined by enterprises' size or by the novelty in the survey involvement (first-time respondents vs. experienced respondents) have been compared. Data quality was further investigated by using a logistic model with the aim of examining the effects of the questionnaire redesign on the risk of misusing the measurement unit usage in the R&D expenditure. Additionally, the logistic model has enabled an analysis of the association between enterprise structural characteristics, objective burden, and perceived burden. The main results[6] are reported in the following paragraphs.

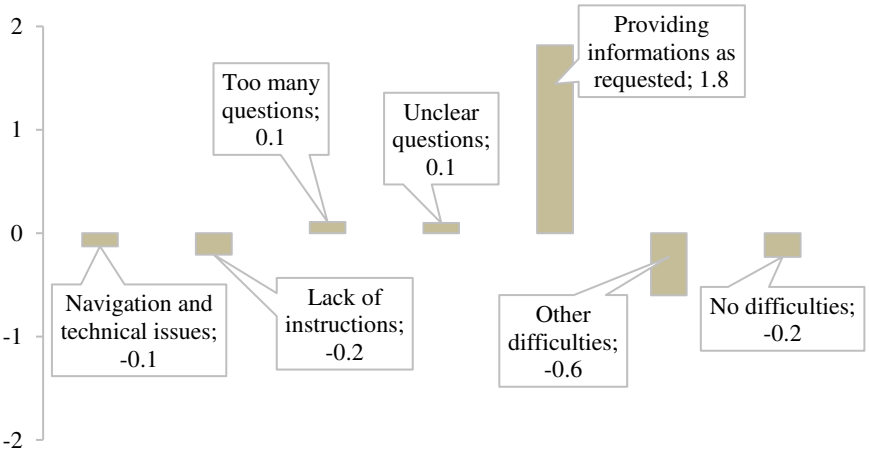
4.1 The impact of the questionnaire redesign on statistical burden

The burden experienced by respondents during questionnaire completion can negatively affect both response rate and data quality (Fricker *et al.* 2019). Responding to a statistical survey is indeed a burdensome task, with the perception of the burden influenced by factors such as questionnaire length, effort required to

[6] Results reported in this paper are elaborations from raw unweighted data.

retrieve information, and question clarity (Bradburn, 1978). Designing a questionnaire is likewise challenging, requiring the management of numerous aspects to minimize respondent stress during the task. The final section of the R&D questionnaire includes a question asking respondents about any difficulties they have experienced during the completion[7]. A comparison of responses to this question from 2022 and 2023 shows a reduction in technical difficulties with the questionnaire: navigation issues decrease from 12.7 percent to 11.1 percent (-0.1) and problems with insufficient instructions decrease from 11.6 percent to 9.2 percent (-0.2). Conversely, difficulties related to the content and structure of the questionnaire have increased. In particular, the difficulty to provide the information required increase from 10 percent to 28 percent (+1.8) (Figure 2).

Figure 2 – *Percentage variation of reported difficulties in questionnaire completion. Years 2022 and 2023.*



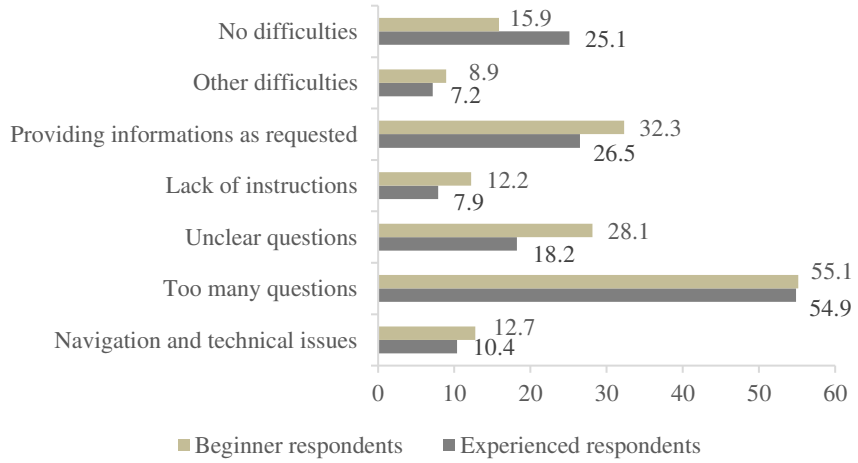
Source: ISTAT, Research and Development in business enterprises (RS1).

Further analysis compared the difficulties reported by first-time respondents with those of experienced respondents in 2023. The findings reveal that beginner respondents encounter more difficulties across all aspects considered (Figure 3), while experienced enterprises more often report no difficulties (25.1 percent vs. 15.9 percent). Previous experience thus seems to be a crucial factor in facilitating the respondents' task. Novice enterprises more frequently report unclear questions (28.1 percent vs. 18.2 percent), difficulties in providing information as required (32.3

[7] The question investigates the following items: difficulty in navigating the questionnaire, high number of questions, unclear questions, lack of instructions to support completion, difficulty in providing information required, other types of difficulties

percent vs. 26.5 percent), and a lack of instructions for completion (12.2 percent vs. 7.9 percent).

Figure 3 – D*ifficulties in questionnaire completion reported by beginner and experienced respondents. Year 2023. (% values).*



Source: ISTAT, Research and Development in business enterprises (RS1).

When enterprises of different sizes are compared, minimal differences in perceived burden are found. In 2023, units with up to 9 employees more frequently report navigation difficulties (13.1 percent compared to 11.1 percent of the total respondents), unclear questions (24.0 percent vs. 21.2 percent) and lack of instructions for completion (12.1 percent vs. 9.2 percent). Enterprises with 250 employees and above more often struggle with providing information as requested (32.3 percent compared to 28.2 percent of the total respondents). Those with 100 to 249 employees more frequently cite the high number of questions (59.5 percent compared to 54.9 percent of the total respondents) as main issue.

4.2 The impact of the questionnaire redesign on accuracy

The quality of data collected through a questionnaire is intrinsically related to the care taken in its design. A well-designed questionnaire can substantially reduce errors and enhance responses consistency (Brown, 2022), as shown by the analysis of changes in the accurate use of units of measurement between 2022 and 2023.

On the whole, the rate of errors in unit of measurement usage has decreased from 13.5 percent in 2022 to 9.2 percent in 2023. However, this overall figure conceals variations among different subpopulations. When focusing on the units that

responded to the survey in both 2022 and 2023, 88.8 percent maintained consistent performance, with 88.1 percent using the unit of measurement correctly in both years and 0.7 percent consistently using it incorrectly. Of those whose performance differed between the two years, 7.0 percent showed an improvement, while 4.2 percent exhibited a decline in their use of the unit of measurement.

Despite the substantial overlap between samples from one year to the next, there are always some new respondents each year (Table 1). Preliminary analyses indicate that units with prior survey experience benefit more from the questionnaire redesign than first-time participants, with experienced enterprises demonstrating a 48.3 percent enhancement in data quality compared to a 40.8 percent improvement among the new ones, regardless of the enterprise's size.

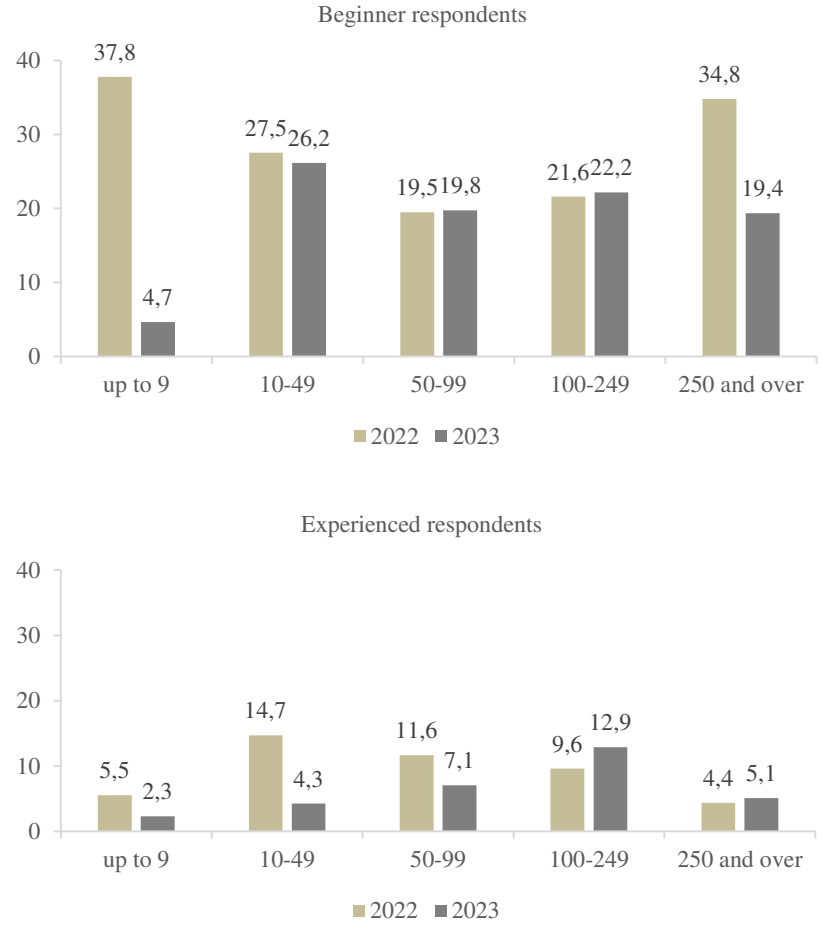
Table 1 – *Respondents in 2022 and 2023 by enterprise size and survey experience.*

Year	Enterprise size					Beginners	Experienced	Total
	Up to 9	10-49	50-99	100-249	250 and over			
2022	2639	5115	1535	1435	1214	1727	10211	11938
2023	3002	5174	1597	1534	1219	3714	8812	12526

However, enterprise size does matter. The redesign of the questionnaire had a different impact across various size classes, depending on whether the units were experts or novices (Figure 4). Under the previous questionnaire design, the smallest and the largest beginner enterprises made the most errors. In 2023, with the new questionnaire, the smallest and the largest newcomers were specifically the ones who outperformed their predecessors in the correct usage of the unit of measurement. Conversely, enterprises in the intermediate size classes, which previously made fewer errors, have maintained their performance largely unchanged. Among experienced respondents, the redesign has had a different effect. The distribution of errors, which previously was right-skewed, has now become left-skewed.

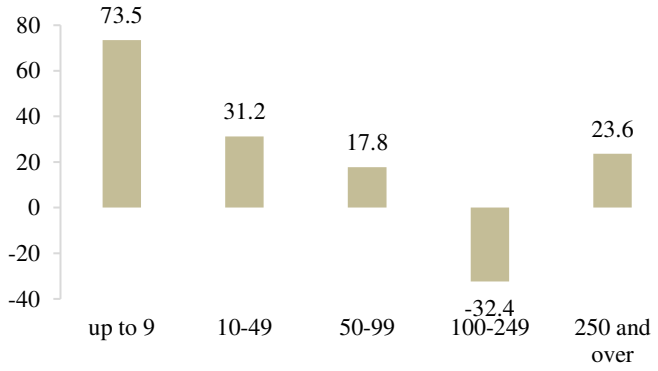
An analysis focusing on the units that responded to both the 2022 and 2023 surveys (Figure 5) reveals that the improvement in the use of measurement unit is the most pronounced among enterprises in the smallest size class. As the number of employees increases, this improvement becomes progressively less significant and disappears entirely in units with 100 to 249 employees. In this size class, a 32.4 percent deterioration was observed. However, the improvement in data quality is regained in the largest size class.

Figure 4 – *Experienced and beginner respondents misusing the unit of measurement in 2022 and 2023 by enterprise size (% values).*



Source: ISTAT, Research and Development in business enterprises (RS1).

Figure 5 – *Percentage variation from 2022 to 2023 in the accurate use of unit of measurement by enterprise size.*



Source: ISTAT, Research and Development in business enterprises (RS1).

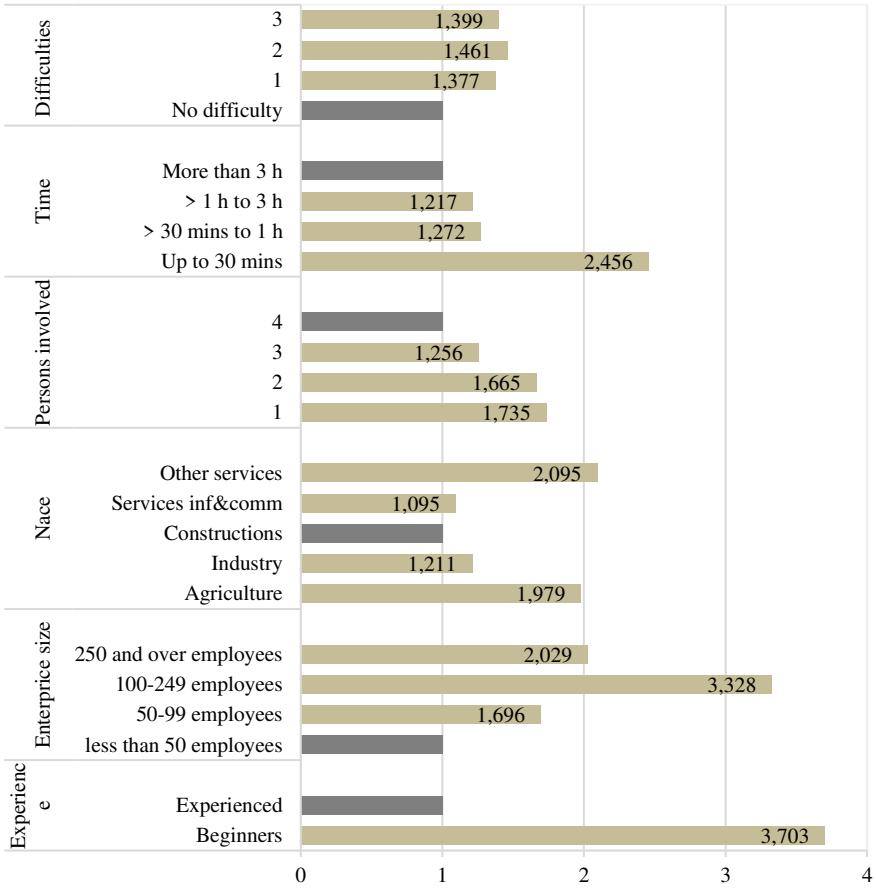
4.3 Factors influencing error occurrence in the unit of measurement usage: a Logistic Regression Analysis

A logistic model has been employed to investigate the quality with which the questionnaire was filled out and the association between enterprise structural characteristics, objective burden and perceived burden (Hosmer *et al.*, 2013).

The presence or absence of errors in the measurement unit usage has been defined as a binary dependent variable. The explanatory variables encompassed: i) structural characteristics, including enterprise size, NACE (Nomenclature of Economic Activities), and previous experience with the survey; ii) objective burden, measured by the time spent and the number of individuals involved in the data preparation before the questionnaire completion; iii) perceived burden, indicated by the number of difficulties reported during the questionnaire completion, and iv) core information, represented by intensity of research and development activities, namely the ratio between the expenditure incurred and the number of researchers involved (Figure 6).

A stepwise procedure has been applied. The only non-significant variable is the intensity of research and development activities. The variable most predictive of errors occurrence is the lack of experience, that is participating in the survey for the first time, whereas NACE is the least predictive variable.

Figure 6 – *Probability of misusing the measurement unit. Odds ratio. Year 2023.*



Source: ISTAT, Research and Development in business enterprises (RS1).

Beginner enterprises are 3.7 times more likely to misuse the unit of measurement than experienced ones, indicating that experience in completing the questionnaire facilitates accuracy and that recent changes have not negatively affected this gained experience. Regarding enterprise size, using the class with less than 50 employees as a reference category, the highest risk of inaccuracy is observed in enterprises with 100 to 249 employees, which have a 3.3 times higher risk. As the time spent collecting and preparing data to enter into the questionnaire increases, the risk of error decreases. Respondents who take less than half an hour to perform these operations have a 2.5 times higher risk of error compared to those who take more than 3 hours, while those who take 1 to 3 hours have a 1.2 times higher risk. Taking enterprises in the construction sector as the reference category, those in the

agriculture sector have a 1.9 higher risk, and those in the industrial sector have a 1.2 higher risk.

5. Discussion

When designing the methodological features of a questionnaire, the respondent must be the primary focus. By paying attention to the content, wording and format of questions, we can reasonably ensure a reduction in statistical burden, an improvement in data quality, and potentially an increased willingness of respondents to participate in surveys (Barcherini *et al.,* 2022). However, each questionnaire is unique (Convers and Presser, 1986) and presents its own challenges, particularly quantitative ones, which can be demanding for both respondents and designers.

Likewise, respondents are not homogeneous; they vary in structural characteristics and response strategies. Unlike prior studies that evaluated the overall performance of the responding companies without examining underlying differences (Ceccarelli *et al.,* 2022), the case study discussed highlights this variability, showing that design choices can improve the experience for some respondents while worsening it for others. For instance, the accuracy of measurement unit use varies with enterprise size. As enterprise size increases, this accuracy improvement diminishes and then plummets in the 100-249 size class. This trend suggests that performance depends on the balance between the task difficulty and the resources available to address it. As the size of an enterprise increases, the complexity of the calculations required to complete the questionnaire also increases. However, the ability to manage this complexity does not scale proportionately, resulting in a gradual decline in accuracy improvement. The sharp decline in performance in the 100-249 size class indicates a breakdown in the balance between task difficulty and the respondents' ability. Larger firms regain this balance thanks to better resources and expertise, which allow them to cope with extreme complexity.

Therefore, continuing to think generically in terms of business questionnaires, or generalising questionnaire design based on the simplistic dichotomy (short forms for small enterprises and long forms for medium and large ones) that is often used to reduce the burden of the business surveys (Istat, 2024) does not seem to be the most effective strategy.

It is reasonable to assume that each questionnaire has a unique breaking point in terms of the difficulty-ability balance, which depends on both its features and respondents' characteristics. Identifying this breaking point is crucial for optimizing design choices to accommodate most respondents. At the same time, it is essential to envision differentiated design solutions tailored to respondents' diverse needs. This requires testing and integrating quantitative methods with qualitative techniques to understand the challenges faced by different respondents and to create increasingly customized solutions.

References

BARCHERINI S., LORÈ B.M.R. 2022. Questionnaire Design as a Tool to Enhance Data Quality in the Italian Census of Agriculture. In: *Book of abstract of ISBIS Conference 2022 on Statistics and Data Science in Business and Industry.*

BARCHERINI S., BONTEMPI K., FAZZI G., LIANI S., LORE' B., PIETROPAOLI S., ROSATI S. 2022. The respondent ad the focus of the questionnaire design, In *UNECE Expert Meeting on Statistical Data Collection 2022*, 26-28 October, Italy.

ISTAT. 2024. *Le innovazioni nella rilevazione multiscopo qualitativa del censimento delle imprese - anno 2022*. Roma: Istat.

BRADBURN N. 1978. Respondent Burden. Proceedings of the Survey Research Methods Section of the American Statistical Association, pp. 35-40.

BROWN T. 2022. The Art of Questionnaire Design, *Journal of Survey Research*, Vol. 15, No. 4, pp 234-256.

CECCARELLI C., FAZZI G., PIETROPAOLI S. 2022. Evaluation of Changing in Respondents' Participation in the Surveys of Information and Communication Technologies Usage in Enterprises (ICT) and Research and Development for Business Enterprises (R&D), *RIEDS*, Vol. 76, No. 1, pp. 107-118.

CONVERSE J. M., PRESSER S. 1986. *Survey Questions: Handcrafting the Standardized Questionnaire.* Beverly Hills: Sage Publications.

FRICKER., YAN T., TSAI S. 2019. Response Burden: What Predicts It and Who is Burdened Out? In BEATTY P., COLLINS D., KAYE L., PADILLA L., WILLIS G., WILMOT A. (Eds) *Advances in Questionnaire Design, Development, Evaluation and Testing*, chapter 8, New York: John Wiley & Sons, Inc.

HOSMER JR D. W., LEMESHOW S., STURDIVANT R. X. 2013. *Applied logistic regression*. Hoboken: John Wiley & Sons.

OECD. 2015. *Frascati Manual 2015: Guidelines for Collecting and Reporting Data on Research and Experimental Development*. Paris: OECD Publishing.

WILLIMACK D. K., LYBERG L. E., MARTIN J., JAPEC L., WHITRIDGE P. 2004. Evolution and Adaptation of Questionnaire Development, Evaluation, and Testing Methods for Establishment Surveys. In PRESSER S. et al. (Eds.) *Methods for Testing and Evaluating Survey Questionnaires*, Hoboken, NJ: Wiley-Interscience, pp. 385- 407.

Sabrina BARCHERINI, Istat, barcheri@istat.it
Barbara Maria Rosa LORÈ, Istat, lore@istat.it
Valeria MASTROSTEFANO, Istat, mastrost@istat.it
Simona ROSATI, Istat, srosati@istat.it

SOCIETÀ E RIVISTA ADERENTI AL SISTEMA ISDS
ISSN ASSEGNATO: 0035-6832

Direttore Responsabile: CHIARA GIGLIARANO

Iscrizione della Rivista al Tribunale di Roma del 5 dicembre 1950 N. 1864

Associazione all'Unione Stampa Periodica Italiana

TRIMESTRALE

La copertina è stata ideata e realizzata da Pardini, Apostoli, Maggi p.a.m.@tin.it – *Roma*

Stampato da CLEUP sc
"Coop. Libraria Editrice Università di Padova"
Via G. Belzoni, 118/3 – Padova (Tel. 049/650261)
www.cleup.it

ATTIVITÀ DELLA SOCIETÀ

A) RIUNIONI SCIENTIFICHE

XXXVII	La mobilità dei fattori produttivi nell'area del Mediterraneo (Palermo, 15-17 giugno 2000).
XXXVIII	Qualità dell'informazione statistica e strategie di programmazione a livello locale (Arcavacata di Rende, 10-12 maggio 2001).
XXXIX	L'Europa in trasformazione (Siena, 20-22 maggio 2002).
XL	Implicazioni demografiche, economiche e sociali dello sviluppo sostenibile (Bari, 15-17 maggio 2003).
XLI	Sviluppo economico e sociale e ulteriori ampliamenti dell'Unione Europea (Torino, 20-22 maggio 2004).
XLII	Sistemi urbani e riorganizzazione del territorio (Lucca, 19-21 maggio 2005).
XLIII	Mobilità delle risorse nel bacino del Mediterraneo e globalizzazione (Palermo, 25-27 maggio 2006).
XLIV	Impresa, lavoro e territorio nel quadro dei processi di localizzazione e trasformazione economica (Teramo 24-26 maggio 2007).
XLV	Geopolitica del Mediterraneo (Bari, 29-31 maggio 2008).
XLVI	Povertà ed esclusione sociale (Firenze 28-30 maggio 2009).
XLVII	Un mondo in movimento: approccio multidisciplinare ai fenomeni migratori (Milano 27-29 maggio 2010).
XLVIII	150 anni di Statistica per lo sviluppo del territorio: 1861-2011. (Roma 26-28 maggio 2011).
XLIX	Mobilità e sviluppo: il ruolo del turismo. (San Benedetto del Tronto, 24-26 maggio 2012).
L	Trasformazioni economiche e sociali agli inizi del terzo millennio: analisi e prospettive (Università Europea di Roma, 29-31 maggio 2013).
LI	Popolazione, sviluppo e ambiente: il caso del Mediterraneo (Università Federico II di Napoli, 29-31 maggio 2014).
LII	Le dinamiche economiche e sociali in tempo di crisi (Università Politecnica delle Marche, 28-30 maggio 2015).
LIII	Mutamento economico e tendenze socio-demografiche tra sfide e opportunità (Università degli Studi Internazionali di Roma, 26-28 maggio 2016).
LIV	Mobilità territoriale, sociale ed economica: modelli e metodi di analisi (Università degli Studi Internazionali di Catania, 25-26 maggio 2017).
LV	Coesione sociale, welfare e sviluppo equo e sostenibile (Università degli Studi dell'Insubria, Varese 24-25 maggio 2018).
LVI	Benessere e Territorio: Metodi e Strategie (Università Politecnica delle Marche, Ascoli Piceno 23-24 maggio 2019).

LVIII Tra marginalità e sviluppo. La sfida della sostenibilità in una prospettiva mediterranea (Università LUMSA, Palermo, 26-27 maggio 2022).

LIX Aspetti economici e sociali dell'invecchiamento demografico (Università degli Studi di Napoli Federico II Napoli, 25-26 maggio 2023).

LX Salute, ambiente e disuguaglianze: istituzioni, imprese e società (Università degli studi di Milano – Bicocca & LIUC - Università Cattaneo, Milano & Castellanza (VA), 22-24 maggio 2024).