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

INDICE

UNHEALTHY AGEING OF IMMIGRANTS:
CURRENT UNDERSTANDING AND FUTURE DIRECTIONS

Silvia Loi

Abstract. Migration and population ageing have been two primary drivers of demographic change in Europe over the past few decades. While immigrant populations in Europe remain relatively young compared to non-immigrant populations, they are ageing, particularly in countries with a longer history of immigration. The ageing process exposes immigrants to greater health risks associated with frailty, highlighting the urgent need to understand the individual, structural, and systemic determinants that may place immigrants on a different health trajectory than non-immigrants. Addressing this challenge is crucial to improving the quality of life and health outcomes for ageing immigrants, and ensuring that they receive the necessary care and resources to manage and mitigate the impacts of population ageing on their frailty and health. This paper explores the current understanding of the unhealthy ageing of immigrants, shedding light on their increasing frailty over the life course, and offers insights into future research directions in the field.

1. Introduction and background

According to Eurostat data, the foreign-born population aged 50+ living in Europe has increased significantly in the last decade, albeit with some differences across countries. Figure 1 shows the proportions of individuals born abroad in selected European countries in the years 2013 and 2023. Overall, in all of the considered countries – Denmark, Germany, Spain, France, Italy, the Netherlands, Finland, and Sweden – the proportion of individuals born abroad increased between 2013 and 2023. In Denmark, Spain, Italy, the Netherlands, Finland, and Sweden, the proportion of the population born abroad increased by between three and four percentage points. In France, the increase was considerably smaller, at around one percentage point, while in Germany, it was significantly larger, at seven percentage points, with the proportion rising from 11% in 2013 to 18% in 2023.

Figure 1 – *Proportion of foreign-born individuals aged 50+ over the total population of the same age in selected European countries. 2013-2023.*
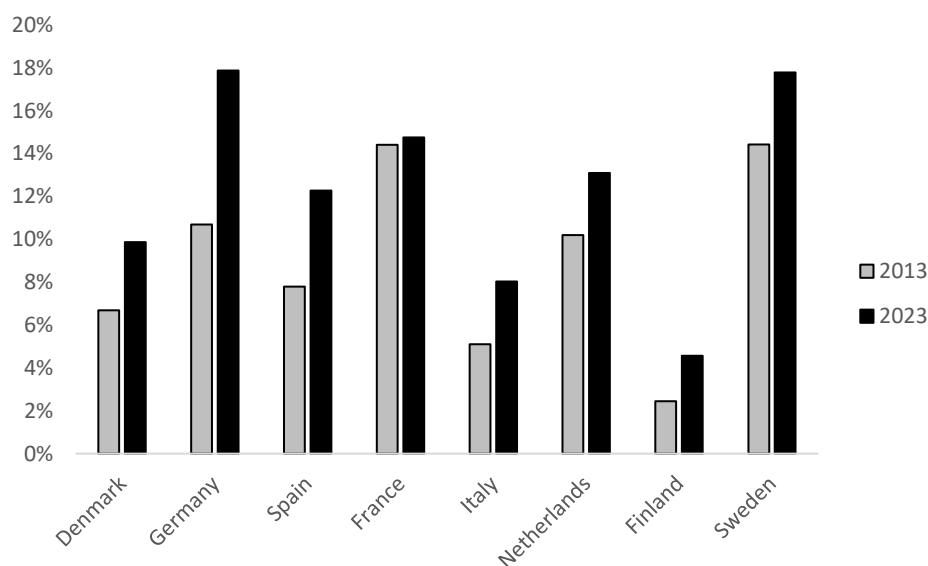
Over the same period, the share of the foreign-born population aged 50+ increased more than the share of the foreign-born population aged 65+ across most of the studied countries (see Figure 2 in the Appendix). Germany was an exception, with the share of the population born abroad aged 65+ being notably higher, rising 11 percentage points from 7% in 2013 to 18% in 2023. The smaller increases in the foreign-born population aged 65+ observed in the other countries may indicate lower baseline values, fewer newly arrived older immigrants, or younger immigrant demographic profiles. Nevertheless, there is clear evidence of the presence of an ageing immigrant population across the studied countries. This demographic trend towards an increasing share of foreign-born older individuals in the population can be attributed to at least two different factors: the ageing process of immigrants who arrived in past decades, and more recent immigrants arriving at older ages.

These differences highlight the heterogeneous patterns of the ageing process of the foreign-born population across European countries. It is important to note that these figures are based on a rather broad categorisation of immigration linked to the

place of birth, which can include not only individuals with a migration background who were born in their country of origin, but also individuals who were born abroad due to particular circumstances at the time of their birth, but whose family does not have a migration background. For instance, some foreign-born individuals are the children of native-born nationals who were living abroad for a limited time only, gave birth in a foreign country, and returned to their country of origin with their children. However, albeit imperfect, these figures are consistent with the evidence of an ongoing ageing process among immigrants reported in the literature (Ciobanu et al. 2020).

As immigrant populations grow older, the question of whether they are at greater risk of frailty and heightened health vulnerability may be raised. At the individual level, chronic and functional health as well as cognitive functions decline with age, leading to a general increase in physical and psychological vulnerability (Deary et al. 2009; Salthouse 2009). However, the age profiles of poor health can develop very differently depending on the context (Kowal et al. 2012), e.g., the place of birth, which is an indicator of migration background.

Immigrants are a socially vulnerable population due to several socio-economic and health-related factors (De Jong and Madamba 2001). As immigrants age in their receiving countries, they may have diverse health needs and face specific challenges due to their cultural backgrounds and previous experiences with different healthcare systems (Razum and Spallek 2014). Language barriers (Kreps and Sparks 2008) and the long-term consequences of adversities experienced during their life course (Leopold, Leopold, and Lechner 2017; Loi, Li, and Myrskylä 2024) can also contribute to these challenges. This is particularly likely to be the case for immigrants who are from poorer socio-economic areas or have fled conflicts or political instability. These challenges can make it more difficult for immigrants to access timely and adequate medical care.

Immigrants are also more socio-economically vulnerable than their non-immigrant counterparts. For instance, they are more likely to be employed in low-income jobs and to experience job insecurity and poor working conditions (Orrenius and Zavodny 2013). Thus, immigrants may have higher levels of stress, which are linked to poorer health (Hämmig and Bauer 2013; Burgard and Lin 2013). Additionally, social isolation, discrimination, and limited social support networks may exacerbate immigrants' social vulnerability, especially among those who have recently arrived (Puyat 2013).

However, despite these social and economic vulnerabilities, there is considerable evidence that, paradoxically, on average immigrants tend to have exceptionally high levels of health, often better than those of the local population (Jasso and Massey 2004; Ichou and Wallace 2019; Loi and Hale 2019). One of the strongest explanations for why this might be the case is related to the complex selection

mechanisms associated with the migration process. However, these selection effects do not last indefinitely. Indeed, this immigrant health advantage tends to erode or even vanish as the duration of stay in the receiving country increases, resulting in the health status of immigrants converging with that of non-immigrants (Loi and Hale 2019; Antecol and Bedard 2006). There are several interconnected mechanisms driving this health convergence, including acculturation, negative assimilation, and prolonged exposure to poor socio-economic conditions (Lechner and Mielck 1998; Palloni and Arias 2004; Ronellenfitsch and Razum 2004).

A question in immigrant health research that requires further investigation is how the health profiles of immigrants develop over the life course after they converge with those of the non-immigrant population. Moreover, a deeper understanding of the factors that drive this change is needed. There is evidence of a crossover of the health trajectories of immigrants and non-immigrants, which underlines a more rapid ageing process among the immigrant population (Loi and Hale 2019; Loi, Li, and Myrskylä 2024; 2025). Recently, more attention has been paid to structural factors and their interplay with individual-level characteristics in an effort to explain how both exposures at the individual level and the social structures in which individuals are embedded contribute to the dynamics of immigrant health (Loi, Li, and Myrskylä 2024; 2025).

In this context, some of the most pressing scientific and societal questions that arise include the following: Are immigrants ageing in good health? Are they able to preserve their initial health capital over their life course in the receiving country? If not, what are the main drivers of the changes in immigrants' health over the life course, and what are the mechanisms behind immigrants' unhealthy ageing? Is there an interplay between individual-level determinants and structural factors that relate to the inequities in the distribution of resources?

2. Theoretical framework

The complex questions raised so far would suggest the need for a unified theoretical framework to address immigrant health. However, a framework for studying the deterioration of immigrants' health has yet to be developed. Useful tools that are well known in the demographic, population health, and socio-epidemiological literature include the life course approach (Kuh et al. 2013; Elder and Kirkpatrick Johnson 2003; Elder 1975) and the intersectional perspective (Crenshaw 1989; Hämmig and Bauer 2013; Bauer 2014; Kapilashrami and Hankivsky 2018; Bauer et al. 2021). The life course perspective is at the core of the most recent approaches to studying the socio-economic determinants of health, and the intersectional perspective is increasingly used to frame research on health

inequalities. Why are these two significant theoretical frameworks relevant to the study of immigrants' health deterioration?

Taking a life course perspective is essential in migration studies (Jürgen Flöthmann 1993; Wingens et al. 2011), particularly when addressing the interplay of migration and health (Spallek, Zeeb, and Razum 2011). The life course approach provides a comprehensive framework for understanding how various stages of individuals' lives interact with their migration experiences to influence their health outcomes. This perspective emphasises the importance of considering the timing and sequence of life events, including, whenever possible, pre-migration conditions, the migration process itself, and post-migration experiences. By examining the cumulative effects of these experiences over time (DiPrete and Eirich 2006), researchers can better understand the long-term consequences of immigrants' life histories for their health trajectories. This approach also highlights critical periods, such as childhood or early adulthood, when migration might have particularly significant impacts on health. Additionally, the life course perspective can shed light on how structural factors, such as socio-economic status, access to healthcare, and social support, change and interact with individual health behaviours across the lifespan.

Intersectionality is a framework for understanding how various social identities, such as race, gender, class, sexuality, and disability, intersect and interact to create unique experiences of oppression and privilege. The intersectional framework was first introduced by legal scholar Kimberlé Crenshaw in the late 1980s (Crenshaw 1989). Intersectionality aims to reveal how social positions interact at the individual level to reflect interlocking systems of power at the structural and systemic levels (Crenshaw 1989; Bauer 2014; Bauer et al. 2021). This framework emphasises that individual experiences of discrimination and marginalisation cannot be fully understood by examining each identity and social position in isolation. For example, the experiences of Black women in the United States cannot be fully understood by examining race and gender separately; rather, the interconnected nature of these identities shapes their specific challenges and opportunities (Crenshaw 1989). This framework is crucial for recognising and addressing the complex and cumulative impacts of systemic inequality, and for developing more inclusive and effective policies and practices.

In migration studies, and especially in immigrant health research, the intersectionality framework allows researchers to consider how several social identities and power structures intersect to shape the experiences and health outcomes of immigrants. This approach recognises that individual-level factors, such as migration background, gender, socio-economic status, age, and legal status, interact in complex ways, reflecting the disparities in the opportunities available to immigrants and non-immigrants at the societal and the structural level (Bauer 2014).

By taking these intersecting identities into account, researchers can uncover the layered and compounded forms of discrimination and disadvantage that immigrants may face, which are often masked in analyses that focus on a single axis of identity.

The complex interplay of these factors creates a multidimensional system of disadvantage that contributes to health inequalities across populations. Moreover, in immigrant health research, particular attention should be paid to the intersection of complex social identities with life course events, as experiencing different sets of critical life events over the life course may disproportionately harm immigrants, who are already at higher risk of poor health due to their social frailty and vulnerability (Loi, Li, and Myrskylä 2024).

3. Previous evidence in the literature and descriptive insights

Despite being a vulnerable and socio-economically frail population, immigrants' health status, especially shortly after their arrival, tends to be much higher than that of the local population, which points to an interesting epidemiological paradox (Jasso and Massey 2004). The evidence indicates that, on average, immigrants have better health profiles than non-immigrants – e.g., a reduced risk of developing chronic conditions, a lower likelihood of having physical limitations, better self-rated health (Caselli, Loi, and Strozza 2017; Loi and Hale 2019), and lower mortality (Caselli, Loi, and Strozza 2017) – across a wide range of socio-cultural contexts, including the US, Canada, Australia, and Europe (Trovato 2017). The main hypothesis used to explain this paradoxical evidence is that of the healthy immigrant effect, which posits that, on average, it is the healthiest and strongest individuals who successfully engage in the migration process, while the most frail individuals are left behind (Jasso and Massey 2004).

However, it has also been observed that this immigrant health advantage tends to erode relatively quickly, and largely disappears within approximately 10 years of arrival (Loi and Hale 2019). Due to this rapid erosion of their health status, immigrants are at risk of ageing in poorer health than non-immigrants. Research for Europe shows that immigrants' health status declines more rapidly at older ages than that of non-immigrants (Jang et al. 2023; Loi, Li, and Myrskylä 2024; 2025). Studies also indicate that older immigrants have higher rates of depression poorer self-rated health, and more chronic conditions compared to their non-immigrant counterparts (Aichberger et al. 2010; Reus-Pons et al. 2018; Jang et al. 2023; Loi, Li, and Myrskylä 2024; 2025).

Table 1 shows the percentage distribution of individuals aged 50+ with poor self-rated health, chronic conditions, limitations, and poor mental health across

participating states[1] for the years 2004-2022 based on SHARE data. Self-rated health is assessed by asking: "Would you say your health is excellent, very good, good, fair, poor?" Self-rated health is recoded such that poor health equals fair and poor. Chronic illness is measured by asking: "Some people suffer from chronic or long-term health problems. By chronic or long-term we mean it has troubled you over a period of time or is likely to affect you over a period of time. Do you have any such health problems, illness, disability or infirmity? Yes or no?" Limitations are assessed by asking: "For the past six months at least, to what extent have you been limited because of a health problem in activities people usually do? Severely limited, limited or not limited?" Limitations are recoded such that severely limited or limited means that the individual has at least one limitation. Self-rated mental health is measured by asking: "In the last month, have you been sad or depressed? Yes or no?" Immigration background is based on the question: "Were you born in (country of residence where the interview took place)? Yes or no?" No means that the respondent is an immigrant, while yes indicates that the respondent is not an immigrant.

Despite the healthy immigrant effect, when we look at the older immigrant population (aged 50+) we see that these individuals face significant challenges in preserving the health advantage observed among younger and recently arrived immigrants (Table 1). It is evident that older immigrants have a health disadvantage, and that this disadvantage is particularly pronounced among immigrant women. Indeed, among women, the prevalence of poor self-reported health is roughly 10 percentage points (+/- 2 points) higher for immigrants than for non-immigrants, irrespective of age.

Among men, the differential between immigrants and non-immigrants tends to be smaller, though it increases with age, and reaches a similar value of roughly 10 percentage points above age 70. The disadvantage for the older immigrant population is consistent across health outcomes, including activity limitations, chronic conditions, and mental health. The more pronounced disadvantage among immigrant women is also observed across outcomes, although it is most notable in self-rated health.

---

[1] All countries that participate in SHARE are included in the pooled sample. Since wave 1: Austria, Belgium, Switzerland, Germany, Denmark, Spain, France, Greece, Italy, Netherlands, Sweden, Israel; since wave 2: Czech Republic, Ireland, Poland; since wave 4 (wave 3 is excluded from the analysis): Estonia, Hungary, Portugal, Slovenia; since wave 5: Luxemburg; since wave 6: Croatia; since wave 7: Bulgaria, Cyprus, Finland, Latvia, Lithuania, Malta, Romania, Slovakia. See https://share-eric.eu/data/data-documentation/waves-overview

Table 1 - *Proportion of individuals reporting poor self-rated health, chronic conditions, limitations, and poor mental health. European countries included in SHARE data, population aged 50+ by migration background and sex.*

		Women		Men	
	Age	**Immigrant**	**Non-immigrant**	**Immigrant**	**Non-immigrant**
Poor self-rated health	50-54	34.4%	24.4%	27.2%	23.3%
	55-59	38.2%	29.6%	33.9%	28.6%
	60-64	41.8%	32.0%	40.8%	31.8%
	65-69	46.2%	36.7%	40.9%	33.7%
	70-74	56.2%	44.9%	47.7%	40.6%
	75-79	63.8%	53.6%	56.0%	47.4%
	80+	70.8%	62.3%	64.6%	55.7%
Chronic conditions	50-54	45.2%	38.9%	40.5%	37.6%
	55-59	49.4%	42.6%	45.8%	44.0%
	60-64	55.6%	53.9%	48.9%	48.3%
	65-69	59.2%	54.7%	53.4%	50.5%
	70-74	64.6%	60.6%	58.8%	55.0%
	75-79	72.1%	64.2%	63.7%	59.3%
	80+	73.8%	71.2%	67.5%	63.1%
Limitations	50-54	39.8%	33.3%	32.1%	30.1%
	55-59	42.9%	38.3%	36.0%	35.7%
	60-64	48.0%	41.1%	42.2%	39.8%
	65-69	51.3%	45.8%	43.7%	41.9%
	70-74	58.0%	52.8%	51.6%	47.8%
	75-79	67.7%	61.4%	59.2%	54.0%
	80+	76.2%	72.6%	70.6%	65.0%
Mental health	50-54	52.6%	45.6%	37.8%	33.2%
	55-59	52.8%	46.5%	38.6%	32.3%
	60-64	50.5%	44.9%	36.0%	30.0%
	65-69	51.8%	46.6%	32.8%	28.8%
	70-74	55.6%	48.5%	34.9%	30.3%
	75-79	55.2%	51.7%	37.3%	32.7%
	80+	60.0%	53.8%	41.4%	37.0%

Data source: SHARE waves 1-9 (pooled, excluding wave 3; wave 3 focused on people's life histories (SHARELIFE) and collected very different information than the regular waves).

The literature has identified several hypotheses explaining these health disparities between older immigrants and non-immigrants (Monserud 2019): the ageing-as-leveller hypothesis, which posits that health inequalities decrease at older ages due to the general worsening of health across all social groups; the persistent inequality hypothesis, which suggests that inequalities remain constant throughout life regardless of age; and the cumulative disadvantage hypothesis, which argues that socio-economic disadvantages accumulate over the life course, exacerbating health inequalities between immigrants and non-immigrants in later life.

Evidence for the cumulative disadvantage hypothesis has been found (Brown 2018; Loi, Li, and Myrskylä 2024). It has, for example, been observed that despite benefiting from a clear health advantage at younger ages, immigrants age in poorer health across societal contexts, and along a variety of health dimensions, including self-reported general health, disability, chronic morbidity and physical functioning (Jang et al. 2023; Loi, Li, and Myrskylä 2024; 2025).

The health of immigrants is influenced by a series of interconnected factors. Age at migration can contribute significantly to health outcomes, as younger migrants may adapt to environmental changes better than older migrants (Gubernskaya 2015). The length of stay in the receiving country can also impact health status, with longer durations associated with more rapid health deterioration (Loi and Hale 2019; Wallace, Khlat, and Guillot 2019). The country of origin and place of birth can reflect differing disease prevalence and health practices (Jang et al. 2024). The immigrant generation can also impact health, with first-generation immigrants benefiting from a strong healthy immigrant effect, compared to subsequent generations (Loi et al. 2021).

The reason for migration is another crucial determinant. For instance, refugees may have experienced trauma prior to immigration, which could adversely affect their mental health. Moreover, refugees are often exposed to stressors such as uncertainty about their legal situation and the length of their residence permit, which can worsen their health outcomes, especially those related to mental health (Ellis et al. 2019; Vono de Vilhena and Loi 2020).

Discrimination is another significant determinant, with racism and xenophobia contributing to anxiety and depression (Williams et al. 2019). Barriers to using the host country's health systems, such as language and cultural obstacles, can limit immigrants' access to care, and thus negatively affect their health (Terui 2017). In addition to individual characteristics and circumstances, events and experiences, especially adversities over the life course may have a differential impact on the health of immigrants and non-immigrants.

Indeed, immigrants are at higher risk of experiencing multiple adverse events over the life course. For instance, immigrants are more likely to have left family members behind in their origin countries, including very close family members, such

as spouses, children, and parents. In addition, immigrants are at higher risk of losing their job, face increased barriers to re-employment after losing their job, and are more likely to face discrimination. While such experiences can have negative effects on the health of individuals in the general population, they appear to be especially harmful to immigrants' health (Leopold, Leopold, and Lechner 2017; Loi, Li, and Myrskylä 2024). The cumulative effect of these adversities and stressors can lead to increased frailty and accelerated health decline at older ages. Moreover, pre-migration experiences, including exposure to traumatic events and adversities, can have long-lasting effects on immigrants' physical and mental health (Sangalang et al. 2019).

Figure 2 – *Major determinants of immigrant health over the life course.*

Age at migration	Length of stay	Accumulation of social
Generation	Reason of migration	disadvantage, adverse events
Place of birth	Exposure to stressors	and stressors over the previous
Reason of migration	Socioeconomic status	phases
Parental characteristics	Living conditions	Increased frailty
Traumas and adverse	Working conditions	Family history
events	Earnings	Bereavement
Discrimination	Family history	Discrimination
	Adverse events	
	Discrimination	
Childhood	Adulthood	Late adulthood

Individual life-course

Source: Author's elaboration

4. Future research directions

Future research on frailty as both a cause and a consequence of accelerated health decline in immigrants must adopt a comprehensive life course approach, incorporating an intersectional lens to adequately address the complexity of the interplay of the individual-level and structural-level determinants of immigrant health. The life course approach emphasises the significance of several life stages and transitions, recognising that health outcomes are shaped by cumulative experiences and exposures over time (Jones et al. 2019). For immigrants, this means considering the health impacts of pre-migration conditions, migration journeys, and post-migration environments.

An intersectional framework is essential to understanding how these intersecting identities influence health disparities within immigrant populations. For instance, a young woman fleeing conflict as a refugee may face different health challenges and vulnerabilities than an older man who voluntarily migrates for employment opportunities. The intersectionality approach helps to uncover these nuanced differences and the compounded effects of various forms of discrimination and disadvantage. Taking a life course approach – while simultaneously considering the interplay of multiple intersecting identities, such as age, gender, socio-economic status, and country of origin – is essential when conducting immigrant health research.

To advance this field of study, there is a pressing need for high-quality longitudinal data that can capture health changes over time as a consequence of life events and circumstances specific to immigrants. Such data should track individuals from their pre-migration context through their migration journey and into their settlement in the host country. Longitudinal studies provide valuable insights into how specific events, such as traumatic experiences during migration or the stress of adapting to a new culture, contribute to frailty and health decline.

Moreover, large datasets with significant sample sizes are crucial to account for the heterogeneity within immigrant populations. Diverse samples are necessary to differentiate between various subgroups, considering factors such as age, sex, country of origin, reason for migration (e.g., voluntary vs forced migration), and socio-economic conditions. By studying samples reflecting a wide range of experiences, researchers can identify patterns and trends that might be obscured in smaller, less diverse samples.

Such comprehensive and detailed data collection would enable researchers to develop more targeted and effective interventions. Understanding the specific health needs and vulnerabilities of different immigrant subgroups can inform policies and programs aimed at preventing frailty and mitigating health decline. For example, tailored healthcare services that address the unique challenges faced by refugee populations or culturally sensitive health promotion programs that consider the backgrounds of various immigrant groups could significantly improve health outcomes.

The European Research Council (ERC) funded project titled "Immigrant-native health disparities: an intersectional approach" seeks to fill this knowledge gap by combining the life course approach and the intersectional perspective to uncover the complex mechanisms behind the unhealthy ageing of immigrants, and to disentangle the differences between the least and the most vulnerable groups. This project will improve our understanding of how structural factors intersect at the micro level to reflect interlocking systems of power at the societal level. Tackling the unresolved puzzle of the causes of the unhealthy ageing of immigrants is crucial, as immigrants

are entering older ages with an increased risk of developing health frailties, and levels of immigration to Europe are likely to rise in response to poverty, conflicts, and the climate crisis. Health disparities between immigrants and non-immigrants will affect a growing segment of the European population, and could become a pressing public health issue.

5. Appendix

Figure 3 - *Proportion of foreign-born individuals aged 65+ over the total population of the same age in selected European countries. 2013-2023.*
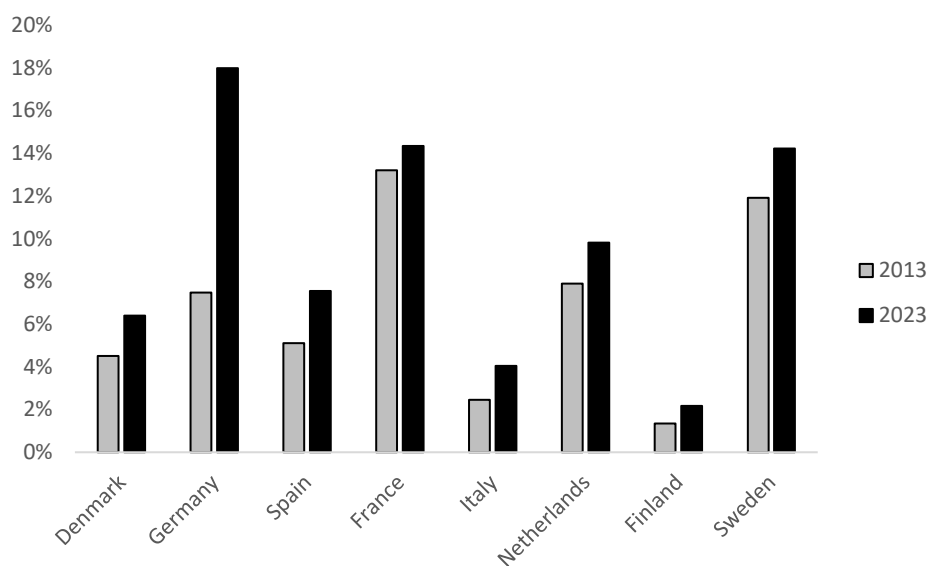
Source: Author's elaboration based on Eurostat data. Population on 1 January of each corresponding year.

Acknowledgements

References

AICHBERGER M. C., SCHOULER-OCAK M., MUNDT A., BUSCH M. A., NICKELS E., HEIMANN H. M., STRÖHLE A., REISCHIES F. M., HEINZ A., RAPP M. A. 2010. Depression in Middle-Aged and Older First Generation Migrants in Europe: Results from the Survey of Health, Ageing and Retirement in Europe (SHARE), *European Psychiatry,* Vol.25, No. 8, pp. 468–75. https://doi.org/10.1016/j.eurpsy.2009.11.009.

ANTECOL H., BEDARD K. 2006. Unhealthy Assimilation: Why Do Immigrants Converge to American Health Status Levels?, *Demography,* Vol. 43, No.2, pp. 337–60. https://doi.org/10.1353/dem.2006.0011.

BAUER G. R. 2014. Incorporating Intersectionality Theory into Population Health Research Methodology: Challenges and the Potential to Advance Health Equity, *Social Science & Medicine,* Vol. 110 (June), pp. 10–17. https://doi.org/10.1016/j.socscimed.2014.03.022.

BAUER, G. R., CHURCHILL S.M., MAHENDRAN M., WALWYN C., LIZOTTE D., VILLA-RUEDA A. A. 2021. Intersectionality in Quantitative Research: A Systematic Review of Its Emergence and Applications of Theory and Methods, *SSM - Population Health* , Vol. 14 (June):100798. https://doi.org/10.1016/j.ssmph.2021.100798.

BROWN T. H. 2018. Racial Stratification, Immigration, and Health Inequality: A Life Course-Intersectional Approach, *Social Forces*, Vol. 96, No.4, pp. 1507–1540. https://doi.org/10.1093/sf/soy013.

BURGARD, S. A., LIN K.Y. 2013. Bad Jobs, Bad Health? How Work and Working Conditions Contribute to Health Disparities, *American Behavioral Scientist,* Vol. 57 , No. 8, pp. 1105–27. https://doi.org/10.1177/0002764213487347.

CASELLI G., LOI S., STROZZA S.. 2017. Chapter 13: Migration, Health and Mortality in Italy: An Unfinished Story. In .

https://www.elgaronline.com/edcollchap/edcoll/9781785365966/9781785365966.00018.xml.

CIOBANU R. O., NEDELCU M., AMMANN E.S. VAN HOLTEN K. 2020. Intersections between Ageing and Migration: Current Trends and Challenges, *Swiss Journal of Sociology,* Vol. 46, No. 2, pp. 187–97. https://doi.org/10.2478/sjs-2020-0010.

CRENSHAW K. 1989. *Demarginalizing the Intersection of Race and Sex: A Black Feminist Critique of Antidiscrimination Doctrine, Feminist Theory and Antiracist Politics.*

DE JONG G. F., MADAMBA A.B. 2001. A Double Disadvantage? Minority Group, Immigrant Status, and Underemployment in the United States, *Social Science Quarterly,* Vol. 82 , No. 1, pp. 117–30. https://doi.org/10.1111/0038-4941.00011.

DEARY I. J., CORLEY J., GOW A.J., HARRIS S.E., HOULIHAN L.M., MARIONI R.E., PENKE L., RAFNSSON S.B., STARR J.M. 2009. Age-Associated Cognitive Decline, *British Medical Bulletin,* Vol. 92, No.1, pp. 135–52. https://doi.org/10.1093/bmb/ldp033.

DIPRETE T. A., EIRICH G.M. 2006. Cumulative Advantage as a Mechanism for Inequality: A Review of Theoretical and Empirical Developments, *Annual Review of Sociology,* Vol. 32 (Vol. 32, 2006), pp. 271–97. https://doi.org/10.1146/annurev.soc.32.061604.123127.

ELDER G. H. 1975. Age Differentiation and the Life Course, *Annual Review of Sociology* , Vol. 1, pp. 165–90.

ELDER G. H., and Johnson M.K. 2003. The Life Course and Aging: Challenges, Lessons, and New Directions*. In *Invitation to the Life Course*. Routledge. https://www.taylorfrancis.com/chapters/edit/10.4324/9781315224206-3/life-course-aging-challenges-lessons-new-directions-glen-elder-monica-kirkpatrick-johnson.

ELLIS B. H., WINER J.P., MURRAY K., BARRETT C. 2019. Understanding the Mental Health of Refugees: Trauma, Stress, and the Cultural Context. In PAREKH R. AND TRINH N.H.A. (Eds.) *The Massachusetts General Hospital Textbook on Diversity and Cultural Sensitivity in Mental Health,*. Cham: Springer International Publishing, pp. 253–73. https://doi.org/10.1007/978-3-030-20174-6_13.

GUBERNSKAYA Z. 2015. Age at Migration and Self-Rated Health Trajectories After Age 50: Understanding the Older Immigrant Health Paradox, *The Journals of Gerontology: Series B,* Vol. 70 , No. 2, pp. 279–90.

HÄMMIG O., BAUER G.F. 2013. The Social Gradient in Work and Health: A Cross-Sectional Study Exploring the Relationship between Working Conditions and Health Inequalities, *BMC Public Health*, Vol. 13, No.1: 1170. https://doi.org/10.1186/1471-2458-13-1170.

ICHOU M., WALLACE M. 2019. The Healthy Immigrant Effect: The Role of Educational Selectivity in the Good Health of Migrants, *Demographic Research*, Vol. 40, pp. 61–94.

JANG, S. Y., LOI S., VAN LENTHE F.J., OKSUZYAN A., MYRSKYLÄ M. 2024. Inequalities in Multimorbidity between Older Migrants and Natives across Europe, *WP-2024-003. 0 ed. Rostock: Max Planck Institute for Demographic Research*. https://doi.org/10.4054/MPIDR-WP-2024-003.

JANG, S. Y., OKSUZYAN A., MYRSKYLÄ M., VAN LENTHE F.J., LOI S. 2023. Healthy Immigrants, Unhealthy Ageing? Analysis of Health Decline among Older Migrants and Natives across European Countries, *SSM - Population Health*, Vol. 23 (September):101478. https://doi.org/10.1016/j.ssmph.2023.101478.

JASSO G., MASSEY D.S. 2004. Immigrant Health: Selectivity and Acculturation. *Working Paper 04/23. IFS Working Papers.* https://doi.org/10.1920/wp.ifs.2004.0423.

JONES N.L., GILMAN S.E., CHENG T.L., DRURY S.S., HILL C.V., GERONIMUS A.T. 2019. Life Course Approaches to the Causes of Health Disparities, *American Journal of Public Health,* Vol. 109, No.S1, pp. S48–55. https://doi.org/10.2105/AJPH.2018.304738.

JÜRGEN F. E. 1993. Migration and the Life Course, *Bulletin of Sociological Methodology*, Vol. 39, No.1. https://journals.sagepub.com/doi/abs/10.1177/075910639303900103.

KAPILASHRAMI A., HANKIVSKY O. 2018. Intersectionality and Why It Matters to Global Health, *The Lancet*, Vol. 391, No.10140, pp. 2589–91. https://doi.org/10.1016/S0140-6736(18)31431-4.

KOWAL P., CHATTERJI S., NAIDOO N., BIRITWUM R., FAN W., RIDAURA R.L., MAXIMOVA T., ET AL. 2012. Data Resource Profile: The World Health Organization Study on Global AGEing and Adult Health (SAGE), *International Journal of Epidemiology*, Vol. 41, No.6, pp. 1639–49. https://doi.org/10.1093/ije/dys210.

KREPS G. L., SPARKS L. 2008. Meeting the Health Literacy Needs of Immigrant Populations, *Patient Education and Counseling*, Translational Community-based Health Communication Interventions to Promote Cancer Prevention and Control for Vulnerable Audiences, Vol. 71, No. 3, pp. 328–32. https://doi.org/10.1016/j.pec.2008.03.001.

KUH D., COOPER R., HARDY R., RICHARDS M., SHLOMO Y.B. 2013. *A Life Course Approach to Healthy Ageing*. OUP Oxford.

LECHNER I., MIELCK A. 1998. Decrease in the 'healthy migrant effect': trends in the morbidity of foreign and German participants in the 1984-1992 Socioeconomic Panel, *Gesundheitswesen (Bundesverband der Arzte des Offentlichen Gesundheitsdienstes (Germany)),* Vol. 60 , No. 12, pp. 715–20.

LEOPOLD L., LEOPOLD T., LECHNER C.M. 2017. Do Immigrants Suffer More From Job Loss? Unemployment and Subjective Well-Being in Germany, *Demography,* Vol. 54, No. 1, pp. 231–57. https://doi.org/10.1007/s13524-016-0539-x.

LOI S., HALE J.M. 2019. Migrant Health Convergence and the Role of Material Deprivation, *Demographic Research*, Vol. 40, pp. 933–62.

LOI S., LI P., MYRSKYLÄ M. 2024. At the Intersection of Adverse Life Course Pathways: The Effects on Health by Migration Status, *Demography,* Vol. 61 , No.3, pp. 665–86. https://doi.org/10.1215/00703370-11314758.

LOI S., LI P., MYRSKYLÄ M. 2025. Unequal Weathering: How Immigrants' Health Advantage Vanishes over the Life-Course, *Journal of Migration and Health* Vol. 11 (January):100303. https://doi.org/10.1016/j.jmh.2025.100303.

LOI S., PITKÄNEN J., MOUSTGAARD H., MYRSKYLÄ M., MARTIKAINEN P. 2021. Health of Immigrant Children: The Role of Immigrant Generation, Exogamous Family Setting, and Family Material and Social Resources, *Demography,* Vol. 58, No. 5, pp. 1655–85. https://doi.org/10.1215/00703370-9411326.

MONSERUD M.A. 2019. Age Trajectories of Physical Health Among Older Adults of Mexican Descent: Implications of Immigrant Status, Age at Immigration, and Gender, *Journal of Aging and Health,* Vol. 31, No. 1., pp: 3–36. https://doi.org/10.1177/0898264317721823.

ORRENIUS P., ZAVODNY M. 2013. Immigrants in Risky Occupations. *Chapters*. Edward Elgar Publishing. https://econpapers.repec.org/bookchap/elgeechap/4026_5f11.htm.

PALLONI A., ARIAS E. 2004. Paradox Lost: Explaining the Hispanic Adult Mortality Advantage, *Demography,* Vol. 41, No.3, pp. 385–415. https://doi.org/10.1353/dem.2004.0024.

PUYAT J.H. 2013. Is the Influence of Social Support on Mental Health the Same for Immigrants and Non-Immigrants?, *Journal of Immigrant and Minority Health*, Vol. 15, No. 3, pp. 598–605. https://doi.org/10.1007/s10903-012-9658-7.

RAZUM O., SPALLEK J. 2014. Addressing Health-Related Interventions to Immigrants: Migrant-Specific or Diversity-Sensitive?, *International Journal of Public Health*, Vol. 59, No. 6, pp. 893–95. https://doi.org/10.1007/s00038-014-0584-4.

REUS-PONS M., MULDER C.H., KIBELE E.U.B., JANSSEN F. 2018. Differences in the Health Transition Patterns of Migrants and Non-Migrants Aged 50 and Older in Southern and Western Europe (2004–2015), *BMC Medicine*, Vol.16, No.1, p.57. https://doi.org/10.1186/s12916-018-1044-4.

RONELLENFITSCH U., RAZUM O. 2004. Deteriorating Health Satisfaction among Immigrants from Eastern Europe to Germany, *International Journal for Equity in Health*, Vol. 3, No. 1, p. 4. https://doi.org/10.1186/1475-9276-3-4.

SALTHOUSE T. A. 2009. When Does Age-Related Cognitive Decline Begin?, *Neurobiology of Aging*, Vol. 30, No. 4, pp. 507–14. https://doi.org/10.1016/j.neurobiolaging.2008.09.023.

SANGALANG C. C., BECERRA D., MITCHELL F.M., LECHUGA-PEÑA S., LOPEZ K., KIM I. 2019. Trauma, Post-Migration Stress, and Mental Health: A Comparative Analysis of Refugees and Immigrants in the United States, *Journal of Immigrant and Minority Health*, Vol. 21, No. 5, pp. 909–19. https://doi.org/10.1007/s10903-018-0826-2.

SPALLEK J. , ZEEB H., RAZUM O. 2011. What Do We Have to Know from Migrants' Past Exposures to Understand Their Health Status? A Life Course Approach, *Emerging Themes in Epidemiology*, Vol. 8, No. 1, p. 6. https://doi.org/10.1186/1742-7622-8-6.

TERUI S. 2017. Conceptualizing the Pathways and Processes Between Language Barriers and Health Disparities: Review, Synthesis, and Extension, *Journal of Immigrant and Minority Health*, Vol. 19, No. 1, pp. 215–24. https://doi.org/10.1007/s10903-015-0322-x.

TROVATO F. 2017. *Migration, Health and Survival: International Perspectives*. Edward Elgar Publishing.

VONO DE VILHENA D., LOI S. 2020. Exclusion through Statistical Invisibility. An Exploration on What Can Be Known through Publicly Available Datasets on Irregular Migration and the Health Status of This Population in Germany, *MPIDR Working Papers*,. https://ideas.repec.org//p/dem/wpaper/wp-2020-009.html.

WALLACE M., KHLAT M., GUILLOT M. 2019. Mortality Advantage among Migrants According to Duration of Stay in France, 2004–2014, *BMC Public Health*, Vol. 19, No. 1, p. 327. https://doi.org/10.1186/s12889-019-6652-1.

WILLIAMS D.R., LAWRENCE J.A., DAVIS B.A., VU C. 2019. Understanding How Discrimination Can Affect Health, *Health Services Research,* Vol. 54, No. S2, pp. 1374–88. https://doi.org/10.1111/1475-6773.13222.

WINGENS M., WINDZIO M., DE VALK H., AYBEK C. 2011. *A Life-Course Perspective on Migration and Integration*. Dordrecht: Springer Netherlands. https://doi.org/10.1007/978-94-007-1545-5.

_____

Silvia LOI, Head of the Research Group on Migration and Health Inequalities, Max Planck Institute for Demographic Research, Rostock, Germany; Affiliated Researcher at the Max Planck – University of Helsinki Center for Social Inequalities in Population Health, Rostock, Germany and Helsinki, Finland, loi@demogr.mpg.de

THE MODERATING ROLE OF AGEING GROWTH ON THE IMPACT OF DEMOGRAPHIC FACTORS ACROSS THE ITALIAN PROVINCES

Erika Dicorato, Rocco Mazza

Abstract. In Italy, the ageing process varies from one province to another, with some ageing faster than others. At the beginning of the 2000s, the country was divided into two groups: the southern and island provinces were younger, while the central and northern provinces were more advanced. In the following years, the younger provinces experienced a greater increase in the mean age, reducing the demographic differences between the macro-areas. This study aims to assess whether and how the contribution of the demographic components, i.e. fertility and migration, to the slowdown in ageing differs according to the speed of the phenomenon over the period 2002-2022.

The provinces were divided into groups according to the quartile of the mean age growth rate and regression models were implemented in which the speed of ageing is considered as a moderating variable that can influences the strength of the relationship between an independent and a dependent variable and then entered through an interaction term.

The results show that fertility is crucial in slowing down ageing, with a greater impact than migration. The fertility of Italian women has a predominant influence on the mean age, while that of foreign women has a less pronounced effect. The presence of foreigners, although increasing, does not compensate for the effects of demographic ageing. Furthermore, the speed of ageing creates differences in the impact of fertility and migration on mean age, with their impact increasing as the speed of ageing increases.

1. Introduction

The ageing of the population is one of the most important demographic phenomena of this century (Bloom and Luca, 2016). Italy is continuing the ageing process that began decades ago (Kinsella and Phillips, 2005); the share of the elderly population is constantly increasing, now, the population aged 65 and over represents 24.1% of the total population. Since 2002, this share has increased by 5,4 percentage points. In the same period, the share of the youngest population under 15 years of age, has fallen by almost 2 percentage point and now represents 12.5% of the population (ISTAT, 2023). The country's demographic dynamics have been characterised by a negative natural balance since the early 2000s. The peninsula has rapidly become one of the oldest countries in the world (Bagautdinova *et al.*, 2014) and the oldest country in Europe (Eurostat, 2021), attracting the attention of politicians and academics looking for the most effective solutions to slow down this unprecedented process. However, Italian territories have not all aged in the same

way, emerging significant territorial disparities (García-Pereiro, 2018). Demographic changes in the age structure have occurred more rapidly and intensively in previously younger areas such as the territories of southern Italy (Golini *et al.*, 2003). Over time, territories have tended to converge towards a similar mean age (Kashnitsky *et al.*, 2017).

The extensive literature on ageing is increasingly considering the significance of territorial differences in this process. However, the concept of the speed of ageing has yet to be fully explored. Our contribution to the existing literature is to link the growth rate of ageing to the analysis of its demographic determinants, thus offering a more comprehensive and in-depth view of both the causes and the results of the phenomenon. The aim of this study is to examine whether and how the contribution of the different demographic components to the slowdown in ageing varies in relation to the speed of evolution of the phenomenon.

2. Literature review

One of the causes of population ageing is the decline in fertility (Bengtsson and Scott, 2010). Coale (1957) showed that prolonged low fertility produces an ageing population and that the level of mortality has a secondary effect on the age distribution of the population compared to the effect that fertility may have. The ageing of Italy is therefore a direct consequence of persistently low fertility levels. A country is considered to have a very low fertility level if its total fertility rate falls below 1.5 children per woman (Lesthaeghe and Willems, 1999). It has been observed that in countries with low fertility, migration flows can be viewed as a means of "replacing" the lack of births in the native population and of coping with the ageing of the overall population. (Bagavos, 2019; Wilson et al., 2013; Billari and Dalla Zuanna, 2011). In the Italian context, García-Pereiro and Paterno (2022) compared the contributions made at the provincial level by both fertility and migration in the rapid ageing process underway in the country. The findings demonstrated that both factors contribute to the observed variability in the mean age, with fertility exerting a more pronounced influence.

The dynamics of this phenomenon vary depending on the geographical area (Schoeni and Ofstedal, 2010). Recently, investigations of population ageing and its connection to space have become more widespread than in the past. A significant proportion of these studies have concentrated on the contrasting patterns of the phenomenon's development between urban and rural municipalities[1] (Heleniak,

---

[1] Ageing and urbanization are seen as the two main transitions of developed populations (Beard and Petitot, 2010). Urbanized regions tend to attract people of working ages, while rural regions are left with a higher proportion of people out of the labour market (Smailes et al., 2014). This comparison is particularly interesting considering the different levels of urbanisation between northern and southern Italian provinces. However, this aspect is not part of the objectives of this research.

2003; Moore and Pacey, 2004; Walford and Kurek, 2008; Gutiérrez Posada *et al.*, 2018; Backmana and Karlssona, 2023). Despite differences in the speed of development between the areas, over time all territories tend to converge to a similar level with each other (Kashnitsky *et al.*, 2017). Golini *et al.* (2003) examined the correlation between the percentage of elderly people observed in 2001 in the Italian regions and the estimated rate of increase of the elderly population from 2001 to 2021 in each region. The findings suggest that the process of population ageing will occur at a faster and more pronounced rate in Italy's southern regions, which are characterised by a younger demographic structure, in comparison to the northern regions, which are characterised by an older population. Furthermore, the rate of this transformation is found to increase as one moves towards regions with a low share of the elderly population. Reynaud *et al.* (2018) examined the evolution of population ageing between 2002 and 2014 across Italian provinces. The findings indicated a tendency towards a convergence of age structures, accompanied by a notable reduction in the initial disparities observed in 2002. The southern and island provinces exhibited a significantly younger population than those in the north-west, north-east and centre. However, during the period under review, a marked increase in the old-age index was observed in the southern and island provinces, in contrast to a slower dynamic in the northern and central regions, where some provinces even experienced demographic rejuvenation. The territorial differences of ageing in Italy are considerable, both within the main socio-economic regions and within regions or provinces (Basile *et al.*, 2022).

Given the heterogeneous nature of the ageing phenomenon in Italy, the impact of fertility and migration on ageing may vary considerably at the local level. The aim of this study is to assess whether and how the contribution of these demographic components to the slowdown in ageing differs according to the speed at which the phenomenon evolves over the period 2002-2022. In particular, we want to answer the following research questions: RQ1: How do fertility and migration contribute to the ageing process? RQ2: Is the contribution of fertility greater in provinces that have experienced faster ageing? RQ3: Is the contribution of migration greater in provinces that have experienced faster ageing?

3. Data and method

A data set was constructed using data provided by the National Institute of Statistics at the NUTS2 level for the period from 2002 to 2022. For each Italian province, data were collected on the demographic phenomena of interest, namely fertility and immigration. Among the various measures available for assessing population ageing, we selected the mean age of the population, in accordance with the research conducted by Garcia-Pereiro and Paterno (2022). Moreover, as demonstrated by the studies conducted by Murphy (2017), the utilisation of this

indicator in comparison to other available measures, e.g. the percentage of elderly persons 65+, does not result in any significant discrepancies in the interpretation of the findings. In our analysis, the total fertility rate (TFR) of Italian women was used as a basis for examining fertility trends[2]. While, in order to assess the impact of international migration, two key aspects were considered: firstly, the TFR of foreign women[3] was employed as a measure of their potential contribution to the country's fertility; secondly, the percentage of the resident foreign population[4] in each province was quantified in order to consider the volume of this population.

In order to answer research questions 2 and 3, i.e. to check whether the contribution of fertility and migration varies with the speed of ageing, it was necessary to have a measure that could quantify the development of the phenomenon over time. In the context of studies on ageing, the annual rate of increase of ageing measures (Nagarajan *et al.*, 2020; Lee, 2003) has been commonly employed to assess the advancement of the phenomenon. In light of these studies, we have choose to use it to measure the speed with which ageing progressed from 2002 to 2022 in the Italian provinces. To this end, we have calculated the geometric rate of increase in the mean age as follows:

$$GR_i = \left(\frac{Mean\ Age_{i,2022}}{Mean\ Age_{i,2002}}\right)^{\frac{1}{20}} - 1 \tag{1}$$

A twenty-year rate was chosen to avoid random fluctuations due to specific periods (e.g. the COVID-19 pandemic). In addition, changes after only one year may not be significant, as ageing typically develops over the long term.

In our study, this growth rate represents the percentage change in the mean age of the resident population between the years 2002 and 2022. The mean age of the Italian population increased by approximately 5% on average, from 41.9 years in 2002 to 46.2 years in 2022. The provinces were then classified according to the

---

[2] There are notable disparities in fertility trends across Italy's macro-areas, with the North and South displaying contrasting patterns. In the northern and central regions of Italy, the TFR of Italian women exhibited an upward trajectory from the 2000s until 2010, when it began to decline to its current levels. Conversely, the TFR at the outset of the period was higher in the South than in the North, remaining relatively constant with some fluctuations until 2010. Subsequently, a decline in TFR values was also observed in this part of the country.

[3] The trend in the total fertility rate (TFR) of foreign women shows a decline at the national level, with differences in intensity between the different macro-regions. In particular, the fertility of foreign women is higher in the northern regions than in the other macro-regions.

[4] Since the beginning of the period under consideration (2002), the percentage of foreigners has increased throughout the country, with significant differences between the north and the south. The northern and central provinces have experienced exponential growth in the foreign presence, while the southern provinces have seen more moderate growth. Currently, the percentage of foreigners in northern Italy is about 10%, which is more than twice as high as in southern Italy, where it stands at around 4%.

quartiles of the distribution of the mean age growth rate (Figure 1) as follows: Fast Ageing (provinces with a growth rate of ageing in the upper quartile; 6.45 – 9.16), Medium-Fast Ageing (provinces with a growth rate between the median and the third quartile; 4.63 – 6.45), Medium-Slow Ageing (provinces with a growth rate between the first quartile and the median; 3.4 – 4.63) and Slow Ageing (provinces with a growth rate of ageing in the lower quartile; 0.77 – 3.4). This classification enables the identification and comparison of the differential impact of fertility and migration on mean age, depending on the rate of ageing.

Figure 1 – *Box Plot growth rate of mean age for Italian provinces.*
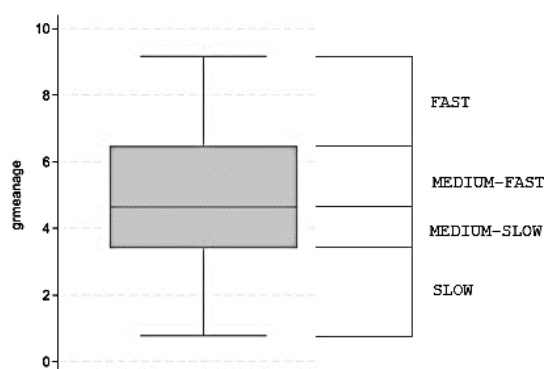
Source: Our elaboration based on ISTAT data

We decided to implement a series of OLS (Ordinary Least Squares) regression models, as *shown in Table 1*, where the dependent variable is the mean age in the provinces and the choice of independent variables varies according to the research question to be answered. The M1 model is designed to answer research question RQ1 by including the TFR of Italian women, the TFR of foreign women and the percentage of foreign population as independent variables.

To answer research questions RQ2 and RQ3, i.e. to test whether the impact of fertility and migration on population structural change varies with the growth rate of the mean age, we treat the latter as a moderator variable. A moderator is defined as a variable that influences the strength of the relationship between an independent and a dependent variable (James and Brett, 1984). The treatment of a moderator variable in a statistical model implies the inclusion of an interaction term between the moderator variable and the independent variable of interest, which makes it possible to test whether the relationship between the independent variable and the dependent variable changes as a function of the values of the moderator variable.

Table 1 – *Description of the models.*

	M1	M2	M3	M4
Dependent variable	Mean age	Mean age	Mean age	Mean age
Independent variables	TFR Italian women TFR foreign women Percentage of foreigners	TFR of Italian women	TFR foreign women	Percentage of foreigners
Moderator variable		Growth rate of the mean age	Growth rate of the mean age	Growth rate of the mean age

The M2 model is designed to answer RQ2 by including the variable TFR of Italian women. Questions RQ3 are addressed in models M3 and M4, which analyse the fertility contribution of foreign women and the foreign presence through the percentage of foreign population, respectively. It is therefore included in the M2, M3 and M4 models the interaction term with the growth rate of the mean age, which allows us to test whether and how the impact of fertility and migration differs between provinces with different ageing speed.

4. Results

The demographic evolution of ageing was observed across the entire national territory, with a notable increase in the mean age, particularly pronounced in the southern and island regions as illustrated in Figure 2. It demonstrates that the territorial differences in ageing between southern and northern Italy has diminished over time. At the outset of the study period, provinces in Northern and Central Italy had a mean age four years higher than those in the South and Islands. However, due to the accelerated ageing process in the southern provinces, the maximum difference in mean age between the macro-areas is now less than two years.

Figure 3 shows the Italian provinces classified according to the speed of ageing. The provinces in dark blue belong to the FAST category, having experienced a greater increase in the mean age, while those in light blue belong to the SLOW category, having experienced a smaller increase. It is clear that the southern provinces, which were among the youngest in 2002, have experienced rapid ageing. In contrast, the northern provinces experienced a more moderate increase in the mean age. These differences in the rate of ageing indicate a trend towards demographic homogeneity in terms of the mean age of the population

Figure 2 – *Trend of mean age across Italian macro-areas. Years 2000-2022.*
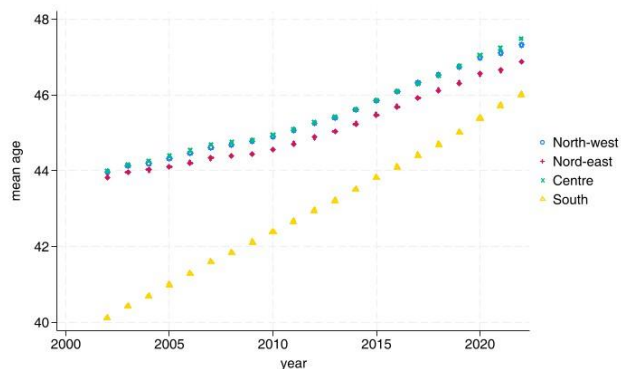
Source: Our elaboration based on ISTAT data

Figure 3 – *Map of growth rate of mean age for Italian provinces between 2002-2022.*
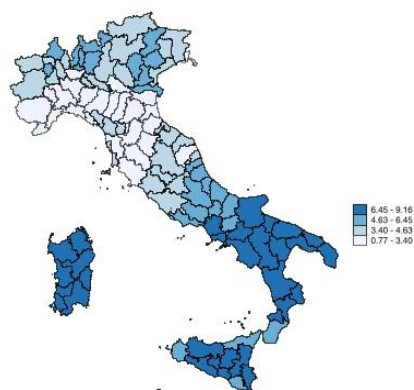
Source: Our elaboration based on ISTAT data

Table 2 presents the results of OLS regression models, each column corresponds to the results of a specific model.

Table 2 − *Results of OLS Regression M1, M2, M3, M4. Year 2002-2022.*

	M1	M2	M3	M4
TFR Italian women	-7.264*** [-8.284, -6.244]	-3.225*** [-4.540, -1.910]		
TFR foreign women	-1.055*** [-1.371, -0.739]		-1.414*** [-1.650,-1.177]	
Percentage of foreigners	0.312*** [0.241, 0.383]			0.203***
SLOW		(baseline)	(baseline)	(baseline)
MEDSLOW		-1.121 [-3.401, 1.159]	-0.953*** [-1.276, -0.594]	0.196*** [0.148, 0.244]
MEDFAST		-2.211 [-5.099, 0.677]	-1.024*** [-1.339, -0.709]	0.454*** [0.350, 0.558]
FAST		-15.205*** [-18.673,-11.737]	-1.479*** [-1.777, -1.181]	1.150*** [0.823, 1.477]
Constant	53.752*** [52.404, 55.100]	54.221*** [52.774, 55.668]	49.590*** [49.340, 49.840]	41.524*** [41.255, 41.793]

* p<0.1; ** p<0.05; *** p<0.001.
Confidence intervals for the coefficient estimates are given in brackets [].

The results of the M1 model indicate that fertility has a slowing effect on the ageing process, since the coefficient relating to the fertility of Italian women (β=-7.26) shows a negative relationship between mean age and fertility. This relationship is also confirmed by the coefficient on the fertility of foreign women (β= -1.05), although the effect of the fertility of native women on the mean age is greater. On the other hand, the foreign presence, expressed by the percentage of foreigners, shows a positive coefficient (β=0.31). This result contrasts with previous research (García-Pereiro, 2018), which showed a negative relationship between mean age and foreign presence. However, we do not interpret this positive coefficient as an increase in the mean age as the number of immigrants increases, but in a different way, which will be explained more clearly in the commentary on the M4 model.

M3 analyses the relationship between the mean age and the TFR of foreign women. Again, there are differences in the effect of the total TFR of foreign women on mean age depending on whether ageing is faster or slower, but they are not as pronounced as in the previous case.

Model M4 relates the mean age to the percentage of foreigners, but rather than seeing the increase in the mean age as a consequence of the increasing foreign presence in the area over time, we see it as an indication that, despite the increase in the percentage of foreigners, this has not been sufficient to halt the ageing process.

Consequently, the beta coefficient indicates that the influence of foreign presence has not been sufficient to offset the effects of ageing. If the beta coefficient had been zero, it would have indicated a situation of perfect compensation between the elderly

population and the foreign population. It should be noted that the coefficient increases in proportion to the speed of ageing in the provinces, indicating that the speed of ageing plays a moderating role in this context. For the provinces in the 'slow' group, the coefficient is neither high nor very far from zero. It is therefore clear that the northern and central Italian provinces, which experienced a slower ageing process over the period considered, also recorded a higher percentage of foreigners. On the other hand, in the southern and island provinces, where the process was more rapid, the percentage of foreigners in the territory was not high enough to mitigate the effects of ageing.

5. Discussion and conclusion

Italy has experienced significant territorial differences in the development of population ageing. Consequently, it is crucial to consider it when studying this phenomenon. (Barile *et al.*, 2022).

At the beginning of the study period (2002), the ageing process divided Italy into two distinct regions: the southern and island provinces, which exhibited younger population structure and the central and northern provinces further along in the ageing process. The literature (Backman & Karlsson, 2024; Golini *et al.*, 2003) indicates that demographic changes occur more rapidly and intensively in previously younger areas. The results of our analysis are consistent with those observed by Golini *et al.* (2003) and Reynoud *et al.* (2018) in their respective research. The provinces that were younger than the others at the beginning of the 2000s exhibited a greater increase in mean age in the subsequent years examined. As a result, the diversity in population structure between the Italian macro-areas diminished, indicating a tendency towards a state of demographic homogeneity with regard to the mean age of the population (Gutiérrez Posada *et al.*, 2018; Kashnitsky *et al.*, 2017).

To answer research question RQ1, namely how fertility and migration contribute to the ageing process, the results of our analysis highlighted the important role of fertility in slowing down this process. According to the research carried out by García-Pereiro and Paterno (2018), the fertility of Italian women influences the mean age more than other demographic phenomena, such as migration. In our research, the influence of the foreign component was analysed through two fundamental aspects: the fertility of foreign women and their number. It turned out that the fertility of foreign women has a slowing effect, although less than that of native women. With regard to numerosity, the positive beta coefficient indicates that the impact of the foreign presence has not been sufficient to compensate for the effects of the ageing process. Despite the increase of immigrants in Italy, they are not enough to reverse the demographic ageing process (Craveiro *et al.*, 2019). Moreover, in provinces where the phenomenon has developed rapidly, a higher percentage of

foreign population is needed to observe significant effects than in provinces where the ageing process has developed more slowly. This raises questions about the sustainability of areas that receive even more immigrants (Bermingham, 2001; Bijak *et al.*, 2006).

With regard to questions RQ2 and RQ3, i.e. whether the contribution of fertility and migration is greater in provinces that have aged faster, the answer is yes. However, the differences in the contribution of the determinants of population structure according to the speed of ageing are more pronounced when fertility is considered than when migration is considered. This could be due to the different impact of the two phenomena on the mean age. Future research could focus on investigating the underlying causes of the different ageing rates in order to design ad hoc policies according to the demographic profile of territories.

One limitation of this research is the use of mean age as a proxy for ageing. Consequently, potential future developments could include repeating the analysis using the median age and a lower level of aggregation to analyse the dynamics of the ageing rate among Italian municipalities.

Acknowledgements

References

BACKMAN M., KARLSSON C. 2024. Ageing places: convergence and the role of the foreign population, *Regional studies*, Vol. 58, No. 5, pp. 922-937.

BAGAUTDINOVA N. G., PANASYUK M. V., PUDOVIK E. M., GILMANOVA A. 2014. Multivariate statistic analysis of the world population ageing, *Mediterranean Journal of Social Sciences*, Vol. 5, No. 28, pp. 50-55.

BAGAVOS C. 2019. On the multifaceted impact of migration on the fertility of receiving countries, *Demographic research*, Vol. 41, No. 1, pp. 1-36.

BASILE R., BASSO S., MICCOLI S., REYNAUD C. 2022. Ageing population in Italy: a space-time analysis, *Rivista Italiana di Economia Demografia e Statistica*, Vol. 76, No. 2, p.77.

BEARD J. R., PETITOT C. 2010. Ageing and urbanization: Can cities be designed to foster active ageing?, *Public Health Reviews*, Vol 32, No. 2, pp. 427–450.

BENGTSSON T., SCOTT K. 2010. *The ageing population. Population ageing-A threat to the welfare state? The case of sweden*. Springer Science & Business Media.

BERMINGHAM, J. R. 2001. Immigration: Not a solution to problems of population decline and aging, *Population and Environment*, Vol. 22, No. 4, pp. 355-363.

BIJAK J., KUPISZEWSKA D., KUPISZEWSKI M. 2008. Replacement migration revisited: Simulations of the effects of selected population and labor market strategies for the aging Europe, 2002–2052, *Population Research and Policy Review*, Vol. 27, pp. 321-342.

BILLARI F., DALLA-ZUANNA G. 2011. Is replacement migration actually taking place in low fertility countries?, *Genus*, Vol 67, No. 3, pp. 105–123.

BLOOM D. E., LUCA D. L. 2016. The global demography of aging: facts, explanations, future. In *Handbook of the economics of population aging,* Vol. 1, North-Holland, pp. 3-56.

CRAVEIRO D., DE OLIVEIRA I. T., GOMES M. S., MALHEIROS J., MOREIRA M. J. G., PEIXOTO J. 2019. Back to replacement migration, *Demographic research*, Vol. 40, pp. 1323-1344.

COALE A. J. 1957. How the age distribution of a human population is determined. In *Cold spring harbor symposia on quantitative biology*, Vol. 22, pp. 83-89. Cold Spring Harbor Laboratory Press.

EUROSTAT. 2021. More than a fifth of the EU population are aged 65 or over, Eurostat News.

GARCÍA-PEREIRO T. 2018. Aging and pensions in Italy: highlighting regional disparities. *Rivista Italiana di Economia Demografia e Statistica*, Vol. 72, No. 3.

GARCIA PEREIRO T., PATERNO A. 2022. The role played by migration and fertility on Italy's aging trends: a provincial-level analysis. In *Books of the Short Papers of the SIS 2022 Statistical Conference*, Pearson, pp. 250-259.

GOLINI A., BASSO S., REYNAUD C. 2003. L'invecchiamento della popolazione in Italia: una sfida per il paese e un laboratorio per il mondo. *Giornale di Gerontologia*, Vol. 51, pp. 528-544.

GUTIÉRREZ POSADA D., RUBIERA MOROLLÓN F., VIÑUELA A. 2018. Ageing places in an ageing country: The local dynamics of the elderly population in Spain. *Tijdschrift voor economische en sociale geografie*, Vol. 109, No. 3, pp. 332-349.

HELENIAK T. 2003. Geographic aspects of population aging in the Russian Federation. *Eurasian Geography and Economics*, Vol. 44, No. 5, pp. 325-347.

ISTAT. 2023. Rapporto Annuale 2023 in pillole.

JAMES L.R., BRETT J.M. 1984. Mediators, moderators, and tests for mediation, *Journal of Applied Psychology*, Vol. 69, No. 2, pp. 307-21.

KASHNITSKY I., DE BEER J., VAN WISSEN, L. 2017. Decomposition of regional convergence in population aging across Europe, *Genus*, Vol. 73, pp. 1-25.

KINSELLA K. G., PHILLIPS D. R. 2005. *Global aging: The challenge of success* Vol. 60, No. 1, p3. Washington, DC: Population Reference Bureau.

LEE R. 2003. The demographic transition: Three centuries of fundamental change. *Journal of Economic Perspectives*, Vol. 17, pp.167–190.

LESTHAEGHE R., WILLEMS P. 1999. Is low fertility a temporary phenomenon in the European Union?, *Population and development review*, Vol. 25, No. 2, pp. 211-228.

MOORE E. G., PACEY M. A. 2004. Geographic dimensions of aging in Canada, 1991-2001, *Canadian Journal on Aging/La Revue Canadienne Du Vieillissement*, Vol. 23, No. 5, S5-S21.

MURPHY M. 2017. Demographic determinants of population aging in Europe since 1850, *Population and Development Review*, pp. 257-283.

NAGARAJAN N. R., TEIXEIRA A. A., SILVA S. T. 2021. Ageing population: identifying the determinants of ageing in the least developed countries, *Population Research and Policy Review*, Vol. 40, pp. 187-210.

REYNAUD C., MICCOLI S., LAGONA F. 2018. Population ageing in Italy: an empirical analysis of change in the ageing index across space and time, *Spatial Demography*, Vol. 6, No. 3, pp. 235-251.

SCHOENI R. F., OFSTEDAL M. B. 2010. Key themes in research on the demography of aging, *Demography*, Vol. 47(Suppl 1), pp. S5-S15.

SHIODE N., MORITA M., SHIODE S., OKUNUKI K. I. 2014. Urban and rural geographies of aging: a local spatial correlation analysis of aging population measures. *Urban Geography*, Vol. 35, No. 4, pp. 608-628.

SMAILES P., GRIFFIN T., ARGENT N. 2014. Demographic Change, Differential Ageing, and Public Policy in Rural and Regional Australia: A Three-State Case Study, *Geographical Research*, Vol. 52, No. 3, pp. 229-249.

WALFORD N. S., KUREK S. 2008. A comparative analysis of population ageing in urban and rural areas of England and Wales, and Poland over the last three census intervals, *Population, Space and Place*, Vol. 14, No.5, pp. 365-386.

WILSON C., SOBOTKA T., WILLIAMSON L., BOYLE P. 2013. Migration and intergenerational replacement in Europe, *Population and Development Review*, Vol. 39, No. 1, pp. 131-157.

_____

Erika DICORATO, University of Florence, University of Bari, erika.dicorato@unifi.it

Rocco MAZZA, University of Bari, rocco.mazza@uniba.it

THE EFFECT OF THE NATIONAL ECOVERY AND RESILIENCE PLAN ON THE HEALTHCARE SUPPLY IN THE ITALIAN PROVINCES

Giuseppe Cinquegrana, Armando D'Aniello

Abstract. The monitoring of the economic, social and environmental phenomena on which National Recovery and Resilience Plan funds represents a challenge for the policy makers. The integration between data at provincial level on the characteristics of the provinces and the open data on the NRRP funds represents an important monitoring support resource for public decision makers. The data available in the Italian government platform allows us to quantify the NRRP financing by unique project code and local project code, being able to trace the amount allocated to the provinces and individual municipalities for the NRRP missions. The scope of this work is to analyse the effect of NRRP funds on the healthcare supply in the Italian provinces estimating an econometric model in order to obtain a parameter to evaluate the impact of NRRP contributions to the access to the healthcare facilities.

1. Introduction

Monitoring the economic, social and environmental phenomena affected by National Recovery and Resilience Plan (NRRP) funds is essential for policy makers to assess the effectiveness of their decisions and implementation strategies. This study analyses the impact of NRRP funds on healthcare provision in Italian regions and provinces by estimating an econometric model. The analysis focuses on evaluating how NRRP contributions affect access to healthcare facilities. To achieve this, we integrate provincial-level data on healthcare facilities with open data on NRRP funds, creating a comprehensive resource for public policy makers. The Italian government's platform (www.italiadomani.gov.it) provides data to quantify NRRP funding by unique and local project codes, allowing the tracking of funds allocated to municipalities for NRRP tasks.

On the one hand, we investigate whether NRRP funds increase healthcare expenditure and examine the potential crowding-out effect (Park et al. 2024) of these financial resources on private spending, given that a large increase in public spending could stimulate inflationary growth and thus induce monetary policymakers to raise interest rates, thereby reducing private investment demand. In addition, we analyze the impact of NRRP funds on the presence of healthcare facilities, considered here as a proxy for healthcare provision (Pamolli et al. 2017). The second section provides

an overview of NRRP missions by region, a literature review on the healthcare market, and a description of demand and supply indicators, including healthcare expenditure by region and healthcare facilities by province. Control variables relevant to healthcare expenditure are also discussed (Meskarpour et al. 2021). The third section describes the data and methods used for the econometric model. Finally, the fourth section concludes the study with a summary of findings and implications.

2. NRRP and Healthcare Expenditure in Italian Provinces

Divided into seven missions, the NRRP has three main objectives. The first, with a short-term horizon, focuses on repairing the economic and social damage caused by the pandemic crisis. In the medium to long term, the plan addresses persistent weaknesses in the Italian economy and society, including territorial disparities, gender inequalities, low productivity growth and limited investment in human and physical capital. Finally, the plan aims to promote a comprehensive ecological transition.

The resource allocation by NRRP is a comprehensive reform package aimed at overcoming historical barriers that have hampered public and private investments, stunted growth and resulted in sub-optimal employment levels, particularly for women and young people.

The NRRP should support the economic recovery by boosting GDP growth and sustaining high-income dynamics in subsequent years. It also aims to increase potential growth and productivity through innovation, digitalisation and investment in human capital. According to the Italian Ministry of Finance, based on the QUEST model developed by the European Commission (D'Auria et al., 2009), GDP is projected to be 3.6 percentage points higher by 2026 compared to a baseline scenario. While these estimates assume efficient public investments, they do not take into account additional gains from the reforms proposed in the plan, in particular those related to youth and female employment. With effective reforms to improve competitiveness, actual growth could exceed these projections.

The EU's Next Generation initiative promotes a robust economic recovery across Europe, emphasizing ecological transition, digitalisation, competitiveness, training, social and territorial inclusion and gender equality, social and territorial inclusion and gender equality.

The Regulation for the Recovery and Resilience Facility identifies six key intervention areas: green transition, digital transformation, sustainable and inclusive growth, social and territorial cohesion, health resilience and policies for younger generations. Based on these pillars, the Italian government has structured the 2021 NRRP into six missions (Figure 1): 1. Digitalisation, innovation, competitiveness,

culture and tourism; 2. Green revolution and ecological transition; 3. Infrastructure for sustainable mobility; 4. Education and research; 5. Inclusion and cohesion; 6. Health.

Figure 1 – *NPRR Funds by region.*

Finanziamenti PNRR
(in mln)
- 1.127 - 3.842
- 3.842 - 5.868
- 5.868 - 8.046
- 8.046 - 16.249
- 16.249 - 20.711
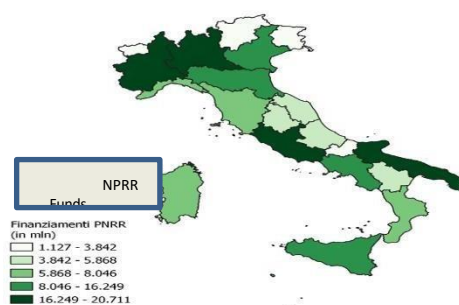
Source: our elaborations on Italia domani data.

The strategy for Mission 6 focuses on aligning healthcare services with the needs of patients across Italy through major reforms and investments. Resources allocation will improve infrastructure, promote research and innovation, and improve the technical, digital and management skills of healthcare workers.

In 2023, the EU launched a seventh mission, RePowerEU, to support the ecological transition. It aims to accelerate renewable energy production, strengthen distribution networks and promote energy efficiency, while fostering green skills in the public and private sectors.

The healthcare sector is characterized by unique service characteristics, as outlined by Batley and McLoughlin (2015): a) The nature of goods and services: Rivalry and/or excludability; (b) Market failure characteristics: Monopoly tendency, positive or negative externalities, information asymmetry; (c) Task-related characteristics: Visibility + measurability of processes and outputs = imputability, discretion of frontline staff, transaction intensity, variability of treatment, provider autonomy; d) Demand characteristics: Frequency of use, predictability of use, territoriality. These characteristics require significant public intervention, particularly to address externalities. The government has to decide whether to manage healthcare institutions directly or to grant concessions to private entities for the provision of services, following a cost-transaction approach (Hart et al., 1997; Shleifer, 2000).

In Italy, the healthcare system is of a mixed type. Public and private institutions coexist, with private providers receiving subsidies from local governments to

provide services. There is also a grey zone of hybrid public/private schemes (Falsone, 2024), arising from the fact that many Italian healthcare entities are non-profit associations, consortia, social cooperatives, ecclesiastical organizations, legal moral bodies, private individuals, foundations, limited liability companies, and cooperative in-house companies. These entities operate on the borderline between public and private, yet they are subject to private business law. In recent years, the significant share of out-of-pocket payments by households confirms that the Italian healthcare system is of a mixed type, characterized by a higher incidence of private expenditure on total healthcare spending compared to the European average. Specifically, out-of-pocket payments accounted for 26.3% of total healthcare expenditures in Italy in 2021, compared to the EU average of 18.9% (OECD, State of Health in the EU, Italy Country Health Profile, 2023). The Italian mixed healthcare system has also been impacted by the reordering of local public services of economic relevance (Legislative Decree no. 201/2022), which does not explicitly exclude social and healthcare services from its scope (Falsone, op. cit.). The improvement of available facilities in this complex mixed system, along with the reorganization of territorial community healthcare services following the COVID-19 emergency and the implementation of Electronic Health Records (Cacciatore et al., 2023), represents a major challenge for NRRP funds.

To assess the impact of NRRP funding, this study uses public healthcare expenditure and the number of healthcare facilities (hospitals) as proxies for goods and services provided in the healthcare sector.

Public healthcare expenditure refers to the amount financed by the government to provide healthcare goods and services needed by households in a given region. It represents a significant proportion of current expenditure: according to the Ministry of Finance, public healthcare expenditure accounted for 6.3% of GDP in 2023, or

€131.1 billion. Data from the Italian National Institute of Statistics (ISTAT) show that public healthcare expenditure had an average annual growth rate of 1.7% between 2012 and 2023 (Basso et al., 2024). The determinants of healthcare expenditure are both economic and social, as noted by Meskarpour et al. (op. cit.). The economic determinants depends on the overall economic growth of a country, with gross domestic product per capita often used as a key economic context variable (Pamolli et al., op. cit.). Social determinants include the size and age composition of the population analyzed as control variables in studies such as Akca et al. (2017) and Pamolli et al. (op. cit.).

In this study, we consider the presence of healthcare institutions as a proxy for hospital and clinic facilities, which are essential for the provision of healthcare services. These facilities are where sick people go for treatment and recovery. Pamolli et al. (op. cit.) identify accessibility as a critical factor linking the identification of healthcare needs, the location of healthcare services, the ease of

access to these services and the ultimate ability to receive appropriate care. In our analysis, we do not directly consider other components of healthcare, such as professional medical advice, pharmaceuticals and medical technology. However, we hypothesize that improvements in healthcare infrastructure create economies of scale that have a positive impact on other components of service provision in the sector.

3. A Model for Estimating the Impact of NRRP on Healthcare Service

a. The model

To analyze the impact of NRRP funding on healthcare services using the available data, we used a linear regression model (Galton, 1886; Kenney & Keeping, 1962) with healthcare expenditure and number of healthcare facilities as dependent variables. All analyses were carried out using R software (R Core Team, 2022) and associated packages: sf (Pebesma, 2018), dplyr (Wickham *et al.*, 2022) and ggplot2 (Wickham, 2022).

b. Creation of the Database and Estimation Methods

Data on NRRP funding were obtained from the Italian government portal "italiadomani" (https://www.italiadomani.gov.it/), which provides details on funding by mission and local project code (LPC) at the municipal level. We integrated the relevant tables on NPRR at provincial level by local project code and we selected information specific to health-related projects.

We obtained data on healthcare expenditure at regional level and on healthcare institutions at provincial from Istat source, as well as information on GDP per capita and on the resident population. We carried out the analysis at provincial level; therefore, we standardized the data at this territorial level: we aggregated funding data at provincial level, while we disaggregated regional expenditure data by provincial healthcare institutions and GDP per capita. First, we evaluated the correlation between Healthcare expenditure and Healthcare institutions and several control variables (Population, GDP per capita, Age, see Table 1), as reported in the literature mentioned in section 2 (Meskarpour *et al*. op. cit., Akca *et al.* op. cit. and in Pamolli *et al*. op. cit.).

Table 1 – *Correlation matrix among all detected variables.*

	Healthcare inst.	Healthcare exp.	Population	GDP per capita	Age
Healthcare inst.	1.00	0.93	0.94	0.63	-0.45
Healthcare exp.	0.93	1.00	1.00	0.80	-0.30
Population	0.94	1.00	1.00	0.77	-0.33
GDP per capita	0.63	0.80	0.77	1.00	0.04
Age	-0.45	-0.30	-0.33	0.04	1.00

We formulated a linear regression model to estimate healthcare expenditure at the provincial level considering the number of healthcare institutions (Figure 3.1) and to avoid multicollinearity, we used GDP per capita as the control variable selected on the base of the correlation analysis (Table 1):

$$healthcare\_exp = \beta_0 + \beta_1\, n\_healthcare\_inst + \beta_2\, GDP\_per\_capita$$

Applying this model, we obtained the estimated healthcare expenditure at provincial level (Figure 2) and the related estimated coefficients are in the following table (Table 2):

Table 2 - *Results of the regression model: healthcare_exp=β_0+ β_1 n_healthcare_inst+ β_2 GDP per capita.*

Coefficients:	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	-589.57264	570.32812	-1.034	0.315739
n_healthcare_inst	79.05567	8.76610	9.018	6.88e-08
GDP per capita	0.02088	0.00448	4.661	0.000224

Residual standard error: 1397 on 17 degrees of freedom Multiple R-squared: 0.9379
Adjusted R-squared: 0.9306
F-statistic: 128.4 on 2 and 17 degrees of freedom p-value: 5.487e-11
Source: our elaborations on Istat data.

Figure 2 − *Estimate of healthcare expenditure in 2021.*
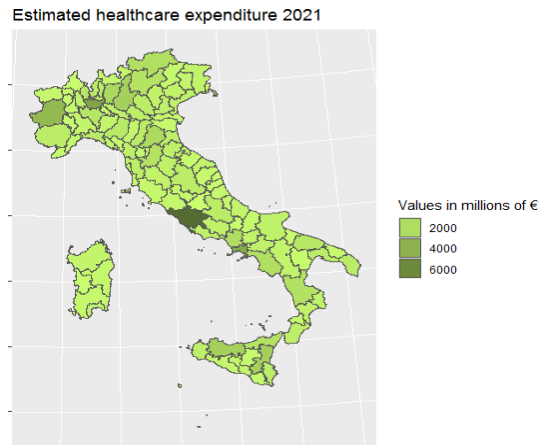
Source: our elaborations on Istat data.

c. Results

After standardizing the data at the provincial level, we analyzed the contribution of NRRP funds to provincial healthcare expenditure (Figure 3). The map shows that in almost all provinces the amount of NRRP funds allocated to healthcare is less than 10% of the estimated provincial healthcare expenditure.

Figure 3 − *Percentage of healthcare expenditure covered by NRRP funds, provincial data.*
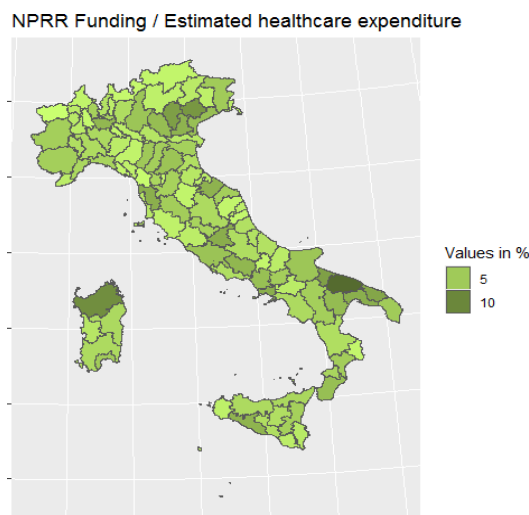
Source: our elaborations on Istat and italiadomani data.

To analyze the relationship between healthcare expenditure and NRRP funding, we applied a logarithmic transformations to the variables:

$$log(est\_healthcare\_expenditure) = \alpha + \beta \, log(NRRP\_funding)$$

The following reasons were on the base of this conversion:
- Linearization of the Relationship: The initial scatterplot of healthcare expenditure versus NRRP funding indicated a nonlinear pattern, suggesting that a simple linear regression model might not accurately capture the relationship. Application of a logarithmic transformation to both variables rendered the relationship linear, allowing for a more precise fit using linear regression techniques. The log-log transformation is especially effective when both variables exhibit a multiplicative or exponential relationship, as it stabilizes variance and linearizes the data.
- Interpretability in Terms of Elasticity: The logarithmic transformation facilitates the interpretation of the coefficient β as the elasticity of healthcare expenditure with respect to NRRP funding. This is particularly pertinent in economic contexts, as it provides insight into the proportional responsiveness of healthcare expenditure to changes in NRRP funding. The coefficient $\beta = 0.53$ indicates that a 1% increase in NRRP funding is associated with a 0.53% increase in healthcare expenditure, thereby highlighting a less-than-proportional response. We present below (Table 3) the results of the model.

Analyzing the same relationship by rescaling the variables based on GDP (considered as control variable as reported in Table 1), we obtain the following result (Table 4).

$$log\left(\frac{est \ healthcare \ expenditure}{GDP}\right) = \alpha + \beta \, log\left(\frac{NRRP_{funding}}{GDP}\right)$$

Again, with a coefficient of $\beta = 0.53$, there is evidence of what was previously described regarding the elasticity of expenditure with respect to NRRP funding. Rescaling this time only the variable related to NRRP funding relative to GDP, we obtain the following graph (Table 5).

$$log(est\_healthcare\_expenditure) = \alpha + \beta \, log\left(\frac{NRRP_{funding}}{GDP}\right)$$

The coefficient β in this case is 0.44, consistent with previous findings.

Finally, we examined the relationship between the number of healthcare facilities per thousand inhabitants and the amount of NRRP funding per province, rescaled by GDP (Table 6):

$$\log(\text{N healthcare } inst \ x \ \frac{Pop}{1000}) = \alpha + \beta \log \left(\frac{\text{NRRP}_{\text{funding}}}{\text{GDP}} \right)$$

The coefficient $\beta = 1.55$ indicates that the number of healthcare institutions is more than proportionally reactive to changes in NRRP funding.

Table 3 – *Results of the regression model: Estimated healthcare expenditure ~ NRRP Funding.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	11.5248	0.6421	17.95	<2e-16
log NPRR funding	0.5292	0.0367	14.42	<2e-16

Residual standard error: 0.2816 on 105 degrees of freedom Multiple R-squared: 0.6644
Adjusted R-squared: 0.6612
F-statistic: 207.9 on 1 and 105 degree of freedom p-value: 2.2e-16
Source: our elaborations on Istat and italiadomani data.

Table 4 – *Results of the regression model: Estimated healthcare expenditure / GDP ~ NRRP Funding / GDP.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	6.7589	0.2515	26.87	<2e-16
log NPRR Funding / GDP	0.5307	0.0339	15.65	<2e-16

Residual standard error: 0.2684 on 105 degrees of freedom Multiple R-squared: 0.7001
Adjusted R-squared: 0.6972
F-statistic: 245.1 on 1 and 105 degree of freedom p-value: < 2.2e-16
Source: our elaborations on Istat and italiadomani data.

Table 5 – *Results of the regression model: Estimated healthcare expenditure ~ NRRP Funding / GDP.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	17.55768	0.32847	53.452	<2e-16
log NPRR Funding / GDP	0.43579	0.04427	9.844	<2e-16

Residual standard error: 0.3505 on 105 degrees of freedom Multiple R-squared: 0.48
Adjusted R-squared: 0.475
F-statistic: 96.91 on 1 and 105 degree of freedom p-value: < 2.2e-16
Source: our elaborations on Istat and italiadomani data.

Table 6 − *Results of the regression model: Number of healthcare institutions * Population/1000 ~ NRRP Funding / GDP.*

Coefficients	Estimate	Std. Error	t-value	Pr(>|t|)
(Intercept)	-3.4894	0.8067	-4.325	3.48e-05
log NPRR Funding / GDP	1.5460	0.1087	14.221	< 2e-16

Residual standard error: 0.8609 on 105 degrees of freedom Multiple R-squared: 0.6582
Adjusted R-squared: 0.655
F-statistic: 202.2 on 1 and 105 degree of freedom p-value: < 2.2e-16
Source: our elaborations on Istat and italiadomani data.

4. Conclusions

The NPRR funds should increase public healthcare expenditure, and our econometric study confirms this proposition. However, it seems that the increase in public healthcare expenditure is not proportional to that of the NPRR funds. In fact, a possible crowding-out effect on aggregate demand due to an inefficient use of NPRR funds could be at work, particularly as regards public healthcare expenditure. The increase in public expenditure due to the NPRR could affect the level of prices of goods and services related to the missions and a subsequent speed of inflation growth could affect a restrictive monetary policy by increasing the interest rate, thus reducing private aggregate demand. In order to better study this aspect, we have considered as a proxy for the supply of healthcare services the presence of healthcare institutions in the provinces.

Taking into account the effect of the NPRR funds in the healthcare sector on the number of healthcare institutions at the provincial level, we have estimated a direct impact coefficient and the result is an increase of the healthcare supply more than proportional compared to that of the NPRR funds.

In any case, the study needs further investigation, particularly in terms of updating the data both on the actual spending of the NPRR funds received by the Italian government and on the monitoring of the works in progress of the infrastructures planned by the NPRR missions.

On the other hand, the study needs to improve both the applied methodology of the Small Area Indicators and the econometric IV methods.

References

AKCA N. , SONMEZ S., YILMAZ A. 2017, Determinants of healthcare expenditure in OECD countries: A decision tree model, *Pakistan Journal of Medical Sciences*; Vol. 33, No. 6, pp. 1490-1494.

BASSO S., FUGNITTO M. A., MARTINA L., PALLOTTI E. 2024, La spesa sanitaria e le sue componenti, *Rivista di Politica Economica*,Vol. 1, pp. 17-42.

BATLEY R., MCLOUGHLIN C. 2015, The politics of public services: a service characteristics approach, *World Development*, Vol. 74 , No.2015, pp. 275-285.

CACCIATORE F., BITONTI A., SGUEO G. 2024, Interest groups and the implementation of electronic health records in the Italian NRRP, between policy and politics, *Journal: Contemporary Italian Politics*, Vol. 16 , No.1 (2024), pp. 21-38.

D'AURIA F., PAGANO A., RATTO M., VARGA J. 2009, A comparison of structural reform scenarios across the EU member states: Simulation-based analysis using the QUEST model with endogenous growth, *Economic Papers* No. 392, European Economy, ECFIN.

FALSONE M. 2024, Integrazione socio-sanitaria e Pnrr: impatti sul lavoro e problemi regolativi, *Lavoro e diritto*, Vol. 3, pp. 437-458.

FRANCIS GALTON. 1886, Regression Towards Mediocrity in Hereditary Stature, *Journal of the Anthropological Institute*, Vol.15, pp. 246-263.

KENNEY J. F. KEEPING E. S. 1962, Linear Regression and Correlation. Ch. 15, , *Mathematics of Statistics*, Pt. 1, Vol. 3rd ed., pp. 252- 285, Princeton, NJ: Van Nostrand.

PAMMOLLI F, PORCELLI F., VIDOLI F., AUTERI M., BORA' G. 2017, La spesa sanitaria delle Regioni in Italia – Saniregio 2017*, Working Papers 01-2017, Competitività, Regole, Mercati (CERM)*

PARK J. K., MENG X. 2024, Crowding out or crowding in? Reevaluating the effect of government spending on private economic activities, *International Review of Economics & Finance*, Vol. 89, Part A, January 2024, pp. 102-117.

PEBESMA, E., 2018, Simple Features for R: Standardized Support for Spatial Vector Data, *The R Journal*, Vol. 10 , No.1, pp. 439-446, https://doi.org/10.32614/RJ-2018-009.

R CORE TEAM 2022, R: A language and environment for statistical computing. R Foundation for Statistical Computing, Vienna, Austria. URL https://www.R-project.org/.

WICKHAM H. 2016. *ggplot2: Elegant Graphics for Data Analysis*. Springer-Verlag New York.

WICKHAM H, FRANÇOIS R, HENRY L, MÜLLER K. 2022, *dplyr: A Grammar of Data Manipulation*. R package version 1.0.10, https://CRAN.R-project.org/package=dplyr.

_____

Giuseppe CINQUEGRANA, Istat, gicinque@istat.it
Armando D'ANIELLO, Istat, armando.daniello@istat.it

COLLECTING DATA ON MIGRANTS' HEALTH STATUS AND ACCESS TO HEALTH SERVICES: THE EXPERIENCE OF THE MOBILE APP "COMESTAI"

Chiara Allegri, Alessandro Avellone, Elisa Barbiano di Belgiojoso, Sara Khatab, Dario Pescini, Stefania M. L. Rimoldi, Antonella Zambon

Abstract. Despite the process of migrant settlement in Italy, there is still a lack of data on migrant health and access to health services. We have developed the mobile app "ComeStai" to collect new data on this population.

ComeStai collects new and original information on migrants' self-assessed health status and access to health care through short surveys. The main questionnaire includes questions about the respondent's immigrant status, health status and health habits, access to and use of health care, and socio-demographic characteristics. Every month, the app displays a follow-up survey to track key variables over time, including respondents' health status and experiences of barriers to accessing health care.

After submitting the answers to the main questionnaire, the user can access an in-app platform that provides an overview of the Italian public health system and regulations, a brief description of the main public health services, and a list of NGOs providing health services or support in the Metropolitan area of Milan, as well as their location on a map.

Our study aims to test the efficacy of a mobile application as a data collection tool. We present the fieldwork and discuss the advantages and challenges of such a tool. Our evaluation considers the sample size achieved, the heterogeneity and representativeness of the sample to the real population. Based on the results, we will evaluate whether to extend the research to a larger geographical scale.

1. The use of mobile apps in social research

The increase in the number of activities reliant on mobile phones and mobile apps has improved users' familiarity with their devices and has paved the way to use mobile devices (tablets, smartphones, mobile Web) for conducting surveys and collecting data (Couper, 2013; Marcano Belisario *et al.*, 2015) even in migration studies (Rocheva *et al.*, 2022). Social studies have therefore analysed big data from social networking sites, or online services targeting migrants for their studies, moreover, surveys online have become more frequent. Mobile apps can represent a useful and additional data-collecting method as they can both passively collect data (e.g. geolocalisation) or be used to conduct surveys (Couper, 2013).

Similarly to online surveys, mobile apps offer several advantages for studying migrants: they enable respondents to complete surveys anywhere and at any time

(Marcano Belisario *et al.*, 2015), reach populations geographically dispersed on a territory, highly mobile and not included in a Population Register, eliminate the need for interviewers and their knowledge of migrants' native languages, since they can employ multilingual interfaces easing the self-administration of the questionnaire (Rocheva *et al.*, 2022; Jacobsen and Kühne, 2021). In addition, the cost of a survey using mobile apps is considerably lower than a traditional survey requiring interviewers. Finally, apps allow researchers to solicit the collection of longitudinal data through mobile notifications rather than through recontact calls or emails. However, many challenges remain: the target population needs to have a mobile device; the mobile app should be designed to run on different operating systems; respondents' reluctance to download a mobile app for privacy or data security concerns; a demanding task, such as daily activities or a long period of the study (Jacobsen and Kühne, 2021; Jäckle *et al.*, 2022, 2023).

The evidence regarding the quality of data collected with mobile apps presents mixed results: some studies found similar quality compared to traditional surveys, while others found the opposite (Jacobsen and Kühne, 2021; Marcano Belisario *et al.*, 2015; Oakeley-Girvan *et al.*, 2018). Previous studies unanimously agreed that the response rate in mobile app surveys is lower compared to other methods (Zhang *et al.*, 2018; Jäckle *et al.*, 2022, 2023), unless there is an interviewer persuading survey respondents to participate or offering a browser-based alternative to those reluctant to download the app (Jäckle *et al.*, 2022). Little evidence on non-respondent rates highlights that personal characteristics may affect participation: younger and frequent users of other apps are more likely to participate (Jäckle *et al.*, 2022; Jacobsen and Kühne, 2021). The characteristics of the survey are determinant too: the length of the questionnaire, the way the questions are formulated (a compromise between the available space and the need for clarity), the compatibility of the app with the device, a demanding task, finding the app on the store and downloading the app, setting relevant permissions in the app (e.g. notifications, location tracking) and invitation message (Jäckle *et al.*, 2023; Wenz and Keusch, 2023). All these aspects are found to affect the participation rate and the completeness and quality of the responses. According to Fan and Yan (2010), the design of the invitation to participate in a survey indicating the organisation's name, the purpose of the study, as well as the contact delivery modes, also affect the response rate.

2. Selection bias: to weight, or not to weight?

Literature unanimously recognises that the auto-selection in surveys conducted by mobile apps is evident, therefore, the use of data collected by mobile apps deserves caution. Usually, young people and women are more likely to complete the

surveys (Haddad *et al.*, 2022). Scholars have used different solutions: poststratification or weighting, ranking, propensity score adjustment or a combination of these methods. However, there is little consensus on whether or not to use weighting to correct for selection bias. According to Mercer *et al.* (2018), the choice of the variable for weighting is more important than the statistical methods used, and the basic weighting method performs as well as more elaborate ones. Moreover, a larger non-probability sample reduces the variability of the estimates but does not significantly increase the accuracy (Mercer *et al.*, 2018; Haddad *et al.,* 2022).

3. Questionnaire design

The population under study consists of individuals with foreign citizenship, naturalised or Italians born abroad, present in Lombardy during the data collection period.

The research design employs two questionnaires, with the main one being presented upon the first download of the app, while a second set of questions is proposed (conditional upon acceptance) at three subsequent deadlines, every month from the first compilation.

The questionnaires were designed to investigate the interaction between health status and socio-demographic factors. Therefore, in the main questionnaire, the questions were grouped into two sets: the health set and the socio-demographic set.

As for the former, we used the European Health Interview Survey (EHIS) and the Istat survey "Condizione e Integrazione Sociale dei Cittadini Stranieri" as references for formulating the questions. This approach ensures that questions have already been validated and allows us to compare our results with the national and European averages. The total number of questions for the health set is 20.

The socio-demographic set is made of 22 questions. A crucial point of this set of questions was to identify immigrants. We operationalised this by asking about the respondents' birthplace, their first and second nationality, parents' birthplace and their type of residence permit. The socio-demographic set was presented after the health status set to reduce the non-response rate[1] (Lor *et al.,* 2017) as well as social desirability bias linked to identity priming. However, as we wanted to ask some questions only to foreign citizens, we moved the question about the place of birth ("Were you born in Italy or abroad?") at the beginning of the questionnaire and filtered the following questions accordingly.

---

[1] Some demographic questions are largely recognized as sensitive and may be left unanswered or respondents may even choose to skip the entire survey due to confidentiality concerns.

As the questionnaire had to be self-completed, it was crucial to have a limited number of questions in order to limit the burden on respondents and increase the response rate. The total number of questions was 42. Of these, 4 were not proposed to people born in Italy and 3 were conditional on a previous affirmative answer, thus not always appearing[2]. The estimated average time of compilation was between 5 and 7 minutes.

The follow-up questionnaires are designed with two objectives. Firstly, to collect longitudinal data on three key aspects: current health status, health services used and barriers experienced in accessing healthcare. Secondly, to further investigate specific respondents' health behaviours, e.g. regarding alcohol and drug use in case they declared a frequent use of these substances in the main questionnaire. The estimated average time of compilation was 1 minute.

The questionnaires were designed in Italian and translated into 7 additional languages: English, French, Spanish, Arab, Chinese, Russian and Albanese. Languages were chosen according to the diffusion of the largest immigrant communities in the Lombardy region.

4. App design

As suggested by Jäckle *et al.* (2023) to increase the number of potential respondents, the ComeStai app was made available for both Android and iOS operating systems. As the app size is only 11 MB, it is fairly simple to download it both on WIFI and data, and it is unlikely that someone won't be able to install it because of a lack of storage space on their phone. When first opening the app, it presents to the users the following steps:

1. Choice of language
2. Informed consent regarding privacy issues
3. Informed consent regarding app notifications
4. Main questionnaire
5. Surfable information about healthcare in Italy and Milan area

At further openings of the app, the user is redirected directly to step 5.
In step 1, people using Android operating systems are forced to choose between the 8 available languages. Unfortunately, it was not possible to implement this feature on the iOS operating system. For Apple devices, by default, the app is set on the language used by the mobile phone, if this is among the 8 languages available, and

---

[2] Therefore, the total number of questions for a foreign-born individual spanned from 39 to 42, while the number of questions for a person born in Italy spanned from 35 to 38.

on Italian otherwise. Users can change the app language from the Settings area of their smartphone.

In step 2, people are informed about the objectives of the research and about the fact that the app does not collect personal data that allow the identification of the respondent such as phone numbers, emails, names, and geolocation of the respondents. Previous studies showed that asking permission for geolocalisation and collecting emails or addresses considerably reduces the consent to install apps (Jäckle *et al.* 2023; Jacobsen and Kühne, 2021; Wenz and Keush, 2023). All data collected through the surveys is therefore anonymous. Upon completion of the surveys, the responses are assigned to a progressive ID number and directly stored in a database of the University of Milano-Bicocca. As no data is stored on the respondents' phones, third parties cannot access the data even in case of loss of the device.

In step 3, people are informed that in the following 3 months, the app will send 3 notifications to check again on their health status. They can accept or refuse to receive notifications. If they accept, after 30, 60 and 90 days from the first compilation, a notification is sent to the mobile phones redirecting to the 3 follow-up questionnaires. Over the 3 months, no other notifications are sent apart from these. This is consistent with the best practices identified in previous studies (Jäckle et al. 2023), which suggest that users are more likely to allow notifications when the reason is given and the task is not demanding, such as a long period of analysis or frequent requests (daily or weekly).

The in-app platform provides information about healthcare for foreign citizens in Italy and Milan, organised in 9 tabs. The users can navigate through brief and simple descriptions about how to access public health services in Italy and some information on prevention services (free screening campaigns) and on the correct behaviours to maintain a healthy life (nutrition, active lifestyle, smoking, sun exposure); a list of all basic public health services available in the Milan Metropolitan area (emergency rooms, centres for addictions, centres for family planning, centres for mental health); as well as a list of the third-sector associations offering free healthcare to migrants in Milan. Links redirecting to the relevant external web pages are provided, including Google Maps links to geolocate the listed services. We also provide a summary map displaying all the points of interest, which was constructed using the "MyMaps" function of Google Maps. Users can also contact the research team through a dedicated email account, as shown within the app. All the contents can be updated over time by the research team through the University server, with no need for action on the respondents' side, i.e. no need to re-download or update the app. This can be considered an incentive to participate although frequently the incentive is monetary. However, Jäckle *et al.* (2023) highlighted that monetary incentives could not compensate for the burden. Jacobsen and Kühne (2021) provided the users with news

on the situation of refugees in Europe without testing the effect of this incentive, however, the consent to use the mobile app was higher among those who arrived in the last 3 years compared to long-term refugees.

5. Invitation design

To recruit the participants, we used different channels. Firstly, we organised, with CSV Milano, several meetings with the selected NGOs that have participated in the design of the app, to help us disseminate ComeStai among their services' users. We provided them with some full-colour flyers in Italian and two posters (one in Italian and one multilingual, Spanish, Chinese, Russian and Arab) showing the purpose of the survey, the name and the logo of the app, the QR code to download the app from both Apple's and Android's app stores, and the logo of the University Bicocca. These elements help to find the app reducing the risk of non-recognition of the app in the stores. According to Wenz and Keush (2023), the identification of the organisation sponsoring the study is crucial to increasing the response rate with apps sponsored by universities showing a higher response rate than those sponsored by market research companies. Secondly, we emailed migrant communities or other associations involved in helping migrants based in the Milan Metropolitan area, introducing the project and the survey, and providing the flyers. Thirdly, the university's press office informed the newspaper. Two of them agreed to publish a short article about the app. Fourth, we promoted the survey through Facebook. Finally, we solicited each staff members' personal contacts to participate in the survey. As shown in Table 1, we sent 192 messages, and we received feedback from 17 of these contacts who decided to promote the app among their users or associates. In addition to overcoming the reluctance of migrants to download the app, the research team or the volunteers invited in-person the users of some services to download the app, helped them with the download and answered their doubts about the questionnaire. As suggested by previous studies (Jäckle et al. 2023), in fact, an in-person invitation increases the participation rate.

Table 1 - *Recruitment of the participant*

Contact	Total
Health services	28
Cultural or community association	64
Place of worship	5
Social networks - newspaper	29
Other associations (Italian language schools, legal services, housing…)	66
Total	192

6. Sample

In the first 4 months since the app was published on the stores' web pages (March-June 2024), we collected 224 answers, of which 92 were from natives. We excluded the latter cases and we focused only on foreign-born and naturalised persons (132 observations). Our sample is unbalanced in terms of gender composition with a higher percentage of women (64.4%) which confirms the higher participation rate of women. The age distribution is quite homogeneous across the age groups, and we interviewed people from 38 different countries of origin. The distribution by country of origin reflects the distribution of the resident foreign population in the metropolitan area of Milan with a higher percentage of Egyptians, Peruvians, Filipinos and Senegalese. The sample is biased with respect to the length of stay: a large proportion of respondents (40%) had recently arrived in Italy (last 2 years). Despite our efforts to disseminate the app through different channels, it was easier to reach foreign-born people who had recently arrived. The availability of information about health services probably acted as an incentive especially for those who needed it, confirming previous studies (Jacobsen and Kühne 2021).

7.   Discussion

While using an app to interview migrant populations presents many advantages, it also comes with several limitations and challenges, most of them anticipated in Section 1. Among these limitations, we found that language barriers can impact sensibly on results. Although the app supports multiple languages, ensuring accurate and culturally appropriate translations is challenging, misunderstandings or mistranslations can affect the quality of the data collected. For example, in our main questionnaire, the question "Was one of your parents born abroad?" was sometimes misunderstood, i.e. some immigrant respondents took their country of origin as country of reference and answered that their parents were *not* born abroad (meaning not born in a third country), while the phrasing intent was to consider any country other than Italy as "abroad". This generated a few incorrect answers. The issue could be solved by asking "Was one of your parents born outside Italy?". Another important issue refers to privacy concerns. Migrants might have concerns about the confidentiality and security of their data, particularly if they are undocumented or fear repercussions. These concerns can lead to lower participation rates or less honest responses. This can indeed be the case of the app here presented, as it deals with health and sanitary issues, which are sensitive data. One way to mitigate this limitation is to present the app to the target population with the help of trusted testimonials, such as NGO volunteers, especially if they belong to the same ethnic

background. Indeed, planning a close collaboration with the main NGOs in the area is one of the key operational strategies needed, both to ensure higher participation in the survey and to improve the overall quality of the responses. The collaboration with the NGOs is a crucial factor especially for longitudinal studies, as in the case of the app presented here. Establishing a close collaboration with NGOs is far from simple. Ultimately, it entails creating a tool, the app, that must be useful to three stakeholders with different needs: researchers, users, and NGOs. In this sense, the app's area dedicated to "content feedback" must be functional to the needs of users and NGOs, and therefore it must be carefully designed and maintained, possibly also with the collaboration of the NGOs themselves. Finally, we also suggest that combining the app-based surveys with other data collection methods, such as face-to-face interviews or paper surveys, can also help reach a broader and more representative sample.

We sent 192 messages through different channels, but most of these messages did not receive a response. The sample size is in line with other studies using apps, as, according to Zhang *et al.* (2018), the median sample size is 95. As mentioned above, our sample is quite heterogeneous in terms of age and country of origin, while it shows some specificity in terms of gender and length of stay.

As for the timeline, each step takes time, which is difficult to predict. The dissemination of the app took longer than expected because, to ensure user participation, we had to contact NGOs to present the app with ad hoc meetings, which always take time to be organised, and we had to allocate additional time for the volunteers to answer the questionnaire and navigate the in-app information on health services in order to receive their evaluation of the potential usefulness for their users. Volunteers disseminated the app to their users through social media posting, distributing the flyers, sending emails and WhatsApp messages to their contacts, or they encouraged their users to download the app during classes or other in-person meetings.

In conclusion, we can take stock of the experiment described in the preceding pages. The use of the ComeStai app as a data collection tool proved to be quite costly in terms of the time dedicated to promoting the tool among members of a "rare and elusive" population. It should also be noted that in this specific case, the topic (health) and the target population (migrants) presented numerous complexities regarding the sensitive points of administering a questionnaire via app (privacy, language, etc.). Numerically, the results were limited, although in line with the experiences cited in the literature. The low number of responses does not allow for comparisons between the different components of the reference population (e.g., legally and illegally present migrants); however, we can discern the positive value of this experience in two particular aspects:

- Enhanced Engagement: Despite the challenges, the process of engaging with the migrant population through the ComeStai app demonstrated the potential for building trust and fostering participation, especially when facilitated by trusted intermediaries such as NGO volunteers.
- Data Integration Potential: The information collected, although limited in quantity, holds significant potential for integration with other data sources. This can enrich the overall understanding of health issues within the migrant population and support the development of more targeted and effective health interventions.

Acknowledgements

References

COUPER M.P. 2013. Is the Sky Falling? New Technology, Changing Media, and the Future of Surveys, *Survey Research Methods* Vol. 7, No. 3, pp. 145-156.

FAN W., YAN Z. 2010. Factor affecting response rate of the web survey: A systematic review, *Computers in Human Behavior,* Vol. 26, pp. 132-139.

HADDAD C., SACRE H., ZEENY R.M., HAJI A., AKEL M., ISKANDAR K., SALAMEH P. 2022. Should sample be weighted to decrease selection bias in online surveys during the COVID-19 pandemic? Data from seven datasets, *BMC Medical Research Methodology*, Vol. 22 No. 63.

JÄCKLE A., BURTON J., COUPER M. P. 2023. Understanding Society: minimising selection biases in data collection using mobile apps, *Fiscal Studies,* Vol. 44, pp. 361–376. DOI: 10.1111/1475-5890.12351.

JÄCKLE A., WENZ A., BURTON J., COUPER M.P. 2022. Increasing Participation In A Mobile App Study: The Effects Of A Sequential Mixed mode Design And In-Interview Invitation, *Journal of Survey Statistics and Methodology,* Vol. 10, pp. 898–922.

JACOBSEN J., KÜHNE S. 2021. Using Mobile App When Surveying Highly Mobile Populations: Panel Attrition, Consent, and Interviewer Effect in a Survey of Refugees, *Social Science Computer Review*, Vol. 39, No. 4, pp. 721-743.

LOR M., BOWERS B. J., KRUPP A., JACOBSON N. 2017. Tailored explanation: A strategy to minimize nonresponse in demographic items among low-income racial and ethnic minorities, *Survey Practice*, Vol. 10, No. 3, pp. 1-11.

MARCANO BELISARIO J.S., JAMSEK J., HUCKVALE K., O'DONOGHUE J., MORRISON C.P., CAR J. 2015. Comparison of self-administered survey questionnaire responses collected using mobile apps versus other methods (Review), *Cochrane Database of Systematic Reviews*, Vol. 7, No. MR000042.

MERCER A., LAU A., KENNEDY C. 2018. For Weighting Online Opt-In Samples, What Matter Most? Pew Research Center https://www.pewresearch.org/methods/2018/01/26/for-weighting-online-opt-in-samples-what-matters-most/

OAKLEY-GIRVAN I., LAVISTA J. M., MILLER Y., DAVIS S., ACLE C., HANCOCK J., NELSON L. M., 2018. Evaluation of a Mobile Device Survey System for Behavioral Risk Factors (SHAPE): App Development and Usability Study, *JMIR Formativ Res,* vol. 3, No. 1 e10246.

ROCHEVA A., VARSHAVER E., IVANOVA N. 2022.Targeting on Social Networking Sites as Sampling Strategy for Online Migrant Surveys: The Challenge of Biases and Search for Possible in S. PÖTZSCHKE, S. RINKEN (Eds.), *Migration Research in a Digitized World*, IMISCOE Research Series, https://doi.org/10.1007/978-3-031-01319-5_3, pp. 35- 58.

WENZ A., KEUSCH F. (2023) Increasing the Acceptance of Smartphone-Based Data Collection, *Public Opinion Quarterly*, Vol. 87, No. 2, pp. 357–388.

ZHANG J., CALABRESE C., DING J., LIU M., ZHANG B. 2018. Advantages and challenges in using mobile apps for field experiments: A systematic review and a case study, *Mobile Media & Communication*, Vol. 6, No. 2, pp. 179–196.

_____

Chiara ALLEGRI, Università degli Studi di Milano-Bicocca, chiara.allegri@unimib.it

Alessandro AVELLONE, Università degli Studi di Milano-Bicocca, alessandro.avellone@unimib.it

Elisa BARBIANO DI BELGIOJOSO, Università degli Studi di Milano-Bicocca, elisa.barbiano@unimib.it

Sara KHATAB, Università degli Studi di Milano-Bicocca, sara.khatab@unimib.it

Dario PESCINI, Università degli Studi di Milano-Bicocca, dario.pescini@unimib.it

Stefania M. L. RIMOLDI, Università degli Studi di Milano-Bicocca, stefania.rimoldi@unimib.it

Antonella ZAMBON, Università degli Studi di Milano-Bicocca, antonella.zambon@unimib.it

HEALTH STATUS BY CITIZENSHIP: INSIGHT FROM SURVEY AND REGISTER DATA ON IMMIGRANT HEALTH IN ITALY

Elisa Cisotto, Eleonora Meli, Cecilia Tomassini, Giulia Cavrini

Abstract. This paper analyses the health status of immigrants in Italy, focusing on their citizenship status and the impact of both individual and macro-level factors on their health. We specifically investigate whether immigrants report different levels of health conditions compared to native-born individuals, using measures such as self-rated health, the number of chronic diseases, and functional limitations. Additionally, we evaluate the relationship between citizenship acquisition and health, while also considering the role of family and social support networks.

The study uses a combined dataset of survey and register data from the ISTAT 'Families, Social Subjects, and Life Cycle' (FSS) survey conducted in 2016. By linking FSS 2016 survey participants with citizenship acquisition registers, we ascertain the citizenship status of immigrants in Italy.

Key findings indicate significant health disparities among different migrant sub-groups. Foreigners have higher odds of reporting good or very good self-rated health compared to Italians but significantly lower odds of experiencing functional limitations and chronic diseases, highlighting a potential 'healthy immigrant effect,' where immigrants often arrive in better health compared to the native-born population. Naturalised citizens tend to have health outcomes more similar to those of native-born Italians, suggesting that the integration process, as proxied by naturalisation, may align immigrant health outcomes with those of the host population.

Our study underscores the importance of considering both individual-level factors and broader socio-economic determinants when addressing health disparities among migrant populations. It highlights the need for tailored public health interventions that consider the unique social support structures and integration processes of migrant sub-groups.

1. Background

Although migration brings numerous positive societal effects, such as meeting labour market demands and sustaining welfare models, the recent large-scale population movements require substantial adaptations in public health and health systems (Pottie *et al*., 2017 Trummer and Krasnik, 2017). Health systems must adapt to address the needs of both disadvantaged migrant populations and non-migrant

residents. Consequently, there has been an increasing focus on the health of migrants in host countries, recognizing the unique challenges and health disparities they face.

Migrants' susceptibility to illness is generally comparable to that of the general population; however, significant health disparities exist among different migrant sub-groups, often delineated by their countries of origin (WHO, 2024). A considerable proportion of migrants are part of the working-age population employed in low-paid jobs and are more likely to hold insecure, temporary contracts. Moreover, migrants may find themselves in vulnerable situations due to the reasons compelling them to leave their country of origin, the circumstances in which they travel, or the conditions they face upon arrival. Further, moving from one country to another entails not only a separation from the country of origin but also the challenging process of integrating into a new physical, institutional, and sociocultural environment. The loss of former support networks, or at the very least their transformation, presents immigrants with the need to rebuild their social support systems in the host country, involving an active search for support.

Research shows that people with greater social support, less isolation, and higher levels of interpersonal trust live longer and healthier lives than those who are socially isolated. Support from living arrangements and family members can provide a buffering effect against health deterioration among migrants, making social support a critical factor influencing their health (Yang *et al*., 2023; Salgado *et al*., 2012; Wong *et al*., 2008). Effective social support plays a positive role in promoting and protecting both physical and mental health, significantly alleviating migration-related stress (Fogden *et al*., 2020; Schweitzer *et al*., 2006). This positive impact of social support is also evident among migrants residing in Italy (Novara *et al*., 2023).

Despite the growing recognition of the importance of this issue, gaps remain in our understanding of the relationship between migration and health, especially in countries with a relatively recent history of immigration like Italy.

This study aims to explore whether foreigners residing in Italy report different levels of health compared to native-born individuals. Among the various questions regarding the health of foreigners, we focus on the role of naturalisation, together with the presence of family and social support networks. From this perspective, we examine the health status of foreigners and foreign-born migrants residing in Italy in 2016. A key objective of our analysis is to evaluate the utility of a combined dataset of survey and register data in studying migrant health. The primary dataset comes from the ISTAT 'Families, Social Subjects, and Life Cycle' (FSS) survey conducted in 2016, which represents a cross-section of Italy's adult population (ISTAT 2016). By linking FSS 2016 survey participants with citizenship acquisition registers, we obtain data on the year of naturalisation from 2012. To our knowledge, no previous studies have merged these data sources to investigate migrants' health and family

information. Therefore, this study offers an in-depth view of migrants' health, the role of citizenship, and the influence of family and social support.

2. Method

The study is based on a combined dataset of survey and register data. The primary dataset comes from the ISTAT 'Families, Social Subjects, and Life Cycle' (FSS) survey conducted in 2016, representing a cross-section of Italy's adult population (ISTAT 2016). By linking FSS 2016 survey participants with citizenship acquisition registers and obtaining data on the year of naturalisation spanning from 2012 to 2021, we ascertain the citizenship status of immigrants in Italy.

In this study, we utilised data from the FSS questionnaire to create three dichotomous variables based on specific health-related questions. First, respondents were asked to assess their general health (SRH), with response options being very good, good, neither good nor bad, bad, and very bad. For analysis purposes, we created a dummy variable where 1 represented good or very good health and 0 represented all other responses. Second, respondents were inquired about the presence of chronic diseases or long-term health problems, defined as conditions lasting or expected to last at least six months. Based on the response, a dummy variable was created where 1 indicated the presence of chronic diseases or long-term health problems and 0 indicated their absence. Last, respondents were asked if they experienced limitations lasting at least six months in performing usual activities due to health problems (ADLs), with responses categorised as severe limitations, non-severe limitations, and no limitations. From these responses, we created a dummy variable where 0 indicated no limitations and 1 indicated severe or non-severe limitations.

To achieve the study's objectives, we utilized multivariate logistic regression analysis to investigate the associations between various individual- and macro-level factors influencing immigrant well-being. Key variables include the acquisition of Italian citizenship and the presence of family and social support networks. Specifically, the frequency of personal contacts is assessed using a dummy variable indicating at least weekly personal contact (1) or less frequent contact (0). Social support is measured by two key variables: informal help and formal help. Informal help is assessed by whether respondents received assistance from people outside the household and is categorized as no (0) and yes (1). Formal help is measured by whether respondents received economic assistance from institutions, also categorized as no (0) and yes (1).

As control variables, demographic information includes age (categorised as 18-34 and 35-64), sex, and marital status (categorised as married, never married,

separated/divorced, and widowed). Socioeconomic status is assessed through educational attainment, which indicates the highest level of education completed by respondents and is categorised as tertiary, secondary, and primary education. Perceived economic resources measure respondents' perceived adequacy of economic resources, categorised as very good or sufficient, and insufficient or absolutely insufficient.

In all models, robust standard errors (S.E.) were used, and the data were weighted using normalised ISTAT weights. All the analyses were performed using Stata 18.

3. Results

3.1. Descriptives

Table 1 provides the sample characteristics stratified by citizenship status, based on weighted data from the ISTAT 2016 FSS survey. The sample comprises 17,982 respondents, with 9.8% identified as foreigners, 2.2% as naturalised citizens, and 88% as Italians.

The data reveal significant differences in demographic and socio-economic variables among the three groups. Most of the foreign and naturalised respondents are foreign-born (98.0% and 93.0%, respectively), contrasting sharply with the Italian group (1.5%). A notable proportion of naturalised citizens (50.5%) have held citizenship for over five years, suggesting a significant period of integration and adjustment.

Age distribution indicates a higher percentage of younger individuals (18-34 years) among foreigners (37.2%) compared to naturalised citizens (29.2%) and Italians (28.6%). Conversely, the 35-64 age group is more prevalent among naturalised citizens (70.8%) and Italians (71.4%) than among foreigners (62.8%). This demographic shift might reflect Italy's relatively recent history as a migration-receiving country and the integration phase where younger immigrants either naturalise or remain as foreigners. Gender distribution shows a slightly higher proportion of women among naturalised citizens (58.3%) compared to foreigners (53.7%) and Italians (49.8%).

Regarding family and social characteristics, naturalised citizens are more likely to be married (61.7%) compared to foreigners (51.9%) and Italians (51.5%). This finding aligns with the naturalisation process, where marriage is a common pathway to citizenship (Boyd and Grieco, 2003), with women having a higher propensity to acquire citizenship through marital ties (Boyd and Grieco, 2003; Jasso and Rosenzweig, 1995).

Social support variables highlight that weekly personal contact is significantly lower among foreigners (20.5%) compared to naturalised citizens (28.0%) and Italians (59.9%). This reduced social interaction among foreigners may indicate potential social isolation, a common challenge faced by immigrants (Cacioppo and Cacioppo, 2014).

The proportion of individuals receiving help is relatively similar across the groups, with 13.3% of foreigners, 17.1% of naturalised citizens, and 15.3% of Italians reporting receiving help. Economic help from institutions is more common among foreigners (7.0%) than among naturalised citizens (3.5%) and Italians (1.3%), reflecting potentially greater economic vulnerability among foreigners (Borjas, 1999). Educational attainment reveals that tertiary education is less common among foreigners (13.2%) and naturalised citizens (13.7%) compared to Italians (17.1%). Furthermore, economic resources are perceived as insufficient by a larger proportion of foreigners (54.3%) compared to naturalised citizens (36.6%) and Italians (29.5%). This underscores the economic challenges faced by the foreign-born population, which can be impacted by the disparity in educational attainment affecting employment opportunities and socio-economic integration for immigrants (Chiswick and Miller, 2009).

Table 1 − *Sample characteristics by citizenship status. Weighted data.*

	Foreigners	Naturalised	Italians	Total
n (abs.)	1,231	385	16,366	17,982
n (%)	9.8	2.2	88.0	100.0
Foreign-born	98.0	93.0	1.5	
Citizen for > 5 years		50.5		
18-34	37.2	29.2	28.6	29.5
35-64	62.8	70.8	71.4	70.5
Women	53.7	58.3	49.8	50.3
Tertiary education	13.2	13.7	17.1	16.7
Married	51.9	61.7	51.5	51.8
Weekly personal contact	20.5	28.0	59.9	55.3
Help receivers	13.3	17.1	15.3	15.1
Economic help by institution	7.0	3.5	1.3	1.9
Insufficient economic resources	54.3	36.6	29.5	32.1
Good SRH	82.2	79.1	78.7	79.1
At least one chronic disease	7.9	13.8	14.9	14.2
ADLs	5.2	6.6	7.3	7.1
Severe ADLs	2.4	2.7	2.9	2.9

Source: Famiglia e Soggetti Sociali, ISTAT.

Health status indicators suggest that most respondents report good self-rated health (SRH), with slightly higher proportions among foreigners (82.2%) compared to naturalised citizens (79.1%) and Italians (78.7%). The prevalence of chronic diseases is lower among foreigners (7.9%) than among naturalised citizens (13.8%) and Italians (14.9%). Lastly, functional limitations (ADLs) are reported by 5.2% of foreigners, 6.6% of naturalised citizens, and 7.3% of Italians, with severe ADLs being reported by a smaller fraction across all groups. These findings indicate that functional limitations are relatively consistent across groups but slightly higher among Italians, possibly due to an older age distribution in this group.

3.2. *Health outcomes by citizenship status*

Figure 1 reports odds ratios and robust standard errors from logistic regression models of citizenship status and three health outcomes: good or very good self-reported health (SRH), presence of at least one chronic disease, and severe or non-severe functional limitations (ADLs).

Figure 1 − *Odds ratio (OR) and robust standard errors from logistic regression models for the three health outcomes (good or very good SRH, presence of at least one chronic disease and ADLs limitations) and citizenship status (reference=Italians). Weighted data.*
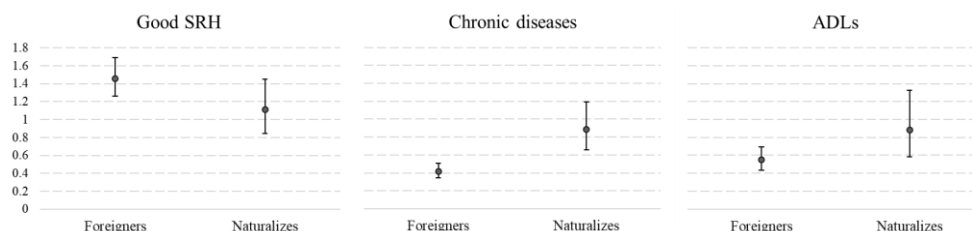
Source: Own elaboration on Families, Social Subjects and life cycle (FSS), ISTAT, 2016. All models control for age (18-34, 35-64), sex, marital status, contacts with the family, received formal and informal help, education and perceived economic resources (see Table 2).

For citizenship status, foreigners generally report better health outcomes compared to Italians. Specifically, foreigners have significantly higher odds of reporting good or very good self-rated health (OR = 1.458, 95% CI: 1.259-1.687) and significantly lower odds of experiencing functional limitations (OR = 0.550, 95% CI: 0.435-0.694) and chronic diseases (OR = 0.417, 95% CI: 0.345-0.505) compared to Italians. This may reflect the so-called 'healthy immigrant effect', where immigrants often arrive in better health compared to the native-born population (McDonald and Kennedy, 2004). Naturalised citizens, on the other hand,

show health outcomes more similar to those of Italians. They do not have significantly different odds of reporting good or very good SRH (OR = 1.109, 95% CI: 0.847-1.452), functional limitations (OR = 0.880, 95% CI: 0.585-1.324), or chronic diseases (OR = 0.888, 95% CI: 0.660-1.193) compared to Italians. This suggests that the integration process, as implied by naturalisation, may influence health status, potentially aligning it more closely with that of native-born citizens.

Overall, family and social networks have a mixed role in relation to health outcomes (Table 2). Weekly personal contact is not significantly associated with the odds of reporting good or very good self-rated health, chronic diseases, or functional limitations. However, receiving help (both informal and formal) is negatively associated with health conditions. These results may reflect the greater need for assistance among individuals with poorer health. Marital status associations are less pronounced, with never married, separated/divorced, and widowed individuals showing varying odds ratios for different health outcomes, but generally not significantly different from married individuals. Notably, widowed individuals have higher odds of experiencing functional limitations and chronic diseases, and lower odds of reporting good or very good self-rated health.

Table 2 − *Odds ratio (OR) and robust standard errors from logistic regression models for the three health outcomes (good or very good SRH, presence of at least one chronic disease and ADLs limitations). Control variables. Weighted data.*

Control variables	Good SRH			Chronic diseases			ADLs		
	OR	95% CI		OR	95% CI		OR	95% CI	
35-64 (ref=18-34)	0.262	0.229 -	0.299	2.570	2.246 -	2.943	2.642	2.189 -	3.189
Women (ref=men)	1.307	1.206 -	1.416	0.776	0.711 -	0.848	0.935	0.830 -	1.054
Never married (ref=married)	1.085	0.977 -	1.205	0.968	0.863 -	1.085	1.307	1.122 -	1.521
Separated/Divorced (ref=married)	0.986	0.867 -	1.121	1.013	0.878 -	1.170	1.202	0.996 -	1.450
Widowed (ref=married)	0.461	0.366 -	0.581	1.375	1.061 -	1.782	2.272	1.698 -	3.040
Secondary education (ref=primary)	1.788	1.639 -	1.951	0.804	0.730 -	0.886	0.536	0.470 -	0.613
Tertiary education (ref=primary)	2.145	1.881 -	2.446	0.818	0.715 -	0.935	0.471	0.383 -	0.578
Weekly personal contact (ref=no)	1.005	0.922 -	1.096	0.972	0.884 -	1.068	0.965	0.848 -	1.097
Receive help (ref=no)	0.790	0.709 -	0.880	1.602	1.435 -	1.789	1.737	1.501 -	2.011
Receive economic help by institution (ref=no)	0.667	0.520 -	0.856	1.733	1.324 -	2.270	1.756	1.284 -	2.403
Very good/good economic resources (ref=bad/very bad)	2.229	2.052 -	2.422	0.581	0.530 -	0.637	0.453	0.400 -	0.512

Source: Own elaboration on Families, Social Subjects and life cycle (FSS), ISTAT, 2016. All models control for citizenship status (Figure 1).

Among the other control variables, all directions are consistent with what is expected according to the literature. Individuals aged 35-64 have significantly higher odds of experiencing functional limitations and chronic diseases, and significantly lower odds of reporting good or very good self-rated health compared to those aged 18-34. Gender differences are notable, with males having lower odds of functional limitations and chronic diseases, and higher odds of reporting good or very good self-rated health compared to females. Educational attainment is inversely related to

negative health outcomes, as are perceived economic resources. Higher educational attainment (secondary and tertiary) is associated with better self-rated health and lower odds of functional limitations compared to primary education. Additionally, tertiary education lowers the odds of chronic diseases compared to primary education. Perceived economic resources, categorized as very good or good, are strongly associated with better health outcomes. Overall, these findings underscore the importance of socio-economic factors in determining health outcomes.

4. Discussion

This study provides a first analysis of the health status of foreigners and foreign-born migrants residing in Italy, with a particular focus on the role of citizenship acquisition and social support networks. Our key findings indicate significant health disparities among different migrant sub-groups. Specifically, foreigners have higher odds of reporting good or very good self-rated health compared to native-born Italians. Conversely, they have significantly lower odds of experiencing functional limitations and chronic diseases. Interestingly, naturalised citizens tend to have health outcomes more similar to those of native-born Italians, suggesting that the integration process, as proxied by naturalisation, may play a crucial role in aligning immigrant health outcomes with those of the host population. Additionally, our results support the 'healthy immigrant effect,' with immigrants exhibiting better health upon arrival compared to the native-born population (Kennedy *et al*., 2006; McDonald and Kennedy, 2004). Given that Italy has a relatively recent history as an immigration country, the immigrant population is predominantly young. This demographic characteristic implies that most immigrants have not resided in the country long enough to experience the well-documented phenomenon where the initial health advantage diminishes with longer stays in the host country. This decline in health, often observed as migrants adapt to the lifestyle and environmental factors of the host country, can be attributed to various factors, including stress associated with the migration process, changes in lifestyle and diet, and barriers to accessing healthcare services (Giannoni *et al*., 2016; Marmot *et al*., 2008; Newbold, 2005; Razum *et al*., 2000). The alignment of health outcomes of naturalised citizens with those of native-born Italians suggests that naturalisation and the associated socio-economic integration play a critical role in mitigating these adverse effects.

Overall, foreigners report diverse configurations of family and social relationships and generally better health conditions, given equivalent socio-demographic, familial, and economic variables. Our analysis highlights the critical role of social support in relation to health outcomes. Weekly personal contact is not significantly associated with reporting good or very good health, chronic diseases,

or functional limitations. However, receiving no help, both informal and formal, is significantly associated with lower odds of reporting good or very good health, chronic diseases, and functional limitations. This likely reflects the greater need for assistance among individuals with poorer health and suggests a need for further analysis of the interaction between family and social support, citizenship, and health outcomes.

Several limitations of the study should be acknowledged. First, the cross-sectional nature of the FSS ISTAT survey limits our ability to establish causal relationships between citizenship status, social support, and health outcomes. Longitudinal data would be more appropriate to assess the long-term impact of naturalisation and social support on health. Second, the reliance on self-rated health measures may introduce reporting bias, as individuals' perceptions of their health can be influenced by various subjective factors. These perceptions may vary significantly across different cultures within the migrant groups. Due to sample size limitations, the study cannot account for the heterogeneity within migrant groups, such as differences in cultural background, migration experience, and length of stay in Italy, which could influence health outcomes in complex ways.

Furthermore, while the linkage of survey data with citizenship acquisition registers provides valuable insights, it is limited to individuals who participated in the survey, potentially omitting important sub-groups of the migrant population. Another limitation is the potential underrepresentation of undocumented migrants or those with precarious legal status, who may face even greater health disparities but are less likely to be captured in official surveys and registers.

Although this study is limited to relatively more integrated migrants, it offers valuable insights and sets the stage for further research. It contributes to the growing body of literature on migrant health by leveraging a unique dataset that combines survey and register data to provide a nuanced understanding of the health status of immigrants in Italy. Our findings underscore the importance of considering both individual-level factors, such as citizenship status and social support, and broader socio-economic determinants when addressing health disparities among migrant populations.

Future research should examine the effect of time since naturalisation (within ±5 years) and assess measures of family and social contact to further deepen our understanding of migrant health. Additionally, developing a social vulnerability index could help identify the most at-risk groups and tailor interventions more effectively.

Acknowledgements

References

BORJAS G.J. 1999. *Heaven's door: Immigration policy and the American economy*. Princeton, NJ: Princeton University Press.

BOYD M., GRIECO E. 2003. *Women and migration: Incorporating gender into international migration theory*. Washington, DC: Migration Policy Institute.

CACIOPPO J.T., CACIOPPO S. 2014. Social relationships and health: The toxic effects of perceived social isolation, *Social and Personality Psychology Compass*, Vol. 8, No. 2, pp. 58-72.

CHISWICK B.R., MILLER P.W. 2009. The international transferability of immigrants' human capital, *Economics of Education Review*, Vol. 28, No. 2, pp. 162-169.

MCDONALD J.T., KENNEDY S. 2004. Insights into the healthy immigrant effect: health status and health service use of immigrants to Canada, *Social Science & Medicine*, Vol. 59, No. 8, pp. 1613-1627.

FOGDEN G., BERLE D., STEEL Z. 2020. The impact of family separation and worry about family on psychological adjustment in refugees resettled in Australia, *Journal of Trauma Stress*, Vol. 33, No. 6, pp. 894–907.

GIANNONI M., FRANCO M., BENDEK M. 2016. Migrant integration policies and health inequalities in Italy, *European Journal of Public Health*, Vol. 26, No. 2, pp. 333-339.

ISTAT. 2016. Sistema di indagini Multiscopo sulle famiglie, Indagine Famiglie, soggetti sociali e ciclo di vita, www.istat.it.

JASSO G., ROSENZWEIG M.R. 1995. Do immigrants screen economic opportunities? The role of visas in immigration to the United States, *International Migration Review*, Vol. 29, No. 1, pp. 85-111.

KENNEDY S., MCDONALD J.T., BIDDLE N. 2006. The healthy immigrant effect and immigrant selection: Evidence from four countries, *Social Science & Medicine*, Vol. 63, No. 8, pp. 1979-1994.

MCDONALD J.T., KENNEDY S. 2004. Insights into the 'healthy immigrant effect': Health status and health service use of immigrants to Canada, *Social Science & Medicine*, Vol. 59, No. 8, pp. 1613-1627.

NEWBOLD K.B. 2005. Self-rated health within the Canadian immigrant population: Risk and the healthy immigrant effect, *Social Science & Medicine*, Vol. 60, No. 6, pp. 1359-1370.

NOVARA M.J., MARTOS-MÉNDEZ L., GÓMEZ-JACINTO L., HOMBRADOS-MENDIETA I., VARVERI C., POLIZZI C. 2023. The influence of social support on the wellbeing of immigrants residing in Italy: Sources and functions as predictive factors for life satisfaction levels, sense of community and resilience, *International Journal of Intercultural Relations*, Vol. 92, pp. 101743. DOI: 10.1016/j.ijintrel.2022.101743.

POTTIE K., HUI C., RAHMAN P., INGLEBY D., AKL E.A., RUSSELL G., LING L., WICKRAMAGE K., MOSCA D., BRINDIS C.D. 2017. Building responsive health systems to help communities affected by migration: an international Delphi consensus, *International Journal of Environmental Research and Public Health*, Vol. 14, No. 2, pp. 144.

MARMOT M., ALLEN J., BELL R., BLOOM G., GOLDLUST J., JAKAB Z., KOH H., LANCET J., MATTHEWS R., MOLD C., NEIRA M., WHITEHEAD M. 2008. Closing the gap in a generation: Health equity through action on the social determinants of health. *Lancet*, Vol. 372, No. 9650, pp. 1661-1669.

RAZUM O., ZEEB H., AKKAYA G. 2000. Low overall mortality of Turkish residents in Germany persists and extends into a second generation: Merely a healthy migrant effect? *Tropical Medicine and International Health*, Vol. 5, No. 4, pp. 297-303.

SALGADO H., CASTAÑEDA S.F., TALAVERA G.A., LINDSAY S.P. 2012. The role of social support and acculturative stress in health-related quality of life among day laborers in Northern San Diego, *Journal of Immigrant and Minority Health*, Vol. 14, pp. 379–385. DOI: 10.1007/s10903-011-9568-0.

SCHWEITZER R., MELVILLE F., STEEL Z., LACHEREZ P. 2006. Trauma, post-migration living difficulties, and social support as predictors of psychological adjustment in resettled Sudanese refugees, *Australian and New Zealand Journal of Psychiatry*, Vol. 40, No. 2, pp. 179–187.

TRUMMER U., KRASNIK A. 2017. Migrant health: the economic argument, *European Journal of Public Health*, Vol. 27, No. 4, pp. 590–591.

WONG D.F., LEUNG G. 2008. The functions of social support in the mental health of male and female migrant workers in China, *Health and Social Work*, Vol. 33, pp. 275–285. DOI: 10.1093/hsw/33.4.275.

YANG Y., ZHAO S., LIN L., QIAN J., ZHANG H., CAI F. 2023. Social support and quality of life in migrant workers: Focusing on the mediating effect of healthy lifestyle, *Frontiers in Public Health*, Vol. 11, Article 1061579. DOI: 10.3389/fpubh.2023.1061579.

WHO. 2024. *WHO global action plan on promoting the health of refugees and migrants, 2019–2030*. Geneva: World Health Organization. Licence: CC BY-NC-SA 3.0 IGO.

_____

Elisa CISOTTO, Università Cattolica del Sacro Cuore, elisa.cisotto@unicatt.it
Eleonora MELI, Istat, elmeli@istat.it
Cecilia TOMASSINI, University of Molise, cecilia.tomassini@unimol.it
Giulia CAVRINI, Free University of Bolzano-Bozen, giulia.cavrini@unibz.it

OBSTETRICAL HEALTH CONSEQUENCES OF FEMALE GENITAL MUTILATIONS/CUTTINGS: EVIDENCE FROM ITALIAN HOSPITAL DISCHARGE RECORDS

Chiara Allegri, Helen Banks

Abstract. More than 230 million women live with FGM/C worldwide, a condition linked to adverse health consequences, and for which the quality of available health care is often inadequate. As it is hard to identify and reach migrant women with FGM/C living in host countries, the research on this population group in Europe is limited. This paper focuses on the Italian context. The aim is to investigate the probability for immigrants coming from countries where FGM/C is practiced to be hospitalised for FGM/C-related obstetrical issues, using data from Italian Hospital Discharge Records for the year 2019. Results show that an increase of 1 percent point in the home country FGM/C prevalence is correlated with an increase of 0.43% in the probability of being hospitalised for an FGM/C-related obstetrical condition. Further research should aim at differentiating between the FGM/C types, with a focus on the most harmful practices, i.e. infibulation, and at investigating other potential health consequences, such as physical, sexual and psychological conditions.

1. Introduction

The term "female genital mutilation or cutting", hereafter FGM/C, refers to any procedure of modification, partial or total removal or other injury to the female genital organs for non-medical reasons (WHO, 2018). According to the last available figures for the countries practicing FGM/C in Africa, the Middle East and Asia where survey data is available, more than 230 million girls and women live today with FGM/C, a 15% increase compared to data released in 2016 (UNICEF, 2024). However, FGM/C is an umbrella term encompassing extremely different, often geographically specific, practices, which is why the World Health Organisation (WHO) classifies FGM/C into four different types.

The causes underlying FGM/C differ greatly across typologies and territories. In some places FGM/C is seen as an important rite of adulthood passage; in other communities FGM/C is (wrongly) believed to enhance female fertility; Type III FGM/C, i.e. infibulation, is often performed to ensure chastity; in other cases, the

fear of breaking social conventions, which would lead to undesired consequences such as lower chances of marriage, plays a strong role as well (Berg *et al.*, 2010a).

Research on FGM/C is hampered by difficulties in reaching the population of interest. As there are no nationally representative surveys on FGM/C in non-practicing countries, direct estimations of the number of women living with FGM/C in Europe are not available. However, other types of estimations have been proposed, commonly based on applying the home-countries FGM/C prevalence rate to the known number of immigrants in destination countries, although such approach is not caveat free (Ortensi *et al.*, 2015).

Across Europe, it has been estimated that 578,068 women aged 10 or more lived with FGM/C in 2011 (Van Baelen *et al.*, 2016), the majority of which were born in East-Africa (Somalia, Egypt, Ethiopia, Eritrea, Kenya, Sudan and Djibouti). In Italy, indirect estimates calculated using data from 2010, 2011 and 2016 indicate respectively a number of 57,000 (Farina *et al.*, 2016), 59,700 (Van Baelen *et al.*, 2016), and 60-80,000 women living with FGM/C (Ortensi *et al.*, 2018). It should be noted that these three estimations are not directly comparable as the considered age brackets differ: 15-49 in the first study, 10+ in the second study and 15+ in the third study.

Women living with FGM/C incur in a number of adverse health consequences, both short- and long-term (Klein *et al.*, 2018; Reisel *et al.*, 2015), whose complication extent depends largely on the FGM/C type (Chibber *et al.*, 2011). It has been estimated that 1 in 500-1,000 FGM/C results in death (Reyners, 2004). Other health consequences pertain physical health, e.g. higher incidence of urinary tract infections and complications of delivery (Berg *et al.*, 2014); mental health, such as depression, anxiety and PTSD (Abdalla and Galea, 2019); sexual health, including pain during intercourse and reduced sexual satisfaction (Berg *et al.*, 2010b); and psycho-social wellbeing, such as adverse effects on women's sense of identity and self-esteem (O'Neill and Pallitto, 2021). However, the quality of the studies, particularly on mental and sexual consequences, is generally weak (Abdalla and Galea, 2019; Berg *et al.*, 2010b). Finally, adverse health consequences are also exacerbated by inadequacy of care (Evans *et al.* 2019a; Evans *et al.*, 2019b; Turkmani *et al.*, 2018).

In Italy, some efforts have been put forward to address the practice of FGM/C and its consequences. In 2006 the parliament passed a law prohibiting FGM/C, that introduced the development of informative campaigns, training of health workers, instituted of a tollfree number, international cooperation programmes and the responsibility of the institution where the crime is committed, and recognised that doctors have a role in eliminating FGM/C by educating patients and communities (Turillazzi and Fineschi, 2007). Nevertheless, evidence highlights inadequate levels

of awareness of health practitioners regarding FGM/C practices and legislation (Surico *et al.*, 2015; Caroppo *et al.*, 2014).

2. Data and Methods

2.1 Data

The present study uses data from the universe of Italian hospital discharge records (HDRs) database (Italian Ministry of Health, Planning Department, *schede di dimissione ospedaliere*, SDO) for the year 2019. For each hospital episode, the data report information on up to six medical diagnoses and procedures, codified according to the International Classification of Diseases, Ninth Revision (ICD-9-CM), plus contextual variables (region, province, and local health authority, i.e. LHA), demographic characteristics of the patient (age, sex, country of citizenship), socio-economic variables (marital status, educational level, health insurance status) and type of hospital (private, public). The initial 2019 dataset includes 8,537,262 observations. As the analysis focuses on female immigrants' health, from the dataset We drop all observations of male sex. Moreover, we include only citizens of countries were FGM/C is known to be practices. Finally, we drop observations younger than 15 years old. This results in a dataset of 26,988 observations. Given that in the dataset is not possible to uniquely identify individuals, we cannot track patients over time. The unit of analysis is therefore the hospitalisation event.

2.2 Methods

The outcome variable is the proportion of FGM/C complications linked to obstetrical health, over the number of hospitalizations. In the main analysis, only the principal diagnosis was considered in order to identify FGM/C-related obstetrical hospitalisations. The conditions were selected following the classification proposed by Cottler-Casanova *et al.* (2020), who operationalized previous descriptive literature by identifying a list of relevant ICD-9 diagnosis codes, reported in Table 1, which include selected complications of pregnancy, labour, delivery and the puerperium.

Table 1 − *FGM/C obstetric and perinatal ICD-9 complications & codes.*

Complications of pregnancy, childbirth, and the puerperium[1]	ICD-9 code
Pregnancy with abortive outcome	
Spontaneous abortion (634)	
Spontaneous abortion complicated by genital tract and pelvic infection	634.0
Complications mainly related to pregnancy	
Anemia complicating pregnancy childbirth or the puerperium	648.2
Normal delivery, and other indications for care in pregnancy, labor and delivery	
Disproportion in pregnancy labor and delivery (653)	
Outlet contraction of pelvis in pregnancy labor and delivery	653.3
Fetopelvic disproportion	653.4
Disproportion of other origin in pregnancy labor and delivery	653.8
Unspecified disproportion in pregnancy labor and delivery	653.9
Abnormality of organs and soft tissues of pelvis (654)	
Congenital or acquired abnormality of vagina complicating pregnancy childbirth or the puerperium	654.7
Congenital or acquired abnormality of vulva complicating pregnancy childbirth or the puerperium	654.8
Complications occurring mainly in the course of labor and delivery	
Obstructed labour (660)	
Obstruction by abnormal pelvic soft tissues during labor	660.2
Failed forceps or vacuum extractor unspecified	660.7
Other causes of obstructed labor	660.8
Unspecified obstructed labor	660.9
Long labour (662)	
Prolonged second stage of labor	662.2
Trauma to perineum and vulva during delivery (664)	
First-degree perineal laceration during delivery	664.0
Second-degree perineal laceration during delivery	664.1
Third-degree perineal laceration during delivery	664.2
Fourth-degree perineal laceration during delivery	664.3
Unspecified perineal laceration during delivery	664.4
Vulvar and perineal hematoma during delivery	664.5
Other specified trauma to perineum and vulva during delivery	664.8
Unspecified trauma to perineum and vulva during delivery	664.9
Other obstetrical trauma (665)	
High vaginal laceration during and after labor	665.4
Other obstetrical injury to pelvic organs	665.5
Obstetrical pelvic hematoma	665.7
Other specified obstetrical trauma	665.8
Unspecified obstetrical trauma	665.9
Postpartum hemorrhage (666)	
Third-stage postpartum hemorrhage	666.0
Other immediate postpartum hemorrhage	666.1
Delayed and secondary postpartum hemorrhage	666.2
Postpartum coagulation defects	666.3

[1] Source: Cottler-Casanova *et al.* (2020).

Table 1 (cont.)– *FGM/C obstetric and perinatal ICD-9 complications & codes.*

Complications of pregnancy, childbirth, and the puerperium[2]	ICD-9 code
Other complications of labor and delivery not elsewhere classified (669)	
Maternal distress	669.0
Obstetric shock	669.1
Maternal hypotension syndrome	669.2
Acute kidney failure following labor and delivery	669.3
Other complications of obstetrical surgery and procedures	669.4
Forceps or vacuum extractor delivery without mention of indication	669.5
Breech extraction without mention of indication	669.6
Cesarean delivery without mention of indication	669.7
Other complications of labor and delivery	669.8
Unspecified complication of labor and delivery	669.9
Complications of the puerperium	
Major puerperal infection (670)	
Major puerperal infection, unspecified	670.0
Puerperal endometritis	670.1
Puerperal sepsis	670.2
Puerperal septic thrombophlebitis	670.3
Other major puerperal infection	670.8
Other complications of the puerperium not elsewhere classified (674)	
Disruption of obstetrical perineal wound	674.2

The main independent variable is an indicator of FGM/C prevalence in the origin country, as reported in the UNICEF Global Databases[3] (Appendix Table A.1), following the epidemiology approach used by several researchers in order to estimate correlation between home country and country of destination behaviours (Fernández, 2011). The equation to be estimated can be expressed as follows:

$$Hosp = \alpha + \beta\ FGMCprevalence + \gamma\ Controls + \delta + \varepsilon \qquad (1)$$

Where $Hosp$ is a dummy that takes value one if the hospitalisation refers to an obstetrical condition linked to FGM/C, and takes value zero if it refers to any other medical condition; $FGMCprevalence$ is a continuous variable that indicates the home country FGM/C prevalence according to the citizenship of the hospitalised woman, $Controls$ is the set of controls outlined above, δ indicates the Local Health Authority fixed effects and ε is the error term. In this equation, β is the parameter of main interest.

---

[2] Source: Cottler-Casanova *et al.* (2020).
[3] Source: data.unicef.org, accessed on 22 November 2021.

3. Results

Table 2 describes the hospital discharge records database according to age, education, marital status, health insurance and hospital type. For completeness, we report descriptive statistics for the sample of interest, i.e. immigrant women coming from countries were FGM/C is known to be practiced, along with the Italian sample and the sample of all other immigrants. On average, immigrants from FGM/C countries are younger than the other groups, have lower education and are less frequently hospitalised in private hospitals.

Table 2 – *Hospital discharge records (HDR) database, hospitalisations characteristics, 2019.*

	Immigrants from FGM/C countries		Italian		Other immigrants	
	N.	%.	N.	%	N.	%
Age class						
15-24	5,296	19.74	168,129	4.52	28,094	11.44
25-34	10,924	40.72	396,038	10.65	80,803	32.91
35-44	6,744	25.14	439,597	11.82	58,954	24.01
45-54	1,932	7.20	430,100	11.57	31,553	12.85
55-64	809	3.02	480,654	12.93	25,116	10.23
65-74	628	2.34	621,113	16.71	13,824	5.63
75 or older	495	1.85	1,182,078	31.80	7,196	2.93
Total	26,828	100.00	3,717,709	100.00	245,540	100.00
Education						
No/elementary	3,964	14.78	763,917	20.55	23,023	9.38
Lower secondary	7,641	28.48	770,708	20.73	67,806	27.62
Upper secondary	4,571	17.04	788,788	21.22	62,634	25.51
University	1,661	6.19	355,568	9.56	20,891	8.51
Missing	8,991	33.51	1,038,728	27.94	71,186	28.99
Marital status						
Married	10,593	39.48	1,448,813	38.97	96,989	39.50
Missing	9,735	36.29	1,144,237	30.78	86,064	35.05
Health insurance						
NHS	26,370	98.29	3,594,116	96.68	239,502	97.54
Co-pay	458	1.71	123,593	3.32	6,034	2.46
Type of hospital						
Private	3,261	12.16	1,082,978	29.13	38,984	15.88
Public	23,486	87.54	2,625,976	70.63	205,745	83.79
Missing	81	0.30	8,755	0.24	811	0.33

Table 3 reports the ORs of being hospitalised for a FGM/C-related disease, given the share of cut women in home countries. As the focus in on obstetrical diagnosis, the sample is restricted to women below 44 years old.

Table 3 – *Logistic regression results (ORs) for the likelihood of hospitalisations due to FGM/C-related obstetrical conditions, 2019.*

	Hospitalisation for FGM/C-related obstetrical conditions
FGM/C % in home country	1.0043***
	(1.003 - 1.006)
Age (ref: 25-34)	
15-24	0.8372***
	(0.735 - 0.954)
35-44	0.5406***
	(0.476 - 0.614)
Education (ref: Upper secondary)	
No/elementary	0.8727
	(0.716 - 1.063)
Lower secondary	0.9818
	(0.843 - 1.144)
University	1.1297
	(0.901 - 1.416)
Missing	1.0393
	(0.885 - 1.221)
Marital status (ref: Unmarried)	
Married	1.7872***
	(1.516 - 2.106)
Missing	1.6016***
	(1.348 - 1.903)
Health insurance (ref: Other)	
NHS	3.0176***
	(1.510 - 6.031)
Hospital type (ref: Private)	
Public	1.8875***
	(1.457 - 2.446)
Missing	6.6278***
	(2.534 - 17.333)
Observations	22,835
Local Health Authority FE	YES

*** p<0.01, ** p<0.05, * p<0.1 Robust cieform in parentheses.

Results show that for a one-unit increase in the home-country FGM/C prevalence, it is expected a 0.43% increase in the likelihood of hospitalisation for an obstetrical FGM/C-related conditions, after controlling for individual characteristics and

province fixed effects. Being hospitalised in a public rather than a private hospital, under a public rather than private or co-pay insurance, and being unmarried has a positive correlation with the likelihood of hospitalisation for a FGM/C-related condition. As robustness check, we performed the same analysis (1) looking for FGM/C related diagnosis in all six diagnosis fields rather than in the principal diagnosis field only; (2) using an alternative data source for the main independent variable of interest, i.e. share of women living with FGM/C in home countries (Ortensi et al. 2018)4; and (3) combining these two robustness checks. The results remain significant at the 99% confidence level, with similar magnitude: OR 1.0032 (95% CI 1.002 - 1.005) in the robustness check (1); OR 1.0042 (95% CI 1.002 - 1.006) in the robustness check (2); and OR 1.0029 (95% CI 1.001 - 1.004) in the robustness check (3).

4. Conclusions

Using Hospital Discharge Record (HDR) data from 2019, we investigated the prevalence of obstetrical health consequences due to FGM/C among immigrants from countries where FGM/C is practiced. Results showed that, among immigrants from FGM/C-practicing countries, a one-unit increase in the home-country FGM/C prevalence is correlated with a 0.43% increase in the rate of hospitalisation for obstetrical FGM/C consequences. This positive and statistically significant correlation suggests that women who have undergone the practice are more likely to experience severe pregnancy-related health issues. FGM/C can cause scar tissue, inflexibility, and narrowing of the vaginal opening, all of which contribute to obstructed labor and perineal trauma. Our data show a clear connection between these anatomical alterations and adverse outcomes such as prolonged labor, perineal lacerations, and postpartum hemorrhage. The high incidence of cesarean deliveries and instrumental births (forceps or vacuum extractor) in our study population highlights the difficulty some of these women face in delivering naturally. These findings indicate a pressing need for preemptive obstetric interventions and individualized care plans for women with FGM/C, particularly those experiencing high-risk pregnancies. This places additional strain on healthcare systems, requiring specialized care and longer hospital stays, particularly in cases of obstructed labor or perineal trauma. These findings underscore the need for healthcare professionals to be trained in managing FGM/C-related complications, which will become increasingly critical as the population of women from FGM/C-practicing countries grows. Finally, the obstetric complications associated with FGM/C not only affect

---

[4] See Appendix Table A.1

the mother but can also have detrimental consequences for the child. Prolonged labor, obstructed labor, and the need for emergency interventions like cesarean sections increase the risk of neonatal morbidity and mortality.

The study suffers from several limitations. First, has the HDRs are compiled by health practitioners rather than ad-hoc trained personnel, the level of data accuracy is lower compared to most survey data. For example, the data records a large number of missing values for marital status and education. We dealt with this issue by creating a residual category that includes the missing values for these two variables. Moreover, outcomes on sexual conditions and psychological health, both indicated in the literature as medical areas affected by the practice of FGM/C, could not be studied due to the low number of observed cases as well as endogeneity issues. Indeed, other factors such as migration patterns and extreme conditions in the country of origin (wars) are likely to be correlated both with citizenship and psychological health.

The association between FGM/C prevalence in home countries and the rate of obstetric complications in Italy underscores the need for targeted public health strategies. Efforts should focus on educating at-risk immigrant populations about the health risks of FGM/C, promoting alternative rites of passage, and offering access to specialized obstetric care. Furthermore, policies aimed at early identification and counseling of pregnant women with FGM/C could help mitigate complications during delivery, ultimately reducing hospitalizations and improving maternal outcomes.

There is a need for more studies on the long-term reproductive health outcomes of FGM/C survivors and for enhanced training programs for medical staff to recognize and manage FGM/C complications effectively. We would encourage future research on health consequences of FGM/C to focus on these understudied areas of interest. Further quantitative and qualitative research is needed to investigate the diffusion of FGM/C among immigrants in destination countries in general, and especially second generation and undocumented immigrants. Research should aim also to understand the mechanisms behind the preservation of this practice in destination countries, with the goal of developing empowering strategies for all women at risk to get freedom of choice on their own bodies.

Appendix Table

Table A.1 – *Share of women living with FGM/C in home countries (main independent variable).*

Country	UNICEF global databases[5] (2021)	Ortensi *et al.* (2018)[6]	Country	UNICEF global databases (2021)	Ortensi *et al.* (2018)
Somalia	99.2	97.9	Chad	34.1	38.4
Guinea	94.5	96.9	Senegal	25.2	24.7
Djibouti	94.4	93.1	CAR	21.6	24.2
Mali	88.6	91.4	Kenya	21.0	21.0
Egypt	87.2	87.2	Nigeria	19.5	24.8
Sudan	86.6	86.6	Yemen	18.5	18.5
Sierra Leone	86.1	89.6	Maldives	12.9	-
Eritrea	83.0	83.0	Tanzania	10.0	14.6
Burkina Faso	75.8	75.8	Benin	9.2	9.2
Gambia	75.7	74.9	Iraq	7.4	8.1
Mauritania	66.6	69.4	Togo	3.1	4.7
Ethiopia	65.2	65.2	Ghana	2.4	3.8
Guinea-Bissau	52.1	44.9	Niger	2.0	2.0
Indonesia	-	49.0	Cameroon	1.4	1.4
Liberia	44.4	49.8	South Sudan	-	1.4
Côte d'Ivoire	36.7	38.2	Uganda	0.3	1.4

References

ABDALLA S. M., GALEA S. 2019. Is female genital mutilation/cutting associated with adverse mental health consequences? A systematic review of the evidence, *BMJ Global Health*, Vol. 4, No. 4, pp. e001553.

BERG R. C., DENISON E. M.-L., FRETHEIM A. 2010a. Factors promoting and hindering the practice of female genital mutilation/cutting (FGM/C). *Knowledge Centre for the Health Services at The Norwegian Institute of Public Health (NIPH).*

BERG R. C., DENISON E. M.-L., FRETHEIM A. 2010b. Psychological, social and sexual consequences of female genital mutilation/cutting (FGM/C): a systematic review of quantitative studies. *Knowledge Centre for the Health Services at The Norwegian Institute of Public Health (NIPH).*

---

[5] Data source used in main regression specification.
[6] Data source used as robustness check.

BERG R. C., UNDERLAND V., ODGAARD-JENSEN J., FRETHEIM A., VIST G. E. 2014. Effects of female genital cutting on physical health outcomes: A systematic review and meta-analysis. *BMJ Open*, Vol. 4, No. 11, pp. e006316.

CAROPPO E., ALMADORI A., GIANNUZZI V., BROGNA P., DIODATI A., BRIA P. 2014. Health care for immigrant women in Italy: are we really ready? A survey on knowledge about female genital mutilation, *Annali dell'Istituto Superiore di Sanità*, Vol. 50, pp. 49-53.

CHIBBER R., El-SALEH E., EL HARMI J. 2011. Female circumcision: obstetrical and psychological sequelae continues unabated in the 21st century. *The Journal of Maternal-Fetal & Neonatal Medicine*, Vol. 24, No. 6, pp. 833-836.

COTTLER-CASANOVA S., HOROWICZ M., GIESZL S., JOHNSON-AGBAKWU C., ABDULCADIR J. 2020. Coding female genital mutilation/cutting and its complications using the International Classification of Diseases: a commentary. *BJOG: An International Journal of Obstetrics & Gynaecology*, Vol. 127, No. 6, pp. 660-664.

EVANS C., TWEHEYO R., MCGARRY J., ELDRIDGE J., ALBERT J., NKOYO V., HIGGINBOTTOM G. 2019a. Crossing cultural divides: a qualitative systematic review of factors influencing the provision of healthcare related to female genital mutilation from the perspective of health professionals, *PloS one*, Vol. 14, No. 3, pp. e0211829.

EVANS C., TWEHEYO R., MCGARRY J., ELDRIDGE J., ALBERT J., NKOYO V., HIGGINBOTTOM G. M. A. 2019b. Seeking culturally safe care: a qualitative systematic review of the healthcare experiences of women and girls who have undergone female genital mutilation/cutting, *BMJ Open*, Vol. 9, No. 5, pp. e027452.

FARINA P., ORTENSI L. E., MENONNA A. 2016. Estimating the number of foreign women with female genital mutilation/cutting in Italy, *The European Journal of Public Health*, Vol. 26, No. 4, pp. 656-661.

FERNANDEZ R. 2011. Chapter 11: Does culture matter? In BENHABIB J. and BISIN A. JACKSON M.O. (Eds.) *Handbook of Social Economics*, North-Holland, Vol. 1, pp. 481-510.

O'NEILL S., PALLITTO C. 2021. The Consequences of Female Genital Mutilation on Psycho-Social Well-Being: A Systematic Review of Qualitative Research, *Qualitative Health Research*, Vol. 31, No. 9, pp. 1738-1750.

ORTENSI L. E., FARINA P., LEYE E. 2018. Female genital mutilation/cutting in Italy: an enhanced estimation for first generation migrant women based on 2016 survey data, *BMC Public Health*, Vol. 18, No. 1, pp. 1-10.

ORTENSI L. E., FARINA P., MENONNA A. 2015. Improving estimates of the prevalence of Female Genital Mutilation/Cutting among migrants in Western countries, *Demographic Research*, Vol. 32, No. 18, pp 543-562.

REISEL D., CREIGHTON S.M. 2015. Long term health consequences of Female Genital Mutilation (FGM), *Maturitas*, Vol. 80, No. 1, pp. 48-51.

REYNERS M. 2004. Health consequences of female genital mutilation, *Reviews in Gynaecological Practice*, Vol. 4, No. 4, pp. 242-251.

SURICO D., AMADORI R., GASTALDO L., TINELLI R., SURICO N. 2015. Female genital cutting: A survey among healthcare professionals in Italy, *Journal of Obstetrics and Gynaecology*, Vol. 35, No. 4, pp. 393-396.

TURILLAZZI E., FINESCHI V. 2007. Female genital mutilation: the ethical impact of the new Italian law, *Journal of Medical Ethics*, Vol. 33, No. 2, pp. 98-101.

TURKMANI S., HOMER C. S., DAWSON A. 2018. Maternity care experiences and health needs of migrant women from female genital mutilation–practicing countries in high-income contexts: A systematic review and meta-synthesis, *Birth*, Vol. 46, No. 1, pp. 3-14.

UNITED NATIONS CHILDREN'S FUND. 2024. Female Genital Mutilation: A global concern. 2024 Update. *UNICEF*, New York.

VAN BAELEN L., ORTENSI L., LEYE E. 2016. Estimates of first-generation women and girls with female genital mutilation in the European Union, Norway and Switzerland, *The European Journal of Contraception & Reproductive Health Care*, Vol. 21, No. 6, pp. 474-482.

WORLD HEALTH ORGANIZATION. 2018. Care of women and girls living with female genital mutilation: a clinical handbook. *WHO*.

_____

Chiara ALLEGRI, Department of Social and Political Sciences, Bocconi University, chiara.allegri@unibocconi.it

Helen BANKS, Centre for Research on Health and Social Care Management (CERGAS), SDA Bocconi School of Management, Bocconi University, helen.banks@unibocconi.it

HEALTH AND SAFETY MANAGEMENT SYSTEM IN THE NATIONAL INSTITUTE OF STATISTICS (ISTAT)[1]

Michele Camisasca, Eva Pietrantonio, Rosario Magro, Alessandro Arborea,
Anna Fabiani, Claudio Giordano, Marcella Pietrantonio

Abstract. Istat is one of the few public institutions that have initiated the implementation of the Occupational Health and Safety Management System (*OHSMS*) since 2018 in order to ensure the Prevention and Protection Measures application. In 2018, Istat achieved the British Standard OHSAS 18001 certification and later, in 2021, UNI ISO 45001:2018 was confirmed and updated. Organisational and management measures are the basis for defining the prevention and protection system. The evolution of health and safety organisation required designated figures and specific measures despite challenges such as changes in managers, transfers and organisational complexity. The goals and the policies focus on worker protection, ethical principles, the *OHSMS* adoption and the Fire Safety Management System development. These processes assign internal responsibilities, encouraging employee participation in the continuous improvement through the Workers' Representatives for Safety and the Employer. *OHSMS* has led to the improvement in working conditions and to a safety culture growth. Many procedures have been implemented such as hazard identification, legal requirements, goals and improvement programmes, training management, information and communication, non-conformity management, health surveillance, emergency preparedness and response, internal audits and management review. Operational instructions are provided for activities such as video terminals usage, manual loads handling, electrical risk, personal protective equipment management, interference risk management, building and plant maintenance and instrumental resource management. All the procedures are applicable to all the Institute Roman offices. Later, *OHSMS* has been extended to regional offices. This work describes the adoption of the *OHSMS* model as per Legislative Decree 81/08, in the complex reality of a public research institution as Istat. This adoption is a best practice to promote the continuous improvement in workers' health and safety protection.

---

[1] This article is the result of the common contribution of all and, therefore, the individual contribution is considered equal and equivalent to that of the other co-authors. The authors' points of view expressed in the article do not necessarily reflect the official opinions of the National Institute of Statistics - Istat.

1. Introduction

The European Framework 2021-2027 on occupational safety[2] establishes priorities and key actions necessary to improve workers' health and safety in the coming years within the context of a post-pandemic world, characterized by green and digital transitions, economic and demographic challenges and the evolution of the traditional work concept (Amatucci *et al.*, 2024). The plan reiterates the need for safe working conditions, essential for a healthy and productive workforce, and emphasizes how crucial is this aspect for the sustainability and competitiveness of the EU economy (Barra, 2022).

The National Institute of Statistics (Istat), as a public research institution, plays a fundamental role in producing high-quality official statistics, operating autonomously but in constant interaction with the academic and scientific world. One of its main missions is to serve the community through the production, communication, analysis and forecasts of statistics based on advanced European scientific standards.

In accordance with art. 30 of Legislative Decree 81/08, Istat has adopted, since 2018, the model of the Occupational Health and Safety Management System (*OHSMS*) in order to ensure the application of prevention and protection measures in the complex and articulated Public Administration reality. Over the years, Istat has consolidated its commitment to workplace safety achieving important certifications such as the British Standard OHSAS 18001 and the UNI ISO 45001:2018.

The effectiveness of the System is confirmed by the results of a monitoring conducted by Accredia and INAIL in 2018 on a large number of companies, which showed a reduction of 16% in the Frequency Rate[3] of certified companies compared to others, and a decrease of 40% in Severity Rate[4] (Nisi *et al.*, 2018).

The work aims to highlight the effectiveness of the management system in improving health and safety conditions in workplaces, reducing the occurrence of injuries and the associated social and economic costs.

---

[2] https://ec.europa.eu/social/BlobServlet?docId=24122&langId=en

[3] The Frequency Rate quantifies the number of accidents per million hours worked during a specific period (Frequency Rate = number of accidents x 1,000,000 / number of hours worked).

[4] The Severity Rate quantifies the number of absences from work due to accidents occurred during a specific period (Severity Rate = number of total days absence accidents x 1,000 / number of hours worked).

2. Materials and methods

The adopted *OHSMS* is compliant with the UNI ISO 45001:2018 standard, it aims to improve health and safety at work by establishing an effective control, and to develop a culture of safety. As described by UNI INAIL 2001, the *OHSMS* follows a cyclical sequence of planning, implementation, monitoring and review of the system, through a dynamic process. The ability of the system to achieve planned objectives depends on the commitment and involvement of all company figures, especially at the highest level. Table 1 shows the organisational structure and roles in the *OHSMS* in Istat.

Table 1 − *Organisational Structure and Roles in the Occupational Health and Safety Management System (OHSMS) in Istat.*

• Employer, Manager and Supervisor	• First Aid and Emergency Responders;
• Prevention and Protection Service	• DUVRI Update Coordinator;
• Occupational Health and Safety Management System Manager	• Workers' Safety Representatives (WSR);
• Fire Safety Technical Manager	• IT Department for work equipment supply (PCs, Monitors, Printers, etc.)
• Asbestos Maintenance and Control Plan Manager	• Administrative Department for the management and compliance of buildings and equipment
• Occupational Physician	• Human Resources Office (organisation of medical examination and medical records archiving)

Source: Istat, Organizational Structure and Roles in the OHSMS.

The adoption of *OHSMS* in Istat was based on the development of a series of managerial procedures, technical guidelines and operational instructions aimed at verifying and monitoring the implementation of Prevention and Protection Measures in a complex reality. These measures have strengthened the safety management system, improving the protection of workers and promoting a culture of safety within the Institute. Furthermore, in accordance with the Ministerial Decree of 2 September 2021 «GSA», the OHSMS has integrated the Fire Safety Management System both in operation and in emergency phase (*FSMS*).

The main organisational, managerial and technical measures of the *OHSMS* form the basis for defining the prevention and protection system. They have been adopted by the Director General who verifies and monitors their implementation through the Occupational Safety Management System Manager and all the involved structures. The procedures include: hazard identification and risk assessment to prevent

potential accidents; regulatory compliance and fulfilment of additional requirements ensuring a safe working environment; application of improvement objectives and programmes to promote an increasingly safe and healthy work environment; accurate management of documentation and ongoing training to ensure compliance and staff awareness of safety regulations; effective communication and non-conformity monitoring to identify and solve promptly potential risk areas in the workplace; prompt and precise management of accidents and injuries to prevent their occurrence; occupational health surveillance as an integral part of employees' health management, ensuring regular checks and prevention of occupational diseases; preparedness and response to planned emergencies to ensure the safety and protection of personnel in critical situations; management of personal protective equipment to ensure they are suitable and correctly used by workers; management of interference risks to avoid accidents due to interaction between different activities or processes in the workplace; accurate ordinary and extraordinary maintenance of buildings and facilities to ensure a safe and functional working environment; management of instrumental resources to guarantee the availability and proper maintenance of tools necessary to carry out work activities safely; regular internal audits and management review to assess the effectiveness of the health and safety management system and identify areas for improvement. Table 2 lists the procedures related to the organisational, managerial and technical measures of the *OHSMS*, fundamental to maintain a safe working environment.

Table 2 – *Main procedures related to organisational, managerial, and technical measures of the OHSMS.*

❑ Hazards identification and risk assessment	❑ Management of injuries and accidents
❑ Legal and additional requirements	❑ Health surveillance management
❑ Objectives and improvement programmes regarding Health and Safety in the workplace	❑ Emergency preparedness and response
❑ Document management	❑ Management of personal protective equipment
❑ Training management	❑ Management of interference risks
❑ Information	❑ Management of ordinary and extraordinary maintenance of building and plant
❑ Communication	❑ Management of instrumental resources
❑ Management and monitoring of non-conformities	❑ Internal audits and management review

Source: Istat, Organizational, management, and technical measures adopted in the OHSMS.

2.1. Operational instructions

In order to ensure workplace safety, specific "operational instructions" support specific activities. These instructions have been developed to cover a wide range of tasks, as the use of video terminals, photocopiers, printers, scanners and fax machines, manual handling of loads, use of stairs and stepladders, management of electrical risk, minor maintenance activities, use of sharp and cutting objects, use of automated archives, management of first aid kits and injuries in case of fire, lifts emergency interventions, hygienic requirements of air treatment systems and general hygiene and health prevention and protection measures for the Istat offices in Rome. These operational instructions are essential to ensure that activities are carried out safely and in compliance with regulations, strongly reducing risks to workers' health and safety.

3. Organisational Measures for Emergency Management

Among the main organisational and managerial measures, we find the emergency preparedness and response which includes a detailed procedure to face situations of serious and immediate danger. The procedure concerns the appointment of emergency responders, the adequacy of teams that should be assembled according to the number of people involved and the work shifts, and the identification of an emergency coordinator. The names of the emergency responders are available to all personnel through signs situated in the workplace. Moreover, in case of immediate danger, employees are given instruction to cease their activity, leave the office and head towards a safe place.

Table 3 – *Data of evacuation drills conducted in the last 6 years.*

Site	2019		2020*		2021*		2022		2023		2024	
	Duration	Emptied	Duration	Emptied	Duration	Emptied	Duration	Emptied	Duration	Emptied	Duration	Emptied
A	7'	140	4'	104	< 15'	21	3'	53	5'	77	4'	71
B	8'	315	4'	338	-	-	5'	93	6'	145	5'	84
C	6'	374	-	-	-	-	5'	218	6'	308	5'	291
D	6'	209	-	-	-	-	5'	75	6'	116	4'	90
E	5'	116	-	-	-	-	5'	38	4'	42	5'	48
F	7'	139	-	-	-	-	8'	60	7'	49	8'	45

*Source: Istat, Internal documents. * In 2020 and 2021, due to the COVID-19 emergency, it was not possible to conduct on-site evacuation drills in some offices. However, in each year, six virtual drills were carried out via web conference with the emergency team members of different offices. "Duration" is indicated in minutes, while the "Emptied" columns show the number of people evacuated from different sites.*

It is fundamental to develop an Emergency and Evacuation Plan with detailed floor plans that show the position of firefighting devices, alarm buttons, emergency switches, evacuation routes and emergency exits. Furthermore, fire drills are scheduled and conducted, at least annually, to test the effectiveness of procedures and to train the staff.

As a final point, the emergency equipment is regularly replenished to ensure the immediate availability in emergency situations. Table 3 reports data of the evacuation drills conducted in the last 6 years, while Table 4 reports the number of fire prevention, firefighting, and emergency management operators over the past 6 years.

Table 4 – *Number of Fire Prevention, Firefighting and Emergency Management Officers in the last 6 years.*

Site	2019	2020	2021	2022	2023	2024
A	85	85	83	77	72	68
B	33	38	38	40	38	31
C	16	16	16	16	16	16
D	17	17	15	15	15	17
E	43	42	39	35	35	33
F	29	28	25	19	17	16
Total	223	226	216	202	193	181

Source: Istat, Internal documents.

4. Active Employee Involvement in the *OHSMS*

The active involvement of employees in the Occupational Health and Safety Management System (*OHSMS*) is crucial to ensure a safe and healthy work environment (ILO-OSH, 2001). The planning of intervention which includes adjustment measures and continuous improvement programmes constitute the operational methods for hazard identification and risk assessment and control. The direct involvement of employees in these activities is part of the Institute goals and policy inasmuch as their experience of daily working conditions can implement and improve the OHSMS.

The Workers' Safety Representatives (*WSRs*) and the Employer play a central role in encouraging employees' participation through regular meetings, safety training sessions with the purpose of solving issues and fostering open dialogue on workplace safety. This collaboration has led to an increase in safety awareness, a greater adherence to procedures and a safer and healthier work environment. As a

result, non-commuting accidents have significantly decreased because they are strictly connected to the effectiveness of prevention and protection measures.

Data collected from surveys on Work-Related Stress highlight the effectiveness of employees' active participation. In the period 2019-2021, around 40% of the workers of the Roman offices (approximately 1825 employees) were involved in the work-related stress risk assessment, identifying 54 organizational units. In the period 2022-2024, of about 1470 workers, 45% were involved in the assessment, identifying 57 organizational units (Camisasca *et al.*, 2023 No.4). These data demonstrate the importance of employees' participation in improving working conditions and risk management.

5. Results

A detailed analysis of the results obtained through the implementation of the Occupational Health and Safety Management System (*OHSMS*) shows the significant effects that the OHSMS has on the workplace. It can be observed that a significant number of visits and inspections have been conducted over the years, both for health surveillance visits and for prevention and risk control activities. As regards in particular health surveillance visits, data show a significant reduction in the total number of visits in the years 2020 and 2021, primarily due to the pandemic emergency.

However, despite these challenges, it was possible to maintain an adequate level of health surveillance visits (Camisasca *et al.*, 2023 No.1) to ensure employees' health and safety, as reported in Table 5.

Table 5 – *Number of health surveillance visits conducted by the Occupational Physician in the last 6 years.*

Number of Visits	2019	2020*	2021*	2022	2023	2024
Total Employees	577	206	338	806	663	766
Video Terminal Users	505	190	336	780	654	726
Periodic	-	-	292	727	493	601
Preventive	-	-	35	23	133	58
On request	6	4	5	30	21	60
Art.41 paragr. 2, e-ter (60 days)	5	-	6	2	7	7
Eligibility for emergency teams	83	12	-	24	8	34

Source: Istat, the data provided by the occupational physician and recorded in internal documents.
* Reduced medical surveillance visits due to pandemic emergency. - Data not available.

Moreover, the Occupational Physician together with the Prevention and Protection Service Manager and the Fire Safety Technical Manager carried out inspections in the Institute Roman offices that made it possible to identify potential risks and to adopt corrective and preventive measures promptly.

However, in spite of the reduction of inspections during the pandemic emergency, it was possible to maintain an adequate level of control and monitoring of safety conditions, as reported in Table 6.

Table 6 – *Number of inspections carried out by the Occupational Physician, the Prevention and Protection Service Manager and the Fire Safety Technical Manager in the last 6 years.*

	2019	2020	2021	2022	2023	2024
Occupational Physician	7	6	5	6	6	6
Prevention and Protection Service Manager	19 *	3 **	3 **	8	7	8
Fire Safety Technical Manager	19 *	1 **	1 **	7	9	6

*Source: Istat, Internal documents. * Inspections carried out in collaboration with external companies.*
*** Inspections reduced due to pandemic emergency.*

Table 7 reports the number of activities over the past 6 years involving the *WSRs*, in which workers have participated actively and extensively. Furthermore, the active participation of Worker Safety Representatives (*WSRs*) in various activities, such as meetings and initiatives related to risk management, significantly helped to increase safety awareness in the workplace and promote a participative and collaborative safety culture.

Table 7 – *Number of activities Workers' Safety Representatives (WRS) have been involved in during the last 6 years.*

|	2019	2020	2021	2022	2023	2024
Number of activities involving WRS *	59	6	7	61	4	5

Source: Istat, Internal documents.
*** This number includes meetings and participation in activities (including the work-related stress risk assessment in the years 2019 and 2022 - Art.35, Art.50).*

All data demonstrate the effectiveness of the *OHSMS* in enhancing employees' safety and well-being, as well as ensuring regulatory compliance and reducing work-related risks. Accident Frequency Rate (FR) and Accident Severity Rate (SR) are INAIL indicators that offer a detailed overview of the workplace safety trend over

the years. The FR quantifies the number of work-related accidents per hours worked, while the SR assesses the gravity of accidents by taking into account the number of days lost per accident. Figure 1 graphically reports the FR and SR trend over the years.

Figure 1 – *Trend of FR and SR over the years.*
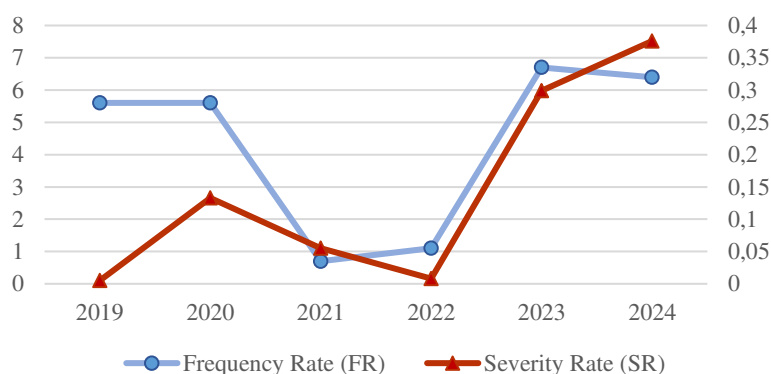
Source: Istat, Internal data processing.

Over the past 6 years, the FR values have been acceptable, with a significant decrease in 2021 in response to the pandemic emergency which reduced the value to 0,7. This outcome suggests an overall improvement in workplace safety conditions thanks to an efficacious risk management and consistent commitment to injury prevention. Similarly, the SR values over the past 6 years have been very low, indicating minimal impact of injuries on productivity. This data suggest that all the efforts to ensure a safe and healthy work environment have led to significant results, minimizing the number of days of work lost due to injuries. Table 8 shows the values of the temporal trend of these indices.

Table 8 – *Trend of FR and SR over the years (Values).*

	2019	2020	2021	2022	2023	2024
Frequency Rate *	5,6	5,6	0,7	1,1	6,7	6,4
Severity Rate *	0,005	0,133	0,055	0,008	0,299	0,376

Source: Istat, Internal documents.
* Data on workplace accidents are predominantly of the «On the Way to Work» type.

Moreover, the percentage of commuting and non-commuting accidents compared to the workforce shows a significant change over the years, with a gradual decrease in non-commuting accidents as reported in Table 9.

Table 9 − *Percentage of accidents occurring during commuting and non-commuting compared to the workforce and impact on the workforce of non-commuting accidents.*

	2019	2020	2021	2022	2023	2024
% of commuting accidents	84%	94%	100%	100%	94%	94%
% of non-commuting accidents	16%	6%	0%	0%	6%	6%
Workforce	1779	1724	1661	1590	1627	1595
Incidence on workforce of non-commuting accidents	0.009	0.003	0	0	0.003	0.003

Source: Istat, Data obtained from processing internal documents.

These data highlight the effectiveness of the preventive measures adopted to reduce workplace injuries and generally improve employees' safety. In fact, non-commuting accidents have significantly decreased from 16% to 6% as they are connected to prevention and protection measures.

To conclude, data confirm that the implementation of the *OHSMS* has led to a considerable improvement in workplace safety conditions, ensuring a safer working environment and protecting the health and well-being of employees.

6. Continuous organisational improvements

This work highlights the continuous improvements in the organisation due to the adoption of the Occupational Health and Safety Management System (*OHSMS*) and its implementation in all the Roman offices of the Institute. Improvements aimed to strengthen prevention also through audits conducted by the Accredited Agency. It is worth noting that during assessments, non-conformities did not emerge but only areas for potential development. Furthermore, the Accredited Agency observed good practices, including a strong safety organisation and the presence of detailed, precise and updated documents, such as the Risk Assessment Document, the Interference Risk Assessment Document and the Emergency Plan for Safety. The completeness and accuracy of these documents also consist in the accurate definition of roles and responsibilities within the organisational structure.

The health and safety management model has been applied also to Regional offices of the Institute to ensure uniform safety standards and extend the benefits of the *OHSMS* to a greater number of employees. Istat has initiated this process with a holistic approach, including staff training and adaptation of procedures to specific regional needs, while ensuring clear assignment of responsibilities in line with decision-making autonomy.

7. Final considerations and conclusions

The adoption of an OHSMS has led to significant improvements in working conditions, to regulatory compliance and to a safety culture growth within Istat. It has significantly enhanced the safety and health of workers, of services users and, in general, the safety of all other stakeholders through the effective application of the system, including processes, by reducing or eliminating the risks to which workers are exposed.

The main organisational and management measures adopted have contributed to emergency preparedness and response, to the assessment of work-related stress risk and to the effective management of workplace injuries and accidents.

The active participation of employees, facilitated by Worker Safety Representatives and the Employer, has played a fundamental role in ensuring a safe and healthy working environment.

The observance of the UNI ISO 45001:2018 standard has led to continuous improvement of policies and processes through the adoption of new digital technologies and the extension of the OHSMS to regional offices.

In conclusion, the adoption of the OHSMS in Istat represents a best practice in the field of workplace safety, promoting continuous improvement in the prevention and protection of the health and safety of workers.

References

AMATUCCI S., BARRA M.I., BENEDETTI F., D'AMARIO S., MORINELLI G., A. TERRACINA A. 2024. From approaches to outcomes: evidence of the reduction of accident trends in certified companies. In INAIL e Accredia. *The effectiveness of accredited certifications for occupational health and safety management systems. Technical standards, regulations, support, and outcome detection: from current status to perspectives*. Milan, pp. 45-58.

BARRA M.I. Occupational health and safety management systems: incentives and economic returns for businesses. Safety notebooks AIFOS, No.4, December 2022.

CAMISASCA M., PIETRANTONIO E., MAGRO R., ARBOREA A., FABIANI A., GIORDANO C., PIETRANTONIO M., GUERRIERO G., SPARANO A., 2023. Psychosocial risks: work-related stress risk assessment in Istat as a goal for the workers' well-being. *The Italian Journal of Economic, Demographic and Statistical Studies. RIEDS.* Vol. LXXVII, No.4, pp. 181-191.

CAMISASCA M., PIETRANTONIO E., MAGRO R., ARBOREA A., FABIANI A., GIORDANO C., PIETRANTONIO M., SPARANO A., 2023. A pandemic health risk management model for the protection of workers: the Istat experience.

The Italian Journal of Economic, Demographic and Statistical Studies. RIEDS. Vol. LXXVII, No.1, pp. 53-64.

ILO-OSH 2001. *Guidelines on occupational safety and health management systems*, 2nd ed. Geneva, ILO - International Labour Office, 2009. Available at: https://www.ilo.org/safework/info/standards-and-instruments/WCMS_107727/lang--en/index.htm

ITALIAN LEGISLATIVE DECREE of 9 April 2008 n. 81. Text coordinated concerning the protection of health and safety in the workplace.

MINISTERIAL DECREE of 2 September 2021. Text coordinated on fire safety in the workplace. Criteria for the management of workplaces in operation and in emergency and characteristics of the specific fire prevention and protection service, pursuant to article 46, paragraph 3, letter a), point 4 and letter b) of the legislative decree of 9 April 2008, n. 81.

NISI A., AMATUCCI S., BARRA I., BENEDETTI F., MORINELLI G., TERRACINA A. 2018. Safety in the workplace and certification, *Osservatorio Accredia*, INAIL e Accredia, No.1.

UNI INAIL 2001. Guidelines for an occupational health and safety management system (OHSMS).

UNI ISO 45001:2018 Occupational health and safety management systems - Requirements with guidance for use.

_____

Michele CAMISASCA, D.G. Istat, michele.camisasca@istat.it
Eva PIETRANTONIO, Istat, epietrantonio@istat.it
Rosario MAGRO, Istat, rosario.magro@istat.it
Alessandro ARBOREA, Istat, arborea@istat.it
Anna FABIANI, Istat, anfabian@istat.it
Claudio GIORDANO, Istat, claudio.giordano@istat.it
Marcella PIETRANTONIO, Istat, pietrantonio@istat.it

CHILDREN AND ADOLESCENTS: A SPATIO-TEMPORAL ANALYSIS BETWEEN INEQUALITIES AND WELL-BEING[1]

Cira Acampora, Antonella La Faci,
Valeriana Leporanico, Massimo Potenzieri, Matteo Potenzieri

Abstract. The physical, psychological, social and environmental well-being of children and adolescents is often a subject of debate in both the scientific and institutional spheres.

Accentuated by the pandemic, the phenomenon has aroused considerable interest in the media; there was therefore a need for a deepening through the study of the phenomenon itself measured through the construction of a "system" of statistical indicators traceable to various domains. These "measures" will allow us to describe in the most exhaustive way possible the vast area of the "well-being of children and adolescents", so as to proceed to the possible construction of a synthetic index that can summarize the living conditions of Italian children and adolescents. Information from multiple sources will then be used to study the evolution over time of the indicators identified and to assess the possible changes caused by the COVID-19 pandemic on the quality of life of children, in different geographical areas of the country. The results of the study could allow Policy Makers to have a valid monitoring tool, efficient and useful to plan social and environmental improvement interventions for the benefit of the young generations who represent the future of our country.

1. Introduction

The well-being of children has been at the center of social debate for years (Istat, Statistiche focus 2023). The problem, also exacerbated by the pandemic emergency, has increased awareness that, starting from the principle that today's children will be tomorrow's adults, Investment in them not only effectively combats poverty but also increases GDP values. Thus, the need for measuring the well-being of children is born, which ISTAT has addressed at different times with the project "Multipurpose Surveys", the Bes and the SDGs Report (2023), compilers of indicators useful to provide information on the state of health of the country. It's in this direction that the contribution of the study has focused on the assumption that the welfare of minors (and for such we have understood the range from zero to seventeen years), although seen as a basic need that must be guaranteed in the various areas where personality develops (school, family, etc.), is established in the context in which they live. To this end, several sources of information

---

[1] Although the contribution is the joint responsibility of the authors, Introduction: Antonella La Faci and Massimo Potenzieri; sections 1, 2.3 and 2.9 Cira Acampora; sections 2.1, 2.5 and 3 Valeriana Leporanico; sections 2.2 and 2.4 Matteo Potenzieri; sections 2.6 and 2.7 Massimo Potenzieri; section 2.8. Antonella La Faci.

which have been updated repeatedly were taken into account for the development of the project; allow the elaboration of historical series useful to provide indications on the evolution of phenomena related to children and in different geographical areas of the country, giving rise to a "system" of statistical indicators that have made it possible to experiment a synthetic index (Fortunati *et al.*, 2022).

2.   The construction of the Database for Child Welfare Indicators

In the absence of a fully shared definition of well-being, it was considered to adopt a multidimensional approach by identifying 212 indicators that provide a key reading on the condition of the phenomenon from multiple dimensions and multiple data sources. Indicators have been identified under 12 thematic areas, which are further sub-themes and cover the following topics: Culture, communication and travel, Daily life and public opinion, Economic situation of households, Education and training, Environment, Health and healthcare, Services, Justice and Security, Politics and institutions, Population and families, Professional condition, Services and Subjective well-being. In the selection of indicators, some requirements such as availability over time were taken into account, with a preference for those whose year of dissemination was at least 2020 and the inclusion of age groups up to 17 years. Once the most significant indicators have been selected, they have been collected within a Data-base containing a set of information relating to the definition of the indicator, the age class of the reference population, the source and type of survey, the time availability of data, the last territorial detail, the link to access the data, the type of dissemination and finally the in-depth notes.

The selected indicators have been further classified into 9 domains of Well-being covering the following contents (Figure 1).

Figure 1 – *Domains of Well-being and number of Indicators.*
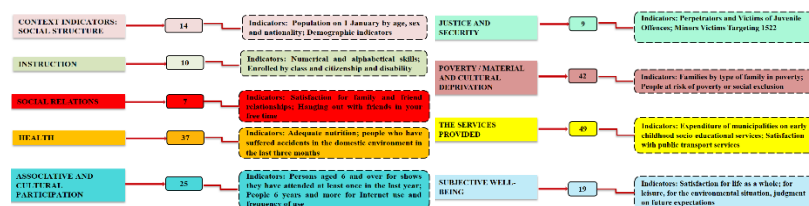
Source: Our data processing from Istat.

3.   Dimensions of Well-being

The indicators proposed below may provide useful guidance for assessing the collective well-being of the new generations to which they belong.

a.   Context indicators: social structure

The population living in Italy is characterized by a progressive aging with young people constantly decreasing. In Italy, at 1 January 2023, residents between 0 and 17 years amounted to 8,040 thousand a decrease compared to 2019. The majority of children of the male sex reside mainly in the North (Table 1).

Table 1 – *Italian and foreign minors (amounts in thousands) by sex and geographical distribution - Years 2023 - 2019.*

Years	Italian minors residents			Foreign minors resident		
1 January 2023	Males	Females	Total	Males	Females	Total
Italy	4,134	3,906	**8,040**	538	498	**1,036**
North	1,817	1,716	**3,533**	335	311	**646**
Centre	780	739	**1,519**	122	112	**234**
South and Island:	1,537	1,451	**2,988**	81	74	**155**
1 January 2019	Males	Females	Total	Males	Females	Total
Italy	4,403	4,158	**8,561**	525	487	**1,012**
North	1,926	1,818	**3,744**	328	305	**633**
Centre	827	782	**1,609**	122	112	**234**
South and Island:	1,649	1,558	**3,208**	76	69	**145**

Source: Istat - Movimento e calcolo della popolazione residente annuale. Data warehouse IstatData.

The incidence of Italian minors in the total resident population shows a constant decrease over the years, from 15.6% in 2019 to 14.9% in 2023 (Figure 2).

Regarding foreigners, however, it should be noted that children under 18 years of age living in Italy represent, on average, 20.1% of the total population (5,141,341 foreign citizens), a slight increase compared to 2019 in the South.

Figure 2 – *Percentage of Italian and foreign children living in Italy. 1 January 2019 – 2023.*
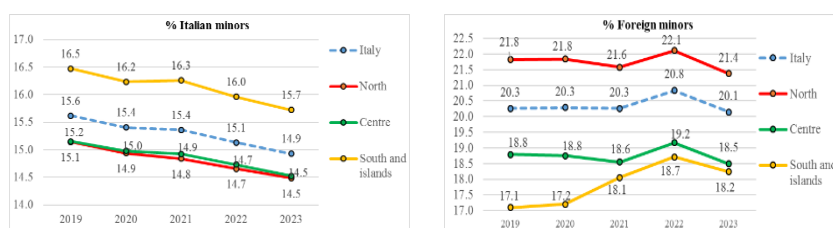
Source: Our data processing from Istat.

Demographic pyramids make the decline in population more visible. The one related to Italy in 2023 is a swollen pyramid in the center that tends to move upwards to show that the Italian population has an average age and a high age index, unlike foreigners (Figure 3).

Figure 3 – *Age pyramid at the population resident in Italy on 1ˢᵗ January, by citizenship. Years 2013 and 2023 compared.*
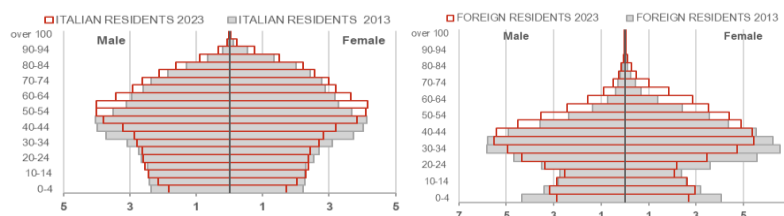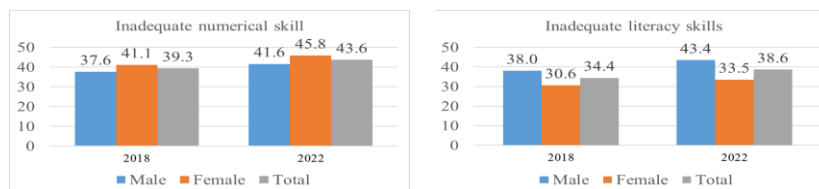

Source: Our data processing from Istat.

b.   Instruction

The focus on indicators was mainly on alphabetic skills, that is, the ability to understand and express thoughts and ideas in written or oral form, and on numerical skills, that is the ability to use mathematical concepts in order to solve the problems of everyday life. The picture that emerges is not encouraging if it is true that - in the five-year period '18-'22 - as regards third-grade students, among males, a "suffering" emerges in this sense with a figure that increases by 5.4 percentage points compared to 2.9 of females who, instead, (4.7% compared with 4.0% of males).

Figure 4 - *Inadequate literacy skills and numerical competence (third grade secondary school students). Years 2018 and 2022.*


Source: Our data processing from Invalsi.

c.   Social relations

The set of indicators included in this dimension allows you to grasp the different aspects of social relations in two sub-domains: family relationships and friendships.

The degree of satisfaction for family and friend relationships is generally high among young people. The 14-17 age group considers these relationships to be quite satisfactory. Conversely, the level of satisfaction for the friendly network reaches a negative peak in 2021 and then rises in 2022. The percentage of minors who attend friends every day tends

to increase with age, reaching the highest values between 15-17 years. Over the last five years, however, rates of attendance have fallen by about 12%.

Figure 5 – *Family and friendly relationships (for 100 people with some characteristics).*
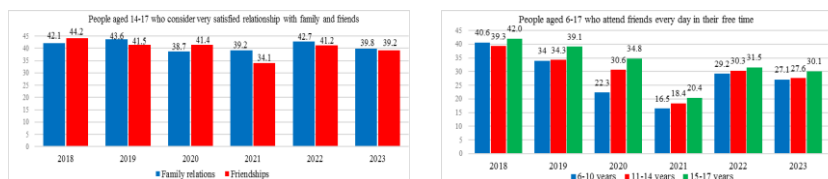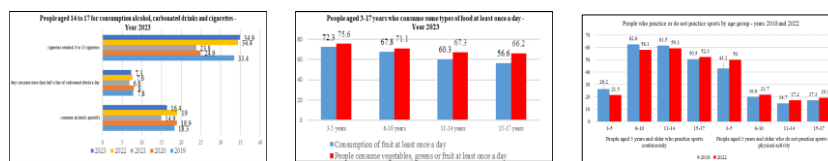

Source: Istat, Indagine Multiscopo sulle famiglie: aspetti della vita quotidiana.

d.   Health

The Health dimension offers a large number of indicators ranging from health facilities to nutrition and physical and sports activity.

Figure 6 – *Lifestyles and risk factors (per hundred people with the same characteristics).*

Source: Istat Indagine Multiscopo sulle famiglie: aspetti della vita quotidiana.

In 2023, although decreasing compared to 2019, the figure of very young people who consume alcohol (16.3%) and carbonated drinks (7.3%) is remarkable. In constant increase instead (except the covid bracket), cigarette consumption (from 6 to 10 per day). Decreases with increasing age groups, the daily consumption of fruit with a peak of just over 50% for the 15-17 years. Ditto for the daily consumption of at least one food among fruits, vegetables and vegetables that sees the same band arrive to 66,2 against 75.6 of the class 3-5 years and 71.1 of that 6-10.

Young and sedentary couple inseparable but not too much: in the five-year period, all the bands have indicators generally always negative except for the 15-17 age group. In the post-pandemic, all data in all age groups, from the point of view of sports practice, appear increasing (Figure 6).

e.   Associative and cultural participation

In 2022 compared to 2018, visitors to monuments and archaeological sites grew (an increase of 2.6% in the age group 6-10 years) and children who visit exhibitions and

museums and participate in sports shows. The decline in cinema spectators continues, affecting all age groups and those aged 1-14 (-9.5%). In the last 5 years the use of the Internet has increased exponentially, especially among children aged 6-10 years with a frequency of daily use (Table 2).

Table 2 - *People aged 6 and over for shows they have attended at least once in the last year and for Internet use and frequency (per 100 people with the same characteristics).*

| Years	Age	Events attended at least once in the last year					Use of the Internet and frequency of use				
		Theatre	Cinema	Museums, exhibitions	Sports shows	Archaeological sites	Use the internet	Every day	One or more times a week	Sometimes a month	A few times a year
2018	6-10 y	32.7	73.5	44.7	36.5	33.2	59.2	21.0	31.0	5.7	1.5
	11-14 y	36.3	80.0	53.5	45.2	41.3	85.9	62.1	20.5	2.7	0.6
	15-17 y	31.2	80.8	48.2	39.8	36.3	95.5	84.4	9.7	1.2	0.2
2019	6-10 y	31.9	74.5	46.8	36.1	34.4	62.5	27.4	28.9	4.5	1.7
	11-14 y	33.6	81.3	53.4	43.4	40.7	90.0	68.3	19.6	1.2	0.9
	15-17 y	31.4	82.2	50.8	41.0	37.0	94.7	83.7	9.5	0.9	0.6
2020	6-10 y	22.8	66.9	35.4	29.1	27.2	75.8	42.8	30.2	2.1	0.8
	11-14 y	24.0	72.7	42.3	36.8	33.5	93.4	76.9	16.0	0.4	0.1
	15-17 y	22.1	74.0	37.8	36.5	27.5	95.1	86.8	7.4	0.3	0.5
2021	6-10 y	2.4	9.1	7.9	4.8	10.2	89.1	55.5	30.2	2.6	0.8
	11-14 y	3.1	11.8	8.8	7.6	10.5	96.6	86.3	9.6	0.3	0.4
	15-17 y	1.6	17.0	8.4	9.3	10.2	98.3	93.5	4.2	0.1	0.5
2022	6-10 y	15.0	44.3	31.4	24.8	24.9	85.1	44.6	34.7	4.6	1.2
	11-14 y	15.4	49.0	32.9	31.5	26.2	96.5	80.8	14.8	0.7	0.1
	15-17 y	17.0	59.4	31.6	30.8	25.3	97.9	92.8	4,5	0.4	0.2

Source: Istat, Indagine Multiscopo sulle famiglie: aspetti della vita quotidiana.

f. Justice and Security

The increase in juvenile crime in the period 2018-2022 is worrying and the slight decrease due to the pandemic period is only illusory, since the trend is on a sharp rise: offenders in the age group up to 13 years are increasing by more than 31% against 12% in the 14-17 age group.

The same trend for victims of crime, an increase of 14.8% in the range up to15 years and 14.8% in the 14-17 range. The number of victims of violence who turn to 1522 for requests for help during the pandemic has increased dramatically, a sign that the Covid-19 pandemic and the measures taken to contain its spread (for example, confinement within the home), as well as the unfolding of the socio-economic consequences of the crisis triggered by the health emergency, have accentuated the risk of violent behavior (Figure 7).

Figure 7 - *Offenders and victims of crimes by age group and victims up to 17 years of age who contact 1522 – Years from 2018 to 2022.*
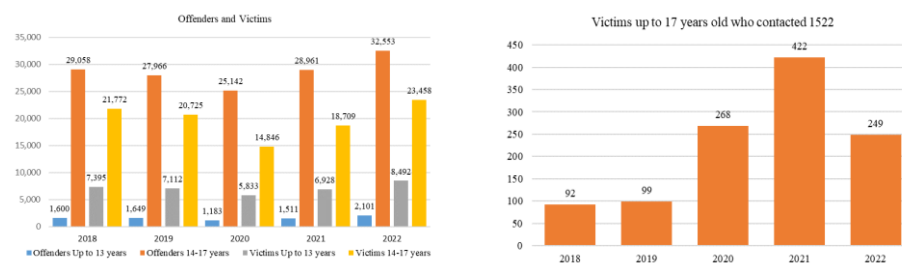

Source: Istat - Crimes reported to the judicial authorities by the State Police, the Carabinieri and the Financial Police - Processing of data archived by the public utility number 1522.

g.   Poverty/material and cultural deprivation

In times of crisis, social exclusion is a real risk for children living in families with greater economic difficulties. The incidence of relative poverty is increasing as the number of family members increases. The spread of the phenomenon increases as the number of minors in the family increases. Among the family types, in fact, the highest values show families with three or more minor children, for which the relative poverty rate is more than three times higher than the national average (36.1% against 10.1%).

Figure 8 – *Families in relative poverty for some family types and by distribution. (Percentage composition) - Years from 2018 to 2022.*
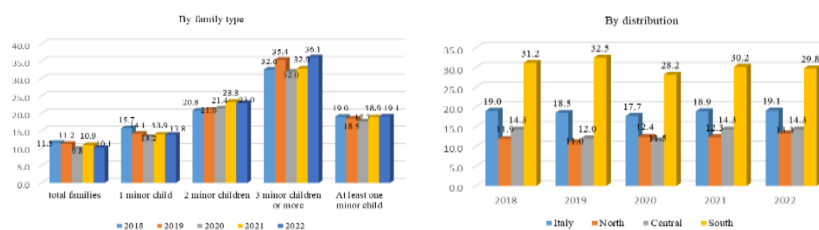
Source: Istat - The survey on family income and living conditions.

The incidence of households with at least one minor is higher in the South and Islands (29.8%) than in Northern Italy (14.3%), and in the Centre (13.3%).

If we consider families with three or more members, this percentage rises to 39.3%. It should be noted that the South and Islands is also the distribution that during the period considered showed a decrease of this value of 1.4% (Figure 8).

h.   Services provided to citizens

The State's response to citizens' demands for social welfare depends mainly on the services provided and their accessibility. For children and adolescents, basic services are identified in health, safety, leisure, education and training. As far as health and prevention are concerned, the State mainly provides with the basic pediatric service and the establishment of pediatric hospitals (Figure 9).

Figure 9 – *Total doctors, specialist doctors, pediatricians. Division comparison, absolute data. Years 2018 and 2021 - Current map of public pediatric clinics in Italy.*
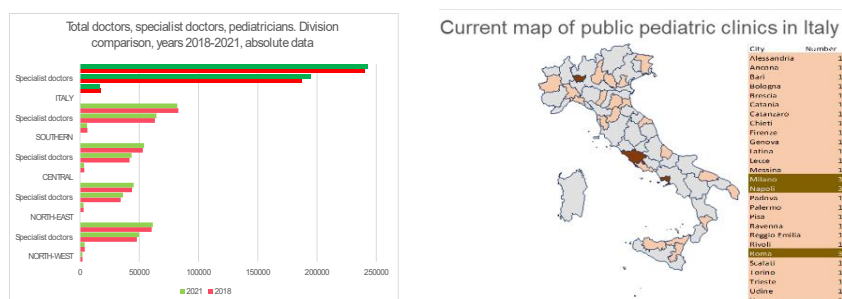
Source: Istat, processing of data on staff in the public and private health system.

Table 3 – *The expenditure of municipalities for social services. Years 2018 -2021. Number of families with minors, absolute data in thousands.*

Service provided	2018	2021	Differences	
Professional social work	670	678	8	
Family foster care service	18	17	-1	
Child Adoption Service	8	7	-2	
Family Mediation Service	10	12	2	
Parenting support activities	59	54	-4	
Other Professional Social Service Activities	55	42	-13	
Interventions for the social integration of weak or at-risk individuals	46	36	-10	
School socio-educational support	48	52	5	
Territorial or home socio-educational support	60	57	-4	
Other socio-educational and job placement activities	35	23	-12	
Contributions for family foster care	17	16	-2	
Contributions and tuition supplements for nursieries	38	42	3	
Contributions and tuition supplements for supplementary or innovative services for early childhood	4	4	0	
Contributions and tuition supplements for other semi-residential services	12	11	-2	
Contributions and tuition supplements for residential facilities	22	22	0	
Financial contributions for school services	157	153	-4	
Nurseries and spring sections	144	141	-4	
Supplementary services for early childhood	10	5	-6	
Summer day centers	164	200	36	
Playrooms / laboratories	94	97	3	
Summer or winter camps (with overnight stay)	6	6	0	

Source: Istat – Survey The expenditure of municipalities for social services, years 2018- 2021.

Municipalities offer citizens the numerous services in the field of social assistance, in particular to families with minors. There are 79 types of interventions and of these, 21 concern minors in families (Table 3).

The users who benefited from these interventions were, in the four-year period 2018-2021, about 35 million, with an expenditure of almost 93 and a half billion euros. The total number of users who used services for children and adolescents was about 6,600,000.

i.Subjective well-being

Subjective well-being defines the evaluations and perceptions that individuals express about their life in general and on more specific areas and represents one of the fundamental size on which the Bes framework is based (Istat, 2023. *Rapporto Bes*). It was therefore chosen to consider the 4 indicators that measure the subjective well-being of Bes of young people aged 14 to 19. As you can see from the graph, during the pandemic (2021) it is the satisfaction for leisure time and for one's life that suffer a decrease, in the first case the reduction is drastic and then rises and remains stable between 2022 and 2023. The satisfaction for the environmental situation, on the other hand, reaches its peak in that period and the positive opinion on future expectations is almost stable over time with slightly higher values in 2023.

Figure 10 – *Subjective well-being (14-19 years).*
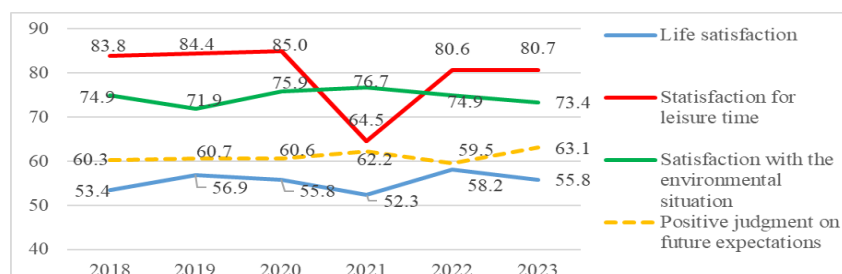
Source: Istat, Indagine Multiscopo sulle famiglie: aspetti della vita quotidiana.

4. Testing of a synthetic index of the well-being of children and young people

For the construction of the composite indexes have been analyzed all indicators inserted in the DB based on territorial availability and which are, at the time of processing, the most updated. A reduced set of 5 key indicators representing the thematic areas related to education, services, justice and safety and health was tested for NUTS 1 (Table 4).

The synthesis of elementary indicators makes it possible to obtain a one-dimensional measure of a complex and clearly multidimensional phenomenon (OECD, 2008). The synthesis indices do nothing but collect all the "signals" coming from the basic indicators

to express them in a single number comparable in space and, where possible, also in time. The objective is to synthesize the selected indicators with the function that can better "interpret" the greatest number of information contained in the starting matrix.

Table 4 – *List of indicators for measuring the well-being of minors.*

Dimension	Indicator	Source	Toward (a)
Education and training	Percentage of repeaters/students, for primary, secondary and second grade schools	Istat, MIUR data processing	-
Services	Expenditure on social interventions and services for families with minors	Istat	+
Justice and security	Number of minor perpetrators reported/arrested by the police on the average population of the same age group	Istat, Ministero dell'Interno data processing	-
Health	% people with excess weight of 6-17 years	Istat, HFA, Health for all	-
Health	Drug consumption rate of 0-14 year olds and children	Istat, HFA, Health for all	-

(a) +: indicator in agreement with the phenomenon; -: indicator discordant with the phenomenon.
Source: Our data processing from Istat.

Table 5 – *Original values of basic indicators.*

Geographical areas	Percentage of repeaters/students, for primary, secondary and second grade schools		Expenditure on social interventions and services for families with minors		Number of minor perpetrators reported/arrested by the police on the average population of the same age group		% people with excess weight of 6-17 years		Drug consumption rate of 0-14 years	
	2018	2021	2018	2021	2018	2021	2018	2021	2018	2021
Northwest	3.0	0.4	39.0	37.9	3.6	3.8	18.1	21.7	14.5	7.6
Northeast	2.9	0.3	36.0	37.5	3.7	3.7	20.7	22.0	14.5	6.3
Centre	3.0	0.5	41.5	40.5	3.0	2.8	24.6	25.7	12.4	8.8
South	3.1	0.8	40.4	38.8	2.2	1.6	29.0	33.2	12.5	6.5
Islands	4.1	0.9	30.3	30.9	3.8	2.7	27.9	29.8	13.9	8.6

Source: Our data processing from Istat.

Table 5 presents the original data of the 5 variables for the years 2018 and 2021, expressed in their different units of measurement.

The objective is the implementation of a synthetic indicator through:

– *construction* of a battery of elementary indicators expressed in appropriate units of measurement; - *normalization* of elementary indicators so as to make them independent of the size of geographical areas and to clear them from specific units of measurement; - *aggregation* of normalised indicators and *construction* of synthetic indices (Mazziotta *et al.*, 2020). In this regard, very well-known synthesis methodologies have been chosen in the literature (Methodological note I.ranker):

1. *Method MPI$^{\pm}$:* transforms elementary indicators into deviations from the mean relativized to the standard deviation; it makes it possible to penalize the score of units that, with the same arithmetic average, have a greater imbalance between the values of the

indicators. The sign ± depends on the type of phenomenon considered and the direction of the elementary indicators (De Muro *et al.*,2009). In this work we will use the version with negative penalty, since it has decreasing variations of the indicator correspond to positive variations in the phenomenon under examination.

2. *Ranking method (MG):* assigns the rank assumed by each unit in a decreasing way that goes from the first to the nth position of the ranking. This transformation makes it possible to release the indicators from the unit of measurement and return them to integer values from 1 to *n* without taking into account of the variability

3. *Method of averaging standardized values (MZ):* transforms the elementary indicators into deviations from the mean relativized to the standard deviation.

4. *Method of relative indices (MR):* re-proportions the value assumed by each unit so that it oscillates between the lowest value assumed by the indicator equal to 0 and the highest value equal to 1.

5. *Taxonomic method of Wroclaw (MTW):* is based on the concept of "ideal unit", which assumes the best values among those observed for each of the indicators considered. The synthesis of the indicators is obtained by calculating the "Euclidean distance" between the actual values of the elementary indicators and those of the ideal unit. Table 6 shows separately, for the year 2018 and 2021, the specific values of the Index of the well-being of children and young people and also offers the ranks of the indicators used for consultation. For a correct reading, it is useful to underline that for each territorial breakdown, the scores of the Index, have been calculated separately; therefore, the comparison between the breakdowns takes a full meaning only within the single annuity taken into account.

Table 6 – *Results and Ranking of the synthesis methods.*

Geographical areas	2021					2018				
	MG	MZ	MR	MPI-	MTW	MG	MZ	MR	MPI-	MTW
Northwest	0.5	0.2	0.6	101.3	0.6	0.4	0.2	0.6	100.9	0.6
Northeast	0.4	0.5	0.7	104.4	0.5	0.6	-0.1	0.5	98.2	0.6
Centre	0.5	0.1	0.6	100.4	0.6	0.3	0.6	0.8	105.9	0.4
South	0.5	0.2	0.6	100.1	0.7	0.5	0.5	0.7	104.5	0.5
Islands	0.8	-0.9	0.2	90.0	1.0	0.9	-11.9	0.1	87.6	1.0
Geographical areas	Ranks					Ranks				
	MG	MZ	MR	MPI-	MTW	MG	MZ	MR	MPI-	MTW
Northwest	2.5	2	2	2	3	2	3	3	3	3
Northeast	1	1	1	1	1	4	4	4	4	4
Centre	4	4	4	3	2	1	1	1	1	1
South	2.5	3	3	4	4	3	2	2	2	2
Islands	5	5	5	5	5	5	5	5	5	5

Note: The indicators were summarized using the Istat software "Rankert Tool".

Consider that one of the objectives of the work is to compare different methodologies of synthesis not so much with the aim of electing one as a "winner" but with the intent to analyze the results as a whole (Mazziotta *et al.*, 2018).

The results of the application do not fully help to understand which synthesis function is the most suitable, but, regardless of the method used, it is clear that the level of well-

being increases along the peninsula from South to North, with the North-West and the North-East obtaining, for all indicators, values much higher so as to be the geographical areas with the best level of well-being in 2021. In 2018, Centre and Southern areas prevailed.

5. Reflections and conclusions

The proposal of this paper is not to indicate a specific route for the identification and subsequent implementation of indicators of the condition and welfare of children on the basis of a defined interpretative model, from which to derive the design and construction of appropriate indicators. This possibility is naturally attractive and innovative, but it can only be a long-term goal. It has thus adopted the path of carrying out an accurate search of the data and statistical information available today for consultation and collecting them in a Database. The available indicators represent an information base that is far from negligible and sufficiently varied and in-depth to develop a first analysis for the comparative measurement of well-being at the territorial repartition level.

References

BELOTTI V., MORETTI E. 2000. *L'Italia "minore"*. Istituto Innocenti, Firenze.
DE MURO P., MAZZIOTTA M., PARETO A. 2009. Composite Indices for Multidimensional Development and Poverty: An Application to MDG Indicators.
FORTUNATI A., BIANCHI D., MORETTI E. 2022. *Indice del Benessere dei bambini*. Istituto degli Innocenti, Firenze.
ISTAT, Rapporto Bes and Rapporto SDGs, 2023.
ISTAT, Statistiche focus: Le Condizioni di vita dei minori 2023.
MAZZIOTTA M., PARETO A. 2020. *Gli indici sintetici,* Giappichelli.
MAZZIOTTA M., PARETO A., TALUCCI V. 2018. *La costruzione di indicatori di disuguaglianza sociale: il caso delle regioni italiane*. XXXI Conferenza Italiana di Scienze Regionali (AISRE). Methodological note I.ranker (https://i.ranker.istat.it/).
OECD 2008. *Handbook on Constructing Composite Indicators. Methodology and user guide.* OECD Publications, Paris.

_____

Cira ACAMPORA, Istat, acampora@istat.it
Antonella LA FACI, Istat, lafaci@istat.it
Valeriana LEPORANICO, Istat, valeriana.leporanico@istat.it
Massimo POTENZIERI, Istat, mapotenz@istat.it
Matteo POTENZIERI, Istat, potenzie@istat.it

CHILD-SPECIFIC DEPRIVATION: INSIGHTS FROM ITALY[1]

Livia Celardo, Francesca Gallo, Mariagloria Narilli

Abstract. The EU-SILC (European Union Statistics on Income and Living Conditions) is one of the main sources of data for periodic reports on the social situation of the European Union and the spread of the risk of poverty in member countries. In the national context, the reference population of the EU-SILC survey consists of all the households residing in Italy at the time of the interview, and their members. All household members are surveyed, but only people aged 16 or over are personally interviewed. However, the needs and living standards of children are different from those of adults, even within the same households. Although many of the household-level material and social deprivation items available from the core questionnaire are relevant to the situation of children, the accurate measurement of the actual living conditions of children requires the collection of information specific to the children's situation and needs. To this end, in addition to the annual variables, the EU-SILC survey includes also variables collected every three years via a specific module on children. This thematic *ad hoc* module includes child-specific items on material and social deprivation, which made it possible to compute the child-specific indicator. To this end, in this paper we present the results of the child-specific indicator calculation for the Italian context – referring to the data from the modules included in the 2017 and 2021 survey editions, also showing which social dimensions are mainly interrelated with child deprivation.

1. Introduction

Leaving no one behind is a central focus of the 2030 Agenda for Sustainable Development, which recognizes the importance of the dignity of the individual and establishes that the Sustainable Development Goals (SDGs) should be achieved for all countries, all people and for all segments of society.

While numerous SDGs address inequalities and the advancement of historically marginalized individuals and communities, the first SDG sets as a priority goal "ending poverty in all its forms everywhere" (United Nations, 2015). In particular,

---

[1] All authors contributed to the study conception and design, and the paper is the result of the common work of the authors. In particular, Francesca Gallo is the lead author of Section 1, Mariagloria Narilli is the lead author of Section 2 and Livia Celardo is the lead author of Sections 3 and 4. All authors red and approved the final manuscript.

it aims at reducing "at least by half the proportion of men, women and children of all ages living in poverty in all its dimensions according to national definitions". It is the first time that worldwide the governments have agreed on a multidimensional poverty target, which explicitly includes children. Moreover, this objective seems to catch concerns that require a broader conception than poverty, addressing inequality explicitly.

Low income has long been recognized as a primary indicator of poverty, but it is essential to acknowledge that other factors also play a crucial role. In more recent years, multidimensional criteria have become fundamental in the study of poverty (Nolan *et al.* 2007), posing interesting challenges, such as choosing the dimensions that are relevant and those that are not, or deciding whether or not to weigh the dimensions to obtain an overall index.

The concept of social exclusion, originally devised in 1970s (Lenoir, 1974), only started to be used more broadly, both in the literature and in the policy discourse, in the late 1990s. Specifically, an important step, which demonstrated the strong attention towards social exclusion, was the European Union's decision to place it at the center of the social policy agenda at the Lisbon summit in 2001. Subsequently, the Common European Plan for Europe 2020 strategy and more recently the Europe 2030 strategy and the work carried out by the Social Protection Committee of the European Union (European Commission, 2015) have continued to put social exclusion at the forefront.

The concept of social exclusion goes beyond the approach that places exclusive attention on monetary poverty as the main parameter for evaluating the inclusive potential of a society. Relying solely on monetary poverty to measure exclusion fails to capture the multidimensional and dynamic nature of the barriers that prevent people from being included (Saraceno, 2001). In line with this criticism, most definitions of social exclusion consider the following elements (Bak, 2018):

1. *Multidimensionality*: social exclusion includes income, poverty and other aspects that capture the level of vulnerability of an individual or group of individuals;
2. *Dynamic*: while the level of monetary poverty can change significantly from one year to the next, social exclusion seeks to capture the underlying factors that predict vulnerability over a longer period of time;
3. *Non-participation*: social exclusion seeks to assess an individual's ability to participate widely in the activities that society deems relevant;
4. *Multilevel*: social exclusion is defined at the individual level, but it refers to factors that go beyond the individual level, such as the family or community of reference.

Despite the agreement on the main factors that make up the concept of social exclusion, there is no agreed definition in the literature. One of the most popular,

which attempts to account for the various factors, comes from Levitas *et al.* (2007, p. 25): "Social exclusion is a complex and multidimensional process. It involves the lack (or denial) of resources, rights, goods and services and the inability to participate in the normal relationships and activities available to most people in a society, whether in economic, social, cultural or political spheres. It affects both the quality of life of individuals and the equity and cohesion of society as a whole".

The AROPE indicator, developed by Eurostat, is one of the most used indicators in European countries to measure this concept. It is the main indicator used to monitor the 2030 agenda target on poverty and social exclusion. It consists of three dimensions intended to capture different aspects of social exclusion: (1) At risk of poverty; (2) Low work intensity; (3) Severe material and social deprivation.

AROPE can be calculated for all countries of the European Union through data collected by EU-SILC survey. This has the notable advantage of comparability across territory and over time. Indeed, although different definitions may be more appropriate for some countries and provide more accurate results, a common indicator has the advantage of allowing comparability between countries. Furthermore, its definition is simple and the values are therefore easy to understand and interpret. However, it only captures a relatively small set of dimensions of social exclusion and this represents its main disadvantage.

The fight against child poverty and social exclusion and the importance of investing in children's well-being has been high on the EU policy agenda. Many authors (Gordon and Nandy, 2012; Main and Besemer, 2013; Main and Bradshaw, 2016) and many recommendations of an EU Task-Force on Child Poverty and Child Well-Being suggested the need for child-specific measures, stressing that simple age group breakdowns of AROPE indicator were insufficient to adequately capture the nature of children poverty and social exclusion. Both the needs and living standards of children can indeed be different from those of adults, even within the same households. Thus, although the household material and social deprivation is relevant to the situation of children, an accurate measurement of the children actual living conditions is required.

The 2009 edition of EU-SILC introduced for the first time an *ad hoc* module on child-specific deprivation. The 13 child-specific items that passed the robustness analysis were subsequently collected in the 2017 and 2021 EU-SILC editions, allowing for the development of a child-specific indicator (Guio *et al.*, 2018).

The advantages of using this index arise from the possibility of taking into account items that have both a direct and indirect impact on the well-being and standard of living of children, which are potentially different from those of adults in the same household. Moreover, the inclusion of the items within the EU-SILC survey questionnaire makes it possible to assess in comparative terms child deprivation and its drivers in the 27 countries of the European Union (Guio *et al.*, 2020).

In this paper, we show the situation of child material and social deprivation in Italy, which includes age appropriate child-specific information available from the thematic deprivation modules included in the 2017 and 2021 edition of EU-SILC. We summarize the main results of an in-depth analysis of these two datasets, attempting to identify the relationship between deprivation and household socio-economic characteristics, and showing how children's deprivation status is strongly influenced by family type and parental education.

2. Data and methods

The EU Statistics on Income and Living Conditions (EU-SILC) is the main source for comparative statistics on income distribution and social inclusion in the European Union (Regulation of the European Parliament no. 1177/2003 and from 2021 (EU) 2019/1700). It is a multi-purpose survey, which focuses on income components, at household and individual level, and social exclusion. Particular attention is paid to material and social deprivation, providing information on housing conditions, labor, education and health[2].

Member States collect yearly data on the so-called primary variables (income, deprivation, economic activity, demography, education, childcare, housing cost, health, quality of life). In addition, a multi-annual rolling plan establishes the list of secondary variables to be collected via modules, every three or six years, to deepen the above-mentioned topics. Both primary and secondary variables are collected at two different levels, the household and the individual level. The reference population includes all private *de facto* households[3] residing in the territories of each country at the time of the interview and their members. People living in institutions are excluded. According to EU Regulation, data shall be based on representative samples drawn from sampling frames that allow households to be selected at random, with a known probability of selection; the sample should have a minimum four-year rotation scheme. In Italy, a two-stages scheme (municipalities and households) with six independent rotational sub-groups is adopted[4]. From one year to the next, part of the sample is rotated while the remaining five-sixths refer to households and

---

[2] For further details, see ISTAT, 2024a.

[3] *De facto* household is a group of people habitually living in the same dwelling, who share the income by contributing and/or benefiting from it.

[4] Until 2019, Italian sample consisted of four independent rotational sub-samples, each of them remaining in the sample for four consecutive years.

individuals extracted in previous years who are re-interviewed[5]. The survey provides two types of data: cross-sectional data on income, poverty, social exclusion and other living conditions at a fixed time and longitudinal data on variation of individual/household conditions over time (six years).

As mentioned, EU-SILC pays particular attention to material and social deprivation. Material and social deprivation refers to the inability to afford a set of thirteen specific items, consisting of goods, services, or social activities that most people consider essential for a decent quality of life. Individuals unable (enforced inability rather than the "choice" not to do so) to afford five or more of the thirteen standard items (6 related to the individual and 7 related to the household)[6] experience material deprivation. The severe material and social deprivation rate (SMSD) is an EU-SILC indicator defined as the proportion of the population experiencing an enforced lack of at least seven out of thirteen deprivation items. SMSD is one of the three dimensions of the "At risk of poverty or social exclusion rate" (AROPE) indicator, the main indicator to monitor progress towards the EU 2030 target on poverty and social exclusion.

In 2021, an in-depth module of the survey took a special look at the living conditions of children aged less than 16 years. The module collects child-specific information from the adult answering the household questionnaire, and not from the children themselves (Guio *et al.* 2018). According to the EU approach, even if only one child in a given household does not have an item, it is assumed that all children in that household lack it. This assumption does not allow for any differences that may exist among the children living in the same family to be captured, but it is necessary to avoid burdening the respondents (Guio *et al.* 2018). It has to be noted that the child-specific deprivation module use "an enforced" concept of lack: only children lacking an item for affordability reasons (and not by choice or due to any other reasons), are considered deprived of it. Data collected enabled the calculation

---

[5] In 2021 data collection was carried out from late June to late November on about 33,000 households (the achieved sample - that was successfully interviewed - consisted of 18,561 households and 38,450 individuals), residing in about 800 Italian municipalities of different size.

[6] The list of thirteen items includes the following (seven related to the household and six related to the individual):

- o *At household level*: Capacity to face unexpected expenses; Capacity to afford paying for one-week annual holiday away from home; Capacity to being confronted with payment arrears (on mortgage or rental payments, utility bills, hire purchase instalments or other loan payments); Capacity to afford a meal with meat, chicken, fish or vegetarian equivalent every second day; Ability to keep home adequately warm; Have access to a car/van for personal use; Replacing worn-out furniture.
- o *At individual level*: Having internet connection; Replacing worn-out clothes by some new ones; Having two pairs of properly fitting shoes (including a pair of all-weather shoes); Spending a small amount of money each week on him/herself; Having regular leisure activities; Getting together with friends/family for a drink/meal at least once a month.

of the specific index of material and social deprivation shared internationally, and based on certain characteristics, conditions and situations typical of minors. A child is considered deprived if he/she presents at least three signs of deprivation out of the seventeen identified (twelve child-specific and five household-specific)[7]. IT-SILC *ad hoc* module and the other household data on the items composing the indicator were replicated for each child living in the same household to compute it. There was only one exception: a reverse calculation was made on the Internet access deprivation item. Information on Internet access for personal use at home is collected for each adult (16 years or more) at individual level. First thing, the percentage of adults lacking this item for financial reasons was computed for each household. Then, each child living in the same household was considered deprived of the Internet access item when at least 50% of the adults members lack it.

The previous survey of the *ad-hoc* module on children was a one-off in 2017. The next paragraph shows the statistical analysis of data on the material and social deprivation of children (aged less than 16 years) in Italy in 2021, in comparison with 2017.

3. Results

3.1. European context

In 2021, 13% of children under 16 in the EU were deprived (Figure 1). Romania (42.5%), Bulgaria (36.5%), and Greece (33.9%) got the highest rates, while Slovenia (2.9%), Sweden (3.5%), and Finland (3.7%) had the lowest.

A key factor influencing the level of child deprivation is the educational level of their parents. In 2021, 39.1% of children in the EU living with parents that had a low education level (up to lower secondary, ISCED levels 0-2) experienced deprivation. In contrast, only 3.8% of EU children whose parents had a tertiary education (ISCED levels 5-8) were affected. This results in an education-related deprivation gap of over 35 percentage points. Across EU Member States, the gap ranged from 8.2 points (Poland) and 13.9 points (Germany), to 74.4 points (Hungary) and 79.0 points

---

[7] The child specific deprivation rate is the percentage of children below 16 who suffer from the enforced lack of at least three items out of the following 17 (unweighted) items:

- o *Child*: Some new clothes; Two pairs of shoes; Fresh fruits and vegetables daily; Meat, chicken, fish daily; Suitable books; Outdoor leisure equipment; Indoor games; Leisure activities; Celebrations; Invite friends; School trips; Holiday.
- o *Household*: Replace worn-out furniture; Arrears; Home adequately warm; Car; Internet (If at least half of the adults in the household are deprived of this item, the child is considered deprived of the item).

(Romania). Eight out of the 27 Member States showed a gap exceeding 50 percentage points (EUROSTAT, 2023).

Figure 1 – *Child-specific deprivation, by the highest level of education attained by their parents (2021, %).*
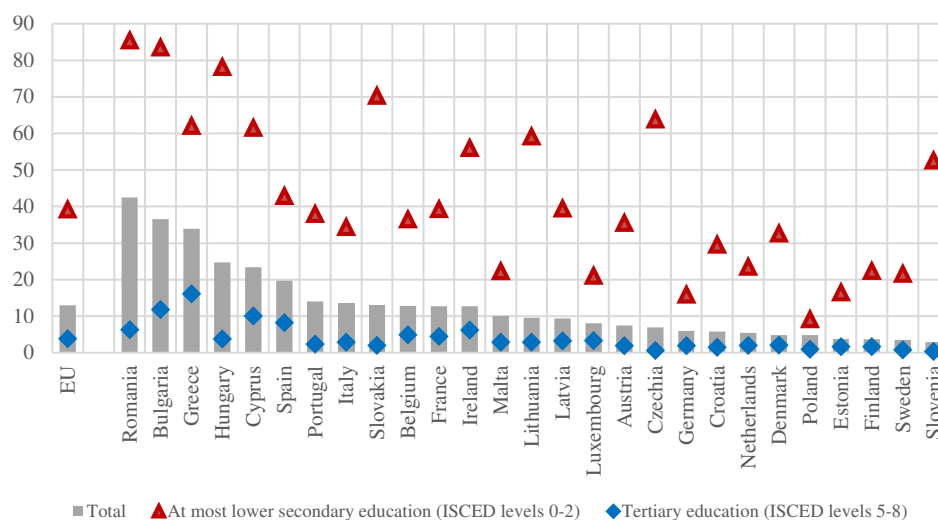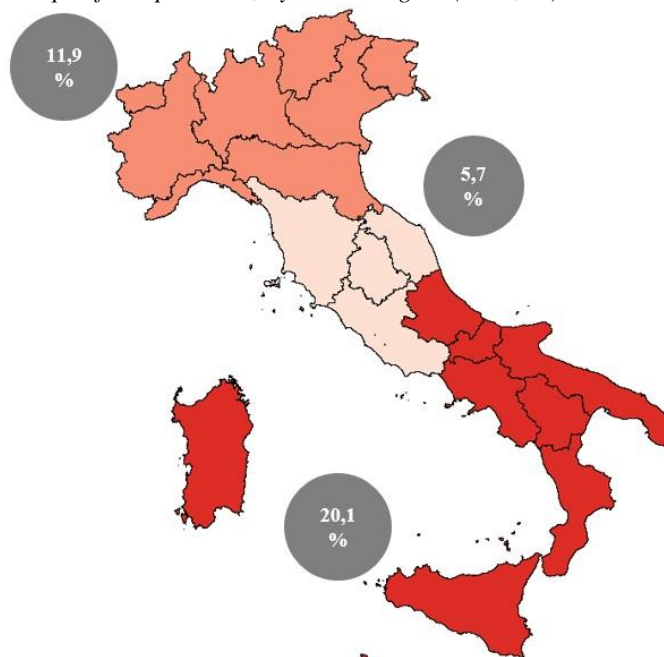

Source: EUSILC survey, EUROSTAT.

3.2. Italian context

In 2023, 4.7% of the Italian population (about 2,788,000 individuals) is in conditions of severe material and social deprivation, i.e. it presents at least seven signs of deprivation out of the thirteen identified by the SMSD indicator. The severe material and social deprivation rate is highest in the South (11.8%) and in the Islands (5.6%), and lowest in the North-East (1.6%), while the Centre and the North-West recorded a similar share (2.5% and 2.3%, respectively).

In Italy, the child-specific deprivation showed a stability between 2021 and 2017 (13.5% and 13.3%, respectively). At territorial level, in 2021 the highest incidence of the indicator was observed in Southern Italy, reaching about one in five children under the age of 16 (Figure 2). On the other hand, the regions of the central area showed the lowest incidence of the deprivation (5.7%), followed by the northern regions (11.9%).

Figure 2 – C*hild-specific deprivation, by Italian region (2021, %).*
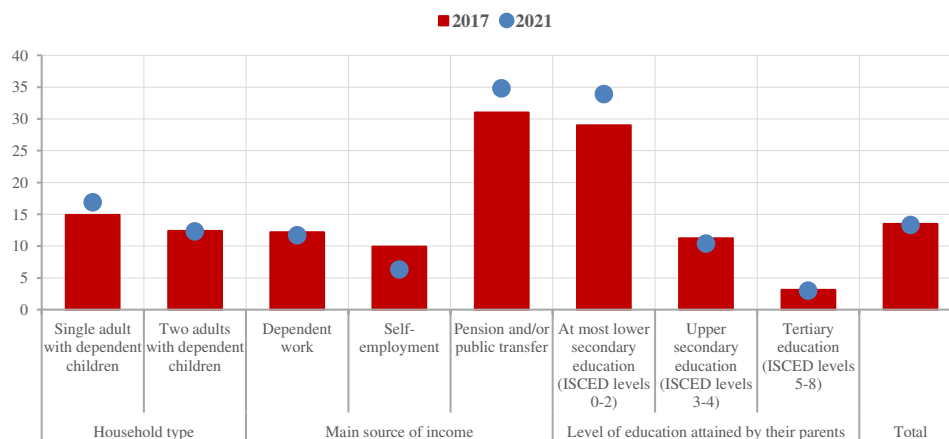

Source: EUSILC survey, ISTAT.

In 2021, the child-specific deprivation rate was highest for the 12-15 age group and lowest for children aged 6-11 (14.8%, as compared with 12.9%). On the other hand, 13.2% of children aged under six years experienced deprivation in 2021, an increase from 2017 (12.2%).

Child-specific deprivation, for children living with one single parent, increased in 2021 (16.9%, compared to 14.9% in 2017), while it remained stable for children living with both parents (12.3% in 2021 compared to 12.4% in 2017). Strictly connected to the household composition, also the number of income earners impacts on the living condition of children. In 2021, children were more likely to be deprived when the number of income earners decreases, ranging from 21.1% of children deprived where there is only one earner in the household, to 9.1% where two or more earners are present. Where the main source of income for the household is dependent work or self-employment, children are less deprived (11.7% and 6.3%, respectively), while the child-specific deprivation rate remains higher for those who can count on income from pensions and/or public transfers (34.8% in 2021, compared to 31% in 2017).

Even in Italy, as in the other countries of the European Union, children whose parents attained a lower educational level are more likely to experience material deprivation compared with children whose parents attained a higher education level. As it is well known (ISTAT, 2024b), an adult's education level affects the type of job an individual can access. Generally, the lower the level, the higher the risk is for the individual and for the household, including children, to experience deprivation compared with those with a higher educational level. In 2021, the child-specific deprivation is equal to 3% if the parental level of education is equal to tertiary education (ISCED levels 5-8), while it reaches 33.9% in case of at most lower secondary education level (ISCED levels 0-2). The child deprivation gap based on the parents' level of education — difference of child deprivation rate between the highest and lowest levels of parents' education — was therefore 30.9 percentage points.

The persistence of large achievement gaps by socio-economic status is an important factor in the intergenerational transmission of poverty (Waldfogel, 2017). Because these gaps are already present early in life, the lack of access to education and early care, which in 2021 affected 66.8% of children in the 0-3 age group, is strictly related to the living conditions of children, in particular those aged 0-5. In 2021, the deprivation rate increases of 3 p.p. for the 0-2 age class (15.3% compared to 12.6%) and doubles for the age class 3-5 (30% compared to 15%), when children do not participate in education and early care.

Figure 3 – C*hild-specific deprivation, by household type, main source of income and level of education attained by their parents (2021, %).*

Source: EU-SILC survey, ISTAT.

Overall, in 2021, about 65% of children under 16 has no signs of deprivation, 15.2% had one and 6.3% had two. Among deprived children (13.5% of the total of children under 16), 35.1% show three out of 17 signs of deprivation, 16.9% four, 11.8% have five and 21.6% a number ranging between nine and 17 (the maximum number of signals considered). In 2021, the most common deprivation item for both deprived and not deprived children is "not being able to afford to replace damaged furniture with others in good condition" (corresponding to 88.6% of deprived children) followed by "not being able to afford at least one week of vacation per year" (81.3%) and "not being able to afford to regularly carry out leisure activities outside the home" (58.4%).

Shifting attention to food deprivation, in 2021, 4.9% of children under 16 live in a household that has experienced economic difficulties that have prevented them from purchasing the necessary food; the share rises to 7.0% in the South. Furthermore, 2.5% of children do not consume at least one protein meal a day because the family cannot afford it. The family's inability to pay for one protein meal a day or the inability to pay for the necessary food outline a condition of food deprivation, which in 2021 affects 5.9% of children under 16 (6.2% in the North, 2.5% in the Center and 7.6% in the South).

There are also differences by household type: couples with minor children account for 4.7%, while single-parent families reach 7.7%.

Finally, the 6-11 age group shows the highest rate of food deprivation (6.3%), which for younger children (up to 5 years) and children between 12 and 15 years of age stops instead at 5.7%[8].

4. Conclusions

Addressing child poverty and social exclusion is high on the international policy agenda. Many authors and institutions push on the need for child-specific measures, stressing that simple age group breakdowns indicators are insufficient to adequately capture the nature of children deprivation.

Starting from the thematic modules included in the 2017 and 2021 edition of EU-SILC survey, in this paper we have shown the situation of children in Italy, in particular with regard to material and social deprivation, which includes age appropriate child-specific information. However, it is important to report some limitations of this study. Firstly, child deprivation variables in EU-SILC are not collected directly from the "voice of the child", but from the household respondents (Guio *et al.* 2020); secondly, two or more children living together are all considered

---

[8] For further details, see ISTAT, 2023.

deprived of an item if at least one of them is deprived of that item. Consequently, it is not possible to investigate differences in child deprivation within the households.

We have reported in the previous section the main results of an in-depth analysis of 2017 and 2021 datasets, trying to identify the links between deprivation and socio-economic characteristics of the household. As shown, children's living conditions are closely related to the territorial context, the parents' working conditions, the household characteristics, the parental education level and the access to early education and care.

In 2021, the proportion of children aged 0-15 deprived is equal to 13.0% in the EU-27 and 13.5% in Italy. In Italy, in 2021, the South has the highest incidence of child material and social deprivation (20.1%). Parental education plays a crucial role in determining the living conditions of children. In 2021 the child material and social deprivation is equal to 3% if the parental level of education is equal to tertiary education, while it reaches 33.9% in case of at most lower secondary education level.

The lack of access to education and early care also impacts on the living conditions of children aged 0-5. The deprivation incidence increases by 3 percentage points for the 0-2 age class and doubles for the 3-5 age class when children do not participate in early childhood education and care. Finally, in 2021 still 5.9% of children aged 0-15 faces food deprivation. Children are much more affected in the South of Italy (7.6%). In addition, there are differences in relation to the family type of the child: couples with minor children have a share of 4.7%, while single-parent families reach 7.7%.

These results represent a starting point for a growing understanding of the living conditions of children, and they could help to identify causes and drivers of child-specific inequalities in specific country context, creating a knowledge base.

References

BAK, C. 2018. Definitions and measurement of social exclusion —A conceptual and methodological review, *Advances in Applied Sociology*, Vol. 08, No. 05, pp. 422-443.

EUROPEAN COMMISSION 2015. Portfolio of EU Social Indicators for the Monitoring of Progress towards the EU Objectives for Social Protection and Social Inclusion, Social Protection Committee Indicators Sub-group, Luxembourg: Publications Office.

EUROSTAT. 2023. Children at risk of poverty or social exclusion, Statistics Explained.

GORDON D., NANDY S. 2012. Measuring child poverty and deprivation. In MINUJIN A. AND S. NANDY (Eds.) *Global child poverty and well-being: Measurement, concepts, policy and action*. Bristol: Policy Press, pp. 57–101.

GUIO A.C., GORDON D., MARLIER E., NAJERA H., POMATI M. 2018. Towards an EU measure of child deprivation, *Child indicators research*, Vol. 11, pp. 835-860.

GUIO A.C., MARLIER E., VANDENBROUKE F., VERBUNT P. 2020. *Micro and macro-drivers of child deprivation in 31 European countries*. Statistical working papers. Publications Office of the European Union.

ISTAT. 2023. *Le condizioni di vita dei minori*. Statistiche focus.

ISTAT. 2024a. *Living conditions and household income – Year 2023*. Statistiche report.

ISTAT. 2024b. *Rapporto annuale 2024. La situazione del Paese*. Roma: PressUP.

LENOIR R. 1974. *Les exclus: Un français sur dix*. Paris: Seuil.

LEVITAS R., PANTAZIS C., FAHMY E., GORDON D., LLOYD E., PATSIOS D. 2007. *The Multi-Dimensional Analysis of Social Exclusion*. Department for Communities and Local Government (DCLG). Bristol.

MAIN G., BESEMER K. 2013. Children's material living standards in rich countries, In BEN-ARIEH A., CASAS F., FRONES I., KORBIN J. (Eds.) *Handbook of child well-being*. New York: Springer.

MAIN G., BRADSHAW J. 2016. Child poverty in the UK: Measures, prevalence and intra-household sharing. *Critical Social Policy*, Vol. 36, No. 1, pp. 1–24.

SARACENO C. 2002, Social Exclusion: Cultural Roots and Diversities of a Popular Concept .in KAHN A., KAMERMAN S. (Eds.), *Beyond Child Poverty: The Social Exclusion of Children, The Institute for Child and Family Development*. New York, N.Y: Columbia University, pp.37-74.

NOLAN B., WHELAN C.T. 2007. On the multidimensionality of poverty and social exclusion. In MICKLEWRIGHT J., JENKINS S. (Eds.) *Poverty and inequality: New directions*. Oxford: Oxford University Press.

UNITED NATIONS. 2015. *Transforming Our World, the 2030 Agenda for Sustainable Development*. General Assembly Resolution A/RES/70/1.

WALDFOGEL J. 2017. Poverty and early care and education. *Focus*, Vol. 33, No. 2, pp. 38-39.

_____

Livia CELARDO, Italian Institute of Statistics (ISTAT), livia.celardo@istat.it
Francesca GALLO, Italian Institute of Statistics (ISTAT), gallo@istat.it
Mariagloria NARILLI, Italian Institute of Statistics (ISTAT), narilli@istat.it

MULTIVERSAL MODEL OF MEASUREMENT OF A COMPOSITE INDEX OF WELL-BEING

Giulio Giacomo Cantone

Abstract. The aggregation of many indicators into a unique index may hide the latent uncertainty in the rank orders of the statistical units due to the freedom in the choice of the aggregating methods. Multiversal modelling enhances this flexibility in the operative definition to derive a posterior distribution of estimates for the latent composite index. This study applies this principle to map the quality of life in 107 provinces in Italy and assess them into robust clusters.

1. Introduction

Gross Domestic Production (GDP) is the fundamental benchmark for measuring the impact of socio-economic policies of well-being and development. Nevertheless, not always a GDP goes along with a consensus on a positive state of happiness or quality of life in a population. In fact, GDP ignores two ideal features of sustainable development: the impact of inequalities in the access to opportunities of development, and the environmental balance between the needs of economic activities and the ecological stability (Patrizii *et al.*, 2017).

The dominance of GDP has been progressively juxtaposed to more granular systems, made of many indicators of socio-economic development. These systems allow the monitoring of indicators for abstract concepts, often articulated in multiple intertwined semantic dimensions. For example, the famous composite Human Development Index (HDI) has the ambition to represent an underlying unity of human activities as biological, technological, and economic facts. In 2014 the Italian National Institute of Statistics of Italy (ISTAT) developed the equally ambitious project for a monitoring system of the Equitable and Sustainable Well-Being of the territories (BES, standing for ``Benessere Equo e Sostenibile"). Originally composed as a system of few indicators to represent 12 dimensions (*dominii*, domains in the Italian) related to the Sustainable Development Goals (SDG) of the United Nations Agenda 2030, over time the number of indicators has grown to exceed a hundred, achieving a remarkable level of granularity even for small territorial areas.

A monitoring system with a hundred variables that, as a collective, define the unitary yet polysemous concept of equitable and sustainable well-being poses more than one challenge for the operative definition of a composite synthetic index, considering that BES is already hierarchically structured along well-distinct domains, too. First of how, abstract concepts as "quality of life" or "sustainability" does not fit well conceptually into continuous scales, where the numeric difference between two units is uninterpretable. Even adopting the composite to establish a ranking of the units, a method that meets the demand of applications more oriented towards discrete decision-making than the estimation of latent features, the compression of many variables into a singular number could result in a decision more driven from the model of aggregation than from evidence (Permanyer, 2012; Greco *et al.*, 2019; Alaimo and Maggino, 2020; Munda and Matarazzo, 2020). A solution for such lack of transparency of uncertainty involved in the aggregation is to represent an interval of ranks instead of a single rank (Permanyier, 2012; Paruolo *et al.*, 2013; Munda, 2022).

This study extends the application of the framework of Multiverse Analysis (MA, Cantone and Tomaselli, 2024) for the elicitation of a set of 20 rank estimates each of the BES in 107 Provinces. The assumption of MA is that by fitting a sufficiently large and well-specified set of combinations of elements of a statistical model, it is possible to approximate the inherent component of variability of results due to the differences in admissible options in modelling the relations between variables. By achieving such result, it would be possible to isolate inferences mainly driven by difference in evidence from inferences mainly driven by the analytical choices in the model. This study extends this principle to models of aggregation of variables, showcasing the benefits of MA over typical alternatives for sensitivity and robustness analysis (see Leibel and Bornmann, 2024). The latter involve random perturbations of the weighting schemes, while MA, running a finite and regular set of combinations, is deterministic. So it is possible to run paired t-tests for a more robust clustering of the Italian provinces into tiers of BES, from the less concerning to the most.

2. The challenges of synthetising many indicators

In a model of a composite index, the relationship between the indicators and the latent variables can either be *reflective* or *formative* (Coltman *et al.*, 2008).

- In reflective relations the latent construct is a 'factor' of the indicators, e.g. "the quality of the health systems is *reflected* in a higher life expectancy". The factor is reconstructed through the tools of Confirmatory Factor

Analysis (CFA) with the hypothesis of a singular factor as communal cause for all the indicators grouped within the domain:

$$X_i = \mu(X_i) + \lambda_i \cdot \Xi + \epsilon_i \tag{1}$$

In Eq. 1 Ξ is the factor, also working later as composite index. X_i is the generic variable within the domain, $\mu(X)$ is its center, generally omitted for standardised X. λ_i is the linear coefficient that best fits the equation (factor loading). This model allows a ϵ_i residual, due to fixed nature of Ξ.

The most immediate test for the hypothesis of a singular fixed Ξ regards the capacity of a singular component of the matrix of the grouped indicators is in the context of the assumptions of the Principal Component Analysis: there must be a singular component that reproduces most of the total variance of the indicators. However, given the confirmatory nature of the model for Ξ, its estimation involves the maximisation of the likelihood for the system of equations of the $X_1, \dots, X_i, \dots, X_k$ indicators in the form of Eq. 1.

- Formative model: in this case the indicators are the causes of the latent dimension (e.g. "an increase of participation in associations and clubs increases the social cohesion of a territory"). Often these processes of formation are designed explicitly through a weighted aggregation of the indicators:

$$\Xi := f(X_1 \cdot w_1, X_2 \cdot w_2, \dots, X_i \cdot w_i, \dots, X_k \cdot w_k) \tag{2}$$

where *W*: $\{w\}$ is the set of weights (*weighting scheme*) and *f(X,W)* is the aggregative function.

These models work well when the analysts can identify and access the sufficient set of variables necessary for a correct specification of the construct. In reality, in many cases the analysts do not design the elicitation of the variables to observe, and as in the case of BES, are provided with sets of semantically tied variables collected by a central institution, without a fully specified causal structure. While in these cases formative models should be preferred, the inclusion of a variable in a system like BES should not be regarded as an event independent from the inclusion of the others, for example because the central institution has more ease to observe some indicators than others; as a consequence, an excess of positive correlations could signal a redundance of information, which should be calibrated with the weighting scheme. in the elicitation of the weighting scheme.

Finally, a linearly aggregative function (e.g. arithmetic average, sum, etc.) implies the principle of compensability of variables, i.e. that it is materially possible

(and socially desirable) to trade a reduction in one dimension for a larger gain in another; the option of a non-linear function suffers of being a relatively arbitrary choice, instead.

In other words, compared to methodologies based on the selection of one singular key indicator (e.g. GDP), methodologies involving multiple indicators suffer from the risk of being sensitive to the analytical choices of synthesis, leading to logically incoherent results across operational definitions of the target construct. The uncertainty resulting from the freedom of choices in formative models justifies the adoption of a whole *posterior* distribution of multiversal estimates for Ξ, where each specification of the formative model combines a weighting scheme and a aggregative function.

3. The dimensions of equitable and sustainable well-being in Italy

This study adopts the Territorial BES for year 2019 (TBES19), consisting in 58 indicators grouped in 11 domains (dimensions), across 107 Italian provinces[1]. Indicators are rescaled in their standard z-values. and polarity aligned to the semantic of the domain (Mazziotta and Pareto, 2013), e.g. if the Domain is "Security" and the indicator is "Violent crimes" then the indicator is multiplied for -1:

$$z_*(x) = \frac{x_* - \bar{x}}{s(x)} \tag{3}$$

where x is the element of variable X for a generic province, $\bar{x}$ is the average x across the 107 province, and $s(x)$ is the standard deviation across the 107 provinces; the asterisk reminds the possibility of an multiplication to invert polarity.

Since the scope of the multiversal method is not to estimate a singular index, but to reproduce the variability in rankings due to the analytical choices of a formative model on a system of indicators, instead of synthetising directly the 58 variables, 11 intermediate variables, one for each domain are synthetised through a simple reduction. The scope of this reduction is to not offer intermediate indexes, but to simplify computation and to avoid to bring an implicit weighting due the different availability of indictors for the different domain in the BES of Provinces. For each domain is conducted a preliminary Principal Component Analysis to check if the reported indicators constitute a reflection of a unitary latent factor (Eq. 1). The method of aggregation of the grouped indicators depends on such test:

---

[1] The dimension "Subjective well-being" is not represented, since it is based on surveys which are not representative at the granularity of provinces. There are 49 missing values in this dataset, less than 0.8% of it. These has been imputed with the predictive algorithm 'missForest'.

- Whereas the principal component with the higher eigenvalue ("first factor") is capable to reproduce more than 50% of the total variance of the variables grouped under the domain, then Ξ is estimated through the Maximum Likelihood Estimator of it (see Eq. 1).
- Where this test fails, the intermediate variables are the arithmetic averages of the indicators with uniform weights, instead.
- The domain "Social participation" groups only one indicator in the TBES19, so that indicator is considered alone as a proxy of the dimension. The domain "Political participation" groups only two indicators, so their average is considered.

Results of this reduction of variables are summarised in Table 1. For domains Health, and Environment, an eigenvalue of the second factor definitely higher than 1 suggests that hypothetically the grouped indicators may conjointly convey information about two independent latent dimensions, for each domain. For example, in the case of indicators of Health, these include both indicators of health in the population and indicators on the performance of the local health systems. However, it is difficult to assume that the health in a population is independent from the performance of hospitals, etc. For this reason, a *naive* formative model that roughly captures both latent sub-dimensions serves as the alternative to a cross-loaded estimation. Similar considerations are applied for Security, Environment, etc.

Table 1 – *Summary of the aggregation of indicators in intermediate constructs.*

Dimensions	N. of indicators	Variance reprod. by 1st Factor	Eigenvalue of 2nd Factor	Method of synthesis
Health	10	28.7%	2.17	Arith. Average
Education	9	62.4%	.87	CFA
Conditions of work	6	77.93%	.88	CFA
Economic activities	4	78.87%	.48	CFA
Social participation	1	---	---	Direct
Political participation	2	---	---	Arith. Average
Security	6	36.37%	1.19	Arith. Average
Territorial patrimony	3	40.27%	1.01	Arith. Average
Environment	9	26.2%	1.88	Arith. Average
Innovative activities	3	52.36%	.83	CFA
Quality of Administration	3	52.6%	.92	CFA

The matrix of correlations of the 11 intermediate variables (Fig 1) allows to hypothesise a very strong relational dependence among the block of Education, condition of Work and Economic activities; meanwhile Security, Environment and Political participation do not positively correlate with the other Domains.

Figure 1 – *Correlation matrix of the 11 intermediate variables.*
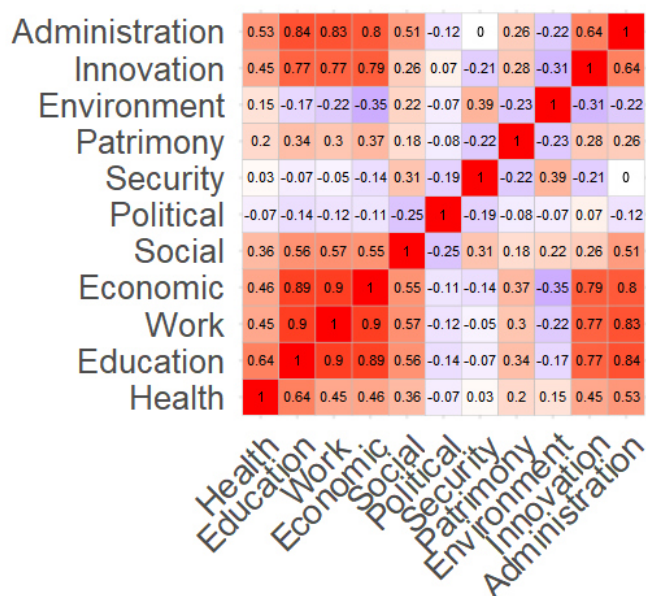
4. Multiversal estimates for a composite index

Once the first step of estimation of 11 intermediate variable is completed, in the second step these are aggregated with a formative model (see Eq. 2) crossing 5 weighting schemes (*W*) and 4 aggregating functions (*f*), for a total of 20 multiversal estimates for a unique index Ξ_0:

$$\Xi_0 = f(\Xi_{Health} \cdot w_{Health}, \dots, X_{QoA} \cdot w_{QoA}) \tag{4}$$

All the considered weighting schemes penalise those intermediate variables highly positively correlated with the other intermediate variables. This principle is adopted for the reason to reduce the potential compensability: in this model of evaluation policymakers cannot not ignore one (or few) dimensions of BES to enhance others, because if they do so, these will become positively correlated to each other and be penalised. In addition, weights must be defined as positive quantities (Munda and Nardo, 2009). The weighting schemes are specified as follow:

- For each pair of constructs for the domains, the similarity of their vectors is measured of through 5 distances: Euclidean, Mahalanobis, Canberra, Soergel (that is the complement of Tanimoto proximity), and Cosine. A summary of these five distances is provided in Appendix A.
- For each Ξ_i intermediate construct the distances with other domains, in the form of $d(\Xi_i, \Xi_j)$, are summed. The weight w_i is equal to

$$w_i = \frac{\sum_j^{QoA} d(\Xi_i, \Xi_j)}{\sum d(\Xi_i, \Xi_j)} \tag{5}$$

The weighted intermediate variables are aggregated into the final index through four specification of the same function:

$$m_q[z_* - \min(z_*)] = \lim_{q' \to q} \left[\sum_{x \neq 0}^{k} \left([z_*^{q'} - \min(z_*^{q'})] \cdot w \right)^{\frac{1}{q'}} \right] \tag{6}$$

which is a generalised form of the normalised mean (de Carvalho, 2016) converging to the Harmonic Mean, Geometric Mean, Arithmetic Mean and Quadratic Mean for the q integer shifting from -1 to 2. Being normalised by substraction of the sample minimum, Eq. 6 is never negative, and being a limit, it ignores the minimum unit in the aggregation, ergo its argument is always positive.

The 20 estimates can be represented as $\hat{\Xi}_{(d,q)}$ where d represent which formula for distance is adopted to calibrate the weighting scheme, and q the value of the parameter for Eq. 6. Given a finite population of 107 provinces, these estimates can are evaluated through a rank statistic: the higher is $\hat{\Xi}_{(d,q)}$ of a province, the lower is the the rank of the province in the specification (d,q).

5. Results

The adoption of the 20 multiversal estimates, compared to the ranks for the 11 intermediate variables, result in a shrinkage in the dispersion in the ranks of provinces, as expected[2].

---

[2] The average Median Absolute Deviation (MedAD) of ranks of the scores of the Italian provinces is equal 14.35 across the 11 dimensions, but it only to 8.58 in the 20 estimates of the composite. This result is visually checked at Figure 3.

Figure 2 – *Relative frequency of ranks for 20 large Italian provinces. 20 multiverse estimates of the composite index are less dispersed than 11 distinct intermediate Domains.*
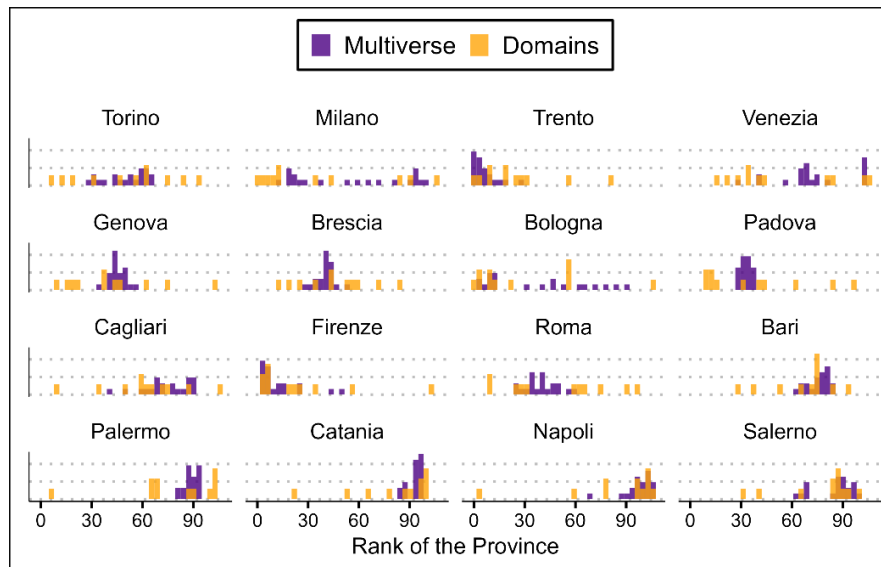

In the multiversal posterior, Pordenone and Trento, the two provinces with the lowest median rank (i.e. the distribution is shifted to the left side of the x-axis in Fig. 2) are characterised not only by a high-performing outlook across the 11 sub-dimensions but also by relatively low variability in ranks. The worst performers Caserta, Agrigento, Crotone and Trapani share concerning states across all domains of the BES system.

For a full visualisation of Italy, a clustering algorithm is run on the multiversal estimates with the sake to establish levels of approximate equivalence in sustainable quality of life among provinces. The core principle of the algorithm is that each member of a higher cluster must be significantly at a higher ranks (more shifted to the right, in Fig 2) of the best performer (lowest ranks) of all the lower clusters. The algorithm is detailed in Appendix B. Given the combinatorial nature of the specifications of the posterior estimates in the multiverse, the Wilcoxon test is ideal to establish this degree of separation. It is important to remark that such procedure does not just split the provinces in percentiles of their outcomes, but optimises am ideal division of territories accounting for the uncertainty in the measurement, so, for example, if a province has an outstanding outperformance of the others, it could still potentially form a cluster in its own, etc.

The algorithm identified 14 clusters of performance. For the sake of a more synthetic representation, these have been manually agglomerated into only 7 tiers

associated to seven colours, from green (more desirable state) to red (worst). This result is reported in Fig 3.

Figure 3 – *Clustering of the Italian provinces in tiers of quality of life.*
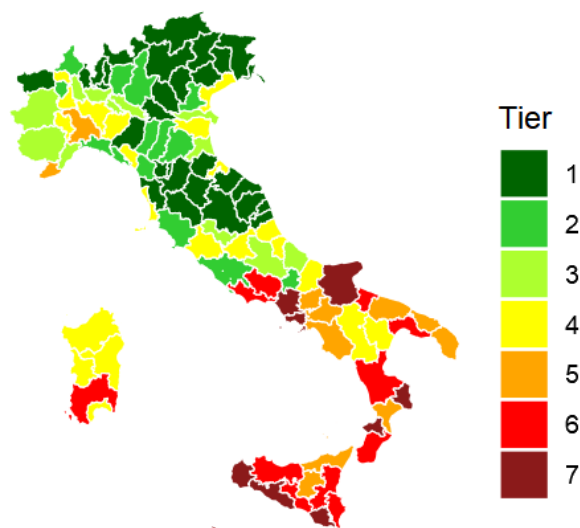
The procedure clearly identified clusters of excellence (Tier 1) in Alps, North-East and North of Center of Italy, while North-West is significantly lower scoring than these areas. The North-West is penalised by its associated with lower Security and Environment, which in the specific scheme of Eq. 5 are weighted more for being less correlated with the other domains (see Fig. 1). Among the Southern provinces, the algorithm identifies Sicily and Calabria as the two regions more in need of structural interventions to equate social development. The little cluster of provinces between Rome and Naples (plus Foggia) is another concerning area, too.

Appendix A

Distances and weighting schemes

Consider *i* as the index for the province.

Euclidean distance:

$$d_E(X,Y) = \sqrt{[\sum_i (x_i - y_i)^2]} \tag{A1}$$

Mahalanobis distance:

$$d_M(X,Y) = \sqrt{(\boldsymbol{x} - \boldsymbol{y}) \cdot S_{(X,Y)}^{-1} \cdot (\boldsymbol{x} - \boldsymbol{y})^T} \qquad (A2)$$

where **x** and **y** are the vectors of *X* and *Y*, and *S* is their covariance matrix.

Canberra distance:

$$d_C(X,Y) = \sum_i \frac{|x_i - y_i|}{|x_i + y_i|} \qquad (A3)$$

Soergel distance:
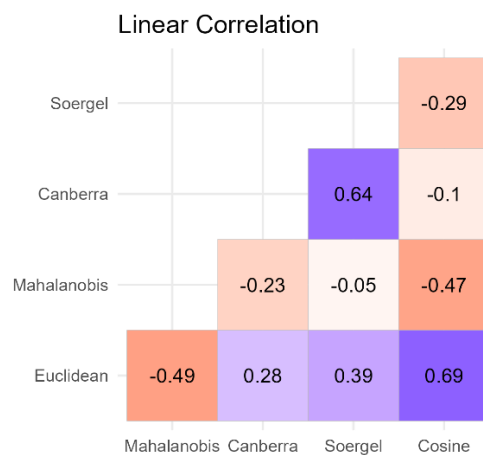
$$d_S(X,Y) = \frac{\sum_i |x_i - y_i|}{\sum_i \max(x_i, y_i)} \qquad (A4)$$

Cosine distance:

$$d_{COS}(X,Y) = 1 - \frac{\sum_i [x_i - \min(x_i)] \cdot [y_i - \min(y_i)]}{\sqrt{\sum_i [x_i - \min(x_i)]^2} \cdot \sqrt{\sum_i [y_i - \min(y_i)]^2}} \qquad (A5)$$

Figure A1 represents the linear correlations among estimates combinations of 107 provinces and 4 values of the *q* parameter, for a total of 428 pairings.

Figure A1 – *Linear correlations among estimates of the formative index weighting schemes.*

Appendix B
Algorithm for Ordinal Clustering

1. Order the provinces from the lowest median rank to the highest, and assign them a *i* for their position.
   Set i=1, and the i=1st province to cluster = 1.

2. Increase *i* by 1. Look at the cluster of province with i-1, then look at the province with the lowest median rank within that cluster. Call this "benchmark".

3. Run a Wilcoxon test between the estimates the i-th province and the benchmark; match the estimates through their (d,q).

4. If $p < \frac{\alpha=.05}{106}$, then assign the i-th province to new cluster,
   If not, assign *i* to the same cluster of the benchmark.

5. If $i \neq 107$, then reiterate from point 2.
   If not, stop.

Acknowledgements

References

ALAIMO L.S., MAGGINO F. 2020. Sustainable Development Goals Indicators at Territorial Level: Conceptual and Methodological Issues—The Italian Perspective, *Social Indicators Research*, Vol. 147, No. 2, pp. 383–419.

CANTONE G.G., TOMASELLI V. 2024. Characterisation and Calibration of Multiversal Methods, *Advances in Data Analysis and Classification*, 10.1007/s11634-024-00610-9.

COLTMAN T., DEVINNEY T.M., MIDGLEY D.F., VENAIK S. 2008. Formative versus reflective measurement models: Two applications of formative measurement, *Journal of Business Research*, Vol. 61, No. 12, pp. 1250–1262.

DE CARVALHO M. 2016. Mean, What do You Mean? *The American Statistician*, Vol. 70, No. 3, pp. 270–274.

GRECO S., ISHIZAKA A., TASIOU M., TORRISI G. 2019. On the Methodological Framework of Composite Indices: A Review of the Issues of Weighting, Aggregation, and Robustness, *Social Indicators Research*, Vol. 141, No. 1, pp. 61–94.

LEIBEL C., BORNMANN L. 2024. Specification uncertainty: What the disruption index tells us about the (hidden) multiverse of bibliometric indicators. *Scientometrics*. https://doi.org/10.1007/s11192-024-05201-1.

MAZZIOTTA M., PARETO A. 2013. Methods for constructing composite indices: one for all or all for one? *Italian Journal of Economic, Demographic and Statistical Studies - Rivista Italiana Di Economia Demografia e Statistica*, Vol. LXVII, No 2.

MUNDA G. 2022. Qualitative reasoning or quantitative aggregation rules for impact assessment of policy options? A multiple criteria framework, *Quality & Quantity*, Vol. 56, No. 5, pp. 3259–3277.

MUNDA G., MATARAZZO A. 2020. On the impossibility of using "the correct" cost–benefit aggregation rule, *Journal of Economic Studies*, Vol. 47, No. 5, pp. 1119–1136.

MUNDA G., NARDO M. 2009. Noncompensatory/nonlinear composite indicators for ranking countries: A defensible setting, *Applied Economics*, Vol. 41, No. 12, pp. 1513–1523.

PARUOLO P., SAISANA M., SALTELLI A. 2013. Ratings and Rankings: Voodoo or Science? *Journal of the Royal Statistical Society Series A: Statistics in Society*, Vol. 176, No. 3, pp. 609–634.

PATRIZII V., PETTINI A., RESCE G. 2017. The Cost of Well-Being, *Social Indicators Research*, Vol. 133, No. 3, pp. 985–1010.

PERMANYER, I. 2012. Uncertainty and robustness in composite indices rankings. *Oxford Economic Papers*, Vol. 64, No. 1, pp. 57–79.

_____

Giulio Giacomo CANTONE, University of Catania / University of Sussex, ggc23@sussex.ac.uk

SMALL AREA ESTIMATION OF POVERTY INDICATORS

Michele D'Alò, Danila Filipponi, Stefano Gerosa, Francesco Isidori

Abstract. ISTAT has been carrying out extensive research to implement Small Area Estimation (SAE) methods for computing Sustainable Development Goals (SDGs) indicators related to health, occupational status, gender equality, and poverty. This work aims to present the main results obtained applying some SAE methods to estimate the "At Risk of Poverty" indicator for unplanned domains using EU-SILC data. The sub-domains of interest are the provinces (NUTS3) and metropolitan cities, while the survey is designed to provide estimates up to the NUTS2 level (regions). The Small Area Estimation (SAE) methods considered encompass both area and unit-level mixed models, and their results are compared against each other. Administrative data sourced from ISTAT's Integrated System of Registers (ISR), specifically from the Population Register and the Labour Register, integrated with income-related administrative data, are used to specify the models. Furthermore, with direct estimates and administrative auxiliary information available from 2017 to 2021, SAE methods can borrow strength not only from other areas but also from various survey cycles. A final step in the process of estimating small-area statistics through an inferential model-based approach is establishing coherence between estimations of the target indicator computed at various levels of granularity. It is performed to align SAEs with precise and unbiased direct estimates computed at higher planned domain levels. This final calibration is not merely cosmetic. It is essential to meet user requirements on coherence and also to enhance the overall accuracy and reliability of model-based SAEs. The application of Small Area Estimation (SAE) estimates allows gains of efficiency compared to direct estimates.

1. Introduction

Poverty indicators are receiving increasing attention from worldwide institutions searching for innovative approaches to contrast socio-economic inequalities.

Recently, EUROSTAT implemented new precision requirements for the At-Risk-of-Poverty-and-Social-Exclusion (AROPE) indicator, applicable at both national and regional levels (Regulation (EU) 2019/1700 (2019)), annually provided by National Statistical Institutes through the EU-SILC survey. In such context, ISTAT is engaged in an ongoing extensive study on AROPE index and its components (At-risk-of-poverty (ARP), low work intensity (LWI), and severe material deprivation (SMD) indicators) involving, among others, small area estimation techniques. The

final aim of the project is to provide stable and affordable estimates of all the above-mentioned indicators, for the period from 2017 up to the present, at NUTS3 level of aggregation. In the present paper, we will focus on ARP index for the year 2021, the last one for which auxiliary variables are currently available, as a starting point for exploring AROPE components. Hopefully, by collecting enough experiences and case studies, we will be able to add steps towards standardizing the production of small area estimates for indicators mentioned above, such as model selection and tuning, collecting appropriate auxiliary variables, and draw an effective process pipeline. The paper is structured as follows. In section 2 we briefly present the survey sampling design and techniques involved in the production of direct estimates of the ARP index. Sections 3 and 4 are dedicated to the description of applied SAE methodologies. Section 5 contains details about the applications and the obtained results. In section 6 some conclusions are drawn.

2. Target variable, sampling design and direct estimates

The at-risk-of-poverty-rate (ARPR) is a relative poverty index defined as the share of people with an equivalised disposable income below the at-risk-of-poverty threshold, set at 60 % of the national median equivalised disposable income. The modified OECD scale is applied to compare households with different size and composition, so that total household income is converted in equivalised disposable income and is attributed equally to each member of the household.

The IT-SILC sampling design is a two-stage design. Primary sampling units are municipalities, while secondary sampling units are households. Municipalities are stratified according to the number of residents and the stratification is carried out inside each administrative region. Moreover, they are selected in each stratum with probability proportional to their size. Households are not stratified, but are selected with equal probability by systematic sampling in each selected municipality from population register lists and no substitution of unit non-response is applied. More details about EU-SILC survey and sampling design can be found in ISTAT (2008). Direct estimates have been obtained using a calibration estimator (Deville-Särndal (1992)), where the final weights reproduce a set of known socio-demographic totals. Since ARPR is a non-linear indicator, its variance has been estimated by a generalized linearization method (Osier (2009)), taking into account all features of the sampling design and of the calibration estimator (strata, sampling stages, externally calibrated weights).

3. Area-level Models

Small area estimation based on an area-level mixed model, often referred to as the Fay-Herriot (FH) method, is a technique used to estimate the parameters of interest for specific sub-domains by combining survey data with available auxiliary information at the area level. Let d be the generic small area of interest ($d = 1, 2, \ldots, D$), $\hat{\theta}_d$ the direct estimate of the target parameter θ_d related to area d, and X_d a set of auxiliary variables known for each area of interest. The area-level mixed model is given by the combination of the following sampling and linking models:

$$\hat{\theta}_d = \theta_d + e_d ; \qquad \theta_d = X_d \beta + u_d.$$

The combination of these two models provides the area-level mixed-effects model,

$$\hat{\theta}_d = X_d \beta + u_d + e_d. \tag{1}$$

In the model above, the random effects u_d are assumed to be independent of the sampling errors e_d, and both are normally distributed. The variance $\sigma_{e_d}^2$ of the sampling errors is assumed to be known and the other model parameters are estimated by using restricted maximum likelihood method as described e.g. in Rao and Molina (2015, Chapter 5). The Empirical Best Linear Unbiased Predictor (EBLUP) for the target parameter θ_d is a linear combination of a direct estimator and a synthetic estimator.

$$\hat{\theta}_d^{sae} = \hat{\gamma}_d \, \hat{\theta}_d + (1 - \hat{\gamma}_d) \, X_d^T \, \hat{\beta} .$$

The weights assigned to the direct estimates are directly related to the variance of the area random effect and inversely related to the sampling variance of the direct estimates

$$\hat{\gamma}_d = \frac{\hat{\sigma}_u^2}{\hat{\sigma}_{e_d}^2 + \hat{\sigma}_u^2},$$

Since direct estimates and administrative auxiliary information are available from 2017 to 2021, efficiency can be improved by borrowing strength not only from other areas but also from other survey occasions. Rao and Yu (1994) proposed an extension of the basic Fay-Herriot model to handle both time-series and cross-sectional data. This model still consists of a sampling model and a linking model.

Let d be the generic small area of interest ($d = 1, ..., D$) and t the generic period of time ($t = 1, ..., T$) the sampling model is:

$$\hat{\theta}_{dt} = \theta_{dt} + e_{dt}$$

It deals with the errors associated with the sample data collected for various areas and each time period, considering the variability introduced by random sampling errors. The area linking model is given by:

$$\theta_{dt} = X_{dt}^T \beta + u_d + v_{dt}$$

This model focuses on how data, such as direct estimates and known area auxiliary information, from different areas are related over time. The final linear mixed model is given by:

$$\hat{\theta}_{dt} = X_{dt}^T \beta + u_d + v_{dt} + e_{dt} \tag{2}$$

where θ_{dt} is the true value corresponding to the estimate $\hat{\theta}_{dt}$ of interest, X_{dt}^T is a (DxP) - dimensional matrix of P covariates available for each area and time, and e_{dt} are the normal sampling errors. Given the true value θ_{dt}, each vector $e_d = (e_{d1}, ..., e_{dT})'$ has a multivariate normal distribution with zero mean and with known variance-covariance matrix Ψ_d. Moreover, $u_d \sim N(0, \sigma_d^2)$ is the area random effect and

$$v_{dt} = \rho v_{d,t-1} + \varepsilon_{dt}$$

with $|\rho| < 1$ and $\varepsilon_{dt} \sim N(0, \sigma_\varepsilon^2)$ is the area-by-time random effect. In this model, e_d, u_d and ε_{dt} are assumed independent of each other and in our application Ψ_d is diagonal, with elements ψ_{dt}, for $t = 1, ..., T$. By combining the direct and synthetic estimators, the final composite estimator efficiently borrows strength across small areas and time periods. For a small area d at time t, the composite estimator $\hat{\theta}_{dt}$ can be expressed as:

$$\hat{\theta}_{dt}^{sae} = \hat{\gamma}_{dt} \, \hat{\theta}_d + (1 - \hat{\gamma}_{dt}) \, X_{dt}^T \, \hat{\beta}$$

in which:

$$\hat{\gamma}_{dt} = \frac{\hat{\sigma}_u^2}{\hat{\psi}_{dt} + \hat{\sigma}_u^2}.$$

4. Unit-level models

The small area estimation using unit-level models are based on the seminal paper of Battese, Harter, and Fuller model (Battese et al. (1988)). These models utilize auxiliary information for each statistical unit, integrating it with survey data to specify a model that borrows strength from similar areas. This approach typically employs a linear mixed model framework to predict parameters of interest in small sub-domains of interest. The basic unit-level mixed model can be formulated as follows:

$$y_{id} = X_{id}^T \beta + u_d + \epsilon_{di} \tag{3}$$

Where, denoted with i and d respectively the generic unit and area, y_{di} is the observed outcome; X_{di}^T is the vector of auxiliary variables; β is the vector of fixed effect coefficients; u_d is the random effect with $u_d \sim N(0, \sigma_d^2)$ and ϵ_{di} is the random error term for unit i with $\epsilon_{di} \sim N(0, \sigma_\varepsilon^2)$.

The variable of interest is a binary indicator which identifies individuals with an equivalised disposable income below the at-risk-of-poverty threshold. Due to the binary nature of the target variable, a logistic mixed model is a natural choice to consider, being specifically designed to handle binary outcomes. The logit of the probability of the outcomes associated with each unit i belonging to the domain can be expressed as follows:

$$logit(P(y_{id} = 1)) = X_{id}^T \beta + u_d + \epsilon_{id}, \tag{4}$$

The Empirical Best Linear Unbiased Predictor (EBLUP) estimates of the target parameter are derived after computing the Restricted Maximum Likelihood (REML) estimates of the model parameters β and σ_u^2 σ_ε^2. The small area estimator $\hat{\theta}_d$ is a combination of the direct estimate and the model-based estimate. It can be expressed as:

$$\hat{\theta}_d^{sae} = \hat{\gamma}_d \hat{\theta}_d^{dir} + (1 - \hat{\gamma}_d) \hat{\theta}_d^{model} \tag{5}$$

in which:

$$\hat{\theta}_d^{dir} = \frac{1}{n_d} \sum_{i \in s_d} y_{id}$$

where n_d is the number of sampled units in area d, while

$$\hat{\theta}_d^{model} = \frac{1}{N_d} \sum_{i \in U_d} \hat{y}_{id}$$

where N_d is the total number of units in area d and $\hat{y}_{id}$ is the predicted value for unit i in area d. In case of linear mixed model (3), the predicted values are given by:

$$\hat{y}_{id} = X_{id}^T \hat{\beta} + \hat{u}_d.$$

In case of logistic mixed model (4), the predicted values are instead given by:

$$\hat{y}_{id} = \frac{\exp(X_{id}^T \beta + u_d)}{1 + \exp(X_{id}^T \beta + u_d)}$$

Finally the weight of the area d of the composite estimator (5) is determined on the basis the variance components estimates and is given by:

$$\hat{\gamma}_d = \frac{\hat{\sigma}_u^2}{\hat{\sigma}_u^2 + \hat{\sigma}_\varepsilon^2 / n_d}$$

The composed small area estimator based on unit-level mixed models effectively integrates direct estimates and model-based predictions, by leveraging individual-level data and area-specific random effects.

5. Application and analysis of the results

The objective of this case study is to estimate the At-Risk-of-Poverty (ARP) indicator at the provincial level (NUTS3) and for 14 Metropolitan Cities. These are considered unplanned domains for the EU-SILC survey since the finest planned domain is at the regional level (NUTS2). Overall, we have 121 unplanned domains, and the target parameter has been estimated using survey data from 2017 to 2021. The next two figures illustrate the distribution of the Coefficients of Variation (CVs) for the direct estimates of the ARP indicator. Figure 1 refers to the NUTS2 planned domains, while Figure 2 shows the distribution of CVs for the NUTS3 unplanned domains. Each box plot in both figures represents the observed distribution of CVs for each available reference period from 2017 to 2021.

Figure 1 – *Boxplot of direct estimates CV within NUTS2 domains.*
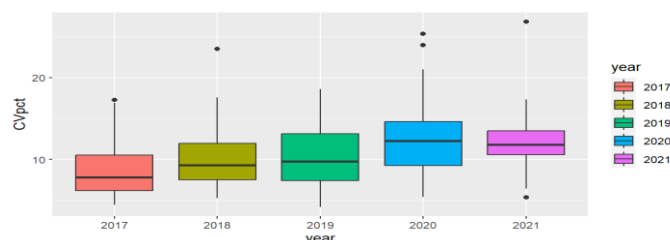
Figure 2 – *Boxplot of direct estimates CV within NUTS3 domains.*
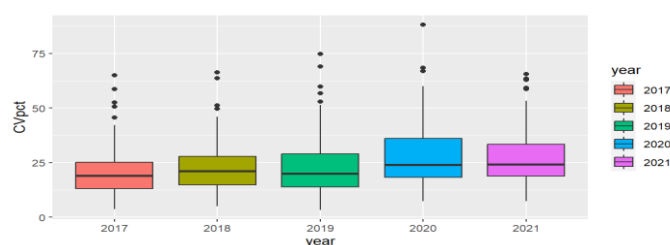
These two plots provide insights into the variability and reliability of the direct estimates over time across different domain levels. It's evident that CVs of the direct estimates have increased over the last two years, largely due to a higher level of non-response rates during the COVID-19 pandemic. This trend appears to be slightly mitigated in Figure 2, which shows the trend of CVs for unplanned domains. For this level of granularity, the impact of missing responses may be masked by the larger variance of direct estimates in unplanned domains, due to the small sample sizes. Given that NUTS2 are planned domains, ARP estimates at the regional level tend to have relatively high CVs. However, since this application focuses on the implementation of SAE methods for unplanned survey domains any analysis of results pertaining to planned domains is set aside for now. In order to evaluate the computed estimates, we will utilize the criteria proposed by Statistics Canada (https://www150.statcan.gc.ca/n1/pub/71-543-g/2016001/part-partie7-eng.htm#archived), although other criteria determined consulting users and experts, may also be considered. According to such criterion, estimates having CV less than 16.6% can be released without any restriction. Estimates with CV between 16.6% and 33.3% can be released with caveats and should be always accompanied by a warning regarding their accuracy. Finally, if CV is greater than 33.3% the corresponding estimates should not be released. Table 1 shows the number of direct estimates in the described groups for the year 2021. As expected, along with the two out of sample areas, many direct estimates of the target parameter show high CVs.

Hence, implementing small area estimator methods is a crucial step to try to enhance the efficiency of estimates at the desired level of disaggregation.

Table 1 − *NUTS3 Estimates grouped by CV*.

CV%	Evaluation	Number of estimates
≤ 16.5	Publishable	20
(16.5; 33.3]	Publishable with caution	67
>33.3	Not recommended for publication	32
Not available	Not available	2

To compute small area estimates of ARP for the 121 sub-domains of interest, we consider the two estimators (eblup_lin and eblup_logit) based on the mixed unit-level model described in paragraph 4, and the two estimators (FH and YR) based on area-level mixed model described in paragraph 3. The fixed part of the models were specified using administrative information available in ISTAT's Integrated System of Registers (ISR), particularly from the Population Register and the Labour Register, integrated with administrative data on income (Baldi et al., 2018). Specifically, we considered:

- Population distribution for 7 age classes;
- Population distribution for 3 education level classes (Primary education, secondary education, university degree)
- At risk of poverty index administrative proxy;
- Quintiles of equivalent income at the national, regional, and provincial level;
- Population distribution for work income, pension income and capital income grouped in five 5 classes;
- Population distribution for 4 classes of the average number of working weeks, obtained by dividing the year into quarters.

This auxiliary information was integrated with the survey data to specify and fit the unit-level models (3) and (4). Aggregated mean values of the same information at the domain level were instead used to fit the mixed area-level models (1) and (2). The standard Fay-Herriot area-level estimator assumes normality and independence of the error terms. However, in this application, these assumptions appear to be violated. To address this issue, the area-level model has been specified on the log-transformed direct estimates. SAEs based on this model have been computed using the emdi package (see Harmening, et al. (2023)). The log-transformation ensures a better fit of the area-level model to the normality assumptions of the random error components. This transformation introduces a bias when converting back to the

original scale, which can be adjusted applying a so called 'crude' method, as described by Harmening et al. (2023).

Additionally, like the direct estimates, their corresponding variance estimates can also be very unstable. Therefore, smoothed estimated variances has been considered for computing both standard and log-transformed FH - SAEs. Assuming that the variance of estimates depends on the area sample size and the intensity of the target variable, a simple linear model has been used to smooth the estimated variances of the direct estimates. The applied model is:

$$\ln(var(\hat{\theta}_d)) = \beta_0 + \beta_1 \ln(n_d) + \beta_2 \ln(\hat{\theta}_d)$$

where n_d and $\hat{\theta}_d$ are respectively the realized sample size in the area d and the direct estimates.

Both of the above adjustments lead to more satisfactory model fitting and improved properties of the small area estimates. Consequently, the following results and analyses related to FH estimates will refer just to the small area estimates computed on the basis of a standard area-level model specified considering the log-transformation of the direct estimates and the smoothing of their variance.

Figure 3 illustrates comparisons between direct estimates and model estimates, highlighting that SAEs based on area-level models align more closely with direct estimates compared to those computed using two EBLUP estimators based on unit-level models. ARP's FH estimates, as expected with SAE methods, allow to smooth both the lowest and highest direct estimates, while YR mainly reduces the intensity of the largest direct. The increasing trend of ARPR estimates from 2017 to 2021 (see Figures 1 and 2) can lead the YR estimator to produce lower SAEs, as the model is specified to borrow strength not only from other areas but also from the time occasions of the survey. The logistic unit-level model does not seem to yield better results compared to its linear counterpart, as expected given the binary nature of the response variable. Further in-depth analysis is needed to understand the reasons.

A benchmarking procedure, aimed at ensuring the consistency of target indicator estimates across different levels of disaggregation, is performed to align SAEs with precise and unbiased direct estimates computed at planned domain levels. This final calibration is not merely cosmetic. It is essential to meet user requirements on coherence and also to enhance the overall accuracy and reliability of model-based SAEs, by reducing the possible bias of SAEs. Those estimates should be aligned to the finer planned domains' direct estimates (NUTS2 level). However, as shown in Figure 1, these estimates are not sufficiently reliable, with some having a CV exceeding 20%. Consequently, the small area estimates were benchmarked against the more reliable ARP direct estimates computed at the NUTS1 level, corresponding to a division of the Italian territory into five groups of administrative regions: North

East, North West, Centre, South, and Island. The benchmarking adjustment introduces an extra variability that is added to the original MSE of SAEs.

Figure 3 − *Comparisons between direct and models estimates.*
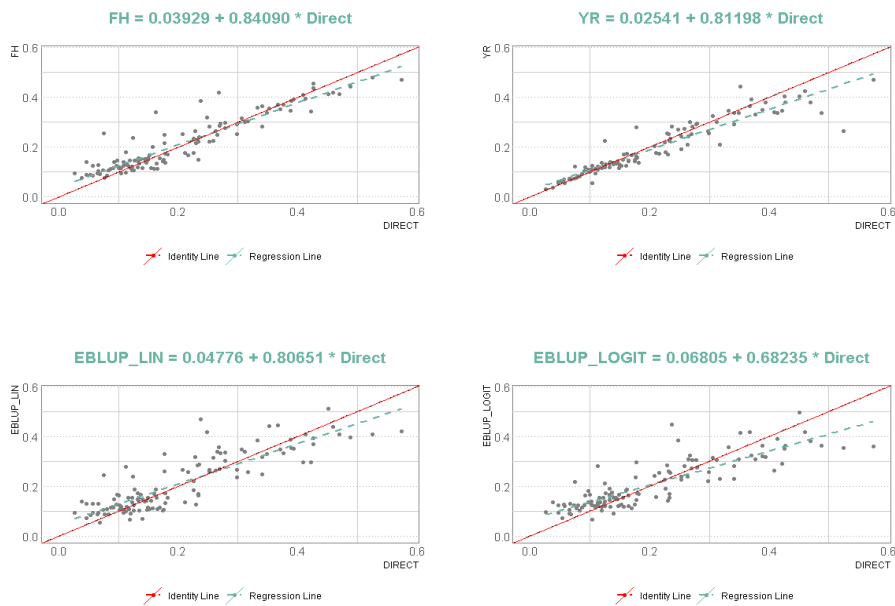
The set of estimates' coefficient of variation is reported in Figure 4. Plot A displays the original CVs of the SAEs, while plot B shows the distribution of CVs of correspondent post-benchmarked estimates. All SAE methods allow considerable efficiency gains over the direct estimator, with the FH estimator outperforming the other SAE methods. It is worth highlighting that the CV distribution for the two estimators based on unit-level models have a lower median compared to other estimators. This can be attributed to the significant correlation between the response variable and the set of unit-level administrative data used to specify these models. However, both SAE methods based on linear and logit unit-level models show a broader distribution of CVs, with higher maximum values compared to the FH estimator. Further model specifications and assumptions analysis are needed to better understand the reasons behind these outcomes. The distribution of CVs for the YR estimator is not good, with only slight improvement observed after the benchmarking, which mitigates the over-shrinkage of the estimates computed with this estimator. To improve results, like done for the FH methods, one might consider

to specify the You-Rao model on the log transformation of the direct estimates and after the smoothing of the estimated variances.

Figure 4 − *CV of direct and the original and post benchmarked SAEs.*
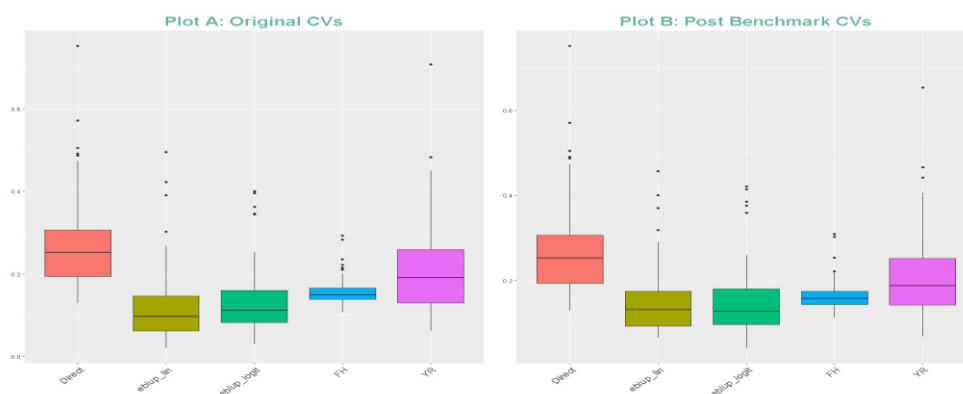
6. Conclusions

The results are encouraging, with the FH estimator outperforming the other SAE methods considered in this study. We are currently working on incorporating both variance smoothing and logarithmic transformation into the YR time series area-level model, as done with the basic FH model. Additionally, other SAE methods that utilize longitudinal information in unit-level models and account for spatial correlation in both area and unit-level models should be considered. Exploring the Empirical Bayes Predictor (EBP) proposed by Molina and Rao (2015) for estimating poverty indicators is also worthwhile, despite its high computational cost. Finally, it is essential to thoroughly evaluate the models' goodness of fit, validate the specified assumptions, and conduct both statistical and thematic assessments of all SAE estimates produced.

References

BALDI C., CECCARELLI C., GIGANTE S., PACINI S., ROSSETTI F. 2018. The Labour Register In Italy: The New Heart Of The System Of Labour Statistics, *Rivista Italiana di Economia, Demografia e Statistica*, Vol. LXXII, No. 2, pp. 95-105.

BATTESE G. E., HARTER R. M., FULLER W. A. 1988. An error components model for prediction of county crop area using survey and satellite data, *Journal of the American Statistical Association*, Vol. 83, pp. 28-36.

DEVILLE J. C., SÄRNDAL C. E. 1992. Calibration estimators in survey sampling, *Journal of the American Statistical Association*, Vol. 87, No. 418, pp. 376-382.

FAY R. E. AND HERRIOT R. A. 1979. Estimates of income for small places: An application of James-Stein procedures to census data, *Journal of the American Statistical Association,* Vol. 74, No. 366, pp. 269-277.

HARMENING S., KREUTZMANN Ann-K., Salvati N., Schmid S. 2023. A Framework for Producing Small Area Estimates Based on Area-Level Models in R, *The R Journal,* Vol. 15, pp. 316-341.

OSIER G. 2009. Variance estimation for complex indicators of poverty and inequality using linearization techniques, *Survey Research Methods,* Vol. 3, No. 3, pp. 167-195.

REGULATION (EU) 2019/1700 OF THE EUROPEAN PARLIAMENT AND OF THE COUNCIL establishing a common framework for European statistics relating to persons and household. 2019. *Official Journal of the European Union.* LI 261/1

RAO J.N.K., MOLINA I. 2015. *Small Area Estimation.* Wiley Series.

RAO J. N. K., YU M. 1994. Small-Area Estimation by Combining TimeSeries and Cross-Sectional Data*, The Canadian Journal of Statistics*, Vol. 22, No. 4, pp. 511–528.

_____

Michele D'ALÒ, Istat, dalo@istat.it
Danila FILIPPONI, Istat, dafilipp@istat.it
Stefano GEROSA, Istat, gerosa@istat.it
Francesco ISIDORI, Istat, francesco.isidori@istat.it

MEASUREMENT OF ABSOLUTE POVERTY IN ITALY:
AN EMPIRICAL ANALYSIS[1]

Valeria De Martino, Livia Celardo

Abstract. Absolute poverty is a socio-economic measure based on the monetary evaluation of a basket of goods and services, considered essential to avoid serious forms of social exclusion. Absolute poverty has been estimated in Italy since 2005 by the Italian Institute of Statistics, with reference to household consumption, using data from the Household Budget Survey (HBS), comparing the expenditure of Italian households with the absolute poverty thresholds. The reference unit is the household, considered in relation to the characteristics of the individual components, their specific needs (nutritional, for instance) and any scale or forms of savings that can be achieved when the family composition varies. Essential needs have been identified in adequate nutrition, in the availability of a dwelling - equipped with necessary goods and services according to the needs of the household - and in the minimum necessary to dress, communicate, get informed, move in the territory, educate and maintain good health. Consequently, the basket is composed of three macro components - food, housing, residual - whose monetary valuation was not carried out at the absolute minimum price, but at the minimum price accessible to all households taking into account the different distribution channels. The monetary value of the total basket was obtained from direct sum of the various components and corresponds to the household absolute poverty threshold. Monthly expenditure used to purchase goods and services exclusively devoted to meet the households needs (including presents purchased), is compared with the value of the poverty threshold, in order to classify a household as absolutely poor or non-poor. After a methodological revision in 2022, the poverty threshold is now defined by the combination of the household type, the region and the municipality of residence. As a consequence, it is possible to identify as many absolute poverty lines as many combinations exist between the elements mentioned before. The methodology revision has allowed the release of more punctual data, capturing the heterogeneity of the expenditure for the different household types in the different areas/territories of the Country. Then, in this paper we briefly show the main changes in the methodology for the measurement of absolute poverty and we present some descriptive analysis on the poverty thresholds calculated for the period of 2014-2022.

---

[1] All authors contributed to the study conception and design, and the paper is the result of the common work of the authors. In particular, Livia Celardo has written Sections 3, Valeria De Martino has written Sections 2. Section 1 and 4 are the result of common work of the authors. All authors have read and approved the final manuscript.

1. Introduction

There are many ways to define and measure poverty, but with few exceptions the empirical basis for poverty comparisons is statistical, employing point estimates of relevant poverty measures, generally derived from household survey data (Simler and Arndt, 2007). The last 50 years has seen great progresses in the production and availability of such data for developing countries, thanks to the efforts of National Statistics Institutions (NSIs) and the support of the international development agencies (Chen and Ravallion, 2007).

One of the primary studies on poverty was done by Rowntree (1901), who defined households as being in primary poverty if their total earnings were insufficient to obtain the *minimum necessities of merely physical efficiency*. He estimated the minimum costs for food, rent, clothing, fuel and sundries that would satisfy the minimum needs of families of different sizes (Ringen, 1988). Therefore, a poverty line identifies the society's minimum standard of living to which everybody should be entitled (Laderchi et al., 2003). Following that, a household is classified as poor if its members cannot afford this minimum. There are two main approaches for measuring poverty (Carbonaro, 1993). The first one is the *relative* approach, which defines the poverty line in relation to the average standard of living experienced by a society (Beycan, 2023). Therefore, the relative approach captures a form of "social inclusion", whose cost in terms of consumption increases with standards of living (thus, the value associated to a relative poverty threshold is larger in richer societies). The second approach is known as the *absolute* approach. This approach captures basic needs satisfaction, so then an absolute poverty line has a fixed threshold in the space of consumption (Klasen, 2016). Following this point of view, the poverty line should be adjusted for individual circumstances – the age for instance, so that all the individuals on the poverty line have the same standard of living. The absolute approach to measuring poverty also implies that the real poverty line (which is the result of the monetarisation of the basket of reference goods and services) is fixed over time. The poverty line should only change over time because of changes in prices (Son and Kakwani, 2009). This property implies that the poverty line should be adjusted over time by means of the true cost of living index, so the observed differences in the poverty line measure the real change in the poverty line.

Traditionally, absolute poverty has been estimated in developing countries (Ravallion, 2016), but even in economically advanced countries there is a non-negligible share of the population that is unable to achieve standards of living that are considered socially acceptable (Aprea et al., 2023). Considering the European context, Italy is the only country that calculates official statistics on absolute poverty. The Italian Institute of Statistics (Istat, hereafter) releases estimates of household absolute poverty, defined with reference to household consumption using the

Household Budget Survey (HBS, hereafter). Also individual measures of absolute poverty are released, through the use of savings/non-savings coefficients included in the calculation of the thresholds, taking into account households of different sizes and allowing comparison between household expenditures and the thresholds. Poverty measures are usually identified as household-based indicators, mainly because government and organizations often prefer family-based measures since they capture shared living arrangements, while individual measures are more useful for the analysis of specific populations, such as children, elderly people or single individuals.

The methodology developed by Istat from 2005 to evaluate the absolute poverty indicator (Freguja et al., 2007; Istat, 2009; Cutillo et al., 2022) is based on the standard budget approach, where poverty thresholds correspond to a basket of goods and services considered essential to avoid serious forms of social exclusion.

The inclusion process of the absolute poverty estimation in Istat started in 1996, when there was a need to combine relative poverty indicators with a methodology based on absolute poverty; through a working group of academic experts on poverty issues composed of Istat researchers and members of the *Commission of Inquiry on poverty and marginalisation*, a first methodology has been developed (Commissione di indagine sulla povertà e sull'emarginazione, 1998). This methodology was mainly based on the definition of a set of essential needs and the availability of minimum resources to enable the acquisition of such assets.

In later studies conducted by Istat, some limitations of the methodology used were highlighted, which imposed a subsequent revision, also due to regulatory changes related to the provision of goods and services and the spread of new lifestyles. For this reason, Istat has set up a Study Committee composed of experts on poverty themes to evaluate the composition of a basket of essential goods and services, reviewing and modifying the previous approach. Adjustments and changes were made focusing on goods and services that were considered essential to avoid serious forms of social exclusion in the reference context. At the same time, the production of estimates has been suspended since 2003, while from 2005 absolute poverty indicators based on this new methodology have been produced again (Istat, 2009).

Then, in 2021 a National Inter-institutional Study Commission was established, chaired by the President of Istat, with the participation of representatives of the University, the Bank of Italy and experts from various government bodies, to revise and update the methodology for estimating absolute poverty.

The Committee validated the overall methodological framework (in terms of main theoretical assumptions and basket components), but at the same time taking into account innovations introduced in the HBS in 2022 (that is, the most recent

version of COICOP[2] 2018 classification and the new populations released on the basis of the results of the Istat Permanent Population Census). Moreover, the Commission introduced some methodological changes in the estimation of the three sub-components of the reference basket (i.e., food, housing, residual), in the annual revaluation of the basket, promoting the use of new available data sources in the estimating methodology.

Then, in this paper we firstly show the main changes occurred in the calculation of the absolute poverty threshold, and then we present an application of the updated methodology to a specific household type (i.e., two adults and two children).

2. Methodology

The main changes implemented in the revision of the absolute poverty estimation concerned all the sub-components of the reference poverty basket. There are three main components of the reference basket (food, housing and residual), which can be further specified through sub-components. Regarding the food component, the main revision applied concerns the number of food items considered. This number was increased to 96 types of items (instead of 34 of the previous version) to be more closely aligned with the population's daily diet and in accordance with the recommendations of the Healthy Eating Guidelines. Food items were selected using data from the latest national survey on food consumption conducted by the Council for Agricultural Research and Economics (CREA - IV SCAI 2017-2020 study), which involved a sample ranging from 3 months to 74 years of age. The quantities in grams of each food item was reshaped following the new nutritional principles, resulting in a balance of nutrients. The age groups considered in the calculation of the appropriate food diets were incremented to seven (from 0 to 3 years, from 4 to 10, from 11 to 17, from 18 to 29, from 30 to 59, from 60 to 74, 75 years old and over) and the minimum price for each food item considered have been calculated by means of the consumer price survey, following for fresh food mainly the traditional part of the CPI (Consumer Price Index) survey and for other foods by exploiting the data source of data scanners that offered a wide variety of detailed information at regional level.

In order to take into account household composition directly related to consumption, the final value of the household food component is obtained by applying to the value of the additive food component specific multiplicative coefficients that synthesize the effect of the forms of savings/not savings when

---

[2] The objective of the Classification of Individual Consumption According to Purpose (COICOP) is to provide an international reference framework for grouping household consumption expenditures on goods and services within homogeneous categories.

purchasing. The general system followed for the calculation of savings is similar to the one adopted for the previous version, but in this case the phenomenon has been studied more in depth. The coefficients have been reformulated through the processing of HBS data, taking advantage of the availability of a wider database. These coefficients have a specific weight for both the food and the residual components.

The housing sub-component is divided into four main categories: rent, electrical energy, heating and durable goods. The rent sub-component main updates and changes concern the rent estimation, which is conducted exogenously through an external census database (the Real Estate Lease Database - the database of all the rental contracts provided by the Italian Tax Office). The rent is calculated as the median value of the cells obtained through stratification given by region, type of municipality and size class of the dwelling.

Electrical energy component includes expenditures on hot water production and cooking gas (considered with heating in 2005); the value has been estimated through a model for the reference year of 2019 on HBS data, so that the new estimate is no longer exogenous. The model is calculated excluding households with high electrical energy expenditure identified by the possession of energy-intensive household appliances.

For the heating component, the Bank of Italy's methodology for calculating energy poverty was utilized. The estimates were made using the unit heating demand for several types of buildings, classified according to climate zone, construction period and type (from the database *Research on the Energy System*), and the value was obtained applying unit prices from the integrated database *Istat-Regulatory Authority for Energy, Networks and Environment*.

For durable goods, the list of goods was updated and reference was made to the minimum price applied at the level of four geographical breakdowns.

The residual component aims to estimate the minimum necessary «*to furnish and maintain housing, dress, communicate, inform oneself, move about the area, educate oneself and maintain good health*» (Istat, 2009), taking account of the needs and behaviour of households without defining the specific quantities. The monetary value of the residual component is obtained from a food basket adjusted for the effect of the forms of saving/not saving when buying only for a share corresponding to the weight, in the residual basket itself, of the non-durable goods (excluding health products, medical self-diagnosis devices and water supply).

These major changes in all components of the basket have led to an improvement in the detail of the calculation of the thresholds for each household type; they can be calculated at regional level and they allow a better representation of the phenomenon in the different areas of the Country. According to the new estimation methodology, the absolute poverty thresholds range by size (number) and composition (age group)

of the household (as it was in the past), region of residence (it was by geographical areas in the 2005 methodology) and demographic size of the municipality of residence (as it was in the past).

Poverty measurement is then based on a comparison of resources to needs. A family is identified poor when his monthly expenditure is equal to or less than the value of the absolute poverty threshold. An individual is poor if belongs to an absolute poor household.

Since 2022, all the components of the absolute poverty basket are annually revaluated using specific consumer price indices calculated mainly at regional level, and the revalorization of all the basket components is carried out every 5 years.

Defining absolute poverty thresholds predominantly exogenous (i.e., calculated using data sources outside the HBS) had the great advantage of bringing to 26.9% the proportion of endogenous source of the average threshold, against 61.1% of the methodology used in the past. By using alternative data sources it was possible to limit potential distortions related to survey data.

3. Results

After the methodological revision of the absolute poverty estimation, the poverty threshold is now defined as the combination of the household type, the region and the municipality of residence. The methodology revision has allowed the release of more punctual data, capturing the heterogeneity of the expenditure for the different household types in the different areas/territories of Italy.

As a consequence, the availability of a larger number of absolute poverty thresholds brought with it a high variability of thresholds; the same family type with a certain average monthly expenditure can be classified as poor in one region and non-poor in another. The same applies to municipalities in the same region, but of different sizes.

In order to show, with a practical example, the huge heterogeneity of the poverty thresholds, in this section we show a descriptive analysis of the absolute poverty threshold referred to a specific type of household (couple of two adults aged 30-59, one child aged 4-10 and one child aged 11-17).

Overall, couples with two children resident in Italy are almost 3.4 million and represent 12.8% of all household types. The households of this type that fall under the condition of absolute poverty are over 361 thousand, registering an absolute poverty rate of 10.7% at national level, with higher values in the Southern regions (13.8%) and lower values in the North-East of the country (8.2%).

In order to show the informative value of the new poverty thresholds, on this specific type of household we have analyzed how poverty line changes in time and space.

If we look at the time variation of the thresholds for this specific household type for all the Italian regions, we observe that from 2014 to 2021 they have slightly grown, while in 2022 it has been observed a significant increase in all the Italian regions, mainly due to an increase in inflation (Figure 1). Looking at the distance between the maximum and the minimum poverty line, from the figure it is possible to observe that over the time this gap has slightly increased (moving from around 660 in 2014 to 730 euro in 2022). Overall, for the family type here considered, each year from 2014 to 2022 the minimum threshold has been observed in small municipalities of Basilicata, while the maximum poverty line has been identified in the metropolitan areas of Lombardia, meaning that over the time Basilicata has remained the area where living costs are lowest, while the metropolitan area of Lombardia – Milan, for instance – is still the area where families need much more budgetary resources to spend in order not to fall below the poverty line.

Figure 1 – *Minimum and maximum absolute poverty thresholds (2014-2022) for the reference household, by year.*
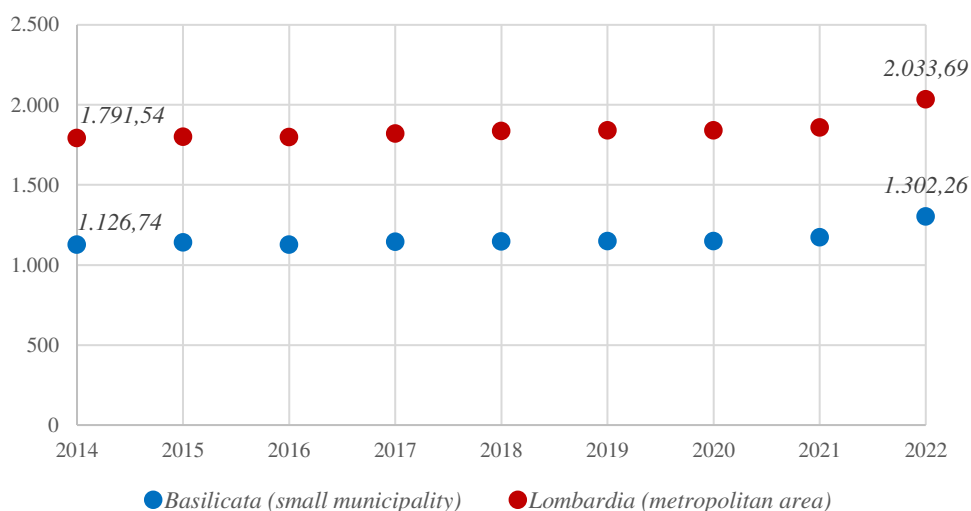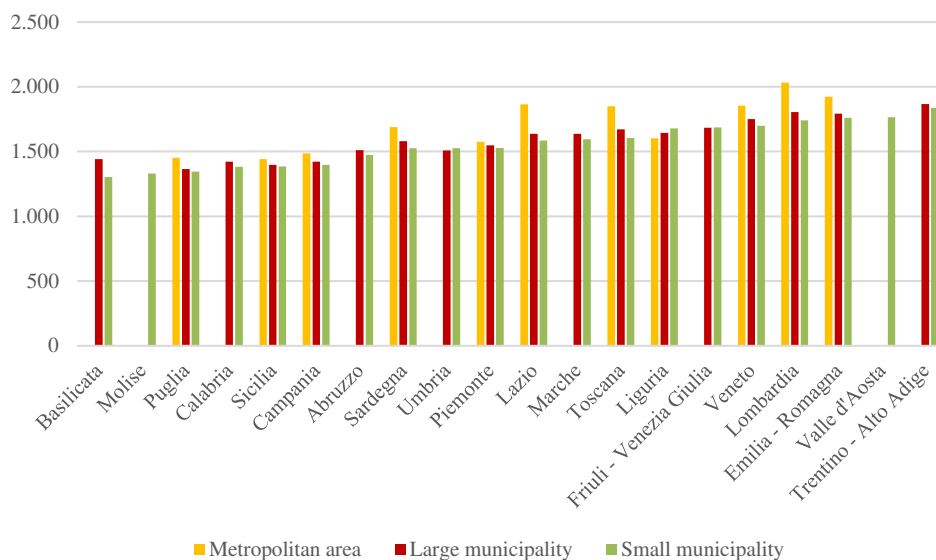

Source: Household Budget Survey (HBS) - ISTAT.

We have then observed the territorial variation of the poverty thresholds, fixing 2022 as the reference year (Figure 2). The distribution of the absolute poverty

thresholds for the family type here considered, in 2022 shows that on average the metropolitan areas have the highest thresholds while small municipalities have the lowest. This means that living in a bigger municipality increase, on average, the living costs of the household, so then they need more resources in comparison to families living in a more "rural" or "peri-urban" context. Liguria is the only case where poverty thresholds are lower in metropolitan areas than in small and medium size municipalities. Looking at the sub-components of the poverty threshold in Liguria region, differently from the other regions, there are two main categories for which the costs are lower in the metropolitan areas than in smaller municipalities: rent and energy sub-components. In fact, in 2022, the rent and the energy sub-components are both almost 40 euros less in metropolitan areas than in smaller municipalities. Concerning the rent component, in particular, one of the factor that influence rents in the smaller municipalities of this region is the tourist vocation. In fact, in Liguria region there are many small cities along the coastline where the number of arrivals per year is high, increasing the cost of rents in these locations.

Figure 2 – *Absolute poverty thresholds (2022) for the reference household, by region and municipality size.*
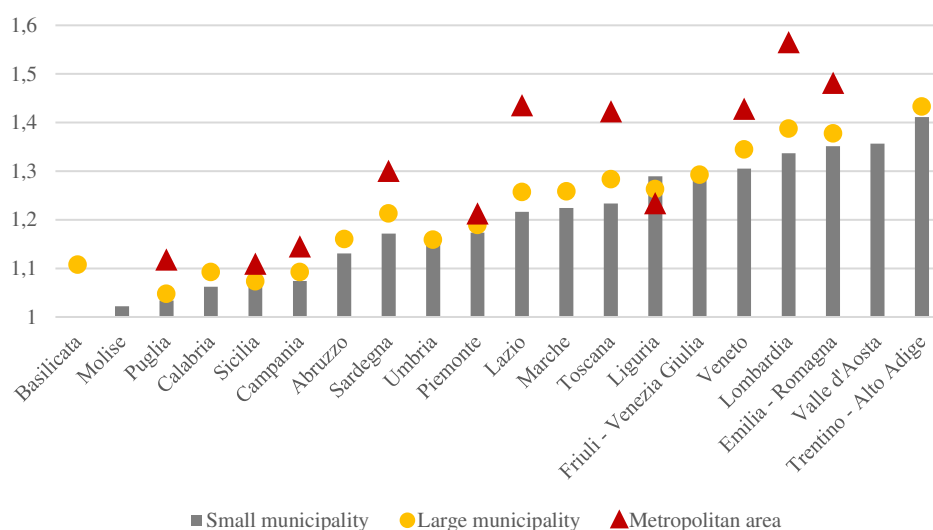

Source: Household Budget Survey (HBS) - ISTAT.

In order to compare more the different poverty thresholds, we have constructed two index numbers using 2022 as the reference year. The first index represents the

ratio between the observed threshold and the global minimum poverty threshold (in this case, the threshold of small size municipalities in Basilicata), aiming at comparing the living cost in the different regions with reference to the lowest poverty line in the Country. The minimum poverty threshold is then equal to 1 and all the other threshold are related to this value. As it can be seen from Figure 3, considering only small municipalities, the highest threshold is observed for Trentino-Alto Adige region (more than 1.4 times the minimum poverty line). On the other hand, the maximum poverty threshold observed (metropolitan areas in Lombardia) is almost 1.6 times over the minimum poverty threshold.

Figure 3 – *Absolute poverty thresholds (2022) for the reference household, by region and municipality size. Lowest among regions and municipality size has been used as reference value (index=1).*

Source: Household Budget Survey (HBS) - ISTAT.

The second index number have been constructed by using for each region the threshold of the small municipality as the reference unit (index=100). Figure 4 shows, for each region, the distance between small/large municipality and the metropolitan area. As shown in the graph, the largest distance is observed for Lombardia region, where the poverty line for this type of household in the metropolitan area is almost 300 euro higher than in the small municipality. Similarly, in the region of Lazio the threshold observed in the metropolitan areas is more than 280 euro higher than small municipalities. Not considering Liguria region, for which

living in the metropolitan area is less expensive than living in small municipalities, the lowest distances where observed in Piemonte and Sicilia regions, where the difference between small and larger municipalities is around 50 euro.

Figure 4 – *Absolute poverty thresholds (2022) for the reference household, by region and municipality size. Lowest within each region has been used as reference value (index=100).*

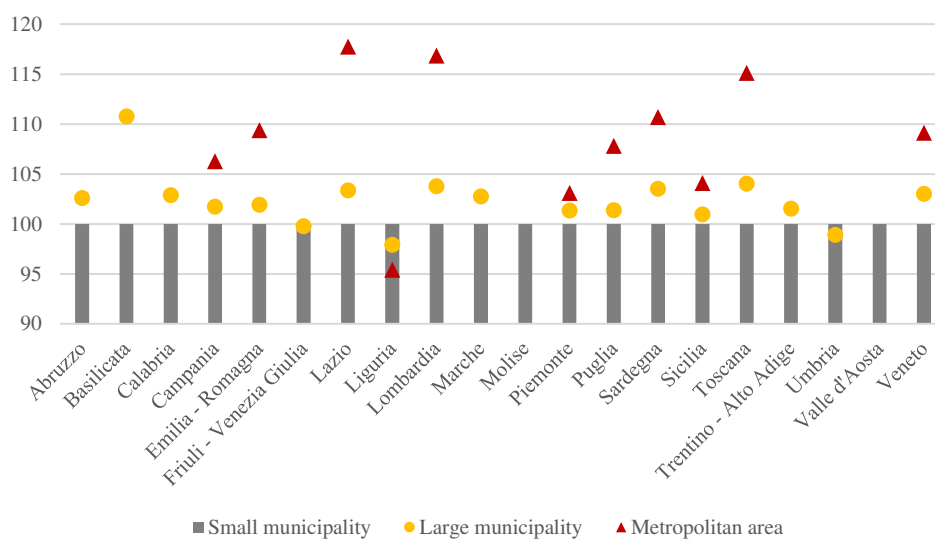Source: *Household Budget Survey (HBS) - ISTAT.*

4. Conclusions

The new methodology introduced in 2022 for estimating absolute poverty in Italy, which provides more detailed data, allows for the calculation of absolute poverty thresholds at the regional level, by municipality size (in three levels) and by family composition, considering all possible combinations of seven age groups. The values of the regional thresholds reflect the variability of price trends, which are very heterogeneous from North to South and within municipalities of different sizes. The study of the threshold's valorisation enables a deeper understanding of the phenomenon of poverty, through the representation of the complexity of the minimum requirements for a standard living. The descriptive analysis highlighted the wide variability of the poverty threshold, not only between regions (those regions

in the North of Italy have, on average, a higher threshold), but also between municipalities of different size in the same region.

For the family type here considered, the metropolitan areas of Lombardia (e.g., Milan) result as the territories where the poverty threshold is highest, for all the years considered (2014-2022), while Basilicata (small size municipalities) resulted the lowest. For a generalization of this trend, the evidences shown in the previous paragraph should be verified for other household type; in general, Northern areas are more likely to reveal higher living costs, resulting in higher poverty lines. The same trend is observed for larger municipalities and metropolitan areas.

The deep analysis of the poverty lines for different households and for different areas of the Country allows a better understanding of the living costs of the Italian families and also a more punctual planning of the social policies.

References

APREA G., BATTLES S., GALLO G., PASSERI S., PALOMBI M., RAITANO M., ROMANO E., ZOPPOLI P. 2023. *Measuring poverty in Italy: how the AD-HBS dataset can offer new insights*. Ministry of Economy and Finance, Department of the Treasury.

BEYCAN T. 2023. Basic Needs, Absolute Poverty: Measuring Poverty in Developing Countries. In *Encyclopedia of Quality of Life and Well-Being Research*, Cham: Springer International Publishing, pp. 1-7.

CARBONARO, G. 1993. On defining and measuring poverty, *International Review of Sociology*, Vol. 4, Nos.1-2, pp. 8-36.

CHEN S., RAVALLION M. 2007. Absolute poverty measures for the developing world, 1981–2004, *Proceedings of the National Academy of Sciences*, Vol. 104, No. 43, pp.16757-16762.

COMMISSIONE DI INDAGINE SULLA POVERTA' E SULL'EMARGINAZIONE. 1998. *La povertà in Italia 1997*. Roma: Presidenza del Consiglio dei Ministri, Dipartimento per l'informazione e l'editoria.

CUTILLO A., RAITANO M., SICILIANI I. 2022. Income-Based and Consumption-Based Measurement of Absolute Poverty: Insights from Italy, *Social Indicators Research*, Vol. 161, No. 2, pp. 689-710.

FREGUJA C., PANNUZI N. 2007. La povertà in Italia: che cosa sappiamo dalle varie fonti? In A. BRANDOLINI e C. SARACENO (a cura), *Povertà e benessere. Una geografia delle disuguaglianze in Italia*, Bologna: il Mulino, pp. 23-60

ISTAT, 2009. *La misura della povertà assoluta*. Metodi e norme n. 39. Istat.

KLASEN S. 2016. Levels and Trends in Absolute Poverty in the World: What we know and what we don't. In *Absolute poverty and global justice,* Routledge, pp. 21-36.

LADERCHI C. R., SAITH R., STEWART F. 2003. Does it matter that we do not agree on the definition of poverty? A comparison of four approaches. *Oxford development studies*, Vol. 31, No.3, pp. 243-274.

RAVALLION M. 2016. *The economics of poverty: History, measurement, and policy*. Oxford University Press.

RINGEN, S. 1988. Direct and indirect measures of poverty, *Journal of social policy*, Vol. 17, No. 3, pp. 351-365.

SIMLER K. R., ARNDT C. 2007. Poverty comparisons with absolute poverty lines estimated from survey data, *Review of Income and Wealth*, Vol. 53, No. 2, pp. 275-294.

SON H. H., KAKWANI N. 2009. Measuring the impact of price changes on poverty. *The Journal of Economic Inequality*, Vol. 7, pp. 395-410.

_____

Valeria DE MARTINO, Italian Institute of Statistics (ISTAT), valedema@istat.it
Livia CELARDO, Italian Institute of Statistics (ISTAT), livia.celardo@istat.it

FIGHTING GENDER INEQUALITIES: ISTAT'S EXPERIENCE [1]

Sara Demofonti, Simona Pace, Sabrina Pifferi

Abstract. Istat has long demonstrated a keen sensitivity to the issue of gender equality and promoted, in a pioneering way, the conduction of surveys, studies and research aimed at a greater knowledge and dissemination of data on gender equality, useful for guiding policies to promote equality. As of 2024, the Institute has a Gender Equality Plan covering for 2024-2026 and a Gender Budget 2022. Their introduction, in the more general set of planning and reporting tools adopted by the Institute, is in accordance with the Horizon Europe strategy, which considers Gender Equality Plans a tool recognized and supported by the European Commission for gender rebalancing among the staff of research institutions and by the Fourth Conference World Conference of Women in Beijing in 1995, and later in the EU context with the European Parliament resolution of July 3, 2003, which identify the construction of public budgets according to the gender perspective as a functional action for the dissemination of greater accountability and commitment of administrations to equality. Finally, an additional tool aimed at reducing inequality should be mentioned: the Plan of Positive Actions drafted by the Comitato Unico di Garanzia which constitutes, as of the 2022 edition, an integral part of the Integrated Plan of Activities and Organization.

1. Istat and gender inequalities

Istat's commitment to contrasting gender inequality has very deep roots and has been evident especially through the production of gender statistics related to all major socio-economic phenomena.

Convinced that reducing gender inequality requires data that adequately orient policy makers, Istat has, over the years, not only ensured the gender disaggregation of all the most relevant information, but has also enriched the range of official statistics with the production of data related to areas and phenomena in which inequalities are more deeply rooted or manifest themselves in a more obvious way. Just to name the most recent examples, think of statistics on issues such as

---

[1] This article is the joint work of the authors, however paragraphs 1, 2 and 3 are written by Sara Demofonti, paragraphs 2.1, 2.2 and 5 by Simona Pace, paragraph 4 is written by Sabrina Pifferi.

employment discrimination against LGBT+ people[2], violence against women[3], discrimination[4], and women entrepreneurs[5].

Statistical data, those collected, processed, analyzed and disseminated by Istat, that describe Italy as a country in which women are on average better educated than men and more unlikely to drop out of school, but they still register very low employment rates and when they do participate in the world of work they are protagonists of more discontinuous careers with lower salaries because of the fewer opportunities to access high-level positions[6]. A country, Italy again, which, according to the Global Gender Report 2024[7], ranks 87th, among the 146 countries analysed, for gender differences.

Istat's commitment was also made evident at the international level through its contribution to the drafting of guidelines on the measurement of violence against women or on classifications on the time use, or even for the definition of a Minimum set of gender indicators agreed by the United Nations Statistical Commission in 2013 and then continued through the provision of useful indicators from the perspective of sustainable development to measure the achievement of Goal 5 of Agenda 2030, concerning precisely gender equality.

Alongside the production of gender statistics, Istat has recently devoted itself to the definition of other tools that also contribute to the reduction of gender inequality such as the Gender Equality Plan (GEP), the Positive Action Plan and the Gender Budgeting.

2. Gender Equality Plan

Istat's Gender Equality Plan (GEP), the first edition of which covering the three-year period 2024-2026 was approved by the Istat Council in March 2024, is part of the more general set of planning tools adopted by the Institute and is in line with the European Union's strategy for gender equality[8], which fulfils the von der Leyen Commission's commitment to a Union of Equality. The strategy set the strategic

---

[2] https://www.istat.it/produzione-editoriale/discriminazioni-lavorative-nei-confronti-delle-persone-lgbt-e-le-diversity-policy/

[3] https://www.istat.it/comunicato-stampa/le-case-rifugio-e-le-strutture-residenziali-non-specializzate-per-le-vittime-di-violenza-anno-2022/ , https://www.istat.it/tag/genere/

[4] https://www.istat.it/produzione-editoriale/indagine-sulle-discriminazioni-dalla-rilevazione-2011-alla-sperimentazione-2022/

[5] https://www.istat.it/comunicato-stampa/donne-imprenditrici-piu-giovani-e-piu-istruite/

[6] https://www.istat.it/it/files/2017/10/A-Audizione-parit%C3%A0-di-genere-25-ottobre_definitivo.pdf

[7] https://www3.weforum.org/docs/WEF_GGGR_2024.pdf

[8] https://eur-lex.europa.eu/legal-content/EN/TXT/PDF/?uri=CELEX:52020DC0152

goals and actions needed to produce significant progress by 2025 towards a gender-equal Europe, and guidelines for drafting the Plans were issued in September 2021.

The European Commission has also ruled that European public institutions that want to access funding from the Horizon Europe and PNRR (National Recovery and Resilience Plan) programmes must have a GEP.

This document, which therefore fits into the context described so far, also represents a form of performance implementation, for the purposes of optimising the productivity of public work and the efficiency and transparency of Public Administrations.

The method adopted at Istat for drafting the GEP, after an initial phase of analysis of the peculiarities of the organisational context, made it possible to outline the areas of intervention. In the planning phase, the objectives to be achieved and the actions and measures to be adopted were established, as well as the indicators necessary to monitor the progress of the actions envisaged in the Plan, the time frames for their implementation and the assignment of the responsibilities.

A number of concrete measures were then defined aimed at promoting a culture of equality and inclusion in respect of diversity and in the constant fight against all forms of discrimination determined by age, gender, ethnic origin, sexual orientation, religion, political position, disability conditions, through actions and tools capable of enhancing differences. It is on the basis of these coordinates that the in-depth studies in the document, drawn up by reading and analysing the available data, have been based. In particular, account was taken of the results of the survey on agile work in the public administration promoted by Politecnico di Milano and of the results of a survey conducted within the Institute and completed by more than half of Istat staff in March 2022. The information reported in Istat's main strategic planning documents, as well as in the Positive Action Plan and the Annual Report drawn up by the Comitato Unico di Garanzia was analysed. In addition, the first results concerning smart working that emerged from the survey on organisational wellbeing and the phenomenon of mobbing were used, as well as those concerning the home-work mobility habits of Istat employees. Finally, use was made of the knowledge offered by the personnel information internal system for a number of specific analyses on the behaviour and habits of internal staff in terms of attendance/absence, working hours, use of leave/permissions and other work-life balance tools.

2.1 The structure of GEP

The document, which is the result of collegial work within a dedicated interdepartmental working group, is structured in the following thematic areas:

Table 1 – *Gender equality plan's areas*

Thematic area	Description
1. Work-life balance and inclusive corporate culture	Refers to creating an environment that supports employees in balancing their professional and personal lives, while fostering a culture of gender equality
2. Gender equality in leadership and organisational decision-making processes	This area focuses on ensuring equal representation of all genders in leadership positions and decision-making processes. It includes strategies to promote women's advancement to senior roles, setting targets for gender balance in committees and boards, and implementing transparent promotion processes.
3. Gender equality in recruitment processes and career advancement	This area refers to hiring, promoting, and developing employees. It involves implementing gender-neutral job descriptions equal pay policies, and mentoring programs to support career advancement for underrepresented genders.
4. Inclusion of gender issues within research and training programmes	This area aims to incorporate gender perspectives into academic curricula and research methodologies. It includes promoting gender-related studies, ensuring gender balance in research teams, and considering gender aspects in research design and analysis.
5. Measures against gender-based violence in the workplace	This theme focuses on preventing and addressing all forms of gender-based violence and harassment in the workplace or academic environment. It involves creating clear policies, establishing reporting mechanisms, providing support for victims, and conducting awareness training.

The document provides, for each thematic area, the presentation of the context of reference and followed by a list of objectives to be achieved and concrete actions to be implemented in order to promote the culture of equality and inclusion. In addition, it identifies the institutional and operational responsible persons, the timeframe for the implementation of the actions and the result indicators. It concludes with a chapter dedicated to the impact assessment of the plan, in which the areas and methods for the verification and monitoring of the measures implemented are described.

### 2.2 Gender equality in leadership and decision-making within the organisation

In order to conduct an initial assessment of the issue of gender equality in leadership and decision-making processes at our institute, the positions of President, General Manager, Head of Department, Director and Head of Division as at July 2024 were considered. The institute can demonstrate a significantly high proportion

of female employees (approximately 60%, rising to almost 66% when researchers and technologists are included). However, an analysis of leadership positions reveals a different picture (figure 1). Female heads of divisions account for 60.8%, compared to 64.8% of women at the first and second professional level (i.e. the levels that can apply for the position of head of division).

Furthermore, the situation is even more disadvantageous for women regarding to the upper positions (directors, heads of department and general manager), where women account for only 47.4% of the total, compared to 59.2% of the potential eligible candidates. Additionally, throughout the history of the Institute, no female president has ever been appointed.

Figure 1 – *Heads of divisions and upper positions (percentage of female- potential and appointed).*
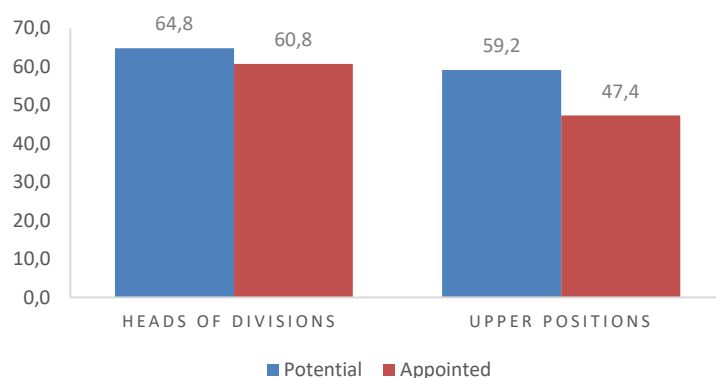
Source: Istat, Our elaborations on Personnel Information System

The following table 2 summarises the objectives and hypothesised actions. They represent a tangible pathway to promote gender equality and create the conditions to remove a series of cultural and psychological barriers that still hinder gender balance.

The first objective aims to build a stable infrastructure to support the study and monitoring of gender issues. This will be achieved through the establishment of an observatory on gender equality, which will ensure a consistent examination of issues pertaining to the Gender Equality Plan within the Institute and externally with other stakeholders in the research community.

Furthermore, a roadmap will be established to facilitate the attainment of certification by an accredited certifying body (UNI/PdR 125:2022). In addition to enhancing the Institute's reputational image, gender equality certification will facilitate access to bonuses for organisations participating in Italian and European calls for proposals.

Table 2 – *Objectives and actions.*

Objective	Action
1. Strengthen governance on gender equality in leadership and normative compliance	Establish an interdepartmental Committee
	Implement the Gender Equality Management System, according to the UNI PdR 125:2022 practice, for its subsequent certification
2. Building a gender-sensitive information framework on upper positions and decision-making bodies	Building a database on the composition of governing bodies
	Analysis of gender gaps in top positions and decision-making bodies
	Annual reporting of leadership data
3. Enhancement of gender diversity in organisational culture and practices	Designing internal mentoring paths
	Organisation of thematic events and inter-institutional round tables for persons with organisational/management responsibilities and the entire staff for sharing the culture of gender leadership

The information on top positions used for context analyses is generally lacking and is partly dispersed in different systems. It is therefore necessary to collect and integrate data concerning the composition of the Institute's governing bodies, management positions and other roles of responsibility within its committees and bodies. The second objective aims at building a database where this information are collected from a gender perspective and stored. This database is based on the principles of re-use of available information and reconstructs historical data series, thereby ensuring the availability of constantly updated data.

This approach will facilitate the development of targeted indicators and the production of regular reports on gender balance in leadership and decision-making processes. These reports will enable the assessment of the impact of current actions and the identification of further interventions aimed at reducing gender inequalities.

The third objective is concerned with the enhancement of gender diversity in organisational culture and practices. For instance, mentoring programmes will be introduced to facilitate career progression, events designed to enhance staff awareness of gender equality concerns in decision-making and management processes, and the creation of Working Groups dedicated to specific topics on gender leadership culture.

3. Positive Action Plan

Another important tool useful to contrast gender inequality, which Istat has had for some time, drafted by the Comitato Unico di Garanzia and from 2021, in compliance with current legislation, becoming an integral part of the Institute's Integrated Plan of Activities and Organisation[9], is the Positive Action Plan.

The document is divided into four areas of intervention as follows:
- organisational wellbeing;
- inclusion, work participation and combating phenomena of discrimination and mobbing;
- communication, training and professional development;
- reconciliation of work and life times.

The Plan, to which we refer you for further details, envisages ten actions to be implemented over the three-year reference period 2024-2026.

4. Gender budgeting

Gender budgeting is a useful tool for suggesting objectives and actions, and for ensuring that financial resources are distributed in a way that supports the goals of the gender plan. It analyses and evaluates, with a gender perspective, the administration's political choices and economic-financial commitments. Despite the presence of gender budgeting experiments at the national level as early as 1980s, five years after the Beijing Conference, the United Nations General Assembly, through an analysis of national reports on the implementation of the platform, found that there had not been significant progress in terms of women's empowerment. Therefore, it officially recognizes gender budgeting as a useful tool to combat inequalities: *"73 (b) Incorporate a gender perspective into the design, development, adoption and execution of all budgetary processes, as appropriate, in order to promote equitable, effective and appropriate resource allocation and establish adequate budgetary allocations to support gender equality and development programmes that enhance women's empowerment and develop the necessary analytical and methodological tools and mechanisms for monitoring and evaluation"[10].*

Gender budgeting's implementation at the state level integrates gender issues into government policies, develops greater institutional accountability and a tangible

---

[9] https://www.istat.it/storage/trasparenza/06-performance/piao-2024-2026/PIAO%202024-2026.pdf . See pages 53-56
[10] November 16, 2000. S-23/3. Further actions and initiatives to implement the Beijing Declaration and Platform for Action. Available online: https://www.un.org/womenwatch/daw/followup/ress233e.pdf

commitment of governments towards gender equality through targeted allocation of financial resources. Budget is not gender-neutral: decisions on revenues and expenditures have different impacts on men and women, ignoring these differences constitutes a *gender blindness* (Elson, 1999). The budget is a tool reflecting the existing distribution of power in society. Gender budgeting is a practice that aims to reduce gender inequalities, assess how public policies affect women and men differently. It helps governments understand and address the different ways their decisions impact people based on their gender, especially when adopting a multidimensional perspective that takes into account both monetary and non-monetary aspects of well-being (Guerra and Romano, 2020). Australia was the first country that introduce gender budgeting at the national level, in the early 1980s. The australian experience allowed for the development of greater awareness of the impacts that gender had on the state budget and its monetary policies, and a greater responsibility of the government with respect to the commitments made to ensure gender equality (Sharp and Broomhill 2002). Later, other countries have promoted and used this tool: South Africa, Canada, Great Britain, France, Israel, Switzerland, Norway, Sweden, and Denmark.

Within the European Union, economic needs drove reflection on gender. The European single market, with the Treaty of Rome in 1957, puts the issue of equal pay at the center. Over the years, measures extended and intensified, with the aim of promoting social change and bridging inequalities. Several resolutions (2003, 2019, and 2021) mark the path towards the European Strategy for Gender Equality 2020-2025, presented in 2020. The strategy contains actions to achieve traditional objectives in terms of gender balance, including the integration of the gender dimension into the entire framework. To counter the multiple dimensions of discrimination against women, which the pandemic has helped to highlight, the Government announced in the PNRR the adoption of a National Strategy for Gender Equality 2021-2026. Its objective is to achieve, by 2026, a five-point increase in the Gender Equality Index ranking. The Strategy outlines individual measures, including crosscutting ones that the Government must implement to achieve the objectives. Among the measures are the promotion of gender mainstreaming and gender budgeting, and the enhancement of official statistics.

In Italy, state level gender budgeting arrives after years of experimentation at local and regional levels. Starting from 2001, some regions and local entities, implementing the guidelines that emerged during the 1995 Beijing World Conference on Women, initiated experiments on gender budgeting in the absence of a national coordinating regulatory framework (Guerra and Romano 2020). The first regional experience with gender budgeting occurred in 2001 with the Emilia Romagna region, followed by the municipality and province of Modena. From 2002 to 2018, there was an increase in the production of gender budgets at the territorial

level, but also at the university level with the publication in 2019 of the Guidelines of the Conference of Italian University Rectors (CRUI) for drafting gender budgets[11].

With the 2016 financial year, the reform of the State Budget[12] aims to make public policies related to gender more transparent and to assess the different impact that budget policy has on women and men, starting from the assumption that women and men experience different economic situations, have distinct individual needs, and use services differently. The State's Gender Budget, produced at the end of the fiscal year, in addition to highlighting the financial commitment in terms of resources aimed at reducing gender gaps, also provides updates on the characteristics of the reference population through the analysis of a data set of gender disaggregated indicators. Through this tool, it is possible to compare actual results with initial forecasts, offering a basis for analyzing organizational dynamics and management choices, as well as providing elements to understand the social and economic impact of implemented policies.

Gender Equality Plans cannot reach their full potential if they are not implemented in parallel with gender budgeting which incorporates a gender perspective at all levels of the budget process in order to promote gender equality (Addabbo, Badalassi and Canali, 2021).

It is important applying gender perspective to every phase of the performance cycle of Public Administrations. The Annual Performance Report's guidelines, issued by the Department of Public Function in November 2018[13], requires that the gender balance be included to highlight the different impact of administrative policies on gender diversity. A gender perspective, within the performance cycle, is therefore an analytical process developed in close connection with the PdG. It increases in attention and interest in issues of gender equality (Addabbo, Badalassi and Canali, 2021). The Directive no. 2 of 2019[14], provides that administrations annually submit to the Comitato Unico di Garanzia (CUG) a quantitative and qualitative analysis of personnel, salaries and actions carried out, with a distinction by gender. These reports must include the analysis of personnel by gender, the indication of average salaries broken down by gender, the description of the actions implemented and planned, and the gender budget of the administration.

---

[11] Guidelines for Gender Budgeting in Italian Universities, 2019. Available online:
https://www2.crui.it/crui/Linee_Guida_Bilancio_di_Genere_negli_Atenei_italiani.pdf
[12] Legislative Decree, May 12, 2016, n. 90. Completion of the reform of the structure of the State budget, implementing article 38-septies
[13] Guidelines for drafting the annual performance report, Public Function, 2018. Available online:
https://performance.gov.it/system/files/LineeGuidaeRifNorm/LG-
Relazione_28_novembre_2018_.pdf
[14] Directive 2, 2019. Measures to promote equal opportunities and strengthen the role of the Single Guarantee Committees in public administrations. Available online:
https://www.funzionepubblica.gov.it/sites/funzionepubblica.gov.it/files/Direttiva_n_2.pdf

In 2022 financial year, Istat adopted State Gender Budget's structure as model. Two factors guided the choice: to produce an exclusively financial document that did not overlap with other documents, the desire to provide insight into the gender-related financial situation specific to public research bodies. In his, first gender budget, Istat choices the expenses to be analyzed both by strategic motivations that determined their relevance and by the availability of accounting data.

Istat analysed the guidelines of Circular No. 22 of 2023[15], which provides detailed guidance for classifying expenses from a gender perspective. It divided expenses into categories:

- Direct to reduce gender inequalities: relating to measures directly at reducing gender inequalities or promoting equal opportunities;
- Gender-sensitive: relating to measures that have or could have an impact, even indirect, on inequalities between men and women;
- Gender-neutral: relating to measures that have no direct or indirect impacts on gender;
- Expenses to be further investigated: due to some of their characteristics, they should fall outside the perimeter of neutral expenses and,

Regarding expenses aimed at reducing gender inequality, Istat examined the Institute's activities that promote equal opportunities through statistical production. Specifically, it focused on surveys that generate gender-related indicators, providing valuable information for policymakers. This approach helps in the understanding that statistical knowledge is more than just a neutral measurement tool; it serves as a powerful instrument for interpreting and transforming social realities. (Desrosières, 1998). Data collection and analysis practices contribute to reproducing or modifying existing social structures. The costs' analysis, associated with statistical surveys, reveals the social investment in the production of gender-sensitive knowledge. (Giddens, 1984). In the category of expenses aimed at reducing gender inequalities, Istat includes also Communication activities, reviewing gender-related work in this area. The goal is to quantify these communication expenses more precisely in future versions of the gender budget. Istat, through its communication practices, not only communicates statistical information but also actively contributes to the construction of social reality and the formation of public discourse on gender inequality. This function aligns with the concept of defining the situation, according to which the social perception of a phenomenon influences subsequent actions (Berger and Luckmann, 1966). Istat included expenses from institutional collaborations in costs'analysis, started gathering information on these expenses and plan to analyse them more thoroughly using accounting data in future gender budget reports.

---

[15] Circular 22, May 16, 2023, Gender budget. Guidelines and launch of activities relating to the 2022 general state statement. Available online: https://www.rgs.mef.gov.it/VERSION-I/circolari/2023/circolare_n_22_2023/

In this context, Istat acts as a key player with valuable resources in two areas: data and the technical expertise to process this data. Our partnerships with both public and private organizations demonstrate how we produce knowledge. These collaborations are interdisciplinary and focus on addressing real-world social issues. By producing statistical knowledge on gender issues, it is going beyond traditional institutional limits. It is building collaboration networks that reflect how complex today social challenges are.

For gender sensitive expenses, Istat considered training and skills development activities because are essential for staff requalification and are an organizational investment. Another gender-sensitive data point relates to expenses for personnel traveling on behalf of the Institute in Italy or abroad. Gender analyses were conducted both from a financial point of view and in descriptive terms of the missions themselves (duration, destination, type). The expenses incurred for social-assistance contributions paid to employees were also considered gender-sensitive. The system of welfare benefits was interpreted as an example of corporate welfare that fits into the broader social exchange between the institution and its employees.

5. Conclusions

The path to reducing gender inequality is long and winding. It consists of the many individual and collective actions to be taken in pursuit of equality. The role of public institutions is crucial to support this process and contribute to achieving the desired goals.

The approach taken by ISTAT to address gender inequality is based on two main pillars: the production of data and the development of working tools. With regard to the latter, the definition of a plan for gender equality is one concrete and important step. The evaluation of its results is a complex process that requires the use of both quantitative and qualitative methods, as well as the involvement of women and all organisational components that are affected by the actions identified or that are called upon to implement them. It should be noted that, at Istat, this is an ongoing process, and the results obtained will be used to implement improvements to existing policies and the design of new targeted interventions.

At the same time, the stakeholders will be able to rely on the vast wealth of data collected to gain a better understanding of the areas where gender differences are most likely to lurk and to guide decision-makers in the design of appropriate gender policies.

References

ADDABBO T., BALDASSI G., CANALI C. 2021. Gender Budgeting in Academia: a powerful tool for Gender equality. In *4th International Conference on Gender Research*, Virtually Host-ed by: ACI and University of Aveiro, Portugal, 21 - 22 June 2021.

BERGER P.L. LUCKMANN T. 1966. *The Social Construction of Reality: A Treatise in the Sociology of Knowledge*. Garden City, NY: Doubleday.

DESROSIÈRES A. 1998. The Politics of Large Numbers: *A History of Statistical Reasoning*. Harvard University Press.

ELSON D. 1999. Gender-Neutral, Gender-Blind, or Gender Sensitive Budgets? Changing the Conceptual Framework to Include Women's Empowerment and the Economy of Care, *Gender Budget Initiative Background Papers,* London. Commonwealth Secretariat.

EUROPEAN PARLIAMENT RESOLUTION, July 3, 2003. La costruzione dei bilanci pubblici secondo la prospettiva di genere. https://www.europarl.europa.eu/doceo/document/TA-5-2003-0323_IT.html.

EUROPEAN PARLIAMENT RESOLUTION, January 15, 2019. Valutazione delle modalità di utilizzo del bilancio dell'Unione europea per la riforma del settore pubblico. https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX:11957E/TXT.

EUROPEAN PARLIAMENT RESOLUTION, January 21, 2021. Prospettiva di genere nella crisi COVID-19 e nel periodo successivo alla crisi. https://eur-ex.europa.eu/legalcontent/IT/TXT/PDF/?uri=CELEX:52021IP0024&from=EN.

EUROPEAN STRATEGY FOR GENDER EQUALITY 2020-2025, march 5, 2020. https://eur-lex.europa.eu/legal-content/IT/TXT/?uri=CELEX%3A52020DC0152

GIDDENS A. 1984. *The Constitution of Society: Outline of the Theory of Structuration*. Berkeley and Los Angeles: University of California Press.

GUERRA M.C., ROMANO E. 2020. Una riflessione sul bilancio di genere in Italia (A critical appraisal of the Italian gender budget report), *Politica economica*, Vol.36, No.2, pp.183-228.

ISTAT 2024. *Piano di uguaglianza di genere 2024-2026*. Roma, https://www.istat.it/wp-content/uploads/2017/03/PIANO-DI-UGUAGLIANZA-DI-GENERE-2024-2026.pdf

SHARP R., BROOMHILL R. 2002. Budgeting for equality: the australian experience, *Feminist Economics*. Vol.8, No.1, pp. 25-47.

_____

Sara DEMOFONTI, Istat, sara.demofonti@istat.it
Simona PACE, Istat, simona.pace@istat.it
Sabrina PIFFERI, Istat, sabrina.pifferi@istat.it

INTEGRATING ADMINISTRATIVE DATA WITH ISTAT SURVEYS FOR MUNICIPAL HOMELESSNESS RISK ASSESSMENT

Angela Chieppa, Marija Mamolo

Abstract. This study investigates the insights and analytical potential of integrating ISTAT data sources concerning the homeless population. The main goal is to derive new municipal classifications associated with different levels of expected homelessness rates, crucial for designing tailored sample surveys. Comprehensive direct enumeration of the homeless population is cost-intensive and often impractical, while accurate territorial indicators could guide surveys only in specific areas.

The surveys sources considered are the National Survey on Homelessness in Italy (2011 and 2014), annual surveys on residential socio-assistance facilities, the permanent census of non-profit institutions, and annual surveys on administrative population registers. Furthermore, the Integrated Data Base of Usual Residents (AIDA) has been integrated, since the AIDA individual occurrences, known as Signs of Life (SoL), combine information from many administrative sources to enhance the analysis of specific population profiles.

This paper begins with an introduction to the challenges of data collection on homelessness and the importance of integrating various data sources. It then reviews existing ISTAT surveys and administrative databases, detailing their possible role in estimating the homeless presence at municipal level. The methodology section describes the municipal dataset built to analyse integrated sources and the computation of 'risk' indicators that are supposed to be associated with homeless presence.

Results highlight opportunities for improvement of data quality and implications for data collection and estimation. Future research goals include updated *ad hoc* surveys and the design of an information system for continuous monitoring of homelessness in Italy.

1. Introduction

The accurate and timely collection of data on the homeless population is crucial for effective policy development and targeted service provision. However, this task is challenging due to the transient nature of homelessness and the substantial costs and complexities associated with conducting ad hoc surveys. In 2010, with the closure of the European Year for Combating Poverty and Social Exclusion, the European Parliament called for an ambitious European strategy on homelessness. Since 2008, the Parliament has increasingly emphasized the need for standardized definitions and measurements of homelessness across Member States (Edgar et al., 2007). Establishing precise and shared definitions and methods is essential to

accurately measure homelessness and capture its multifaceted nature (Leterme et al., 2023).

FEANTSA, the European Federation of National Organizations Working with the Homeless, has developed in 2005 a classification that serve as a crucial framework for understanding and measuring homelessness across Europe. The classification is called ETHOS, European Typology of Homelessness and Housing Exclusion (Amore et al., 2011). ETHOS encompasses various forms of homelessness, including rooflessness, and insecure or inadequate housing. ETHOS Light, a simplified version, offers a harmonized definition for statistical purposes. This framework not only standardizes data collection and supports comparability across countries but also constitutes a reference point for planning new data acquisition methods, ensuring target identification for potential *ad hoc* surveys, and providing an essential basis for evaluating the integration potential of different data sources.

Recent comparative reports on data acquisition related to homelessness across various countries highlight that there is still no comprehensive monitoring system at the EU level. Countries employ diverse measurement methods and intervention policies (Busch-Geertsema V. et al., 2010) but recent years have seen a growing trend towards harmonization and improved data acquisition (Busch-Geertsema V. et al., 2014). These reports also indicate that traditional sources for data acquisition exhibit significant gaps: while the population census serves as a powerful mechanism for data collection, it is primarily designed for a general target population and must be suitably adapted to effectively capture information on homelessness. *Ad hoc* surveys can yield valuable snapshots of the homeless population; however, their high costs necessitate improvements to ensure longitudinal analysis and maximize their utility (O'Sullivan et al., 2020). Administrative data and registers present substantial limitations due to under-coverage of the homeless population, which, by its nature, evades registration. Nonetheless, they remain potential indirect sources of information, complementing other data collection efforts (Zindato et al., 2023).

Since 2018, Italy's Permanent Population Census strategy has integrated administrative sources with a set of surveys (ISTAT, 2022) specifically designed to enhance the quality of ISTAT's statistical population register data. Homelessness figures, as part of the broader census outputs, are a key focus of this methodological effort. The integration of these sources and the development of targeted surveys for homelessness present new opportunities that require further investigation. To address these challenges, a dedicated task force comprising thematic experts, methodologists, and census specialists has been formed. The goal of this work is to transition from sporadic to continuous statistical production for homelessness statistics, similar to the approach used for other census population statistics.

This paper investigates the potential utility of existing ISTAT surveys in estimating the homeless population and explores how administrative data can enhance insights into municipal classifications of homelessness. It begins with an examination of available ISTAT sources, details the creation of an integrated dataset for this study, and presents initial findings from multidimensional analyses, including clustering. Finally, it discusses key findings and outlines future steps for advancing these methodologies.

2. Available Data Sources

In planning *ad hoc* surveys targeting the homeless population, ISTAT relies on the ETHOS classification as a foundational framework. For example, a Point-In-Time enumeration survey is scheduled for 2025, targeting roofless individuals and shelter users, key categories within ETHOS Light. When investigating innovative methodologies and multiple data sources, however, the framework is expanded to encompass broader ETHOS categories and data from sources with wider target populations, thereby supporting the development of a multi-source information system and related indicators, which forms the core of this paper. This flexible approach aids in constructing monitoring indicators and covariates for estimation models, focusing on correlations across target groups rather than exact alignment.

Thus, a further distinction can be drawn among the various data sources considered, based on their potential to directly measure the target population—where homelessness is a primary focus—or to provide indirect insights through related populations. In this latter category, administrative registers, for instance, yield indirect information via statistical data referred to as "Signs of Life" (SoL) (Bernardini *et al.*, 2024a)., which potentially correlate with aspects of homelessness without explicitly targeting it.

2.1. National Surveys on homeless population (2011, 2014).

The most recent *ad hoc* surveys on the homeless population in Italy, carried out by ISTAT, date back to 2011 and 2014 (ISTAT, 2014; Inglese et al., 2021). These surveys provided relevant insights, including some socio-demographic characteristics, a list of services for homeless people by municipality, and estimates of the homeless population at the national level and for some larger municipalities. These surveys represented a significant methodological and innovative milestone in Italian official statistics, as they conducted a nationwide assessment of the homeless population using indirect sampling, yielding promising results. Nonetheless, critical organizational and methodological issues arose, underscoring the importance of conducting supplementary control investigations using alternative survey

techniques. The data estimated from these surveys still represent the most accurate and comprehensive source of information about the homeless population in Italy.

2.2. *Surveys on administrative municipal registers: people registered in special addresses to support Census dissemination.*

The Permanent Population Census, conducted by ISTAT, integrates administrative data with sample surveys designed specifically to improve the quality of individual data in the statistical registers (Bernardini *et al.*, 2024). This approach allows for detailed census results with specific classifications and territorial levels typical of census dissemination. For households and dwellings, two annual surveys are conducted on samples of addresses/households present in the registers. For people not belonging to these two main population groups, additional surveys and quality improvements are necessary. To address this, ISTAT collaborates annually with municipalities to conduct specific surveys (ISTAT, 2022) and validation using municipal administrative registers (*anagrafi*) related to population segments not previously included in the sample surveys of the Permanent Census. These segments are: 1) People living in institutional households. 2) People residing in authorized camps or in tolerated and spontaneous settlements. 3) People registered at dedicated addresses, real or fictitious, specifically designed to register homeless individuals and people without a stable dwelling/address.

These surveys aim to fill gaps in the statistical registers and ensure that the Permanent Census reflects the entire population in all its components. However, analysis of these data and municipal metadata confirmed that these special addresses, although intended for the homeless, are now used to administratively manage many other irregular situations, such as women and minors who are victims of violence or people living in dwellings that do not meet legal requirements.

2.3. *Surveys on residential social and care facilities.*

ISTAT conducts an annual survey on the availability of socio-assistance and socio-health residential facilities and the types of users they assist, allowing for precise documentation of both the users and the resources dedicated to this form of territorial assistance (ISTAT, 2023). The survey is conducted online via an electronic questionnaire. It covers all public or private facilities providing residential services (assisted accommodation with overnight stays) of a socio-assistance and/or socio-health nature. These facilities accommodate individuals in need for various reasons, such as elderly individuals living alone or with health issues, persons with disabilities, minors without guardianship, young women in distress, victims of gender-based violence, but also foreigners or Italian citizens facing economic difficulties and social distress. This latter category could be directly associated with

the homeless condition. The survey takes place between October and February each year.

2.4. Surveys supporting the Permanent Census of Non-profit Institutions.

The Permanent Census of Non-profit Institutions in Italy offers a comprehensive statistical overview of the sector through a Statistical Register, which integrates administrative and statistical sources to annually update data on the main characteristics of institutions (Della Queva *et al.*, 2023). Additionally, a periodic sample survey is conducted every three years to gather additional information on specific topics. This survey serves to verify and supplement the data in the register. This non-profit system facilitates the extraction of data related to homelessness by identifying organizations dedicated to homeless services, such as soup kitchens.

2.5. Administrative Signs of Life to derive "indirect" information on homeless presence.

The AIDA thematic register (Integrated Data Base of Usual Residents) utilizes administrative sources to compile population statistics. It incorporates a new statistical integrated individual data concept called "Sign of Life" (SoL) for individuals recorded in administrative databases like employment, education, tax returns, earnings, retirement benefits, and residency permits. Some Signs of Life signify specific individual activities that clearly indicate a sustained period and location, such as employment or holding a rental contract. Others pertain to individual conditions or statuses, such as dependents listed in tax returns.

Information on SoL of the individuals registered as residents in each municipality can be used to compute indicators and rates associated with homeless presence. For example, the percentage of people located in a certain municipality who do not record any SoL of employment activity or are not associated with any housing sign (no rental, no property) can be considered. Alternatively, specific indicators can be calculated by working with a subset of "at-risk" individuals. For instance, rates based solely on the SoLs of individuals registered at special addresses designed for homeless in the municipal registries can be calculated.

3. Setting up the Municipal Dataset for Experimental Purposes

To analyse the available information on the homeless population in Italy using ISTAT official statistics, a municipal dataset integrating the following sources was built: national surveys on homeless population (2011, 2014), the annual survey on population registers (2021), the annual survey on residential social and care facilities (2020), the Permanent Census of Non-Profit Institutions (2021), and AIDA (2021).

The dataset is at a municipal level and includes, among other variables, the demographic size of municipalities, the presence and number of services for homeless people derived from the survey sources, and the number of people recorded in administrative population registers at special addresses. Additionally, the following three indicators are computed based on the SoL related to the people of each municipality:

- % RU - Municipal Population Register Under-coverage: the proportion of people not recorded in the Municipal Population Register but added during Census validation because recognized as residents, on the total number of individual records in the municipal population register.
- % RH - Registered Homeless: the percentage of individuals recorded at special addresses designed for homeless people on the total number of individual records in the municipal population register.
- % DP - Discontinuous Presence: the percentage of individual records with irregular SoL on the total number of individual records in the municipal register. The irregular SoL includes presence in administrative sources with discontinuous or sporadic duration patterns.

The choice of these rates depends on specific hypotheses:

1. The total under-coverage in the municipal population registers correlates with the under-coverage of specific population targets, such as the homeless, implying that higher total under-coverage in the register indicates higher under-estimation of the homeless population.
2. The proportion of registered homeless individuals in each municipality is associated with the proportion of people registered as homeless at special addresses.
3. Discontinuous administrative patterns are likely linked to homeless individuals or those at risk of homelessness.

Some rates considering only the SoL of people registered at special addresses are also computed. These specific rates represent the type/profile of individuals recorded as homeless and can help differentiate among municipalities through an indirect evaluation of the effective homeless population. Specific rates for each SoL class are computed, focusing on those relevant to differentiate individual profiles of people recorded in the population register. Among others, the following specific rates are computed:

- % RH_stable_signs: (total number of individual records registered at special addresses with stable/continuous administrative signs)/(total number of individual records registered at special addresses)
- % RH_no_signs: (total number of individual records registered at special addresses with no administrative signs)/(total number of individual records registered at special addresses)

- % RH_pensions: (total number of individual records registered at special addresses with pensions or support income signs)/(total number of registered at special addresses)

The hypothesis is that different levels of these rates are correlated with different levels of homeless presence. For example, the %RH_no_signs (percentage of registered homeless individuals with no signs of life) are supposed to be positively correlated with the number of homeless individuals in the municipality. Conversely, the %RH_stable_signs (percentage of registered homeless individuals with stable signs) are supposed to be negatively correlated with the number of homeless individuals in the municipality.

4. Classification of Municipalities Based on Homeless Presence Evidence

Four main groups of municipalities were identified based on direct evidence of homeless presence, as shown in Table 1.

Table 1 - *Municipalities according to direct evidence of homeless presence.*

Presence of services for homeless people	No homeless in the pop. register	People registered in special homeless addresses	*Total*
No services	5,656	1,985	**7,641**
With services	50	213	**263**
Total	**5,706**	**2,198**	**7,904**

This initial classification of Italian municipalities defines four groups, which provide a framework to tailor data collection strategies for investigating the homeless phenomenon:

- *Group G00 – No Services, No Registered Homeless*. This group includes 5,656 municipalities. It can serve as a layer from which a few municipalities can be periodically sampled to verify the actual absence of homeless individuals.
- *Group G01 – No Services, Presence of Registered Homeless*. Comprising 1,985 municipalities, where there is a need to improve the design and monitoring of current surveys on services. Additionally, more detailed information is required on individuals registered at special addresses to confirm if they are indeed homeless, given the lack of available services.
- *Group G10 – Only Services*. 50 municipalities. There is a need to verify the accuracy of registry data, as it appears to be unreliable. An ad hoc survey on the homeless population is necessary in these municipalities.

- *Group G10 – Services and Registered homeless.* This group has to be sampled in homeless survey, since it encompasses the 213 towns with both services and people registered at special addresses.

Using the other variables and rates present in the municipal dataset, the characteristics of each group were analysed in more detail. The analysis started with demographic size and then studied the differences according to the risk indicators. Significant differences among groups were revealed.

Figure 1- *Municipal population size of emerging groups.*

	G00	G01	G10	G11
>250th	0	0	0	12
100to250th	0	0	1	31
50to100th	4	26	3	63
10to50th	275	679	17	93
<10th	5377	1280	29	14
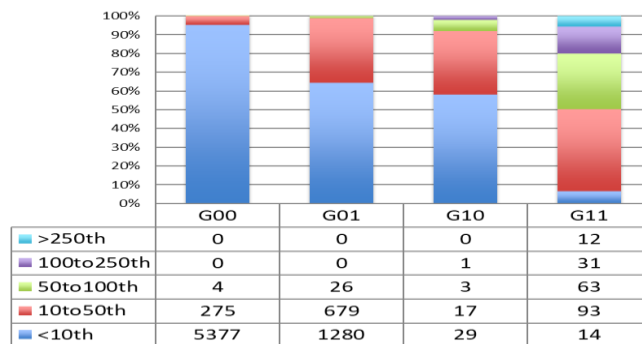
As shown in Figure 1, Group G00 primarily consists of small municipalities. Group G01 predominantly comprises municipalities with fewer than 50,000 inhabitants. Group G10 includes medium-sized municipalities and larger cities like Latina. Group G11 mainly encompasses larger municipalities but also includes small municipalities with fewer than 10,000 inhabitants.

Figure 2 - *Distribution of groups across Italian regions.*

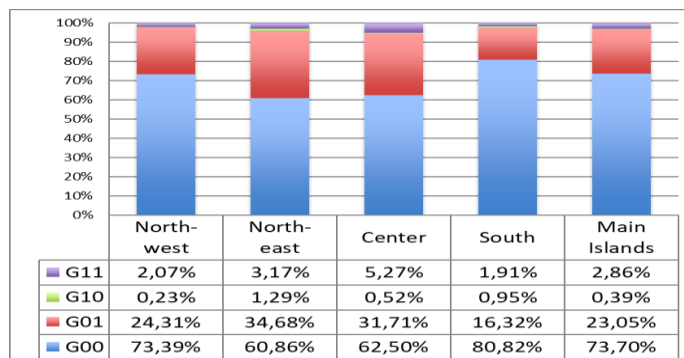|	North-west	North-east	Center	South	Main Islands
G11	2,07%	3,17%	5,27%	1,91%	2,86%
G10	0,23%	1,29%	0,52%	0,95%	0,39%
G01	24,31%	34,68%	31,71%	16,32%	23,05%
G00	73,39%	60,86%	62,50%	80,82%	73,70%

Figure 2 illustrates the percentage composition of groups across Italian regions. Group G00 dominates in all regions, especially in the South (80.82%) and Main Islands (73.70%), representing municipalities without services nor registered homeless. Group G01 is prominent in the Northeast (34.68%) and Center (31.71%), highlighting areas with registered homeless individuals despite lacking services.

For each group, further evidence of the risk of the presence of homeless people was evaluated using administrative signs presented in Table 1. For instance, the percentage of people registered at special homeless addresses in municipalities with no services but with registered homeless individuals (G01) is similar to that in municipalities with services and registered homeless individuals (G11). This result calls for further socio-demographic analysis of the individuals registered at special addresses to better understand the homeless phenomenon and to question the absence of services. In the group of municipalities with services but without individuals registered at special addresses (G10), indicators related to population register under-coverage and the presence of unstable populations suggest the presence of homeless people who might not be registered at special addresses or at all.

Table 2. *Risk rates computed for each group of Municipalities (average value).*

Group	% RH Registered Homeless	% RU Register Undercoverage	% DP Discontinuous Presence
G00 – No Services,No Registered Homel.	-	0.1%	8‰
G01 – No Services, Presence Registered H.	1.6	0.18%	7‰
G10 – Only Services	-	0.17%	11‰
G11 –Services and Registered homeless	1.7	0.23%	8‰
All Municipalities	*0.4*	*0.12%*	*8‰*

5. Cluster Analysis Results: Municipalities According to Risk Indicators

The groups discussed in precedent paragraph can also be segmented internally. The administrative risk rates and available variables in the municipal dataset were used to create additional subgroups within the four main groups already identified. Cluster analysis was performed, one for each group, using the k-means method. This resulted in a final classification, shown in Table 3, in which the clusters resulting are labeled according to the evaluation of their statistical profiles. In table 4, clusters profiles are shown by reporting average values and counts of the main analysis dimensions. Some anomalous profile/cluster also emerge, where anomaly is detected when values of average cluster indicators are outliers of pertaining groups.

Table 3 - *Municipal classification derived from cluster analysis.*

Group	Subgroup/ Cluster	Label of final municipal class	Frequency
G00:	G00-1	*Very small Municipalities, no risk*	3,860
No Services,	G00-2	*Small Municipalities, no risk*	1,640
No Registered Homeless	G00-3	*Risk of homeless presence*	108
	G00-4	*Anomalous/Risk*	48
G01	G01-1	*Anomalous/Risk*	13
No Services,	G01-2	*Very low risk of homeless presence*	1,559
Registered Homeless	G01-3	*High Risk of homeless presence*	413
G10	G10-1	*With night shelters*	28
Services,	G10-2	*Other services*	22
No Registered Homeless			
G11	G11-1	*Considerable presence of homeless*	205
Services,	G11-2	*Bigger Municipalities*	6
Registered Homeless	G11-3	*Milano*	1
	G11-4	*Rome*	1
Total nr. Municipalities			*7,904*

Table 4 - *Clusters results by average group rates and counts.*

Subgroup /cluster	Nr. Municipalities	Municipal Residents	Registered Homeless	%RH	%RH no_signs	%DP	%RU
	(frequency)	*(average of municipal counts)*			*(average of municipal rates)*		
G00-1	3,860	2,137		-	-	5.20	0.03
G00-2	1,640	4,753		-	-	7.50	0.22
G00-3	108	4,153		-	-	30.01	0.72
G00-4	48	1,843		-	-	202.33	0.26
G01-1	13	1,304	71	43.58	0.05	12.91	0.13
G01-2	1,559	9,930	12	1.37	0.08	5.47	0.12
G01-3	413	12,845	12	1.03	0.09	12.21	0.38
G10-1	28	10,600		-	-	14.20	0.12
G10-2	22	25,345		-	-	7.59	0.23
G11-1	205	63,312	124	1.60	0.07	7.49	0.23
G11-2	6	619,332	2,685	3.82	0.08	10.55	0.38
G11-3	1	1,349,930	8,541	6.33	0.08	15.94	0.63
G11-4	1	2,749,031	22,182	8.07	0.16	8.92	0.42

6. Concluding Remarks and Current Work

This study underscores the critical need for updated survey data and the incorporation of additional variables on the homeless population to improve the accuracy and depth of findings. Despite these limitations, the integrated approach demonstrates that significant improvements in data quality in predicting the presence of homeless population in each Municipality can be achieved at minimal cost. By combining administrative data with traditional survey methods, valuable insights are gained that enhance the investigations on homelessness.

The results of this study suggest several practical benefits. Firstly, integrating various data sources can significantly improve the quality and reliability of information on the homeless population. Secondly, minor adjustments to existing surveys can lead to more accurate and comprehensive data collection, which is crucial for effective policy-making and resource allocation. Finally, classifying Italian municipalities based on available data sources can aid in developing targeted sampling strategies and predictive models, thereby providing more accurate estimates of the homeless population.

Looking ahead, current activities and future goals focus on several key areas. The analysis will be enhanced by incorporating updated sources and additional variables, which will provide a more detailed and nuanced understanding of homelessness. ISTAT is set to conduct ad hoc surveys on the homeless population, beginning with a Point-in-Time survey in 2025. This survey will provide a snapshot of the homeless population at a specific moment, offering valuable data for the statistical validation of the proposed risk indicators and for suggesting additional ones.

Moreover, the development of an information system that could continuously monitor and update data on the homeless population is currently under study. This system will leverage the added value of integrating various sources and components.

In conclusion, while there are challenges and limitations, the integration of administrative data with traditional survey methods offers a promising step forward. By leveraging these combined data sources, a more comprehensive and accurate understanding of the homeless population can be gained, ultimately leading to more effective interventions and support systems.

References

AMORE K., BACKER M., HOWDEN-CHAPMAN P. 2011. The ETHOS Definition and Classification of Homelessness: An Analysis, *European Journal of Homelessness*, Vol. 5, No. 2, pp. 19-37.

BERNARDINI A., CHIEPPA A., TAMBURRANO T. 2024. Discovering individual profiles from administrative signs of life useful for the estimation of Census results,

RIEDS - Rivista Italiana di Economia, Demografia e Statistica, Vol. 78, No. 1, pp. 15-24.

BUSCH-GEERTSEMA V. et al. 2010. Homelessness and homeless policies in Europe: Lessons from research. In *Conference on Homelessness*, Vol. 9.

BUSCH-GEERTSEMA V., et al. 2014. *Extent and Profile of Homelessness in European Member States: A Statistical Update.* FEANTSA, Brussels.

DELLA QUEVA S., LEPORANICO V., NICOSIA M., STOPPIELLO S. 2023. The nonprofit sector in Italian Inner Areas, *Rivista di Statistica Ufficiale*, Vol. 77-4.

EDGAR B., HARRISON M., et al. 2007. *Measurement of Homelessness at European Union Level.* Brussels: European Commission.

GOSME L. 2014. Key steps towards a European Union homelessness policy, *Journal of European Social Policy*, Vol. 24, No. 3, pp. 289-299.

INGLESE F., MASI A. 2021. Una metodologia per la stima della homelessness attraverso le Unità di strada: il caso della città di Torino. *ISTAT WORKING PAPERS* N. 5/2019, Istat-Istituto Nazionale di Statistica, Roma.

ISTAT. 2014. *La ricerca nazionale sulla condizione delle persone senza dimora in Italia.* Roma: ISTAT.

ISTAT. 2022. *Piano Generale del Censimento Permanente della Popolazione e delle Abitazioni 2022-2031.*Roma: ISTAT.

ISTAT. 2023. *Le strutture residenziali socio-assistenziali e socio-sanitarie, 1° gennaio 2022.* Roma: ISTAT.

LETERME Y., DEVELTERE P. 2023. The European Platform on Combating Homelessness (EPOCH): From Policy to Practice and from Practice to Policy, *European Journal of Homelessness*, Vol. 17, No. 2.

O'SULLIVAN E., PLEACE N., et al. 2020. Distorting Tendencies in Understanding Homelessness in Europe, *European Journal of Homelessness*, Vol. 14, No. 3, pp. 109-135.

ZINDATO D., TRUSZCZYNSKI M. 2023. Hard-to-reach population groups in administrative sources: Main challenges and future work, *Statistical Journal of the IAOS*, Vol. 39, pp. 849-863.

_____

Angela CHIEPPA, Istat, chieppa@istat.it
Marija MAMOLO, Istat, mamolo@istat.it

RESIDENTIAL SEGREGATION IN MESSINA (SOUTHERN ITALY): AN INFORMATION THEORY BASED STUDY

Francesca Bitonti, Angelo Mazza, Daniela Ghio, Massimo Mucciardi

Abstract. Residential segregation stands out as one of the most noticeable and potentially concerning consequences of urbanization. Adopting the framework proposed by the Information Theory, the study investigates residential segregation patterns in the Italian municipality of Messina that has recently experienced deteriorating urban conditions. We rely on anonymized individual data sourced from the Population Register to examine the major immigrant groups residing in Messina in 2016 and 2022, Sri Lankans, Filipinos, Romanians, and Moroccans. The analysis computes the Shannon's entropy index and Kullback-Leibler (KL) divergence, aiming at: 1. drawing comparisons in the residential segregation patterns among immigrant populations; 2. appraising changes in residential patterns between 2016 and 2022; 3. assessing to what extent ethnic concentration depends on the adoption of different territorial scales to classify metropolitan areas. Results reveal nuanced patterns of residential segregation among the selected migrant populations, with Filipinos and Moroccans remaining the most segregated groups, both in 2016 and 2022. However, two common dynamics are affecting all immigrant groups: a. the presence of micro-scale segregation; b. the increase of segregation degrees over time. Furthermore, when comparing the distribution of immigrant groups with native populations, concentration levels, detected by the Shannon's entropy index, have not always implied significant KL divergence. These results suggest complex interactions between migrant and the local populations, challenging simplistic assumptions about segregation. Accounting for the multi-scalar dimensionality of segregation, this study contributes to a deeper understanding of residential dynamics and provides insights for fostering social cohesion in diverse spatial urban settings.

1. Introduction

Residential segregation, as complex multidimensional phenomenon (Massey and Denton, 1988), has been extensively studied through the lens of the Information Theory. In this framework, concepts, such as information and entropy, have been revived (Theil and Finizza, 1971). Entropy appraises the degree of randomness in a system or the informational content of a message (Coulter, 1989; Cover and Thomas, 2006; Shannon, 1948; Theil, 1967). Introduced to the social sciences by Theil (Theil, 1967; 1972), entropy became a valuable tool for assessing population diversity and

income inequality (Reardon and Firebaugh, 2002; White, 1986). Essentially, entropy can be interpreted as a measure of uncertainty, representing the amount of information needed to describe a probability distribution. Social researchers apply entropy to gauge residential segregation, as it quantifies the homogeneity of neighbourhoods or regions based on demographic and social characteristics, like ethnicity, education level, or income. In residential segregation, high entropy indicates an equal probability distribution of population groups across space, while lower entropy signifies a higher probability for one group, reflecting reduced uncertainty about the distribution (Cover and Thomas, 2006).

Previous studies on residential segregation, particularly ethnic segregation, have emphasized the importance of setting appropriate spatial scales and implications of this methodological choice in its measurement (Arcaya *et al.*, 2018). Distinctive racial residential patterns, and consequently a wide variation in segregation, become evident when changing the range of spatial scales (Reardon *et al.*, 2008). This is due to the decision-making processes regarding where to live within a city. Excluding public housing allocations, residential decisions are individual-group-varying and involve: 1) housing rental prices, 2) access to work, school, and leisure (for single and potential family members), influenced by the presence and efficiency of local services, 3) proximity to significant others like family or co-ethnics. Consequently, some groups might be highly concentrated in certain parts of a metropolitan area but scattered within those parts, while others might form tight, exclusive clusters spread across different housing market segments (Jones *et al.*, 2015). For these reasons, different levels of residential segregation can be detected at various spatial scales.

Utilizing anonymized individual-level data coming from the Population Register, this paper investigates the residential segregation patterns of migrants within the metropolitan area of Messina, Italy. The study focusses on the four largest immigrant groups — Sri Lankans, Filipinos, Romanians, and Moroccans — in 2016 and 2022. The primary inquiries center around 1) Carrying out a multi-scalar analysis of the segregation levels exhibited by the selected immigrant groups; 2) Measuring ethnic residential segregation patterns by immigrant group; 3) Leveraging entropy and divergence when comparing the spatial distribution of immigrants with native populations over time

The reimaging part of the paper includes four sections. The next section analyzes data and the methodology implemented, while the third section portrays the geographical area of Messina and depicts descriptive migrant population patterns. Then, the last two sections are dedicated to the presentation of results and the discussion of the main findings and related implications, drawing the conclusions of the work.

2. Data and Methods

Characteristics of immigrants' groups come from the Population Register, accounting for individuals recorded as of June 30th, 2016 and November 30, 2022. This dataset includes all individuals (Italians and immigrants) residing in Messina, along with their children or nephews who were born abroad (in their respective countries of origin) and obtained solely the citizenship of parents at birth. Their residential addresses have been geocoded by querying the Google Maps Geocoding API exploiting the R "ggmap" library (Kahle and Wickham, 2013). The statistical analysis was conducted with the R software (R Core Team, 2023).

In this study, the residential segregation of the selected foreign groups is examined through the concept of entropy, a measure often utilized in Information Theory. Entropy represents the amount of information required to describe a (in our case spatial) probability distribution. When two outcomes (e.g., two ethnic groups) are equally probable, the uncertainty about the outcome is high, resulting in high entropy. Conversely, if one outcome is more likely than the other, there is less uncertainty and, consequently, lower entropy. As a consequence, the higher the entropy, the lower the segregation[1]. In this context, Shannon's entropy metric is calculated (Shannon, 1948). For a categorical variable X with I possible outcomes (or groups), Shannon's entropy is defined as:

$$H(X) = \sum_{i=1}^{I} p(x_i) log \frac{1}{p(x_i)} \tag{1}$$

where $p(x_i)$ for $i = 1, 2, \dots, I$ is the probability of occurrence of group i in a given area. The relative entropy, measuring the discrepancy of the immigrant groups' probability distributions from the local population's one, is also evaluated. This involved computing the Kullback-Leibler (KL) divergence (Kullback, 1987) to assess the spatial distribution differences between Italians and each of the four immigrant groups individually, as follows:

$$D(p|q) = \sum_{m=1}^{M} p_m log \frac{p_m}{q_m} \tag{2}$$

where the q distribution defines the reference (Italians) against which the p distribution of the immigrant group is compared in a given area m. In general, the KL divergence is able to better control the contextual factors influencing residential

---

[1] In residential segregation studies, entropy is inversely related to the concept of diversity, intended as ethnic or group mixing: higher diversity corresponds to lower segregation.

choices in general (e.g., building distribution, industrial areas etc.) because it compares the distributions themselves.

3. Context and descriptive results

Over the past fifty years, Messina has been struggling with challenges due to deteriorating urban conditions, a rise in youth emigration, and a shift in population towards neighbouring villages, leading to a decline and spatial redistribution of its population (Scrofani, 2018).

Table 1 – *Demographic characteristics of the four main immigrant groups residing in the metropolitan areas of Messina, 2016 and 2022.*

Characteristic		Sri Lanka		Philippines		Romania		Morocco	
		2016	**2022**	**2016**	**2022**	**2016**	**2022**	**2016**	**2022**
Age									
	0-25	30.7 %	28.3 %	29.7 %	25.8 %	21.7 %	18.8 %	28.8 %	27.1 %
	26-65	66.7 %	64.7 %	66.2 %	64.4 %	76.7 %	76.5 %	66.6 %	65.1 %
	65+	2.6 %	6.9 %	4.1 %	9.8 %	1.6 %	4.7 %	4.6 %	7.8 %
Sex									
	Female	46.8 %	49.0 %	52.8 %	53.0 %	68.0 %	67.3 %	36.6 %	38.7 %
	Male	53.2 %	51.0 %	47.2 %	47.0 %	32.0 %	32.7 %	63.4 %	61.3 %
N° individuals		4199	4030	2555	2226	1661	1668	1218	1155
% of total immigrant population		33.2	30.3	20.2	16.8	13.1	12.6	9.6	8.7
N° households		1742	1823	902	917	1015	1122	573	636
% of total number of immigrants' households		27.6	24.1	14.3	12.1	16.1	14.8	9.1	8.4
Mean n° of individuals in households		2.4	2.2	2.8	2.4	1.6	1.5	2.1	1.8

Source: authors' elaborations on Population Register data.
Notes: 2016 observations refer to 30.06.2016: 2022 observations refer to 30.11.2022

From the 1980s onwards, the city has received the inflows of immigrants mostly coming from Sri Lanka, the Philippines, Romania and Morocco. These first four groups accounted for the 68.35% of the total foreign population in 2022 (against 76.2% in 2016, suggesting an increase in the ethnic diversification of the population – table 1). Their demographic characteristics show important similarities and

differences. Beside a general shrinkage in the immigrant groups' size, also the mean household size has decreased over time, with Sri Lankans and Filipinos accounting for the highest mean of 2.2 and 2.4 individuals per household as for 2022, respectively. The population pyramids (figure 1) illustrate that overall, the middle and adult age classes are the most numerous. As regard the gender composition, Sri Lankans and Filipinos are balanced with a bottleneck for the young adult age classes, whereas a gender characterization can be observed for Romanians (with a female dominance) and Moroccans (with a male prevalence) (see both figure 1 and table 1).

The four immigrant groups are settled in the urban core of the municipality of Messina and along the seaside, following the overall resident population density (figure 2). Nevertheless, Sri Lankans and Romanians seem to be more dispersed than the other groups, being in more peripheral northern and in the western inner areas.

4. Results: residential segregation patterns

The computation of the H index and the KL divergence at the district[2] level (mean area: 35.33 km^2) yielded different results.

According to the H index Sri Lankans (table 2) and Filipinos appear more mixed with the Italians and, in general, the H values for all the groups do not vary much between the two years.

The KL divergence, on the contrary, highlights a general increase of segregation through time for all the groups with Sri Lankans and Romanians being the least segregated with respect to Italians.

Considering the KL values together with demographics, it is possible to draw residential profile by immigrant group. Specifically, in 2022:

− Filipinos: highly segregated in «middle-size household» groups (mean household size: 2.2)
− Moroccans: segregated in «small household» groups (mean household size: 1.8)
− Sri Lankans: segregated in «middle-size household» groups (mean household size: 2.1)
− Romanians: poorly segregated in «small household» groups (mean household size: 1.5)
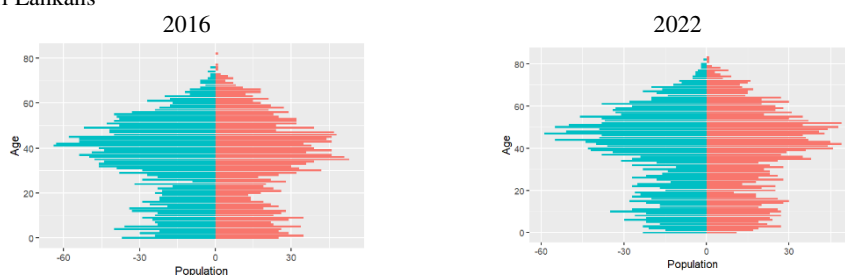
Overall, with the increase of the household size the KL divergence, and hence the segregation, unsurprisingly increases too.

---

[2] The city is divided into six municipal districts, or "*circoscrizioni*" (I to VI), which function as subdivisions of the urban area, similarly to the municipal arrondissements of Paris or the London boroughs.

Figure 1 – *Population structure for the main four foreign groups in the municipality of Messina, 2016 and 2022.*
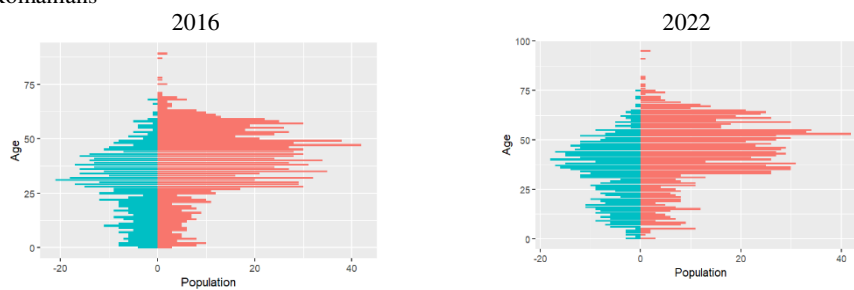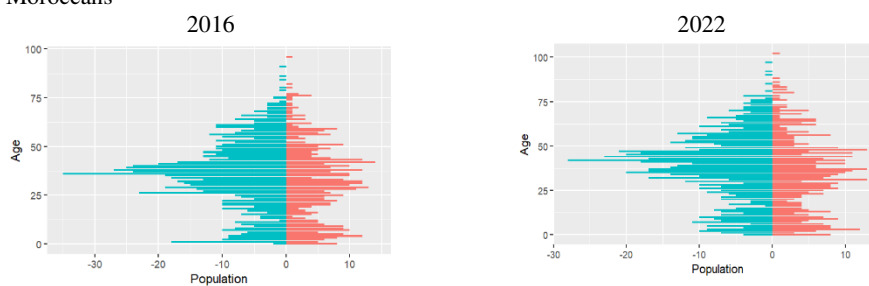
a) Sri Lankans

2016	2022

b) Philippines

2016	2022

c) Romanians
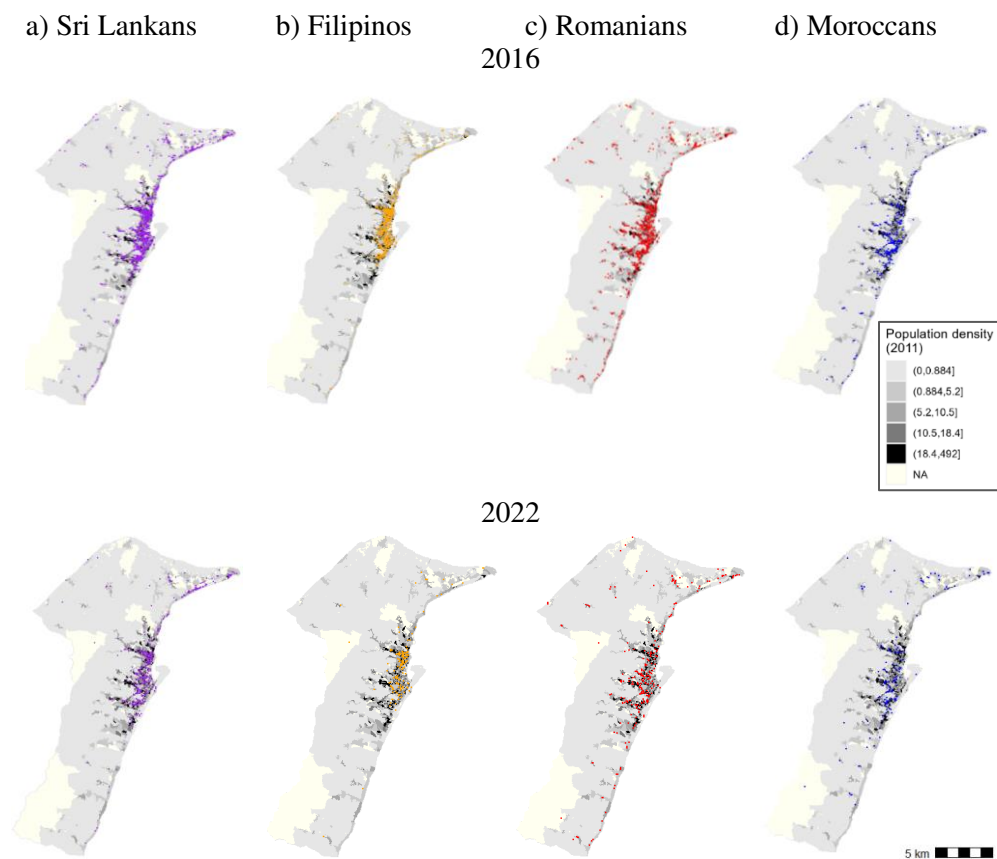
2016	2022

d) Moroccans

2016	2022
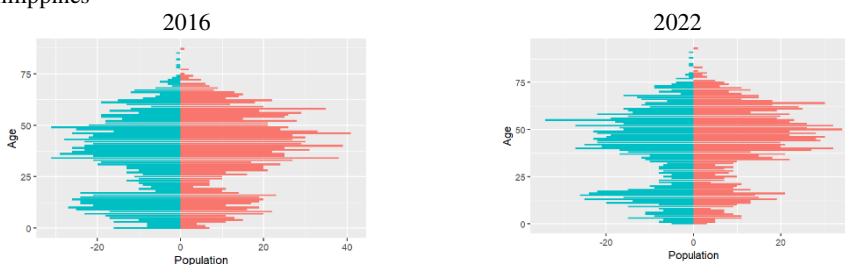
Note: females in pink; males in light blue.

Figure 2 – *Spatial distribution of the main four foreign groups in the municipality of Messina in 2016 and 2022.*

a) Sri Lankans   b) Filipinos   c) Romanians   d) Moroccans

2016

2022

Note: the points referring to the individual residential addresses have been jittered for privacy concerns.

Table 2 – *Shannon's entropy index and KL divergence values for the four selected immigrant groups against Italians in Messina in 2016 and 2022 at the district level.*

Foreign group	Shannon's entropy H(X)		KL divergence	
	2016	2022	2016	2022
Sri Lankans	0.129	0.146	0.070	0.132
Filipinos	0.087	0.072	0.207	0.309
Romanians	0.061	0.072	0.050	0.073
Moroccans	0.047	0.048	0.169	0.164

As already pointed out by a large body of work (Leckie et al., 2012; Louf, 2016; Östh et al., 2015), segregation is not a scale-invariant phenomenon. Instead, high variation in segregation level can be detected at different scales of measurement depending on several demographic, socioeconomic but also urban factors. For this reason, the KL divergence was measured at different scales by superimposing to the urban area of Messina several regular grids composed by quadrats of different side's lengths (i.e.: 100, 200, 500, 1000 meters). As reported in table 3, except the general decrease in divergence with the time, for both years, the higher the scale, the lower the segregation for all of the groups considered. This should imply that if at small scales some sort of divergence is detected, there is lower level of concentration for these groups when lager scales are adopted.

Table 3 – *Multilevel dynamics of the KL divergence against Italians.*

Foreign group	2016				2022			
	Quadrat side's length (meters)							
	100	200	500	1000	100	200	500	1000
Sri Lankans	0.922	0.752	0.532	0.404	1.522	1.125	0.721	0.490
Filipinos	1.357	1.161	0.892	0.760	2.450	2.039	1.448	0.978
Romanians	0.692	0.514	0.332	0.217	2.100	1.613	0.910	0.499
Moroccans	1.420	1.150	0.743	0.524	2.218	1.834	1.200	0.734

5. Conclusions

The results showed that the concentration assessed by the Shannon index do not always simply a divergence in KL terms. The KL metrics highlighted heterogeneity in the levels of divergence when comparing the spatial distribution of selected immigrant groups with Italians. This mirrors potential differences in integration dynamics, not just in terms of sharing space, but also different life domains.

Yet, KL divergence results suggest disparities in segregation levels across foreign groups that interact with and are exposed to the same environments as the local population. This could imply heterogeneous levels of integration between the different foreign groups and the local population, not just in terms of sharing the same neighbourhoods, but also similar workplaces and social contexts. In particular, the analysis detected a general increase of segregation for all the groups investigated with the passing of the time. Despite this, the consideration of different scales of analysis ruled out the presence of large neighbourhoods of segregation. Nonetheless, the different divergence levels characterizing the groups, especially at the smallest scales, are evidence that group-specific policies should be implemented to guarantee the integration of all the groups.

The present work represents the initial effort made to map and understand the evolution of residential allocation patterns of the main immigrant groups in Messina. The influence of additional individual, group-specific and contextual socioeconomic factors on residential choices will be assessed in future steps of the analysis to unveil the causes, dynamics and possible socioeconomic implications of residential segregation in Messina. Some of the research questions that will be investigated concern the potential differences in the spatial distribution of the first and second generations of immigrants, the individual residence movements across time, the socioeconomic factors influencing residential choices, as job opportunities and spatial heterogeneities in housing cost (as partially investigated in Bitonti *et al.* (2023)), as well as the differences in settlement models based on ethnic-specific migratory behaviours: e.g., family migration, family reunion and "solo-migration".

Acknowledgements

References

ARCAYA M.C., SCHWARTZ G., SUBRAMANIAN S. 2018. A multi-level modeling approach to understanding residential segregation in the United States. *Environment and Planning B: Urban Analytics and City Science*, Vol. 45, No. 6, pp. 1090–1105.
BITONTI F., MAZZA A., MUCCIARDI M., SCROFANI L. 2023. Urban transformations and the spatial distribution of foreign immigrants in Messina. *Models for Data Analysis. Selected papers of 49th Meeting of Italian Statistical Society*, pp.53-67.

COULTER P.B. 1989. *Measuring Inequality: A Methodological Handbook*. Boulder: Westview Press.

COVER T.M., THOMAS J.A. 2006. *Elements of Information Theory*. Hoboken, N.J.: Wiley-Interscience.

JONES K., JOHNSTON R., MANLEY D., DEWI O., CHARLTON C. 2015. Ethnic Residential Segregation: A Multilevel, Multigroup, Multiscale Approach Exemplified by London in 2011. *Demography*, Vol. 52, pp. 1995–2019.

KAHLE D., WICKHAM H. 2013. ggmap: Spatial Visualization with ggplot2. *The R Journal*, *5*(1), 144–161.

KULLBACK S. 1987. Letters to the Editor. *The American Statistician*, Vol. 41, pp. 338–341.

LECKIE G., PILLINGER R., JONES K., GOLDSTEIN H. 2012. Multilevel modeling of social segregation. *Journal of Educational and Behavioral Statistics*, Vol. 37, No. 1, pp. 3–30.

LOUF R. 2016. Patterns of residential segregation. *PLoS ONE*, No. e0157476.

MASSEY D.S., DENTON N.A. 1988. The dimensions of residential segregation. *Social Forces*, Vol. 67, pp. 281–315.

ÖSTH J., CLARK W.A.V. MALMBERG B. 2015. Measuring the scale of segregation using k-nearest neighbor aggregates. *Geographical Analysis*, Vol. 47, No. 1, pp. 34–49.

R CORE TEAM. 2023. R: A language and environment for statistical computing. Vienna, Austria: R Foundation for Statistical Computing.

REARDON S.F., FIREBAUGH G. 2002. Measures of Multigroup Segregation. *Sociological Methodology*, Vol. 32, pp. 33–67.

REARDON S.F., MATTHEWS S.A., O'SULLIVAN D., LEE B.A., FIREBAUGH G., FARRELL C.R., BISCHOFF K. 2008. The Geographic Scale of Metropolitan Racial Segregation. *Demography*, Vol. 45, No. 3, pp. 489–514.

SCROFANI L. 2018. Le aree urbane nei processi di periferizzazione e di sviluppo del Mezzogiorno. In *Sussidiarietà e… giovani al Sud. Rapporto sulla Sussidiarietà 2017/2018*, pp. 167–198. Fondazione Sussidiarietà.

SHANNON C.E. 1948. A Mathematical Theory of Communication. *Bell System Technical Journal*, Vol. 27, No. 3, pp. 379–423.

THEIL H. 1967. *Economics and Information Theory*. Amsterdam: North- Holland Publishing Company.

THEIL H. 1972. *Statistical Decomposition Analysis.* In THEIL H. (Ed.). Amsterdam: North- Holland Publishing Company.

THEIL, H., FINIZZA, A.J. 1971. A note on the measurement of racial integration of schools by means of informational concepts. *The Journal of Mathematical Sociology*, Vol. 1, No. 2, pp. 187–193.

WHITE M.J. 1986. Segregation and Diversity Measures in Population Distribution. *Population Index*, Vol. 52, No. 2, pp. 198–221.

_____

Francesca BITONTI, University of Catania, francesca.bitonti@unict.it
Angelo MAZZA, University of Catania, a.mazza@unict.it
Daniela GHIO, University of Catania, daniela.ghio@unict.it
Massimo MUCCIARDI, University of Messina, massimo.mucciardi@unime.it

LIFESTYLE, ENVIRONMENTAL CONDITIONS AND MORTALITY IN EUROPEAN COUNTRIES AND IN ITALIAN REGIONS

Simona Cafieri, Gianmarco Borrata

Abstract. This paper uses state-of-the-art machine learning techniques to study the relationship between environmental pollution, life expectancy and lifestyle variables in European countries, with a focus on the Italian regions.

K-means clustering allowed to analyse the impact of the pandemic on socio-economic variables between 2019 and 2021, showing how countries position themselves with respect to these changes.

Different regional typologies were outlined, reflecting the diversity of environmental and health challenges.

Furthermore, a random forest analysis was used to predict life expectancy in European countries and Italian regions based on the presence of the most polluting and health-damaging substances.

This methodological approach offers new ways of identifying priorities for intervention, combining environmental mitigation with targeted prevention and treatment strategies.

1. Introduction

According to the World Health Organization, Europe is the most affected region in the world by non-communicable diseases such as cancer, cardiovascular diseases and chronic respiratory diseases, with a relatively small group of health conditions accounting for a large proportion of the disease burden.

Since 2013, European Commission reports have identified the main causes and effects of health inequalities, including living conditions, health-related behaviours, education, occupation and income. The report recognises the role that exposure to air pollution can play in health inequalities.

Air pollution is the most important environmental health risk factor, independent of an individual's lifestyle. It remains a major cause of ill health, contributing not only to the development of cancers but also to respiratory and cardiovascular diseases, and is thought to be responsible for more than 6.5 million deaths per year worldwide.

According to the European Environment Agency (EEA), 253,000 deaths in the EU-27 in 2021 were attributable to exposure to concentrations of fine particulate matter (PM2.5), and coarse particulate matter (PM10). A further 52,000 deaths were associated with exposure to other key air pollutants, such as high NO2 (nitrogen dioxide) and O3 (ozone) concentrations. According to the EEA, energy consumption in residential, commercial and institutional buildings was the main source of PM10 and PM2.5. Agriculture was the main source of ammonia and methane, accounting for 94% and 55% of emissions respectively.

Figure 1 – *Main sources of air pollutants in Europe, 2021.*
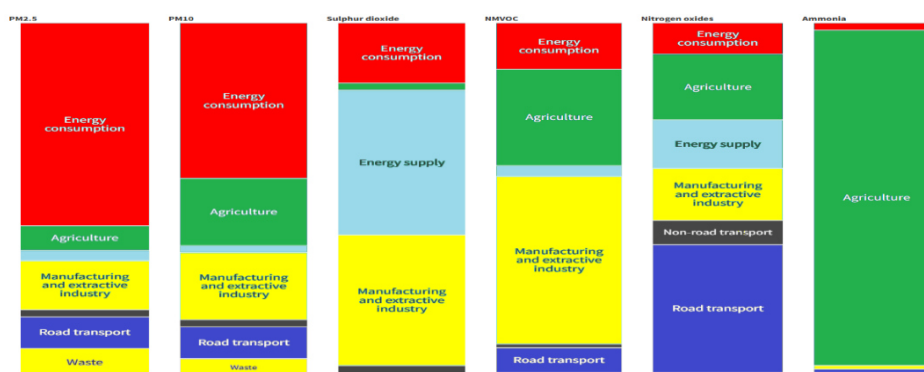
Source: European Environment Agency.

In 2021 road transport was the main source of nitrogen oxides, accounting for 39% of emissions. In the same year, the energy sector was the main source of sulphur dioxide, responsible for 46% of emissions. Manufacturing and extractive industries were the main emitters of heavy metals to air.

Figure 2 – *N. of deaths attributable to the environment in EU countries (2019 -2021).*
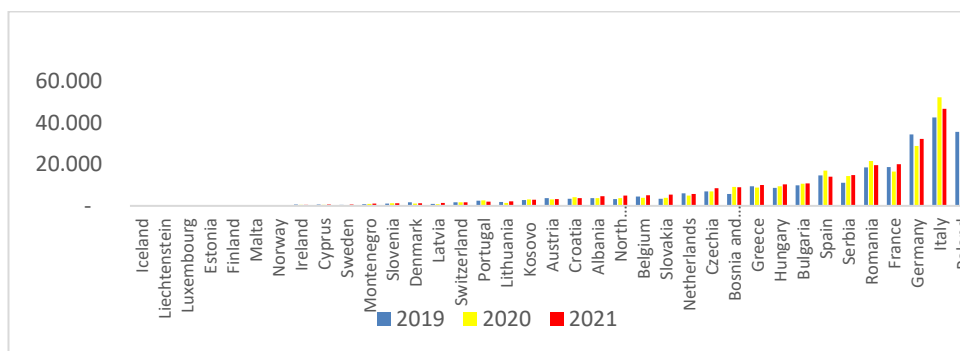
Source: European Environment Agency

Figure 2 presents the number of deaths attributable to the environment: Eastern European countries carry a significantly higher environmental burden of disease and mortality than western European countries, exacerbating economic inequalities across the European region. The relationship between socio-economic status and health inequality is unequivocal[1].

---

[1] Pickett and Wilkinson, (2015)

Societies with wide disparities in socio-economic status also have wide disparities in health and mortality outcomes. Social disparities are evident in both lifestyle choices and dietary patterns. As incomes decline and household budgets tighten, food choices often shift towards cheaper, more energy-dense options. High-quality protein, whole grains, fruits, and vegetables are typically the first to be sacrificed. Over time, this dietary pattern can lead to an increased risk of chronic diseases and premature mortality.

2. Methodology: preliminary consistency analysis

This study aims to identify potential significant correlations between environmental pollution, life expectancy and lifestyle variables using cutting-edge machine learning techniques. For a preliminary consistency analysis, a K-means cluster analysis has been applied to look for likely relationships within the data without any prior assumption. The K-Means clustering technique is an unsupervised learning algorithm widely used in data science to identify hidden structures in data and break them down into homogeneous groups.K-Means algorithm, minimizing within-cluster inertia, partitions quantitative observations into K clusters, with K random initial centroids, thus associating each observation to the nearest centroid according to the Euclidean distance:

$$dE = \sum \sqrt{(x_i - y_i)2} N_i = 1 \tag{1}$$

Where x_i and y_i are coordinates of two observations, $X = (x_{1,2}, ..., x_N)$ and $Y = (y_1, y_2, ..., y_N)$, respectively. Then, the algorithm computes the centroids of the new groupings iteratively until convergence.

The K-means algorithm was implemented for regional analysis using independent variables that concern some socioeconomic and lifestyle variables at the regional scale:

The feature **"Meat consumption"** derives from five features concerning the consumption of animal-source food meats, defined as the percentage of individuals who declare that they - consume cured meats, chicken, turkey, beef, pork, more than once a week[2].

The five variables have been summarized on animal-source food into a single feature ("Meat consumption"), namely the first component resulting from a **Principal Component Analysis**.

PCA are made as a linear combination, orthogonal to each other, of the dataset features; the first principal component PC1 represents a large fraction of variation (variance explained) in the sample, and successive PCs account for decreasing portions of the remaining variation.

---

[2] For Italy data are provided by the 2021 Aspects of Daily Life (AVQ) Istat survey, Data for other countries, are provided by surveys carried out from other National Institutes of Statistics and collected by Eurostat. in Regions database

Therefore, to reduce the variability to get a good representation of the data and to build the feature **"Meat consumption"**, only the first few PCs have been used only PC1, which contained almost 80 % of the data variance.

Table 1 – *Independent variables relating to socio-economic aspects and lifestyle.*

Variable	Description
Environmental pollution	the value of the annual average concentration of PM10 and PM2.5
Available hospital beds	the average number of beds in public hospitals, per regional population
Income	the mean annual income per family provided by the EuSilc survey
Life expectancy	an expect to live at birth
Overweight	the average percentage of people in excess weight (overweight and obese individual[3])
Smoke	the average percentage of smokers
Fruit and vegetable consumption	the percentage of subjects who declare that they eat fruit or vegetables at least once a day

3. Results of European regions between 2019 and 2021

As a result of the K-means cluster analysis for European regions based on environmental and socio-economic variables in 2019 and 2021, three clusters were identified as the optimal number according to the Elbow method[4].

Cluster 1 (Red in Fig.3): Cluster 1 includes Eastern European countries such as Romania, Bulgaria, and Hungary. These states remain characterized by socio-economic challenges, including lower income levels and limited access to advanced healthcare services. Unfavorable health behaviors such as higher smokers' prevalence and overweight rates are notable in this group. Additionally, this cluster shows moderate life expectancy and significant environmental challenges (Fig: 4a, 4b). Between 2019 and 2021,Cipro and Greece join this cluster.

Cluster 2 (Blue in Fig: 3) predominantly includes Western European countries such as France, and Switzerland. These countries demonstrate strong socio-economic indicators, such as high income levels and advanced healthcare systems., lower smokers' rates and higher fruit and vegetable consumption, environmental pollution and meat consumption are moderate concerns in some countries within this group, while life expectancy is generally high (Fig: 4c, 4d). Between 2019 and 2021 Norway, Germany, Belgium and Austria will leave this cluster, while Italy, Spain and Sweden will enter.

Cluster 3 (Green in Fig.3): This cluster features Nordic and Southern European countries. These states present a balanced profile, with moderate to high income levels and positive lifestyle factors (Fig: 4e, 4f). Life expectancy remains relatively high overall, reflecting positive health outcomes in these states.

---

[3] Overweight" means people with a body mass index (BMI) between 25 and 29,9 while people with a BMI of 30 are included in the "obese" group.

[4] Elbow

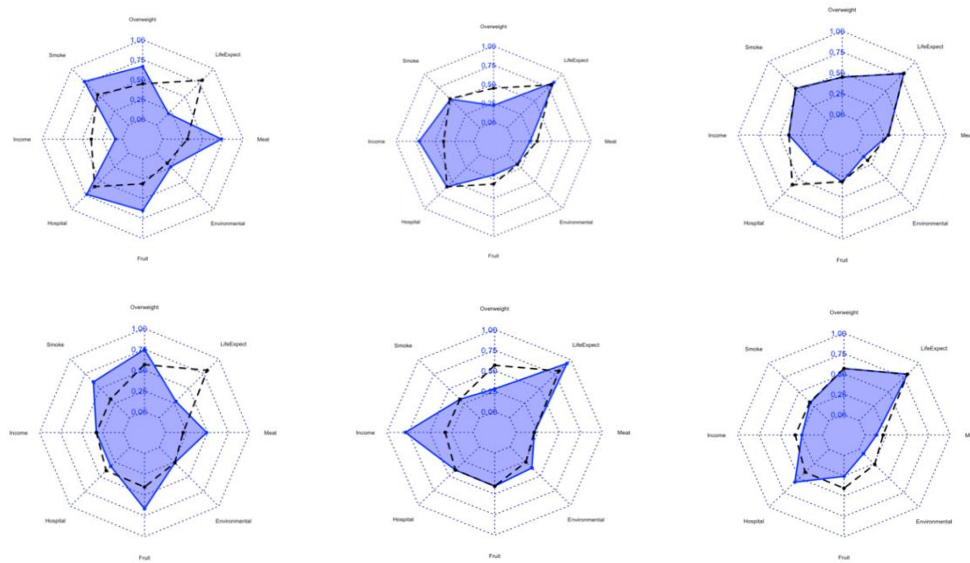**Figure 3 –** *Cluster in EU regions in 2019 and 2021*
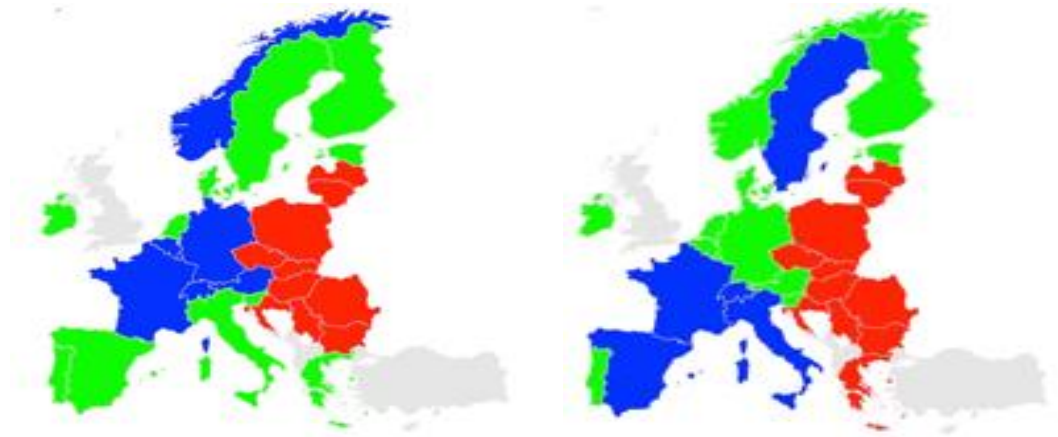
Figure 4 – *Cluster characteristics in the EU regions in 2019(a,c,e) and 2021(b,d,f)*

4. Focus on Italy

Focusing on the Italian regions to perform a cluster analysis based on environmental and socio-economic variables in 2019 and 2021, again using Elbow methods, three clusters were identified as the optimal number.

Figure 5 – *Cluster in Italian regions in 2019 and 2021.*
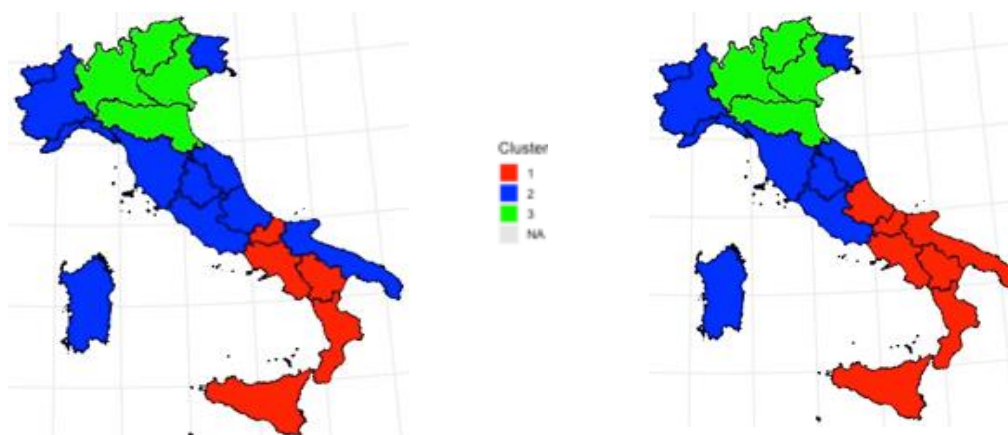
Cluster 1:(Red in Fig: 5): Composed of southern regions, this cluster highlights socio-economic challenges. It is characterized by lower income levels, higher smoking prevalence, and significant rates of overweight individuals and meat consumption. The life expectancy is very low in this group. (Fig: 6a, 6b)

Cluster 2: (Blue in Fig: 5): Includes the north-west and central regions, which have moderate socio-economic indicators. This cluster is characterized by healthier lifestyles, including lower prevalence of overweight individuals and high consumption of fruit and vegetables, reflecting a relatively balanced health profile, with high life expectancy. (Fig: 6c, 6d)

Cluster 3 (Green in Fig: 5): This cluster groups northern regions. These regions demonstrate high income levels and favorable health behaviors, such as higher fruit and vegetable consumption and lower smoking prevalence with life expectancy remaining notably high compared to other regions. (Fig: 6e, 6f).

5. A deeper level of analysis: prediction of future mortality incidence

To delve deeper into the specific air pollutants linked to mortality in EU and Italian regions, a secondary analysis was conducted using a Random Forest[5] model.

---

[5] Babu S, Thomas B (2023)

Figure 6 – *Cluster characteristics in the Italian regions in 2019(a,c,e)and 2021(b,d,f).*
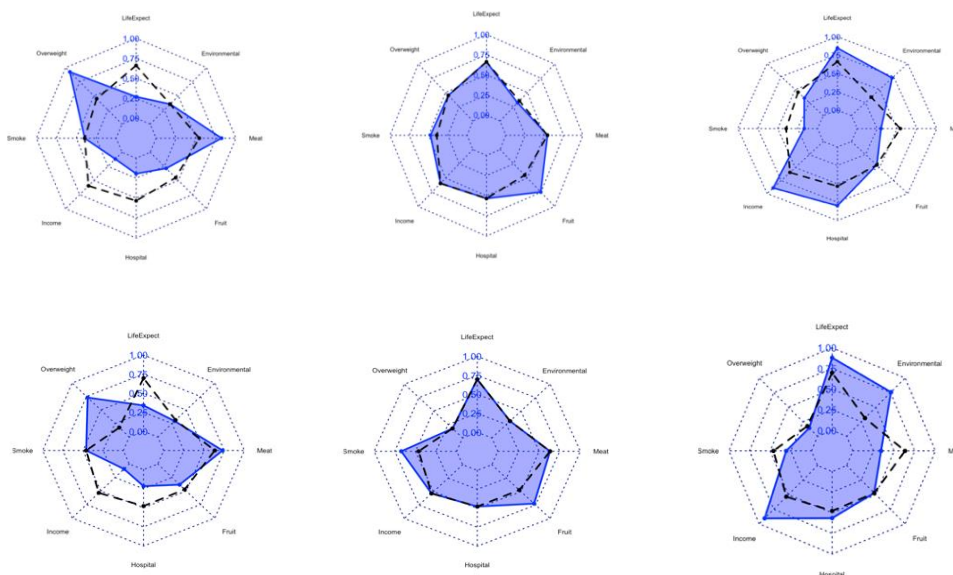
The Random Forest technique is a regression tree technique which combines multiple decision trees and randomization of predictors to achieve a high degree of predictive accuracy. Each tree in the forest builds from a different subset of the data and makes its independent prediction. The final prediction for input is based on the average of all the individual trees' predictions. The RF regression is one of the most popular machine learning algorithms and has been success fully applied to both classification and regression in many different fields.

A Random Forest analysis was developed to predict life expectancy in the six identified clusters, using major environmental pollutants (associated to life expectancy reduction) such as PM2.5, PM10, O3 and NO2 as predictors according to EEA and Ispra data.

The prediction was made from socio-economic data and environmental variables in 2021. The importance of each variable and its predictive accuracy were assessed. The evaluation used leave-one-out cross-validation, highlighting the predictive ability of the model within each cluster.

Table 2 – *Mean Values of Air Pollutants for Different Clusters of Italian Regions.*

	NO2	O3	PM10	PM2.5
Cluster 1	15.55	54.39	22.10	11.53
Cluster 2	16.27	57.98	19.95	11.87
Cluster 3	22.54	53.12	24.26	16.59

Table 3 – *Mean Values of Air Pollutants for Different Clusters of European States.*

	NO2	O3	PM10	PM2.5
Cluster 1	7.80	61.77	16.76	12.84
Cluster 2	5.88	60.74	14.52	8.25
Cluster 3	6.59	65.75	13.94	7.73

After identifying the relevant characteristics (pollutants), cleaning and pre-processing the data, dealing with missing values and normalizing pollutant levels, the following steps were taken:

• Model Training: Data are split into training and test sets. Random Forest model is trained with pollutants as features and life expectancy rates as the target.

• Model Evaluation: The model's performance is assessed on the test set using metrics like Mean Squared Error (MSE)[6] Mean absolute error (MAE)[7] and Root Mean Squared Error (RMSE)[8] .

• Future Data Prediction: future pollutant data are collected and input into the trained model.

• Life expectancy prediction: The model predicts future life expectancy based on the input pollutant data, providing insights into potential future health impacts in the region based on the levels of the main pollutants detected in 2021 according to EEA data.

The following table illustrates how the model's predictions assesses the model's accuracy using the MSE, MAE, RMSE

Table 4 – *Performance Measures to predict Life Expectancy in European countries.*

	Cluster 1	Cluster 2	Cluster 2
MSE	0.038	0.003	0.018
MAE	0.145	0.056	0.097
RMSE	0.196	0.059	0.136

In Cluster 1, NO2 was identified as the most significant predictor, with PM10 and PM2.5 also contributing notably. O3 had a limited influence on life expectancy predictions (Fig: 7a). This cluster demonstrated a MSE of 0.038, MAE of 0.145, and RMSE of 0.196, indicating reliable predictions (Tab: 4).

6 $\quad MSE = \frac{1}{n} \sum e_t^2$

7. $\quad MAE = \frac{1}{n} \sum |e_t|$

8 $\quad RMSE = \sqrt{\frac{1}{n} \sum e_t^2}$

For Cluster 2, PM2.5 emerged as the most critical variable, highlighting the substantial impact of fine particulate matter on life expectancy. The variables PM10, and NO2 played meaningful roles, while O3 had minimal relevance (Fig: 7b). This cluster achieved the best predictive performance, with the lowest MSE (0.003), MAE (0.056), and RMSE (0.059), reflecting highly accurate predictions (Tab: 4).

In Cluster 3, NO2 and O3 were the dominant variables, underlining their importance in regions characterized by diverse environmental conditions. PM2.5 and PM10 were less influential compared to other clusters (Fig: 7c). The predictive metrics for this cluster were strong, with an MSE of 0.018, MAE of 0.097, and RMSE of 0.136, showcasing good model performance (Tab: 4).

Figure 7 – *Predictors of life expectancy in EU regions grouped in 3 clusters(a, b, c).*
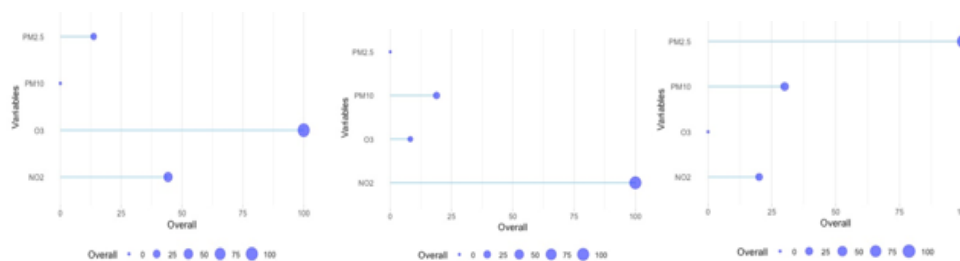
A similar Random Forest model can be build to predict life expectancy by analyzing the three clusters previously identified, with environmental variables levels (main pollutants detected in 2021) as predictors according to Ispra data.

Table 5 – *Performance Measures to predict life expectancy in Italian regions.*

	Cluster 1	Cluster 2	Cluster 2
MSE	0,032	0,011	0,008
MAE	0,124	0,104	0,084
RMSE	0,178	0,104	0,089

The predictions were evaluated using the leave-one-out cross-validation method, and the results provide insights into the predictive performance and importance of different variables across clusters.

In Cluster 1, the PM10 was the most critical predictor, with the highest importance score, indicating its strong association with life expectancy in this cluster. NO2 and PM2.5 also played significant roles, while O3 was less influential (Fig: 8d) Cluster 1 exhibited the highest error

metrics among the three groups, with an MSE of 0.032, an MAE of 0.124, and an RMSE of 0.178, but the overall predictive performance is still acceptable.

For the cluster 2, NO2 emerged as the most important predictor, emphasizing the role of traffic-related pollution in influencing mortality rates. PM10 and PM2.5 were also relevant, while O3 showed minimal importance (Fig: 8e). Cluster 2 performed well, with an MSE of 0.011 and an RMSE of 0.104.

Finally, in cluster 3 the PM2.5 was the dominant variable, reflecting the relevance of fine particulate matter in regions with higher industrial activities. PM10 and NO2 followed in importance, with O3 having a negligible impact (Fig: 8c). Cluster 3 achieved the best results, showing the lowest error metrics, including a MSE of 0.008, a MAE of 0.084, and a RMSE of 0.089.

Figure 8 – *Predictors of life expectancy in EU regions grouped in 3 clusters(d, e, f).*
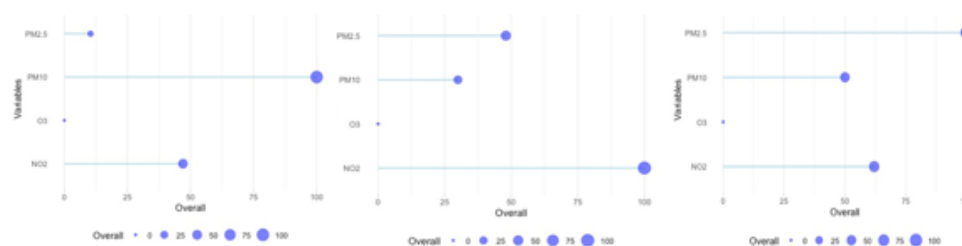
6. Results and discussion

The results highlight the crucial role of environmental and socio-economic conditions in determining health inequalities. Regional classification using K-means clustering allowed the identification of three macro-groups with distinct socio-economic and health characteristics. Eastern European regions, although less polluted than some in Western Europe, show greater vulnerability due to lower income levels and limited access to health services. Conversely, Western European countries, while benefiting from advanced health care systems and generally healthier lifestyles, face growing concerns about air pollution, as evidenced by the effects of fine particulate matter (PM2.5 and PM10).

An important finding is the importance of particulate matter and nitrogen dioxide (NO2) as primary predictors of mortality and life expectancy, independent of socio-economic factors. This underlines the fact that in high-pollution contexts, even a healthy lifestyle cannot offset the negative effects of prolonged exposure to pollutants. In Italy, regional disparities are particularly pronounced: northern regions show better health indicators due to higher incomes and healthier lifestyles, while southern regions face a combination of adverse factors, including lower incomes and higher rates of obesity and smoking. The Random Forest analysis confirmed the key role of specific pollutants, with PM2.5 emerging as the most significant predictor of reduced life expectancy in many clusters. These findings underscore the importance of targeted

interventions to reduce air pollution and integrated policies addressing both socio-economic inequalities and environmental risks.

7.   Conclusions

This paper demonstrated the effectiveness of advanced techniques, such as K-means clustering and the Random Forest model, in identifying relationships between environmental pollution, socio-economic factors, and life expectancy. The emergence of PM2.5 and NO2 as key predictors highlights the need for specific policies aimed at improving air quality, particularly in the most vulnerable areas.

These findings underscore the importance of targeted interventions to reduce air pollution and integrated policies addressing both socio-economic inequalities and environmental risks.

Moreover, the observed disparities call for focused strategies to promote health equity and to reduce pollution. A polluted environment can impede our efforts to achieve optimal health, just as a polluted train carriage can impede our comfort on the journey of our lives.

References

BABU S, THOMAS B**.** 2023.A survey on air pollutant PM2.5 prediction using random forest model**,** *Environmental Health Engineering and Management Journal*, Vol. 10, No. 2, pp. 157–163

BALAKRISHNAN K., FULLER R., AND OTHER. 2022. Pollution and health: a progress update, *The Lancet Health Review*, Vol. 6, No. 6, e535-e547.

BREIMAN L**.** 1996**.** Bagging predictors. *Machine Learning.* Vol. 24, pp. 123–140. Springer, Berlin/Heidelberg, Germany.

BREIMAN L. 2001. Random forests*, Machine Learning,* pp. 5–32.

DI LORENZO G., FEDERICO P., DE PLACIDO S., BUONERBA C. 2015 Increased risk of bladder cancer in critical areas at high pressure of pollution of the Campania region in Italy: a systematic review, *Critical reviews in oncology/hematology*, Vol. 96, pp. 534–541

EUROPEAN ENVIRONMENT AGENCY 2019 *Healthy Environment, healthy lives: how the Environment Influences Health in Europe,* Report N. 21/2019

EUROPEAN ENVIRONMENT AGENCY 2023 *Air Quality e-Reporting*

GURURAJ T., VISHRUTHA Y. M., UMA M., RAJESHWARI D., RAMYA B. K. 2020. Prediction of Lung Cancer Risk using Random Forest Algorithm Based on Kaggle Data Set. *International Journal of Recent Technology and Engineering (IJRTE),* Vol. 8, No. 6, March 2020. ISSN: 2277-3878 (Online),

IARC 2022. https://monographs.iarc.who.int/agents-classified-by-the-iarc/

ISTAT 2022. *Aspetti della vita quotidiana.*

ISTAT 2021. *Dati ambientali nelle città.*

ISTAT 2021. *Indagine sulle cause di morte.*

ISTAT 2021. *Indagine sui prodotti fitosanitari destinati all'uso agricolo.*

JAIN A.K., DUBES RC. 1988. *Algorithms for Clustering Data.* Prentice-Hall, New Jersey.

JACKSON E.J.1991, *A User's guide to principal components,* John Wiley &Sons, p.569.

KASSOMENOS, P., PETRAKIS M., SARIGIANNIS D., GOTTI A., KARAKITSIOS S. 2011. Identifying the contribution of physical and chemical stressors to the daily number of hospital admissions implementing an artificial neural network model, *Air Quality, Atmosphere & Health,* Vol, 4, pp. 263–272.

LIAW A., WIENER M. 2002. Classification and regression by random Forest, *R News,* Vol. 2 , No. 3, pp.18–22.

LIN Y.-C., TSAI C.-H., HSU H.-T., LIN C.-H. 2021. Using Machine Learning to Analyze and Predict the Relations Between Cardiovascular Disease Incidence, Extreme Temperature and Air Pollution. *IEEE 3rd Eurasia Conference on Biomedical Engineering, Healthcare and Sustainability (ECBIOS)*, pp. 234–237.

MARIEN L., VALIZADEH M., ZU CASTELL W., NAM C., RECHID D., SCHNEIDER A., MEISINGER C., LINSEISEN J., WOLF K., BOUWER L. 2022. Machine learning models to predict myocardial infarctions from past climatic and environmental conditions, *Natural Hazards and Earth System Sciences*, pp. 1–36.

PAVONE P., PAGLIACCI F., RUSSO M., RIGHI S., GIORGI A. 2021. Multidimensional clustering of EU regions. A contribution to orient public policies in reducing regional disparities, *Social Indicators Research*, April 2020.

PICKETT K. E, WILKINSON R. G. 2015. Income inequality and health: A causal review, *Social Science & Medicine,* Vol. 128, pp. 316-326.

QUINLAN J.R. 1986. Introduction of decision trees, *Machine Learning,* Vol. 1 , pp. 81–106.

SYAKUR M.A., KHOTIMAH B.K, ROCHMAN E.M.S, SATOTO B.D. 2018, Integration K-means clustering method and Elbow method for identification of the best customer profile cluster. In *IOP conference series: materials science and engineering*, Vol. 335, pp. 12-17.

_____

Simona CAFIERI, Istat, cafieri@istat.it

Gianmarco BORRATA, Università di Napoli "Federico II", gianmarco.borrata@unina.it

DEMOGRAPHIC IMPLICATIONS ON EDUCATION: A CASE STUDY IN THE PROVINCE OF MANTOVA[1]

Simona Ballabio, Rossella Luca, Lorenzo Maraviglia, Alberto Vitalini

Abstract. The decreasing birth rates in Italy are rapidly transforming the demographic landscape, with forecasts indicating a significant reduction in the youth population over the next ten years.

In this work, using data provided by the National Institute of Statistics and the Ministry of Education and Merit, a statistical model has been developed to estimate the future composition of the student population in the province of Mantova. Specifically, demographic forecasts, school participation rates, and other relevant parameters were analyzed to create a robust predictive framework and answer the following types of questions: "How will the student population change in the province of Mantova, even at the level of school districts, over the next ten years? How many more or fewer classes will there be? What effects will this have on staffing?".

While focusing on the province of Mantova as a case study, the project aims to develop a solid methodology that can be used in all Italian provinces, leveraging the informative resources of official statistics and public administrations, at this historical moment when we are faced with digital innovation and the development of artificial intelligence.

The results of the conducted analysis, besides providing a valuable contribution to local policy-level educational planning, can, once extended nationally, bring objective data into the debate on government educational policy choices, thus helping to prepare the Italian educational system for evolving demographic challenges.

1. Introduction

Medium- and long-term educational planning is a complex and critical challenge to ensure equitable and quality education for all students. Effective educational planning decisions must be supported by accurate data and reliable student

---

[1] The work is the joint responsibility of the authors. Paragraphs 1 and 2 are attributed to Alberto Vitalini, paragraphs 3, 3.1, 3.2 and 3.3 to Simona Ballabio, paragraph 4 to Rossella Luca, paragraph 5 to Lorenzo Maraviglia.

population forecasts that take into account changing demographic trends and the specific needs of each territory.

In a context in which birth rates are decreasing and population distribution is constantly changing, it is becoming increasingly critical to forecast the number of students and the resources required to meet society's educational needs with greater precision and territorial granularity. In Italy, the National Institute of Statistics (Istat) forecasts a decrease of more than 1 million potential students (3-18 years) over the next 10 years (Istat, 2024). This scenario requires careful planning and efficient management of resources in the education sector.

2. Aims

This paper aims to address this challenge by focusing on the implementation of a policy tool based on a standardised, robust, accessible and simple methodology to estimate the future composition of the student population, as well as class and staffing levels, in different types of schools and at sub-regional level. In particular, a tool that, using data from official statistics, can be easily applied across the country with a level of disaggregation of estimates at provincial and sub-provincial levels.

The work is the result of a collaboration between institutions, including researchers from Istat Lombardy, the Union of Italian Provinces and INVALSI. It aims to explore the challenges and opportunities that the emerging demographic scenario presents for local and national political strategies in the field of education and more broadly for the design of sustainable development strategies. It is part of the broader analysis of statistical measures by Goal of the European Union's 2030 Agenda, specifically referring to Goal 4: "Quality education for all. Provide quality, equitable and inclusive education and promote lifelong learning opportunities for all".

The proposed forecasting tool is characterized by several distinctive features. First, it relies on reliable and consolidated data, drawing from sources such as Istat and the Ministry of Education and Merit (Miur) to ensure robustness and reliability. Second, the statistical model is designed to be intuitive and easily applicable, allowing the offices of the National Statistical System (Sistan) to implement it independently with minimal resource investment. Additionally, the model offers national coverage and territorial granularity, enabling forecasts to be extended across the entire Italian territory. This includes detailed predictions of the student population at a sub-provincial level, down to the scale of school autonomy and individual municipalities, thereby providing a comprehensive view of educational needs and regional disparities. This detailed granularity supports targeted, data-driven planning that transcends administrative boundaries. Finally, the model

addresses the limitations of previous approaches, which were often partial or localized, by offering a unified and consistent statistical framework that is applicable nationwide (Filippi & Migliore, 2020; Molina, 2018).

In addition to explaining in detail the methodological aspects underlying the proposed policy tool, this article presents some initial results of its application in the province of Mantova. This example illustrates the tool's potential in supporting local policies in the medium and long term in the field of education (of school sizing) and in the field of school buildings (of building sizing and interventions for the innovation, adaptation and safety of institutions).

3. Data and methods

Starting with the data from individual municipalities, the tool enables predictive estimates by school grade (up to secondary schools) for the student population, for the number of classes/sections and finally for the number of places/chairs needed to ensure basic teaching.

Initial estimates are made at the municipal level, but further aggregations can be performed by grouping neighbouring municipalities, school districts, and provinces. The choice of aggregation level depends on the estimates' uncertainty and, secondarily, on what is considered most suitable to support potential local social policy decisions.

The data underlying the model are the experimental regional and municipal demographic forecasting statistics produced by Istat[2], complemented by demographic statistics always from Istat[3] and data from Miur surveys on enrolment numbers, enrolment types, and class numbers for Infancy, Primary, and Secondary I and II grade schools[4].

In the application of the tool, data from Istat's projections of the resident population as of January 1 2022 were used, assuming a median scenario. It is important to be aware of the limitations and uncertainties of Istat's demographic forecasts: while they ensure overall consistency, they are based on specific assumptions about demographic behaviours regarding birth rates, mortality rates, and migration, which may differ from actual data[5]. Additionally, the specific application includes assumptions about school participation and organization. The forecasts thus represent a "what-if" exercise based on realistic assumptions that may

---

[2] https://www.istat.it/statistica-sperimentale/previsioni-demografiche-comunali-1-gennaio-2021-2031/
[3] https://demo.istat.it/app/?i=POS&l=it
[4] https://dati.istruzione.it/espscu/index.html?area=anagStu
[5] For details on the methodologies used for the estimates, please refer to the methodological note produced in support of the released data (Istat, 2023).

not be empirically confirmed due to unforeseen changes in individual or organizational behaviours. For instance, the estimate of class numbers is based on the current average number of students per class, but this number could change to improve educational quality offer. Forecasts become more uncertain the further they are from the baseline, especially in smaller geographic areas. Therefore, we limit our predictive estimates to 10 years after the base year, up to 2032. The further we move from the base year, the more the values should be considered as approximations rather than precise estimates.

3.1 Estimated student population

The proposed tool consists of three consequential steps. The first step is the estimation of the student population, based on projections of the resident population in different age groups (corresponding to schools of different grades) and the participation rate.

The formula for this calculation is:

$$N° \ of \ students = Demographic \ forecasts \ per \ age \ group \ (municipalities) \\ * \ Participation \ rate$$

Therefore, data from the resident population projections for individual municipalities and specific age groups are used first. The estimates at supra-municipal level, on the other hand, are the result of aggregations.

Four age groups were considered:

- o   3-5 years, representing potential Infancy school students;
- o   6-10 years, representing potential Primary school students;
- o   11-13 years, representing potential Secondary I grade school students;
- o   14-18 years, representing potential Secondary II grade school students.

Since some residents might attend schools outside their local area of residence and because Infancy and Secondary school (for students aged 17 and over) are not compulsory, the estimated student population was calculated by multiplying the population forecasts for the different age groups considered with their relative

participation rates. These rates, calculated at territorial level[6], represent, for each school grade, the arithmetic mean of the last 4 years of the ratio between the number of enrolled students and the population of the age groups corresponding to the school grade on 1 January. For our application, with 2022 as the base year, the school years considered are 2018/19, 2019/20, 2020/21 and 2021/22, with the population at 1 January 2019, 2020, 2021 and 2022.

Assuming stable schooling rates over time, changes in the number of enrolled students at different education levels primarily depend on demographic dynamics incorporated in Istat's resident population projections (Istat, 2023). Future projections of the student population are mainly influenced by migration flows and, to a lesser extent, birth and death rates. Given the age brackets considered, errors in the estimates due to variations in mortality rates are negligible, while variations in birth rates, though more uncertain, are limited, affecting only Infancy and Primary school children.

3.2 Estimating classes/sections

The second step in constructing the model involves estimating the number of classes or sections, depending on the school grade.

The formula for this calculation is:

$$Classes/sections = \frac{n° \ of \ students \ per \ grade \ of \ education}{\mu \ (n° \ of \ students \ per \ class \ per \ grade \ of \ education \ of \ a.s. \ 2018/19, \ 2019/20, \ 2020/21, \ 2021/22)}$$

To estimate the number of classes, the student population estimated in the previous step is divided by the average number of students in a class, per school grade present at provincial level[7], calculated as the arithmetic mean of the last 4 years. The average number of students per class is determined, using data available on the Miur website, as the ratio of enrolments to the number of classes. This calculation helps determine how many classes/sections are needed based on the expected number of students and the average class capacity in the province, assuming that the average number of students per class remains constant over time.

---

[6] For regional estimates the regional participation rate was calculated, for provincial and sub-provincial estimates the provincial participation rate.
[7] For regional estimates, the regional value was used.

3.3 Estimating posts/chairs

Variations in the number of classes translate into variations in the number of places/chairs needed. The number of places (at Infancy and Primary schools) or chairs (at Secondary schools) in the workforce depends on several factors, primarily the number of classes formed.

This estimate provides an idea of the minimum number of teachers needed to guarantee basic classroom coverage. Additional staff, such as specialists, educators, and support teachers, are not estimated due to policy dependencies and the unavailability of forecast data for children and young people with disabilities, and therefore with special educational needs.

The number of required teachers would increase if the number of classroom hours for students increased, a factor dependent on policy considerations and a balance between educational supply and individual preferences. For example, in Lombardy, there is considerable variability in the average number of hours Primary school students spend in the classroom. It is worth considering whether this reflects individual preferences or constraints defined by the educational offer.

To calculate the number of teachers needed to guarantee basic education, with the caveats just considered, the formula is used:

$$Places/chairs = classes/sections * \frac{\mu\ (school\ timetable\ by\ grade\ of\ education\ of\ a.s.\ 2018/19,\ 2019/20,\ 2020/21,\ 2021/22)°}{Contractual\ hours}$$

Once the number of classes is obtained, it is multiplied by the ratio of the actual school hours to the contractual hours of a full-time teacher in the public sector (cfr. National Collective Labour Agreement of personnel in the Education and Research sector Period 2019-2021).

The actual school timetable, which reflects the planned hours of lessons for students, is determined from various sources. For Infancy and Primary schools, it is calculated as an arithmetic average of the weighted average of the actual enrolments in the various timetable schemes currently offered by the school system over the last four years. For lower and upper Secondary schools, an average of 30 hours of lessons per week is adopted.

Teachers' contractual hours, representing the number of teaching hours in their employment contracts, are:

o   25 hours for Infancy schools;
o   22 hours for primary schools;
o   18 hours for I and II grade Secondary schools.

4. Results

To highlight the model's potential, we present an application in Lombardy, in the province of Mantova and in two school districts within the province. The tool provides an overall view of future trends, allowing for the identification of the unique characteristics of different territories.

More operationally, it determines the student population, the number of classes, and the consequent number of chairs needed for a specific year in a given area.

Estimating the student population over the next decade allows for a detailed analysis of trends in both Lombardy and the province of Mantova.

While the overall patterns in these regions are similar, there are notable differences. In Mantova, the decline in primary school students occurs slightly earlier than in Lombardy as a whole. Meanwhile, the growth in the Upper Secondary student population is more pronounced in Mantova, with the eventual decline delayed by a couple of years compared to the broader Lombardy context.

These regional and provincial trends, however, do not fully capture the important local variations that become apparent when examining specific school districts. Incorporating these territorial specificities into provincial and regional educational policies is critical. For instance, in the Asola district, a sharper decline in preschool enrollment is observed, while in Suzzara, the contraction of secondary school students is more prominent. However, Suzzara also experiences a notable short-term expansion in its secondary school population, surpassing the growth seen in both Asola and the broader Mantova territories (Fig. 1).

These localized variations emphasize the need for tailored policies that address the unique demographic shifts occurring within individual districts, ensuring that educational planning is responsive to the evolving needs of each area.

However, these trends should be analyzed beyond just numbers. It is essential to consider how local socioeconomic factors, migration patterns, and birth rates influence these shifts. For instance, declining student populations in some areas could signal broader demographic challenges such as aging populations or outward migration of younger families. Conversely, growth in certain student age groups, like Upper Secondary in Mantova, may necessitate further investment in schools, teachers, and training programs to ensure educational standards are maintained.

Figure 1 – *Variation in student population by age groups in Lombardy, Province of Mantova, district of Asola and district of Suzzara. Index numbers (2022=100).*
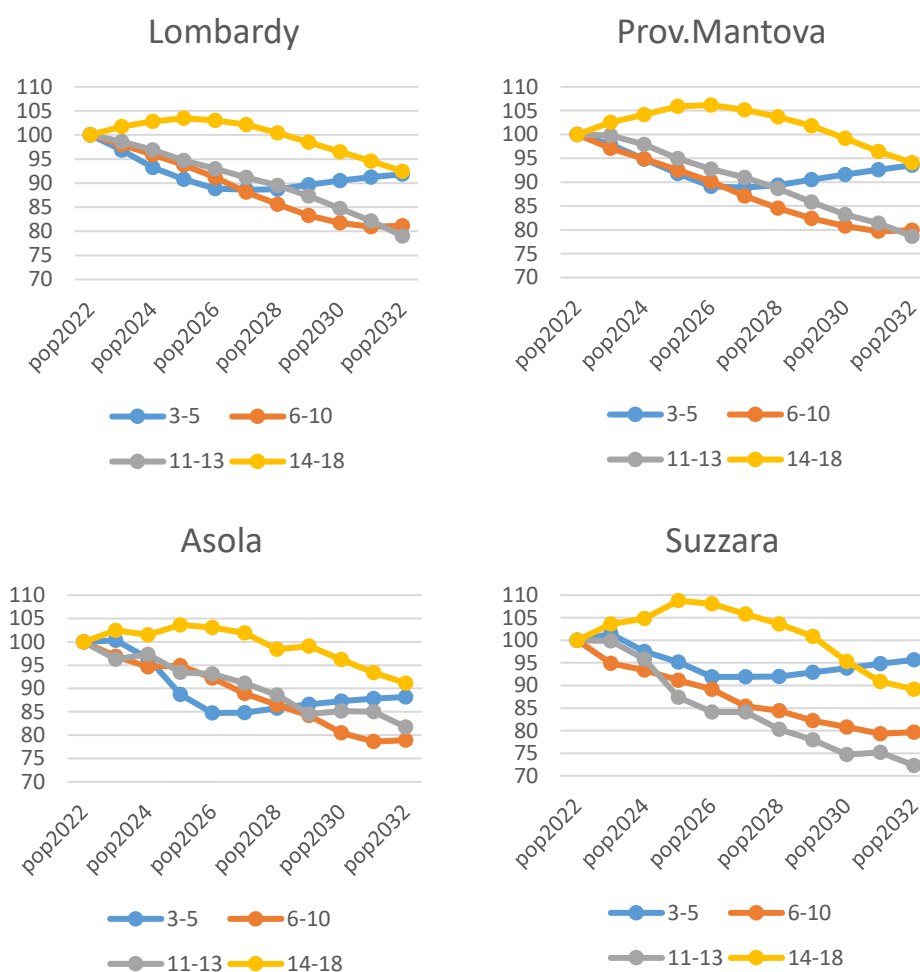
For planning purposes, the model is particularly useful as it can quantify, in terms of order of magnitude, the future population of specific years, as well as the number of classes/sections and places/chairs, with their variations for each school grade at different territorial levels. As an example, we report the estimates for the 2029/30 school year (Tables 1, 2 and 3). In this time span Lombardy will see a decrease of almost 161 thousand students and the province of Mantova of more than 6 thousand, with a relative variation of 11.7%. The relative contraction in the two

districts considered is even more substantial. In the various territorial levels considered, the greatest decreases are observed in Primary and First grade Secondary schools.

Table 1 – *Forecast of student population in a.s. 2029/30 by age groups. Absolute variation (a.v.) and relative variation (r.v.).*

	Lombardy		Prov. Mantova		Distr. Asola		Distr. Suzzara	
	b.y.*	a.v. *(r.v.)*	b.y.*	a.v. *(r.v.)*	b.y.*	a.v. *(r.v.)*	b.y.*	a.v. *(r.v.)*
3-5 | Infancy	22,4752	-21,304 *(-9.5)*	9,237	-774 *(-8.4)*	1,157	-147 *(-12.7)*	1,155	-71 *(-6,1)*
6-10 | Primary	440,324	-80,463 *(-18.3)*	17,754	-3,410 *(-19.2)*	2,127	-415 *(-19.5)*	2,260	-434 *(-19.2)*
11-13 | Secondary I	294,531	-44,843 *(-15.2)*	11,866	-1,989 *(-16.8)*	1,414	-209 *(-14.8)*	1,614	-409 *(-25.3)*
14-18 | Secondary	412,268	-14,308 *(-3.5)*	14,805	-125 *(-0.8)*	1,797	-68 *(-3.8)*	1,919	-90 *(-4.7)*
Total	1,371,875	- *(-11.7)*	53,663	-6,299 *(-11.7)*	6,496	-840 *(-12.9)*	6,948	-1,004 *(-14.5)*

* Frequencies in the base years (=2022)

Table 2 – *Forecast of classes/sections by age groups in Lombardy, Province of Mantova, district of Asola and district of Suzzara. Estimated of absolute variation.*

	Lombardy		Prov. Mantova		Distr. Asola		Distr. Suzzara	
	b.y.*	v.a.	b.y.*	v.a.	b.y.*	v.a.	b.y.*	v.a.
3-5 | Infancy	10,218	-969	410	-34	51	-7	51	-3
6-10 | Primary	22,085	-4,036	920	-177	110	-22	117	-23
11-13 | Secondary I	13,651	-2,078	545	-91	65	-10	74	-19
14-18 | Secondary	19,538	-678	733	-6	89	-3	95	-4
Total	65,491	-7,761	2,608	-309	316	-41	338	-49

* Frequencies in the base years (=2022)

Table 3 – *Forecast of posts/chairs by age groups in Lombardy, Province of Mantova, district of Asola and district of Suzzara. Estimated of absolute variation.*

	Lombardy		Prov. Mantova		Distr. Asola		Distr. Suzzara	
	b.y.*	v.a. 2030	b.y.*	v.a.	b.y.*	v.a.	b.y.*	v.a.
3-5 | Infancy	16,980	-1,610	665	-56	83	-11	83	-5
6-10 | Primary	33,821	-6,180	1,237	-238	148	-29	157	-30
11-13 | Secondary	22,752	-3,464	908	-152	108	-16	123	-31
14-18 | Secondary	32,563	-1,130	1,222	-10	148	-6	158	-7
Total	106,116	-12,384	4,032	-456	488	-61	522	-74

* Frequencies in the base years (=2022)

5. Conclusion and limitations of the study

The proposed statistical forecasting tool presents several key strengths. One of its primary advantages is its accessibility and practicality, as it relies on publicly available data and clear, easily understandable assumptions. This makes the model straightforward to implement, even for organizations with limited resources. Another notable strength is its reliability and methodological soundness. By using official data and established statistical methods, the model ensures that the forecasts are both robust and reliable. Additionally, the tool offers spatial granularity, allowing for detailed forecasts at both municipal and provincial levels of school autonomy. This capability supports targeted planning that can be adapted to the specific needs of each territory.

These attributes make the model a valuable resource for local and national school supply planning. This is especially relevant at the local level, where local authorities (municipalities and provinces) make many decisions regarding the management of school buildings. The introduction of solid forecasting elements concerning student population size and the consequent need for educational resources (teachers, classrooms, facilities) can rationalize and improve the efficiency of decisions that might otherwise be made erratically or based on partial considerations.

The current formulation of the model presents several limitations that should be addressed to improve its effectiveness as a tool for educational planning. One significant gap is the lack of insights into preferences regarding study directions at the upper secondary school level, such as high school, technical, vocational, and IeFP paths. While incorporating these preferences into a forecasting model is challenging, it is essential for decision-makers. A possible approach could be to combine demographic forecasts with trends in study path selection to better capture these dynamics. Another limitation involves the impact of citizenship and migratory background, as educational choices and course preferences are closely tied to these factors. Families of foreign origin, often concentrated in specific areas, have a notable influence on school behavior, birth rates, and migration patterns. Including elements related to immigrant populations in the forecasting model would provide a more comprehensive understanding of these influences. Additionally, while the demographic trends underlying the model—such as birth, death, and migration rates—are relatively stable in the short term, some school planning decisions, such as constructing new schools, require a longer-term perspective and are difficult to reverse. Therefore, the model's forecasts should not be seen as purely quantitative inputs but rather as tools to highlight an area's demographic and social characteristics and to facilitate continuous monitoring of developmental trends.

References

FILIPPI M., MIGLIORE M.C. 2020. La popolazione scolastica e le forze lavoro nei prossimi 10 anni in Piemonte. Torino: Regione Piemonte - IRES Piemonte.

ISTAT 2023. Previsioni demografiche comunali 1 gennaio 2022-2042 – Nota Metodologica. Istat: retrieved from https://www.istat.it/it/files//2022/08/Previsioni-comunali-nota-metodologica-2023.pdf

ISTAT 2024. Previsioni della popolazione - Anni 2023-2080. Istat: retrieved from https://esploradati.istat.it/databrowser/#/it/dw/categories/IT1.POP.1.0/POP_DEM OPROJ/DCIS_PREVDEM1/IT1.165_889_DF_DCIS_PREVDEM1_1.1.0

MOLINA S. (Eds.) 2018. *Scuola, Orizzonte 2028 Evoluzione della popolazione scolastica in Italia e implicazioni per le politiche.* Fondazione Agnelli: retrieved from https://www.fondazioneagnelli.it/wp-content/uploads/2018/04/Fondazione-Agnelli-Demografia-scolastica-2028-Report.pdf

_____

Simona BALLABIO, Istat, Sede della Lombardia, ballabio@istat.it
Rossella LUCA, Provincia di Mantova, rossella.luca@provincia.mantova.it
Lorenzo MARAVIGLIA, INVALSI, lorenzo.maraviglia@invalsi.it
Alberto VITALINI, Istat, Sede della Lombardia, vitalini@istat.it

INTERREGIONAL MOBILITY OF UNIVERSITY STUDENTS IN ITALY: THE IMPACT OF UNIVERSITY'S POLICIES AND SIZE ON THE ATTRACTIVENESS OF REGIONS

Thaís García-Pereiro, Anna Paterno, Raffaella Rubino

Abstract. The interregional mobility of students to Italian universities represents a complex and constantly evolving phenomenon of growing importance within the context of the country's higher education landscape. Several studies have been conducted to analyse underlying causes, current trends and wider implications of this phenomenon.
The article aims to analyse universities' attractiveness at the regional level, disaggregating data according to students' gender and type of degree course. This study also assesses the influence of policy interventions and the size of universities on universities' capacity to attract more students. The macro-data were extracted from the National Student Registry of MIUR Cineca. In particular, the first dataset was extracted from the "students" section with various levels of territorial disaggregation, and the second from the "contributions and interventions" section. Applying a linear regression model, it was possible to identify the main areas for policy intervention and to assess the extent to which the size of universities can generate a greater inflow of students to certain regions. The results of this research can contribute to understanding the dynamics shaping higher education in Italy and enrich the perspective of higher education policymakers.

1. Introduction

The study of university student mobility is of central importance to the analysis of the role that universities play in regional development. In particular, the term interregional student mobility is used to describe the temporary movement of individuals from one region to another within the same nation across regions for the purpose of attending educational institutions at the post-secondary level (Attanasio et al., 2020).

The analysis of internal university mobility in Italy is based on the examination of aggregated administrative data. These data are accessible in two ways: either through the National Student Registry of the Ministry of Education, Universities and Research (ANS, hereinafter) or by consulting individual data from the archives of each university, which are organized according to different spatial scales (regional, provincial and municipal levels). The studies conducted thus far, based on ANS data, have employed indicators of outgoing (from the region of residence) and incoming (to the region of study) mobility (CNVSU, 2011; ANVUR, 2018). These studies have demonstrated that the direction of Italian university student mobility is

predominantly unidirectional, with students mainly moving from the South to the Centre-North (Enea and Attanasio, 2019). Furthermore, northern regions have the greatest capacity for retaining graduates (ISTAT, 2010). This is evidenced by the tendency of southern students who graduate from universities in the Centre-North to eschew returning to their region of origin, instead remaining in the cities where they pursued their studies (Dotti et al., 2013; SVIMEZ, 2014; Vecchione, 2017).

As posited by Strozza (2010) and Impicciatore (2017), these are migrations in progress, denoting mobility toward graduation and subsequently the movement of graduates toward their initial employment opportunities.

Research on student mobility in Italy indicates that mobility for study purposes - defined as the propensity to pursue one's studies in a province or region other than the own - is driven primarily by certain conditions present or absent in the macro-area of origin (Ordine and Rose, 2007; Dal Bianco et al., 2009). Strozza (2010) posits that student mobility is driven primarily by certain conditions present or absent in the macro-area of origin. For instance, the absence of universities able to meet local demand has been identified as a significant factor influencing student mobility (Bruno and Genovese, 2008).

Bruno and Genovese (2012) put forth an origin-bound gravity model for the analysis of student flows at the regional level. The relative attractiveness of each region (i.e., the capacity of a region to draw students from another region) is determined by a score that considers the quality of services provided by universities in that region and the level of social, economic, and cultural well-being characteristic of that region.

The striking disparities between regions (in favour of northward mobility) in the proportion of individuals who have opted to pursue a course of study available at an Athenaeum outside their region of origin raise questions about the underlying causes. These disparities are the result of external factors, such as differences in social composition and the geographic distribution of enrolees raises the question of whether there are real university effects, whereby some universities - due to the quantity and size of the Athenaeum, as well as the policy interventions adopted in favour of the greater reception of off-campus students, known as movers[1] - induce a greater and more consistent attraction to different locations than others.

With regard to Ateneo initiatives that may encourage greater numbers of off-site students to enrol, a study by Hossler et al. (2009) posits that financial assistance and opportunities for academic collaboration are key factors in enhancing the probability of student enrolment. Financial grants can alleviate financial constraints, while academic collaborations can enrich the overall educational experience. However, as

---

[1] In Italy, the terms movers and stayers are employed in academic literature to differentiate between off-site university students who relocate for educational purposes and those who remain in their place of origin (Martini e Romano, 2017; Ciriaci e Muscio, 2011; Dotti et al.; 2013).

evidenced by the findings of Baum and Ma (2007), interventions that are specifically focused on housing subsidies may, while reducing the overall cost of student expenditures, fail to enhance the appeal of the institution in question. This is likely due to the influence of other environmental and quality-of-life factors (such us safety, access to public transportation, cost of living, professional opportunities, natural and green spaces and climate)

In their analysis of the impact of institution size on student integration and satisfaction, Berger and Milem (2000) employed a variety of methodological approaches. The researchers discovered that larger institutions often provide a plethora of resources and opportunities, yet they may also be perceived as less attractive due to the sense of anonymity and the challenge of accessing individualized support. Pascarella and Terenzini (2005) propose that smaller institutions tend to offer a more personalized and supportive environment, which may enhance their appeal for some students. However, the dearth of resources and opportunities in comparison to larger institutions may ultimately limit their overall attractiveness.

In this intricate context, studies have also demonstrated that in regions with a greater number of institutions, there is a heightened level of competition, which can enhance the provision of services and subsidies to attract students (Hoxby, 1997).

Based on the literature, we pose two research questions that this contribution endeavours to address.

RQ1: Based on the regional distribution, which universities are the most attractive? Do mobile university students exhibit differences in terms of gender or degree path preference (e.g., bachelor's, master's, etc.)?

RQ2: To what extent can Ateneo policies that aim to support off-campus students with scholarships, grants, housing, etc., effectively encourage more students to enrol in an Ateneo located in a different region from their home region? Additionally, how does the size of the universities influence this phenomenon?

2. Data and method

This paper employs macro-data from the National Student Register, an administrative database established by Law 170/2003 and implemented by Ministerial Decree 9/2004.

The initial dataset ("students" section of the Register) encompasses the two academic year intervals between 2021- 2022, and 2022- 2023. It includes regional-level data, disaggregated by gender, region of origin, region of destination, and degree program chosen.

The second dataset was derived from the "contributions and interventions" section of the National Student Registry and pertains to the number of interventions conducted by universities during the 2022-23 academic year.

A specific Attractiveness Index was constructed to observe interregional student mobility in Italy. The Attractiveness Index (AI_i) provides a measure of the proportion of off-campus students who enrol in a specific Italian region in comparison to the total number of students enrolled[2] in all Italian regions.

$$AI_i = \frac{N_{os\_i}}{\sum_{j=1}^{n} N_{os\_j}} \, x \, 100 \; (i = 1,2,3 \dots, n = 20); (j = 1,2,3 \dots, n = 20)$$

The location of the institution is as follows: the term *N_(os_i)* represents the number of off-site students enrolled in region *i*. The sum of the total number of students enrolled in each region (both local and off-site) is represented by $\sum_{j=1}^{n} N_{os\_j}$.

A linear regression model (Ordinary Least Squares) was estimated to investigate the impact of Athenaeum initiatives on the appeal of regions with regard to the number of off-site students enrolled. The model correlates the indicator of regional attractiveness with the university's interventions and size in terms of capacity. The dependent variable of the model is the Attractiveness Index and it includes several independent variables related to the number of students who benefit from interventions enrolled in first- and second-level degree programs, aggregated by type of Athenaeum intervention and the size of the Athenaeums.

The formula for a linear regression model (OLS) can be expressed as follows:

$$AI_i = \beta_0 + \beta_1 \cdot UP + \beta_2 \cdot US + \epsilon$$

where the indicator AI_i is used to quantify the relative attractiveness of regions. *UP* represents the impact of university interventions, specifically policies enacted by the institution. *US* represents the size in terms of capacity. β_0 is the intercept of the model, and *β₁* and *β₂* are the regression coefficients. The term ε represents the error term.

Next, we included fixed effects to the model using Italian geographical macro-areas (North, Centre, and South-Islands). The categories of the macro-area are included as dummy variables to account for any systematic variations in the dependent variable (AI) across macro-areas. Reference formula can be expressed as follows:

$$AI_i = \beta_0 + \beta_1 \cdot n104 + \beta_2 \cdot n101 + \beta_3 \cdot n81 + \beta_4 \cdot n94 + \beta_5 \cdot n92 + \beta_6 \cdot mega + \beta_7 \cdot big + \beta_8 \cdot medium + \beta_9 \cdot small + \beta_{10} \cdot nAtenei + \beta_{11} \cdot macro + \epsilon$$

---

[2] Student enrolled in a degree course in academic year t/t+1: a student enrolled in a degree course in academic year t/t+1 on 31/7/t+1.

The variables pertaining to the University's policy interventions in favor of non-resident students are as follows: additional subsidies; soft loans provided by the ICC; part-time collaborative activities; scholarships, except for postgraduate grants, which are reported in the appropriate section; grants for accommodation; allocated accommodation places.

The following variables (treated dichotomously) consider the size[3] of the universities in question: the term *mega university* is used to describe institutions with an enrollment of over 40,000 students. The category *large* encompasses universities with an enrolled number of students between 20,000 and 40,000. A university is considered *medium-sized* if it has an enrolled number of students between 10,000 and 20,000. A university is classified as *small* if its enrolled student population is less than 10,000[4].

3. Results: attractive regions

A review of the Italian regions reveals considerable heterogeneity in the phenomenon of university student mobility (Figure 1a). The data for the 2021-2022 and 2022-2023 academic years indicate that Trentino-Alto Adige has the highest number of out-of-town university students. The Attractiveness Index (AI_i) for these regions is as follows: Molise (62.8%), Emilia-Romagna (48.2%), Lazio (44.5%) (see Figure 1a). These regions are notable for their capacity to attract students from other parts of Italy, which serves to underscore the significance of their educational institutions and the opportunities they provide to students.

Trentino-Alto Adige, which exhibits the highest level of attractiveness, demonstrates a noteworthy capacity to attract students from across the country. Notwithstanding its relatively modest size and population, Molise has an AI of 49%. Emilia-Romagna recorded a 48.2% IA and Lazio 44.5%[5].

The data on the Attractiveness Index (AI_i) at regional level by gender (Figure 1b&c) for the academic years 2021-2022 and 2022-2023 indicates that in the region of Valle d'Aosta, 47.3% of out-of-residence university students are female and 29.3% are male. In Veneto, 32.2% of students attending courses off-campus are female, while 24.1% are male. In Basilicata, 31.4% of students attending courses off-site are female, compared with 19.2% male. These data demonstrate that female students are more likely to be mobile than male students in these regions.

---

[3] For the classification of the size of the universities, the classification used by Center for Social Investment Studies (CENSIS) was considered.

[4] Variables related to the size of the university have been treated as categorical because the original data provide this information this format.

[5] Please refer to CENSIS (Center for Social Investment Studies): Annual reports on the quality of Italian universities and trends in student mobility.

Figure 1 – *Attractiveness Index (AI_i) at the regional level (a), for females (b), and males (c), for the a.y. 2021-'22 to 2022-'23.*
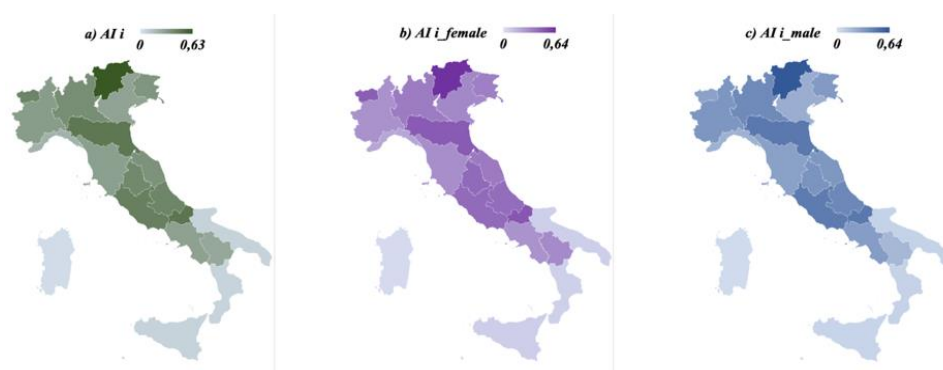
Source: own elaborations based on ANS data.

As shown in Figure 2, most female university students relocate to other regions to pursue master's degree programs, which serves to illustrate a notable trend in academic gender mobility. According to the data, 16.3% of female students relocate to Trentino-Alto Adige, 13.8% to Emilia-Romagna and 13.3% to Veneto to attend master's degree.

The mobility of students pursuing three-year degree courses is more limited and concentrated mainly in Centre Italy, with Lazio registering a significant percentage of 26% (Figure 2a).

Figure 2 – *Attractiveness Index (AI_i) at the regional level by type of degree program for females: (a) Bachelor's degree, (b) Master's degree, (c) Single-cycle Master's degree, for the a.y. 2021-'22 to 2022-'23[6].*

Source: own elaborations based on ANS data.

---

[6] The map regarding the Attractiveness Index of old-school degree programs has been omitted because the data show no significant differences between regions, neither in number of students nor in gender distribution.

Many male university students in Italy relocate to other regions to enrol on three-year degree courses (Figure 3a). This trend in academic mobility is particularly evident in Trentino-Alto Adige (33.9%), Lazio (32.7%) and Emilia-Romagna (26.5%), where the majority of students choose to pursue their degree courses.

Conversely, mobility for master's degrees is constrained and predominantly concentrated in Northern Italy, with Trentino-Alto Adige accounting for a notable proportion of 18.7% (Figure 3b). The mobility of students pursuing single-cycle Master's degrees and degrees from the old system is relatively low and confined to a single region. This may be attributed to the fact that these courses necessitate a long-term commitment, frequently at the same institution, which renders relocation to another region a less viable or appealing option.

Figure 3 – *Attractiveness Index (AI_i) at the regional level by type of degree program for males: (a) Bachelor's degree, (b) Master's degree, (c) Single-cycle Master's degree, for the a.y. 2021-'22 to 2022-'23.*
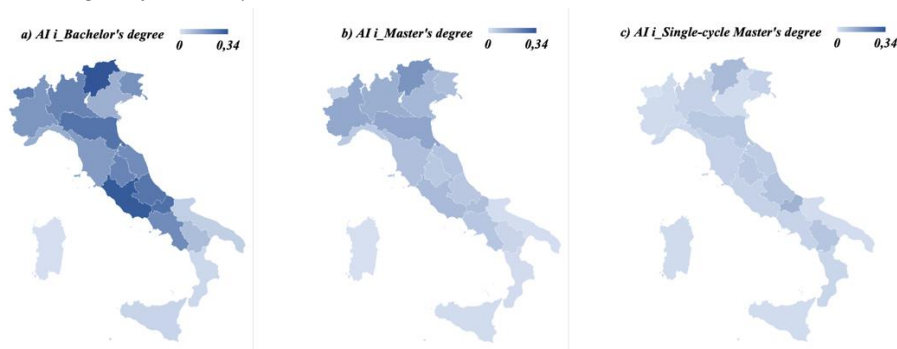

Source: own elaborations based on ANS data.

4. The impact of university policies and size on the attractiveness of Italian regions

The analysis of the data indicates that only a limited number of university interventions were identified as having a significantly positive influence on the mobility of out-of-state students. In particular, the results of the regression model (Table 1, M1) indicates that the effect of the number of other subsidies related to student merit is positive and significant. A one-unit increase in the number of subsidies is associated with an increase in attractiveness, indicating that subsidies enhance the appeal of the university (Hossler et al., 2009). The formation of collaborative relationships with students has been identified as a highly beneficial strategy. A one-unit increase in the number of such relationships is associated with

a 0.004-unit increase in attractiveness, indicating that these partnerships play a pivotal role in enhancing the university's appeal.

The impact of policies linked to forms of contributions, such as subsidised loans granted by credit institutions, the allocation of scholarships, and housing contributions, on the university's attractiveness, is not significant. In fact, these policies have a negative effect on the mobility of students outside their region. Indeed, with regard to accommodation subsidies, an increase of one unit in accommodation subsidies is associated with a decrease in attractiveness of 0.05 units, indicating that accommodation subsidies have a negative impact on the university's attractiveness.

These results prompt the formulation of two categories of Athenaeum policy interventions. The first category of contributions is merit-based or collaborative in nature, requiring the student to engage in certain activities in order to obtain the contribution. The second category of contributions is not merit-based (e.g., baccalaureate grade, average exam grade) or collaborative in nature, but is based on income requirements.

It is notable that most large universities, often referred to as "mega universities", are situated in the northern regions of Italy. The northern and central regions of Italy exhibit a greater variety of universities in terms of size than their southern counterparts and islands. Regions such as Lombardy and Lazio which have larger populations, offer a wide range of academic institutions of all sizes, from small universities to large university centres. Conversely, smaller regions or regions with smaller populations, such as Valle D'Aosta and Molise, demonstrate a very limited presence of mostly small universities.

In terms of the impact of university size on attractiveness, two distinct perspectives exist. One posits that students gravitate towards larger universities due to factors associated with reputation, infrastructure, and career prospects (Hoxby, 2009). The other perspective postulates that the size of universities may be less attractive due to factors linked to a lack of personalised support (Berger and Milem, 2000; Pascarella and Terenzini, 2005).

The regression model shows a significant, negative relationship between the ability to attract out-of-state students and the size of universities, particularly for the categories of large, medium and small universities. This suggests that, compared to mega-universities (the reference category), smaller institutions tend to have lower attractiveness. However, a positive and relevant factor for regional attractiveness seems to be the number of universities present in a region, which appears to have a significant influence on the choice of out-of-town students. This result indicates that a greater overall supply of academic institutions contributes to making a region more competitive in the university landscape (Table 1, M1).

Table 1 – *Results from OLS regression models without (M1) and with macro-area fixed effects (M2) on the attractiveness of Italian regions, for the a.y. 2022-'23.*

AI_i	M1			M2		
	Coef.	Str. Err.	P>t	Coef.	Str. Err.	P>t
-N. Additional subsidies	0.000***	0.000	0.001	0.000***	0.000	0.000
-N. Soft loans provided by the ICC	-0.015***	0.002	0.001	-0.015***	0.003	0.004
-N. Part-time collaborative activities	0.005***	0.000	0.000	0.006***	0.000	0.000
-N. Scholarships	-0.001**	0.000	0.026	-0.001	0.000	0.105
-N. Grants for accommodation	-0.004***	0.001	0.006	-0.004**	0.001	0.019
-N. Allocated accommodation places 92	0.000	0.001	0.565	0.000	0.001	0.805
-Mega	0.219	0.666	0.751	0.344	1.013	0.745
-Large	-2.750***	0.570	0.001	-2.854***	0.707	0.007
-Medium	-2.416***	0.633	0.005	-2.401**	0.721	0.016
-Small	-3.067***	0.599	0.001	-3.219***	0.851	0.009
-Number of universities	1.540***	0.186	0.000	1.505	0.226	0.001
Fixed Effects	NO			YES		
North	-	-	-	-	-	-
Centre	-	-	-	0.341	0.961	0.735
South and Islands	-	-	-	0.270	0.746	0.730
Intercept	1.360*	0.678	0.080	1.372*	0.921	0.187

Source: own elaborations based on ANS data.
Notes: Robust Standard Errors: *** p<0.01, ** p<0.05, * p<0.1.

The inclusion of dummy variables for macro-areas (M2) changed some coefficients compared to the model without fixed effects (M1). Additional subsidies and subsidized loans remain significant, but the negative effect of subsidized loans decreases slightly. Part-time collaborative activities show a slight decrease in the coefficient, suggesting that differences between macro-areas partially influence the positive effect observed in M1. Scholarships are no longer significant in M2, while housing subsidies remain negative (-0.00), but with a lower coefficient than in the initial model.

For university size, the coefficients for large (-2.75 to -2.85), medium (-2.41 to -2.40) and small (-3.06 to -3.21) universities remain negative and significant, but with a slight reduction in magnitude. The number of universities continues to be highly significant (1.54 to 1.50), confirming its importance in regional attractiveness. The macro-area variables are not significant (Center 0.34, South and Islands 0.27), suggesting that, once controlled for other factors, regional differences do not significantly influence attractiveness.

Comparing the two models shows that some variables, such as scholarships and housing subsidies, are affected when controlling for macro-areas, while others, such

as the number of universities or the size of universities, retain their significance regardless of regional differences. This approach allows the direct effects of the variables considered to be more precisely distinguished from the effects due to macroregional inequalities.

5. Final remarks

The impact of policies that facilitate interregional mobility of university students is a significant consideration for universities. Firstly, the mobility of students has an impact on the contribution income of enrolled students and the Ordinary Financing Fund, which is increasingly linked to the standard costs. This effect determines the ability of universities to finance a significant proportion of research and teaching activities. Consequently, it has implications for the positioning of Southern universities in the annual rankings of Italian universities, which influence their reputation, as well as being a valuable resource for attracting new students.

The regions of the Centre-North are perceived as more attractive by both male and female students, particularly those pursuing professionalised courses from the bachelor's degree onwards.

The scientific literature, as discussed in the introductory paragraph, provides a context and theoretical support for the results observed both through the attractiveness index and in the regression model. This confirms that only some of the independent variables, in this specific case of an endogenous nature, actually influence the attractiveness of educational institutions. These are variables linked to interventions aimed at a policy of making students protagonists and not beneficiaries of subsidiary contributions. Furthermore, the size of the university is not a relevant factor of attractiveness.

The university's policies, which are designed to provide support to students in the form of scholarships, grants and accommodation, are not aligned with the needs of students who are predisposed to engage in mobility outside of their region. The latter cohort likely responds to a specific profile determined by a range of external variables. Besides, the efficacy of these policies in facilitating access to higher education is questionable. While they are designed to promote welfare and equal opportunities, they have not had a significant impact on the student population they are intended to serve.

In conclusion, targeted interventions could have a positive effect on student mobility, thereby enhancing the attractiveness of different Italian regions as destinations for higher education. Understanding these elements is crucial to develop effective strategies that can improve the attractiveness of educational institutions, promoting a more balanced distribution of students across the country.

References

ANVUR 2018. Rapporto biennale sullo stato del sistema universitario e della ricerca.

ATTANASIO M., ENEA M. 2020. La mobilità degli studenti universitari nell'ultimo decennio in Italia. In DE SANTIS G., PIRANI E., PORCU M. (Eds), *Rapporto sulla popolazione. L'istruzione in Italia*. Bologna: Il Mulino, 43–58.

ATTANASIO M., PRIULLA A. 2020. Chi rimane e chi se ne va? Un'analisi statistica della mobilità universitaria dal Mezzogiorno d'Italia. In ATTANASIO M., GIAMBALVO O., PORCU M., RAGOZZINI G. (Eds.), *Verso Nord. Le nuove e vecchie rotte delle migrazioni universitarie*, pp. 27–63.

BAUM S., MA J. 2007. *Education Pays: The Benefits of Higher Education for Individuals and Society*. College Board.

BERGER J. B., MILEM J. F. 2000. The Role of Student Involvement and Perceptions of Integration in a Causal Model of Student Persistence, *Research in Higher Education*, Vol. 41, No.6, pp. 641-664.

BRUNO R., GENOVESE D. 2008. La mobilità degli studenti universitari: determinanti e implicazioni, *Rivista di Politica Economica*, Vol. 98, No. 1, pp. 79-110.

BRUNO R., GENOVESE D. 2012. Un modello di gravità per l'analisi della mobilità degli studenti universitari in Italia, *Rivista Italiana degli Economisti*, Vol. 17, No. 2, pp. 211-238.

CIRIACI D., MUSCIO A. 2011. University choice, research quality, and graduate employability: Evidence from Italian national survey data, *Higher Education Quarterly,* Vol. 65, No. 4, pp. 365-389.

CNVSU 2011. *Decimo rapporto sullo stato del sistema universitario*.

DOTTI N. F., FRATESI U., LENZI C., PERCOCO M. 2013. Local labour markets and human capital in Italy: A spatial analysis, *Regional Studies*, Vol. 47, No. 3, pp. 373-388.

ENEA M., ATTANASIO M. 2019. La mobilità degli studenti universitari italiani: evidenze empiriche e analisi, *Studi di Sociologia*, Vol. 57, No. 1, pp. 81-102.

HOSSLER D., SCHMIT J., VESPER N. 2009. Student College Choice: A Research Overview. In J. C. SMART (Ed.) *Higher Education: Handbook of Theory and Research*, Vol. 24, pp. 231-288. Springer.

HOSSLER D., ZISKIN M., GROSS J.P.K., CEKIC O. 2009. Student Aid and Its Role in Encouraging Persistence. In *Higher Education: Handbook of Theory and Research*, Springer, pp. 389-425

HOXBY C. M. 1997. How the Changing Market Structure of U.S. Higher Education Explains College Tuition. *National Bureau of Economic Research*.

HOXBY C. M. 2009. The Changing Selectivity of American Colleges, *Journal of Economic Perspectives, Vol. 23*, No. 4, pp. 95-118.

IMPICCIATORE R., STROZZA F. 2016. Mobilità degli studenti universitari italiani: un'analisi con dati amministrativi. *IRVAPP 9/2016*.

IMPICCIATORE R. 2017. Migrazioni interne per motivi di studio e di lavoro: un'analisi delle determinanti, *Polis*, Vol. 31, No. 3, pp. 393-424.

IMPICCIATORE R. 2017. Mobilità studentesca e immigrazione: il caso italiano, *Rivista di studi sulla migrazione internazionale*, Vol. 3, pp. 121-135.

ISTAT 2010. I laureati e il mercato del lavoro. Inserimento professionale dei laureati. Indagine 2007. Roma: Collana Informazioni Istat, n. 3.

MARTINI A., ROMANO M. 2017. Student mobility in Italy: Movers and Stayers in the university system, *Italian Journal of Sociology of Education,* Vol. 9, No. 2, pp. 120-145.

ORDINE P., ROSE G. 2007. Student mobility and academic performance: A theoretical model, *Economics of Education Review*, Vol. 26, No. 5, pp. 483-492.

PASCARELLA E. T., TERENZINI P. T. 2005. *How College Affects Students: A Third Decade of Research*. Jossey-Bass.

PIRAS R. 2008. Mobilità studentesca e distanze geografiche in Italia: un'analisi empirica con i dati della Gazzetta Ufficiale. *Economia e Politica Industriale* (3) 123-136.

STROZZA S. 2010. *Mobilità degli studenti universitari in Italia: analisi delle determinanti e implicazioni*. Genova: Franco Angeli.

SVIMEZ 2014. Rapporto sull'economia del Mezzogiorno.

TOBLER W.R. 1970. A computer movie simulating urban growth in the Detroit region, *Economic Geography*, Vol. 46.

VECCHIONE G. 2017. La mobilità dei laureati italiani: caratteristiche e determinanti, *Quaderni di Economia del Lavoro*, Vol. 106, pp. 37-56.

_____

Thaís GARCÍA-PEREIRO, Università degli studi di Bari Aldo Moro, t.garcia.pereiro@uniba.it
Anna PATERNO, Università degli studi di Bari Aldo Moro, anna.paterno@uniba.it
Raffaella RUBINO, Università degli studi di Bari Aldo Moro, raffaella.rubino@uniba.it

DOES DISCUSSING WITH THE SUPERVISOR ENHANCE THE EFFECTS OF TRAINING?

Valentina Ferri, Salvatore Marsiglia, Giuliana Tesauro

Abstract. In Italy, weak economic growth is primarily due to businesses' reluctance to invest, hindering both human and physical capital accumulation, which are key drivers of productivity and innovation. The capitalization of knowledge also contributes to creating virtuous exchanges between trained employees and their supervisors, allowing companies to derive growing benefits.

This study aims to investigate the likelihood of positive changes occurring in firms following training received by workers. Specifically, it examines the probability that the worker will experience positive changes in the company after completing the training course and in particular, it emphasizes the importance of discussing the training path with one's supervisor. To achieve these research objectives, we employ a probit model. The data from the ROLA survey will make it possible to analyse a significant sample of employees trained through Italy's largest interprofessional fund. The survey (conducted by Fondimpresa in collaboration with INAPP) is instrumental in understanding the impact of training funded by Fondimpresa and whether it achieves desired outcomes, such as supporting corporate investments, particularly in innovation and sustainability, and facilitating organizational and process innovation. This contribution demonstrates that discussing training content with the supervisor enhances the multiplier effects of training. The results of the estimates confirm that these effects are more pronounced when discussing training activities with one's supervisor after completing the training program.

1. Introduction and literature review

Organisational structures follow increasingly dynamic development paths to petachieve growth objectives (Hosseini *et al.*, 2018). Technological innovations embedded in the business environment are creating a new workforce increasingly characterised by high knowledge standards.

The most efficient and productive companies have highly engaged employees (Pourbarkhordari *et al.*, 2016). The rapid changes brought about by organizational and technological innovations together require leadership capable of combining traditional management characteristics with growing capabilities for employee involvement, in teams and individually.

The advantage of this approach is confirmed by the existence of a positive association between engaging leadership and employee work engagement[1] (Firouznia *et al.*, 2021). According to widespread literature, modern organisations need increasingly engaged employees. The so-called work engagement is a predictor of a plurality of performance indices: profit and productivity, organisational performance, but also elements related to service quality and customer loyalty (Sarti, 2014). The concept of work engagement is increasingly entering into organisational decision-making processes (Karatepe, Demir, 2014), as the identification of ways to involve workers ensures the realisation of growth paths and goals, thanks to the establishment of a widespread climate of trust (Engelbrecht *et al.*, 2017).

The leadership model based on human resource development is an essential element in improving employee competencies, fostering and supporting creativity and innovation in organisations (Gilley *et al.*, 2011). Developmental leadership is a driver of organisational innovation as it stimulates employee involvement and commitment. Despite the acknowledged importance of these aspects, as highlighted by Firouznia *et al.* (2021), there are still few studies that investigate the processes which enable engaging leaders to create an impact on employee performance and competencies. Bakker and Schaufeli (2008) emphasised the importance of Positive Organisational Behaviour, which helps to stimulate job involvement and career advancement (Luthans, 2002). Involved employees show increased energy in performing work and high levels of concentration (May *et al.*, 2004).

The analysis mentioned above reveals that participative leadership of supervisors is a predictor of "employee vigor and dedication", while instrumental leadership is positively correlated with employee vigor and absorptive capacity, understood as the total ability to concentrate on the task at hand with increased skill involvement. The participative approach implies that companies focus on investments to keep employees engaged and involved (Macey *et al.*, 2008). Furthermore, as stated by Harter *et al.* (2002), there is a positive association between commitment and particular business performance metrics. It examines the relationship between employee satisfaction and commitment and business unit performance, finding significant relationships between the magnitudes considered.

Nevertheless, the nature of many of the relationships between the variables considered remains to be clarified. It is recognised, for example, that engaging leadership plays a crucial role in fostering numerous internal company activities: creating connections between company areas, increasing motivation among work team members, encouraging a culture of continuous training and providing opportunities for skills development (Chaudhary *et al.*, 2018). In particular, employee discussion with leaders about training outcomes is a key engagement and

---

[1] "Work engagement is defined as a positive, fulfilling, work-related state of mind that is characterized by vigor, dedication, and absorption" (Schaufeli *et al.*, 2002).

growth practice within an organisation. Therefore, engaged leaders give employees the opportunity to acquire new skills, increase their authority or responsibility and experience a challenging career (Anthony, 2017).

However, studies have shown that work resources such as peer exchange, confrontation with supervisors and learning opportunities are positively associated with work engagement (Bakker and Demerouti, 2007; Schaufeli and Salanova, 2007). Indeed, adequate and correct feedback facilitates learning and increases work competence (Meijman and Mulder, 1998). In short, work engagement leads to higher work performance and consolidates the results of company training by making them operational, thanks to continuous feedback between workers and managers (Kompier, 2003).

The paper is structured as follows: the next paragraph presents the ROLA (Survey of Worker and Company Opinions) survey from which the data are extracted. The third paragraph presents descriptive statistics, the model used, and estimates with a territorial focus. The fourth paragraph concludes.

2. Data and methodology

The ROLA[2], conducted annually, targets a representative sample of workers who have participated in training courses financed by Fondimpresa[3] and managers who assume the role of training supervisors. ROLA is conducted by Fondimpresa in collaboration with INAPP. The survey is carried out using CAWI methodology. It aims to capture perceptions from the main beneficiaries of training—workers and companies—to assess the effectiveness and utility of training funded by Fondimpresa. ROLA involves online questionnaires completed by both workers and companies. The collected data is aggregated and used to produce the National Evaluative Monitoring Report (Ferri and Iencenelli, 2022; Ferri and Iencenelli, 2024). This survey is instrumental in understanding the impact of training funded by Fondimpresa and whether it achieves desired outcomes, such as supporting corporate investments, particularly in innovation and sustainability, and facilitating organizational and process innovation.

The data we will use in this work pertains to the latest available wave, that of 2022. After explaining in descriptive terms how workers interact with their supervisor to discuss training, we estimate a probit model that is useful for

---

[2] For further details regarding the ROLA survey please refer to Ferri and Iencenelli (2022); Ferri and Iencenelli (2024).

[3] Fondimpresa is a National Interprofessional Joint Fund for Continuing Training, one of the main tools of financing corporate training in Italy.

understanding how discussing with one's supervisor can influence the probability of changes occurring within the company.

3. Descriptive statistics and model estimates

Synergy with manager turns out to be one of the most important aspects in consolidating the effectiveness of corporate training provided to employees (Tab. 1). This is because if the worker is the one who implements the skills acquired through training, the training manager plans the training courses based on the needs of the organization and the staff, to fill any knowledge gaps. In our sample, 46.27% of respondents spoke with the manager before and after training, while almost 19% never spoke, revealing a lack of involvement and strategic vision in management participation. The involvement of the entire class group[4] is quite common (54.35%).

Table 1 − *Discussion between the worker and the supervisor regarding the training path (frequencies and percentage).*

Did you talk to your manager about the training path?	Freq.	Percentage (%)
Yes, before the training to discuss what it would offer	1151.2	14.31
Yes, after training in the application of the new knowledge in the work activity	1676.32	20.84
Yes, both before and after training	3721.54	46.27
No, never	1493.94	18.57
Total	8043	100

Source: Authors' elaboration on ROLA data 2022. Note: Sampling weights applied

It is an important factor because it favors a context of collaborative learning and constructive exchange. In this way, active participation in the teaching process is encouraged, increasing the motivation of individuals (Tab. 2). This is a fundamental process for improving work performance and organizational efficiency.

According to the worker's classification, the data in Table 3 shows a balanced situation regarding the consultation both before training, to share expectations about the added value of the courses to be attended, and afterward for the application phase of the newly acquired knowledge. The noteworthy fact is that a greater share of middle managers (20.17%) declare that they do not share the training phase with their supervisors, who are the top managers. This result is attributable to the role

---

[4] The class groups involved are variable depending on the company, generally there are at least four workers per class. It is assumed that individuals are at the same level of knowledge regarding the subject they are being trained on.

characterized by greater autonomy, including decision-making, often at the forefront of training decisions.

Table 2 − *Involvement of the class group in the training process (frequencies and percentage).*

Class Groups Involvement	Freq.	Percentage (%)
Not at all	175.27	2.18
A little	745.77	9.26
Enough	4375.06	54.35
A lot	2753.90	34.21
Total	8050	100

Source: Authors' elaboration on ROLA data 2022. Note: Sampling weights applied.

Table 3 − *Discussion with the supervisor regarding the training path based on Job Classification (frequencies and percentage).*

Job classification	Yes, before the training	Yes, after training	Yes, both before and after training	No, never	Total
Workman	242.07	409.89	968.04	363.45	1983.45
	12.20	20.67	48.81	18.32	100
Office worker	787.09	1062.52	2323.43	939.42	5112.45
	15.40	20.78	45.45	18.38	100
Middle management	122.04	203.92	430.07	191.07	947.10
	12.89	21.53	45.41	20.17	100
Total	1151.20	1676.32	3721.54	1493.94	8043
	14.31	20.84	46.27	18.57	100

Source: Authors' elaboration on ROLA data 2022. Note: Sampling weights applied

Analyzing the age groups, it emerges that 20.94% of those over 50 have never spoken with their supervisor about training (Tab. 4). This outcome does not necessarily represent a reluctance to share but it could be quite attributable, among other factors, to a role with greater autonomy or a lower interest in updating skills when nearing retirement.

In any case, dialogue with supervisors should be promoted and supported as it allows for a better understanding of both the company's and individual employees' needs and potential, enabling the customization of training and the evaluation of its planned outcomes.

Table 4 − *Discussion with the supervisor regarding the training path based on worker's age (frequencies and percentage).*

Age groups	Yes, before the training	Yes, after training	Yes, both before and after training	No, never	Total
Under 30	73.99	120.78	272.91	95.22	562.90
%	13.14	21.46	48.48	16.92	100
From 30 to 50	696.27	1050.51	2254.76	847.77	4849.30
%	14.36	21.66	46.50	17.48	100
Over 50	380.94	505.04	1193.88	550.94	2630.80
%	14.48	19.20	45.38	20.94	100
Total	1151.20	1676.32	3721.54	1493.94	8043
%	14.31	20.84	46.27	18.57	100

Source: Authors' elaboration on ROLA data 2022. Note: Sampling weights applied

The territorial analysis reveals that in Southern Italy, compared to other macro-regions of the country, there is greater sharing of training outcomes both before and after the training activity (Tab. 5). This can be largely attributed to the organizational structure of Southern Italian companies, which is more hierarchical and personal, characterized by the direct and continuous involvement of supervisors in the daily interaction with employees to align their skills with the final objectives.

Table 5 − *Discussion with the supervisor regarding the training path by geographic area (frequencies and percentage).*

Geographic Area	Yes, before the training	Yes, after training	Yes, both before and after training	No, never	Total
North	730.31	1085.15	2141.37	866.61	4823.44
	15.14	22.50	44.40	17.97	100
Centre	177.96	316.03	576.54	341.99	1412.51
	12.60	22.37	40.82	24.21	100
South	242.92	275.15	1003.64	285.34	1807.05
	13.44	15.23	55.54	15.79	100
Total	1151.20	1676.32	3721.54	1493.94	8043
	14.31	20.84	46.27	18.57	100

Source: Authors' elaboration on ROLA data 2022. Note: Sampling weights applied

Shifting the focus to the productive sectors, it is noted that in the construction industry, over 50% of respondents have spoken with their supervisor about training both before and after the courses. This percentage is nearly matched in the healthcare

sector (49.15%). It is worth highlighting that almost 27% of respondents in the transportation sector did not share their training experiences with their supervisor at all (Tab. 6).

Table 6 − *Discussion with the supervisor regarding the training path by economic sector (frequencies and percentage).*

Economic sector (ateco)	Yes, before the training	Yes, after training	Yes, both before and after training	No, never	Total
Industrial manufacturing	303.23	518.52	1151.30	479.68	2452.72
	12.36	21.14	46.94	19.56	100
Other manufacturing	275.67	307.31	767.92	209.04	1559.95
	17.67	19.70	49.23	13.40	100
Construction and other non-manufacturing enterprises.	78.10	94.55	227.27	46.74	447.55
	17.65	21.13	50.78	10.44	100
Trade, hotels and restaurants	105.61	182.68	436.62	125.61	850.52
	12.42	21.48	51.34	14.77	100
Business Services	135.82	211.60	444.22	234.87	1026.52
	13.23	20.61	43.27	22.88	100
Healthcare	123.52	82.25	296.20	100.66	602.63
	20.50	13.65	49.15	16.70	100
Transportation, storage and comunication	112.64	255.76	395.89	288.25	1052.54
	10.70	24.30	37.61	27.39	100
Production and distribution of electricity, gas and water	15.70	23.66	2.11	9.10	50.57
	31.05	46.79	4.17	17.99	100
Total	1151.20	1676.32	3721.54	1493.94	8043
	14.31	20.84	46.27	18.57	100

Source: Authors' elaboration on ROLA data 2022. Note: Sampling weights applied

As already introduced, a probit model was used for the analysis. The response variable of the model is 'Did the employee perceive the presence of at least one (positive) change in the company after the training process?'. The response variable

is binary, equal to 1 when the individual perceives changes, and 0 otherwise. Among the trained workers, 81.68% reported having noticed at least one change in the company, while 18.32% did not notice any change. The empirical results from the probit[5] model in Table 7 show that talking to one's supervisor after the course increases the probability of positive changes[6] occurring for the employee[7].

Specifically, these changes are organizational, with an increase of 25 p.p.. Training plays a central role in these organizational changes, contributing in various ways to facilitate transitions and support new company initiatives aimed at optimizing production times and methods. Consequently, these organizational changes are fundamental to increasing company competitiveness and adapting to market conditions.

Furthermore (Table 7), the variable concerning the alignment of training content with company needs is also statistically significant; indeed, the more training meets the company's needs, the more it is associated with changes within the company (17.7 p.p.).

It is important to note that the variable related to the duration of training courses is also significant. The greater the number of hours in the courses completed, the more likely company changes are to occur (+0.14 p.p.). A female employee decreases the probability of change in the company (2.8 p.p.). The number of the training course hours increases the probability of changes occurring in the company (0.1 p.p.). Moreover, being an employee of a medium-sized company decreases the

---

[5] The probit model is a type of regression used to model binary outcome variables. It assumes that the probability of the outcome is linked to the predictors through the cumulative distribution function (CDF) of the standard normal distribution (Categorical Data Analysis 3rd Edition by Alan Agresti). STATA software was used for the analyses.

[6] In the ROLA survey the company changes considered are: Reduction of hierarchical levels; Increased sharing of data and information between different company areas; Greater participation in process/product innovation processes; Expansion of the contents of work positions, greater discretion and decision-making autonomy, greater participation in planning and control processes; Adoption of approaches such as Lean Manufacturing, Six Sigma, Agile, Total Quality Management, World Class Manufacturing etc.; Greater diffusion of the culture of safety at work and/or its application; Greater understanding and communication in a foreign language and improvement of dialogue with colleagues, suppliers and foreign customers; Greater awareness and effectiveness of activities that fall within the scope of circularity and environmental sustainability; Greater efficiency in the use of new operating/management systems; Improvement of processes and procedures related to quality system; Increase in levels of automation and/or digitalisation of processes (also through the use of applications for data analysis); Improvement of production activities (e.g.: welding, packaging, etc.)

[7] In the probit model, the values described are marginal effects, which indicate the change in the probability of the outcome for a one-unit change in the independent variable, expressed in percentage points (p.p.). It is important to note that if the independent variable is a proportion or a categorical variable (including dummy variables), the interpretation of the marginal effects will differ.

probability of changes in the company (-4.2 p.p.) compared to employees of smaller companies.

Table 7 − *Probability of encountering changes in the company (beta coefficients, and standard errors in brackets).*

Variables	Company Changes
	b/se
Yes, before the training to discuss what it would offer (vs. No never)	0.1534***
	[0.0323]
Yes, after training in the application of the new knowledge in the work activity (vs. No never)	0.2531***
	[0.0259]
Yes, both before and after training (vs. No never)	0.2059***
	[0.0258]
Women	-0.0283*
	[0.0155]
Involvement of Class Groups, a little (vs. Not at all)	-0.0194
	[0.0649]
Involvement of Class Groups enough (vs Not at all)	0.0924
	[0.0586]
Involvement Class groups a lot (vs. not at all)	0.0815
	[0.0598]
Contents in line with company requirements, a little (vs. Not at all)	-0.0645
	[0.0972]
Contents in line with company requirements, enough (vs. Not at all)	0.1342
	[0.0940]
Contents in line with company requirements, a lot (vs. Not at all)	0.1777*
	[0.0950]
Training Course hours	0.0014***
	[0.0004]
Employees (50 to 249) (vs. up to 49)	-0.0419**
	[0.0174]
Employees (Over 250) (vs. up to 49)	-0.0058
	[0.0204]

Source: Authors' elaboration on ROLA data 2022.
Other variables included in the model: Educational qualification (secondary school diploma, Diploma, Bachelor's degree);Age; ATECO Code; Geographic Area (North, Centre,South); Contract classification; Econimic Sectors
Note: Statistical significance: *** at 1%, ** at 5% and * at 10%. Sampling weights applied. The total number of observations is 7,974.

4. Conclusions

The study provides a picture of the importance of leardership in employee involvement within organisations and in corporate relations. The organisational change requires leadership that is able to combine traditional management characteristics with increased employee engagement skills, in teams and individually. There is, therefore, a positive association between engaging leadership and the work engagement shown by employees (Firouznia *et al.*, 2021).

Our research confirms what is already widely shared in the literature about the importance of the continuous confrontation between the functional organisational manager and the human resource he or she employs, both in identifying the training course necessary to increase performance and in enhancing the effect of the training administered to also bring about a possible change in job description. The greater the synergy, the more significantly the course increases the likelihood of changes in firms. The positive effect generated by making people more involved in achieving the company target has a significant impact on learning levels. As is widely confirmed in the literature, "development leadership" is a driver of organisational innovation as it stimulates employee involvement and commitment. Confrontation with managers enables employees to experience sustainable employability through the delegation of challenging tasks that increase the sense of belonging and self-efficacy (Schaufeli, 2015). In conclusion, training programs improve employees' skills and facilitate the implementation of innovations within the company. Our study shows that the benefits of such programs increase when the training results are shared with the manager.

References

AGRESTI A. 2012. *Categorical data analysis*, Vol. 792. John Wiley & Sons.

ANTHONY E.L. 2017. The impact of leadership coaching on leadership behaviors, *Journal of Management Development*, Vol. 36, No. 7, pp.930–939.

BAKKER A.B., SCHAUFELI W.B. 2008. Positive organizational behavior: engaged employees in flourishing organizations, *Journal of Organizational Behavior*, Vol. 29, pp. 147-54.

BAKKER A.B., DEMEROUTI E. 2007. The job demands-resources model: state of the art, *Journal of Managerial Psychology*, Vol. 22, No. 3, pp.309–328.

CHAUDHARY R., AKHOURI A. 2018. CSR attributions, work engagement and creativity: examining the role of authentic leadership, *Academy of Management Proceedings*, Vol. 2018, No. 1, p.16800, Academy of Management, Briarcliff Manor, NY 10510.

ENGELBRECHT A.S., HEINE G., MAHEMBE B. 2017. *Integrity, ethical leadership, trust and workengagement,* Leadership & Organization Development Journal, Vol. 38, No. 3, pp. 368–379.

FERRI V., IENCENELLI N. 2024. *La sfida della formazione in azienda nell'era delle twin transition*, FONDIMPRESA INAPP.

FERRI V., IENCENELLI N. 2022. *Formazione continua, innovazione e cambiamenti*, FONDIMPRESA INAPP.

FIROUZNIA M., ALLAMEH S. M., HOSSEINI S H. 2021. Engaging leadership, engaging environment, engaging job, and engagement, *International Journal of Process Management and Benchmarking*, January 2021, DOI: 10.1504/IJPMB.2021.113740.

GILLEY J.W., SHELTON P.M., GILLEY A. 2011. Developmental leadership: a new perspective forhuman resource development, *Advances in Developing Human Resources* , Vol. 13, No. 3,pp. 386–405.

HARTER J.K., SCHMIDT F.L., HAYES T.L. 2002. Business-unit-level relationship between employee satisfaction, employee engagement, and business outcomes: a meta-analysis, *Journal of Applied Psychology*, Vol. 87, No. 2, p.268.

HOSSEINI A. S., SOLTANI S., MEHDIZADEH M. 2018. Competitive Advantage and Its Impact on New Product Development Strategy (Case Study: Toos Nirro Technical Firm), *Journal of Open Innovation Technology Market and Complexity*, May 2018.

KARATEPE O.M., DEMIR E. 2014. Linking core self-evaluations and work engagement to work-family facilitation: A study in the hotel industry, *International Journal of Contemporary Hospitality Management* Vol.26, No. 2.

KOMPIER M. 2003. Job design and well-being, in SCHABRACQ, M.J., WINNUBST, J.A.M. AND COOPER, C.L. (Eds), *The Handbook of Work and Health Psychology*, 2nd ed., Wiley, Chichester, pp. 429-54.

LUTHANS F. 2002. Positive organizational behavior: developing and managing psychological strengths, *Academy of Management Executive*, Vol. 16, pp. 57-72

MACEY W.H., SCHNEIDER B. 2008. The meaning of employee engagement, *Industrial and Organizational Psychology*, Vol. 1, No. 1, pp. 3–30.

MEIJMAN T.F., MULDER G. 1998. Psychological aspects of workload, in DRENTH, P.J.D. AND THIERRY, H. (Eds), *Handbook of Work and Organizational Psychology,* Vol. 2, Psychology Press, Hove, pp. 5-33.

MAY D.R., GILSON R.L., HARTER L.M. 2004. The psychological conditions of meaningfulness, safety and availability and the engagement of the human spirit at work, *Journal of Occupational and Organizational Psychology*, Vol. 77, pp. 11-37.

POURBARKHORDARI A., ZHOU E. H. I., POURKARIMI J. 2016. How Individual-focused Transformational Leadership Enhances Its Influence on Job

Performance through Employee Work Engagement, *International Journal of Business and Management* , January 2016.

SARTI, D. 2014. Leadership styles to engage employees: evidence from humanservice organizations in Italy, *Journal of Workplace Learning*, Vol. 26, Nos. 3/4, pp.202–216.

SCHAUFELI W. B., SALANOVA M., GONZÀLEZ-ROMÀ V., BAKKER A. B. 2002. *The Measurement of E-ngagement and Burnout: A Two Sample Confirmatory Factor Analytic Approach*. Journal of Happiness Studies, Vol. 3, No. 1, pp. 71-92, January, 2002.

SCHAUFELI W.B. 2015. *Engaging leadership in the job demands-resources model*, Career Development International, Vol. 20, No. 5, pp.446–463.

SCHAUFELI W.B., SALANOVA M. 2007. *Work engagement: an emerging psychological concept and its implications for organizations*, in GILLILAND, S.W., STEINER D.D., SKARLICKI D.P. (Eds), *Research in Social Issues in Management: Managing Social and Ethical Issues in Organizations*, Vol. 5, Information Age Publishers, Greenwich, CT.

_____

Valentina FERRI, National Institute for Public Policy Analysis (INAPP), v.ferri@inapp.gov.it

Salvatore MARSIGLIA, National Institute for Public Policy Analysis (INAPP), s.marsiglia@inapp.gov.it

Giuliana TESAURO, National Institute for Public Policy Analysis (INAPP), g.tesauro@inapp.gov.it

SPATIAL CORRELATION BETWEEN CLIMATE CHANGE AND ECONOMIC GROWTH IN EU

Vincenzo Marinello, Rossella Maria Pia Di Rocco, Alessandro Indelicato,
Juan Carlos Martín

Abstract. Over the past decade, Europe has faced significant challenges due to the increase in net greenhouse gas emissions and the resulting economic losses associated with climate change. This article focuses on a detailed analysis of the trends in such emissions, the economic losses incurred, and the impact of adopted environmental taxation policies. Utilizing data from Eurostat spanning from 2013 to 2021, our study aims to explore the interconnections among these factors, evaluate the effectiveness of implemented fiscal policies in mitigating these impacts, and examine their spatial distribution. Through the application of the Moran's Index, we examined the presence of spatial autocorrelation in the data to identify any significant geographic patterns. Results reveal that there has been a slight decrease in net greenhouse gas emissions across Europe from 2013 to 2021, thanks the efforts to curb them also through environmental taxation policies. The analysis indicates that while environmental taxation policies have been implemented, their effectiveness in reducing emissions and mitigating economic losses varies across regions. Some areas have seen more success in curbing emissions and minimizing economic impacts compared to others.

1. Introduction

The industrial revolution at the beginning of the 20th century led to an increase in global average temperature (Leggett, 2007). Today, rapid climate change is an urgent concern (Tashilova *et al*., 2019). Over the past 200 years, human activities have played a critical role in global warming through the greenhouse effect (Alirezaei *et al*., 2017), with emissions of gases such as carbon dioxide, methane and nitrous oxide resulting from high levels of industrial and economic production (Albergel *et al*., 2010), population growth, deforestation, globalisation, economic expansion and consumption of manufactured goods (Chen *et al*., 2015; Cloy *et al*., 2017). Extreme weather events such as hurricanes, floods, droughts and heatwaves are becoming more frequent and intense (Stott, 2016). The economic impacts of climate change are significant, with predominantly negative effects (Tol, 2009). Extreme events such as hurricanes and droughts damage infrastructure, agriculture, and buildings, resulting in substantial economic losses for governments, businesses, and individuals. In agriculture, reduced productivity decreases food availability, driving up prices and causing economic and social instability (Su and Wen, 2023).

The analysis of per capita income and temperature suggests that climate can contribute to poverty (Masters and McMillan, 2001; Van Kooten, 2004). Low-income countries, already vulnerable, could suffer greater economic damage due to rising temperatures (Dell *et al*., 2008). Reducing greenhouse gas emissions is crucial to mitigating these impacts (Zheng *et al*., 2019), becoming a priority on every country's political agenda. To this end, governments are adopting strategic and concerted policies aimed at environmental sustainability and climate resilience. The OECD recommends the use of fiscal mechanisms to protect the environment, which may include the introduction of new taxes, the restructuring of existing taxes or the reform of legislation to remove subsidies for environmentally harmful activities (Barde, 1999). In this context, environmental taxes play a fundamental role in implementing the concept of sustainable development (Wang *et al*., 2022).

This analysis aims to extend academic literature by exploring the links between increases in net greenhouse gas emissions, economic losses due to climate change and the effectiveness of fiscal policies. Specifically, it investigates spatial autocorrelation in the data and evaluates environmental fiscal policies in mitigating economic impacts in Europe. The document includes the sections: "Data," "Methodology," "Results," and, the final section, "Discussion and Conclusions" provides an in-depth analysis of the results and the conclusions drawn from the study.

2. Data

The study uses the Eurostat time series from 2013 to 2021 to analyse greenhouse gases, energy taxes and climate-related economic losses. This dataset contains a total of 262 observations, including data on emissions of a range of greenhouse gases, measured in CO_2 equivalents to allow a standardised comparison of their impact on global warming. In addition to emissions data, the study also examines energy taxes, which are key fiscal instruments used by governments to incentivise reductions in fossil fuel use and promote cleaner energy alternatives (Qadir *et al*., 2021). By analysing energy tax data, the study aims to understand how these fiscal mechanisms have been applied in different countries and to assess their effectiveness in reducing greenhouse gas emissions. The study focuses on 29 European countries (Austria, Belgium, Bulgaria, Croatia, Cyprus, Czech Republic, Denmark, Estonia, Finland, France, Germany, Greece, Hungary, Iceland, Ireland, Italy, Latvia, Lithuania, Malta, Netherlands, Norway, Poland, Portugal, Romania, Slovakia, Slovenia, Spain, Sweden, Switzerland), which provides a robust context to explore the linkages between these factors, to assess the effectiveness of the fiscal policies implemented in mitigating these impacts, and to understand the broader economic implications of climate change (Adger *et al*., 2011; Klein *et al*., 2005). This geographical scope includes countries with varying levels of industrialization, energy use, and climate

policies, providing a comprehensive view of European climate policies. The study also examines climate-related economic losses, including costs from extreme events and long-term changes. By correlating these losses with emissions and energy tax policies, the analysis aims to understand how current policies are mitigating the economic damages of climate change.

3. Methodology

Once having selected the indicators of Greenhouse gases (GHG), Energy taxes, and Climate related economic losses, we analyse whether these indicators exhibit spatial correlation. This involves determining if two or more geographic units (countries) are spatially correlated. In line with the study's aim, we subsequently examine the spatial influence of Energy taxes and Climate related economic losses on climate-related economic losses by establishing a Spatial Autoregressive Regression Model.

The theory of spatial correlation has evolved from the necessity to compare geographical units and maps, along with the understanding that georeferenced observations tend not to be independent of each other (Griffith, 2021). Unlike unidirectional temporal correlation, spatial autocorrelation requires identifying correlations in all geographical directions, making the study of this phenomenon particularly complex (Wagner and Fortin, 2005). Nonetheless, the procedures for studying spatial autocorrelation share many similarities with those used for temporal autocorrelation, such as identifying outliers, trends (temporal/spatial) (Fallah Ghalhari and Dadashi Roudbari, 2018), degrees of association, statistical significance, and relevant models.

A fundamental contribution by statistician Moran (1948) was to delineate the mathematical characteristics of spatial autocorrelation, initially referred to as the "contiguity ratio." Moran developed join count statistics based on the probability that neighbouring spatial units were of the same type more often than expected by chance. The Moran's Index, which measures spatial autocorrelation, can be formalized as follows:

$$I = \frac{n}{\sum_{i=1}^{n} \sum_{j=1}^{n} w_{ij}(x_i - \tilde{x})(x_j - \tilde{x})}$$

where n is the number of spatial units, x_i and x_j are values of the variable being analyzed for spatial units i and j, respectively, $\tilde{x}$ is the mean of the variable, and w_{ij} is the spatial weight between spatial units i and j. The p-value indicates the significance of Moran's I statistic.

Spatial Autoregressive (SAR) models are commonly employed in various fields such as geography (Dong and Harris, 2015) or economics (Bekti *et al*., 2014) to

analyse spatial relationships and make predictions based on spatially correlated data. SAR models aim to estimate spatial regression coefficients and generate values at spatial sites. By leveraging information from neighbouring locations, SAR models enhance the accuracy of estimations by smoothing observed data (Thorson, 2019).

Let Y be the dependent variable used to model observations. The spatial regression framework can be expressed as:

$$Y = \rho WLY + X\beta + \varepsilon$$

or adopting the notation of the variables used in this study:

$$C - rel_i = \rho WLC - rel + \text{GHG}\beta_1 + Energy\ taxes\beta_2 + \varepsilon$$

where ρ is the spatial autoregressive parameter, W represents the matrix of weights, $C - rel$ identifies the climate-related economic losses of neighboring areas, and GHG and Energy taxes are the climate change indicators (independent variables). β_1 and β_2 are the coefficients, and ε is the error term.

4. Results

In this section, thematic choropleth maps (Figure 1, 2, and 3) are presented, using a colour scale to represent the variation of our three variables of interest between 2013 and 2021 across European countries. This visualization technique is employed to display quantitative data and their spatial distribution, aiding in understanding the geographical and temporal differences among the various states. Figure 1 illustrates the variation and spatial distribution of net greenhouse gas emissions. Between 2013 and 2017, there was a modest decrease in net greenhouse gas emissions in some countries such as Germany, Belgium, and the Netherlands, while Portugal saw a slight increase. Emissions remained virtually unchanged between 2020 and 2021.

Figure 1 - *Net greenhouse gas emissions between 2013 and 2021.*
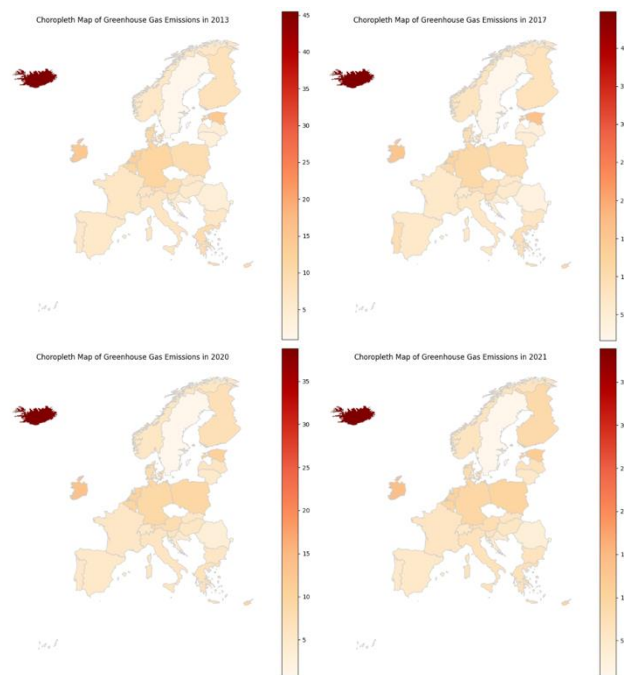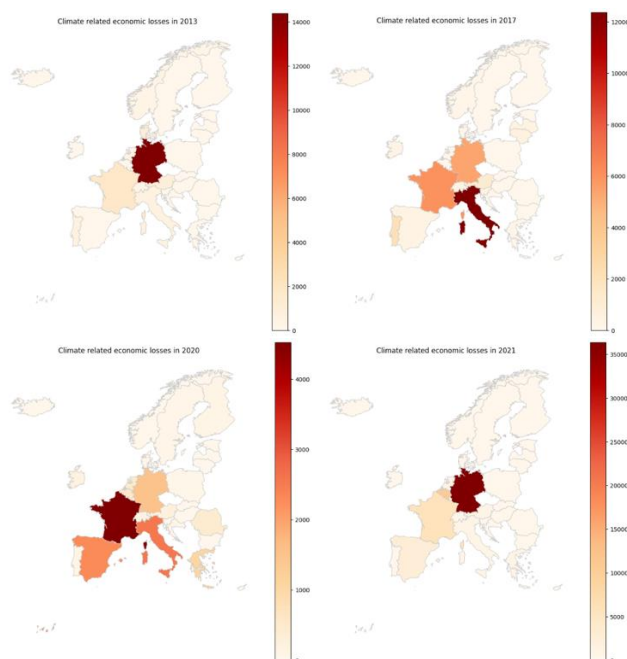

Source: own elaboration.

Figure 2, on the other hand, highlights the changes and geographic distribution of energy taxes, noting that starting from 2013, there was a significant increase in environmental taxation policies in France, while these policies were already widespread in Italy, Germany, and Spain. From 2020 onwards, there has been a slight decrease in these policies in Italy and France, whereas they have remained unchanged in Germany, Spain, Poland, and the Netherlands.

Figure 2 - *Energy taxes between 2013 and 2021.*
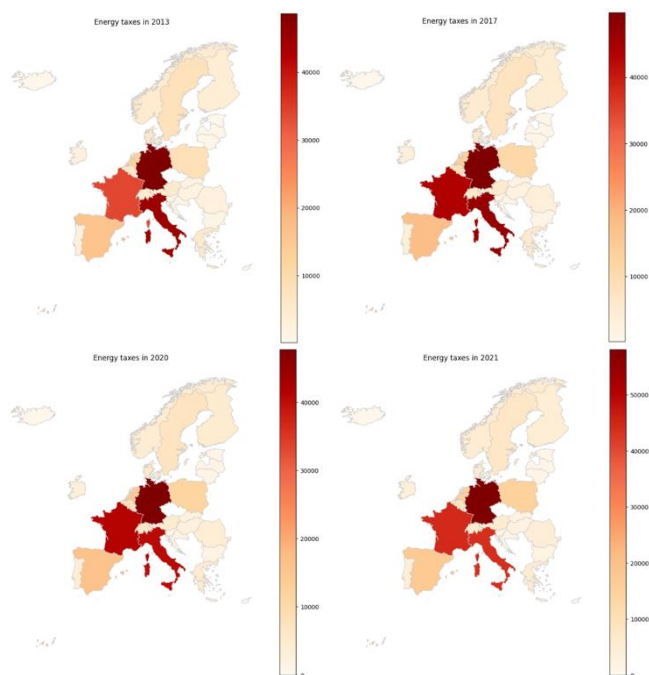
Source: own elaboration.

Figure 3 highlights the economic losses caused by climate change. Between 2013 and 2017, these losses increased in France, Portugal, and especially in Italy, but decreased in Germany. In 2020, losses increased in Spain, France, and Greece, while decreasing in Germany and Italy. However, in 2021, there was a reversal of this trend in Germany, followed by Belgium, while most European countries experienced an overall decrease in total losses.

Figure 3 - *Climate related economic losses between 2013 and 2021.*

Source: Own elaboration.

Additionally, the study reports the p-value associated with the Moran's Index, which measures the statistical significance of calculated spatial autocorrelation (Table 1). In the first row of each variable, the p-value indicates the correlation with neighbors, while the second row shows the corresponding p-value. A p-value less than 0.1 suggests significant spatial autocorrelation, as seen for environmental taxes and economic losses related to climate change, indicating a non-random spatial pattern. On the other hand, a p-value greater than 0.1, as observed for net greenhouse gas emissions, suggests that the variations do not exhibit any particular spatial autocorrelation.

Table 1 - *Moran Index.*

Variable/Year		2013	2014	2015	2016	2017	2018	2019	2020	2021
Greenhouse	coef.	0.07	0.07	0.06	0.05	0.04	0.04	0.06	0.07	0.06
gases	pvalue	0.10	0.12	0.12	0.17	0.21	0.21	0.16	0.12	0.16
Energy taxes	coef.	0.22	0.22	0.25	0.26	0.28	0.29	0.28	0.29	0.26
	pvalue	0.08	0.08	0.05	0.04	0.05	0.05	0.05	0.05	0.05
Climate related	coef.	0.22	0.22	0.25	0.26	0.28	0.29	0.28	0.29	0.26
economic losses	pvalue	0.08	0.08	0.06	0.06	0.05	0.04	0.04	0.05	0.05

Source: own elaboration.

Finally, Table 2 presents the SAR model, an econometric model used to analyse spatial data (Pineda-Ríos *et al*., 2019) and based on the idea that observations in a given area depend on the characteristics of neighboring areas. The model highlights a significant relationship between the economic losses related to climate change in one country and those observed in neighboring countries, as well as between environmental fiscal policies, as shown by statistically significant coefficients with p-values below 0.1. These results suggest that the policies adopted by one country also influence neighboring countries, particularly in the context of climate change.

Table 2 - *SAR Model.*

Variable	Coeff.	p-value
WLClimate related economic losses	-0.202	0.084
CONSTANT	-301.479	0.266
GHG	13.060	0.540
Energy taxes	0.1410	0.000

Source: own elaboration.

The model has an adjusted R-squared of 0.371, indicating that 37.1% of the variability in the data is explained by the model's variables. Although this value is not particularly high, the model effectively captures the relationships between the variables. The Akaike Information Criterion (AIC) is 4780, suggesting a good fit of the model to the data. A lower AIC, when comparing models, would indicate greater effectiveness of the SAR model in representing the data.

5. Discussion and Conclusions

This study highlights significant differences in the geographical distribution of net greenhouse gas emissions, energy taxes and economic losses associated with climate change across European countries. These differences can be understood by analysing the underlying factors that influence the three variables studied. Between 2013 and 2017, Germany, Belgium and the Netherlands experienced a modest reduction in net greenhouse gas emissions, suggesting the effectiveness of the environmental policies implemented or the adoption of cleaner technologies. Previous studies (Clinch *et al*., 2006; Do Valle *et al*., 2012) argue that environmental taxes can generate significant environmental benefits. Albrecht (2002) examined the case of Belgium and showed that environmental subsidies in the transport sector contributed to reduced energy consumption and CO2 emissions. In Germany, GHG emission reductions have been supported by industrial change and a partial shift to cleaner energy sources (Pauliuk and Heeren, 2021). The Federal Climate Change Act sets binding annual emission targets for each sector. However, COVID-19

influenced the results, in some cases helping to meet the targets (Shammugam *et al*., 2022). Overall, net GHG emissions in Europe remained stable between 2020 and 2021, largely due to the economic slowdown caused by the pandemic (Kumar *et al*., 2022).

As highlighted in Figure 2, between 2013 and 2017, France strengthened its environmental tax policy and implemented various fiscal measures aimed at reducing carbon emissions, which proved to be particularly effective (Fiedler and Rihs, 2020). However, the Yellow Vest protests that began in November 2018 against the planned doubling of the carbon tax prompted the government to halt the trajectory of tax increases that had begun in 2014 (Douenne and Fabre, 2020). Figure 3 highlights the increasing economic losses caused by climate change, mainly due to the increasing frequency and intensity of extreme events such as heat waves, floods and storms, which directly affect national economies (Diab *et al*., 2022). In particular, Italy has suffered significant economic damage in critical sectors such as agriculture, with significant production losses, and tourism, due to reduced demand (Galeotti and Roson, 2011). Furthermore, the analysis reveals a pronounced spatial pattern in the relationship between environmental fiscal policies and economic losses related to climate change. This pattern, which is observed in many European countries, is not random. In particular, among the Member States of the European Union (EU), the importance of common environmental policies emerges as essential to address global environmental challenges. Such policies, aimed at promoting sustainable development and enhancing economic competitiveness, play a crucial role in coordinating national responses to environmental issues (Stojanović and Radukić, 2006).

This study analyzed emissions, energy taxation policies, and economic losses related to climate change, assessing the effectiveness of current policies in mitigating these damages. The results highlight the need for coordinated environmental policies at the European level and common strategies, given the geographical interdependence of emissions and measures implemented. However, the limited number of observations in this analysis is a limitation as it may reduce the ability of the model to capture more complex spatial relationships. Future research should extend the analysis to other European countries in order to increase the robustness of the results. In addition, an important area for future research could focus on updating the data to assess the implementation of the European Green Deal and whether this environmental policy plan is effectively contributing to the goal of reducing greenhouse gas emissions by 55% to achieve climate neutrality.

References

ADGER W. N., BROWN K., NELSON D. R., BERKES F., EAKIN H., FOLKE C., GALVIN K., GUNDERSON L., GOULDEN M., O'BRIEN K., RUITENBEEK J., TOMPKINS E. L. 2011. Resilience implications of policy responses to climate change, *Wiley Interdisciplinary Reviews: Climate Change*, Vol. 2, No. 5, pp. 757–766.

ALBERGEL C., CALVET J.-C., GIBELIN A.-L., LAFONT S., ROUJEAN J.-L., BERNE C., TRAULLÉ O., FRITZ, N. 2010. Observed and modelled ecosystem respiration and gross primary production of a grassland in southwestern France, *Biogeosciences*, Vol. 7, No. 5, pp. 1657–1668.

ALBRECHT J. 2002. 11. Technical potential for CO2 emissions reductions and the scope for subsidies1, *Greening the Budget: Budgetary Policies for Environmental Improvement*, Vol. 743: 195.

ALIREZAEI M., ONAT N. C., TATARI O., ABDEL-ATY M. 2017. The climate change-road safety-economy nexus: a system dynamics approach to understanding complex interdependencies, *Systems*, Vol. 5, No. 1, p.6.

BARDE J.-P. 1999. Environmental taxes in oecd countries: an overview. China in the Global Economy Environmental Taxes Recent Developments in China and OECD Countries, *Recent Developments in China and OECD Countries*, Vol. 19.

BEKTI R. D., NURHADIYANTI G., IRWANSYAH E. 2014. Spatial pattern of diarrhea based on regional economic and environment by spatial autoregressive model. In *AIP Conference Proceedings*, Vol. 1621, pp. 454–461.

CHEN Z., YU G., ZHU X., WANG Q., NIU S., HU Z. 2015. Covariation between gross primary production and ecosystem respiration across space and the underlying mechanisms: A global synthesis, *Agricultural and Forest Meteorology*, Vol. 203, pp. 180–190.

CLINCH J. P., DUNNE L., DRESNER S. 2006. Environmental and wider implications of political impediments to environmental tax reform, *Energy Policy*, Vol. 34, No.8, pp. 960–970.

CLOY J. M., SMITH K. A., DELLASALA D. A., GOLDSTEIN M. I. 2017. Greenhouse gas sources and sinks. In *Encyclopedia of the Anthropocene* , Elsevier, pp. 391–400.

DELL M., JONES B. F., OLKEN B. A. 2008. *Climate change and economic growth: Evidence from the last half century*. National Bureau of Economic Research.

DIAB M. Y., KHALIFA M. A., RADY T. A., ABO LABAN A. M. 2022. Proposed framework For The Environmental Tax System To Reduce Environmental Pollution and Contribute To Sustainable Development (Applied study On The Industrial Sector, *Journal of Environmental Science*, Vol. 51, No. 2, pp. 41–88.

DO VALLE P. O., PINTASSILGO P., MATIAS A., ANDRÉ F. 2012. Tourist attitudes towards an accommodation tax earmarked for environmental protection: A survey in the Algarve, *Tourism Management*, Vol. 33, No.6, pp. 1408–1416.

DONG G., HARRIS R. 2015. Spatial Autoregressive Models for Geographically Hierarchical Data Structures. *Geographical Analysis*, Vol. 47, No. 2, pp. 173–191.

DOUENNE T., FABRE A. 2020. French attitudes on climate change, carbon taxation and other climate policies, *Ecological Economics*, Vol. 169: 106496.

FALLAH GHALHARI G., DADASHI ROUDBARI A. 2018. An investigation on thermal patterns in Iran based on spatial autocorrelation, *Theoretical and Applied Climatology*, Vol. 131, Nos. 3–4, pp. 865–876.

FIEDLER A., RIHS T. 2020. Carbon taxation: Comparing France and Switzerland. *Der Öffentliche Sektor*, Vol. 46, No. 2.

GALEOTTI M., ROSON R. 2011. *Economic impacts of climate change in Italy and the Mediterranean: updating the evidence*. Available at SSRN 1935280.

GRIFFITH D. A. 2021. Interpreting Moran Eigenvector Maps with the Getis-Ord Gi* Statistic, *Professional Geographer*, Vol. 73, No. 3, pp. 447–463.

KLEIN R. J. T., SCHIPPER E. L. F., DESSAI S. 2005. Integrating mitigation and adaptation into climate and development policy: Three research questions. *Environmental Science and Policy*, Vol. 8, No. 6, pp. 579–588.

KUMAR A., SINGH P., RAIZADA P., HUSSAIN C. M. 2022. IMPACT of COVID-19 on greenhouse gases emissions: A critical review, *Science of the Total Environment*, Vol. 806: 150349.

LEGGETT J. A. 2007. Climate change: Science and policy implications.

MASTERS W. A., MCMILLAN M. S. 2001. Climate and scale in economic growth. *Journal of Economic Growth*, Vol. 6, pp. 167–186.

MORAN P. A. P. 1948. The Interpretation of Statistical Maps, *Journal of the Royal Statistical Society. Series B (Methodological)*, Vol. 10, No. 2.

PAULIUK S., HEEREN N. 2021. Material efficiency and its contribution to climate change mitigation in Germany: A deep decarbonization scenario analysis until 2060. *Journal of Industrial Ecology*, Vol. 25, No. 2, pp. 479–493.

PINEDA-RÍOS, W., GIRALDO, R., & PORCU, E. 2019. Functional SAR models: With application to spatial econometrics. Spatial Statistics, 29, 145–159.

QADIR S. A., AL-MOTAIRI H., TAHIR F., AL-FAGIH L. 2021. Incentives and strategies for financing the renewable energy transition: A review, *Energy Reports*, Vol. 7, pp. 3590–3606. Elsevier Ltd.

SHAMMUGAM S., SCHLEICH J., SCHLOMANN B., MONTRONE L. 2022. Did Germany reach its 2020 climate targets thanks to the COVID-19 pandemic?, *Climate Policy*, Vol. 22, No. 8, pp. 1069–1083.

STOJANOVIĆ B., RADUKIĆ S. 2006. EU environmental policy and competitiveness, *Panoeconomicus*, Vol. 53, No. 4, pp. 471–485.

STOTT P. 2016. How climate change affects extreme weather events, *Science*, Vol. 352, No. 6293, pp. 1517–1518.

SU N., WEN H. 2023. The Impact of Extreme Weather Events on the Economic Performance. *BCP Business & Management*, Vol. 38, pp. 2703–2709.

TASHILOVA A. A., ASHABOKOV B. A., KESHEVA L. A., TEUNOVA N. V. 2019. Analysis of climate change in the caucasus region: end of the 20th–beginning of the 21st century, *Climate*, Vol. 7, No. 1, p.11.

THORSON J. T. 2019. Guidance for decisions using the Vector Autoregressive Spatio-Temporal (VAST) package in stock, ecosystem, habitat and climate assessments, *Fisheries Research*, Vol. 210, pp. 143–161.

TOL R. S. J. 2009. The economic effects of climate change. *Journal of Economic Perspectives*, Vol. 23, No. 2, pp. 29–51.

VAN KOOTEN G. C. 2004. *Climate change economics: Why international accords fail.* Edward Elgar Publishing.

WAGNER H. H., FORTIN M. J. 2005. Spatial analysis of landscapes: Concepts and statistics, *Ecology*, Vol. 86, No. 8, pp. 1975–1987. Ecological Society of America. https://doi.org/10.1890/04-0914

WANG X., KHURSHID A., QAYYUM S., CALIN A. C. 2022. The role of green innovations, environmental policies and carbon taxes in achieving the sustainable development goals of carbon neutrality, *Environmental Science and Pollution Research*, pp. 1–15.

ZHENG X., STREIMIKIENE D., BALEZENTIS T., MARDANI A., CAVALLARO F., LIAO H. 2019. A review of greenhouse gas emission profiles, dynamics, and climate change mitigation efforts across the key climate change players, *Journal of Cleaner Production*, Vol. 234, pp. 1113–1133.

_____

Vincenzo MARINELLO, Università degli Studi di Enna Kore (Italy), vincenzo.marinello@unikore.it

Rossella Maria Pia DI ROCCO, Università degli Studi di Enna Kore (Italy), rossellamariapia.dirocco@unikorestudent.it

Alessandro INDELICATO, University of Eastern Finland (Finland), alessandro.indelicato@ULPGC.ES

Juan Carlos MARTÍN, Universidad de Las Palmas de Gran Canaria (Spain), jcarlos.martin@ulpgc.es

BURDEN ANALYSIS FOR SHORT-TERM BUSINESS SURVEYS RESPONDENTS[1]

Silvia Binci, Katia Bontempi, Claudio Ceccarelli, Francesca Monetti,
Francesca Rossetti

Abstract. Short-term business statistics are produced by the Italian National Institute of Statistics (ISTAT) and governed by specific European regulations which outline the structure of questionnaires and surveys, the scope of observation, the reference population, the sampling methodology and the precision of the estimates.

The Italian productive sector, characterized by a fragmentation of enterprises in terms of size, along with the sampling strategies mandated by European regulations, results in the participation of specific business types, notably medium and large enterprises, in most of the surveys conducted by ISTAT.

This work analyses the burden on respondents and their behaviour over time by assessing the profiles of respondents and non-respondents. The objective, using survival analysis methods, is to identify the factors contributing to the permanent exit of respondents from surveys, and particularly to measure the extent of this withdrawal. This involves analysing the duration of cooperation between respondent units and ISTAT.

The data analysed come from the *The Business Statistical Portal*, i.e. the system that collectively manages all short-term business surveys. The information used in the study covers all the survey units involved in short term business surveys in the period 2016 to 2023.

1. Introduction

Short-term business statistics (STS) are subject to specific European regulations that outline the structure of questionnaires and surveys, the scope of observation, the reference population, the sampling methodology and the precision of the estimates.

In the context of enterprises, particularly within the Italian production sector characterized by the prevalence of small businesses, regulatory criteria and constraints necessitate the consistent inclusion of large enterprises in samples across multiple surveys over time.

The aim of this work is to analyse the burden on respondents and their behaviour over time by assessing the profiles of respondents and non-respondents.

---

[1] The article was only possible thanks to the joint work of the authors. In particular, Claudio Ceccarelli wrote section 1 and 6, Silvia Binci wrote section 2, Francesca Monetti wrote section 3, Francesca Rossetti wrote section 4 and Katia Bontempi wrote sections 5.

The information used in the study, appropriately normalised and standardised, covers all the survey units involved in short term business surveys in the period 2016 to 2023 and is organised in a single database.

Our purpose, using survival analysis methods, is to identify the factors contributing to the permanent exit of respondents from surveys and to analyse the extent and the duration of cooperation between respondent units and Italian National Institute of Statistics (ISTAT).

Section 2 gives a description of the purpose of "The Business Statistical Portal" and outlines the information collected. Section 3 describes the characteristics of the short-term business surveys on which the survival analysis is applied. Section 4 describes the method on which the work is based. Section 5 contains the main results and Section 6 presents the main conclusions.

2. 'The Business Statistical Portal': the system that manages all short-term business surveys collectively

In October 2010, following a Memorandum of Understanding signed in May 2010 between ISTAT, the National Ministry for Public Administration and Innovation and the Italian Union of Chambers of Commerce (Unioncamere), ISTAT started a project for the development of a platform dedicated to the acquisition of statistical information from enterprises. It resulted in the implementation of a comprehensive innovative tool, aimed at the integration and standardization of data collection processes both internally and externally (companies that provide statistical information): the Business Statistical Portal (BSP). It is an attempt to streamline the organization and management of business surveys as a whole in order to reduce the respondent burden, increase both ordinary and extraordinary communications on survey events and activities, and standardize and harmonize data collection procedures to increase process efficiency (Fazio et al. 2013).

The BSP is composed of a front-end and a back-office. The front-end is "enterprise-centred" with its main features being, for example, a single sign-on and single point of access to all the questionnaires with unique credentials; a delegation system to manage in a flexible way the assignment of the questionnaires to the appropriate contacts; a specific section dedicated to news about the conduct of the surveys (start, closure, extraordinary events, extensions and technical problems); and a status of obligations, a complete and updated framework of all the statistical activities required by each company and of the status of fulfilment of each questionnaire. The back-office supports all the users participating in the survey network: survey managers, interviewers, data analysts, representatives of administrative registers, supervisors, data reviewers and help desk operators. It

enables an integrated, harmonized and centralized management of all survey stages for all areas of production, allowing a shared access to information and data, acting on a role-based user profile system (Bellini et al. 2019).

Referring to the completion status of the questionnaires, data are stored in an Oracle table. The table contains a record for each responding unit, for each survey and for each reference period in which it is involved; information on the fulfilment status or any reasons for exclusion, and the relative date of completion or exclusion, are saved in real time. In particular, for short-term statistics, the response date registered is that corresponding to the first data transmission, so as to prevent the enterprise from incurring sanctions in the event that it overwrites updates after the deadlines established in the information letter. Storing data in an Oracle table allows for great flexibility in analysing the performance of statistical surveys and the behaviour of each responding unit.

The portal entered a testing phase in June 2013, involving a purposive sample of about 70 enterprises across a subset of representative surveys of economic statistics. It became fully operational in early 2014 and then progressively hosted nearly all ISTAT economic surveys and their related survey units.

Table 1 – *Surveys and Authorized Users of the Business Statistical Portal - May 2024.*

Surveys included in the Portal	Short-term surveys included in the Portal	Number of companies authorized to access	Number of registered NSI external users	Number of registered NSI internal users
117	55	1,032,910	1,125,363	765

Elaboration of data from "Business Statistical Portal"

3. Short-term business statistics overview

Short-term business statistics are a set of indicators, with a monthly or quarterly frequency, used for tracking closely the business cycle of an economy. STS indicators are important tools for the formulating and monitoring of economic and monetary policies. The legal authority for these indicators is Regulation EC No 2152/20219 amending Regulation EC No 1158/2005 and further implementing and amending all appropriate regulations; they are also included in the National Statistical Program that contains, in a specific list, instances of non-compliance with the obligation to provide the required data, to which the law equates knowingly incorrect or incomplete data, which are punished with a financial administrative penalty. Administrative penalties are not provided for all the units involved in

statistical surveys, but only for a subset. For the majority of short-term surveys, the threshold for penalties is set at a staff of 100 employees or a turnover of 500 million euros (the turnover criterion has been introduced from 2022). The introduction of Centralised Data Collection has required a complete revision of the procedures adopted in order to standardize and generalize all the activities performed. In the following paragraphs, the main innovative issues regarding the STS are presented (Bellini et al. 2019).

In 2018 a new penalty system was introduced: the new criteria concern the organization of penalties on an annual basis, the provision of the administrative penalties in the event of non-compliance within a single period (month or quarter) and the possibility of delayed delivery, with two types of flexibility: the number of days of tolerance with respect to each monthly or quarterly deadline, varying from survey to survey, and the annual cumulative delay tolerated, lower than the sum of the delays tolerated in the single periods. For legal reasons, the amount of the penalty applied is fixed and independent of the number of periods of the year omitted (months or quarters). Only since 2020 has the new penalty scheme been fully operational.

The information letter is the official document that ISTAT uses to communicate to enterprises their involvement in the surveys; it also illustrates the objectives and the regulations in force at the time of each survey and the method of communication of any penalties. Since 2018, the layout of the information letter has been revised, paying particular attention to the deadlines for the provision of data. Strict adherence to deadlines is an essential prerequisite for the data processing, subsequent transmission to Eurostat and national data dissemination to take place by the due dates.

The introduction of the new sanctioning system has led to a strict scheduling of formal and informal communications by certified email (PEC) and ordinary email, jointly with telephone reminders addressed to the units involved in the surveys. The deadlines indicated in the information letter involve the definition of a strict timetable in order to remind the respondents about the required collaboration. The texts of the communications have also been revised recently in order make them more effective with respect to the units.

The following standards have been adopted: i) a single centralized access point both for the data capturing systems (Business Statistical Portal see par. 2) and for the incoming contacts (free of charge inbound Contact Centre - CC) by telephone or by email; ii) centralized outbound CC services; and iii) a system of harmonized standard answers to provide timely assistance to enterprises on non-thematic and recurring thematic requests. An analysis of the response rates of selected short-term surveys in the period 2016-2023 highlighted that the introduction of the current penalty rules,

jointly with the other main innovative fields, had an average impact of 29 percentage points (pp), starting from 59 in 2016.

Table 2 – *Selected short-term business statistics: main characteristics.*

Survey	PI	Observation field	Sampling design	Survey unit
Employment in large enterprises (OCC)	M	Enterprises with at least 500 employees	Census survey for enterprises with at least 500 employees	Functional unit
Retail trade (DETT)	M	Enterprises with main economic activity in sec G of the Nace Rev. 2 classification	Stratified random sampling for enterprises with less than 50 employees - Census survey for enterprises with at least 50 employees	Enterprises
Service turnover (FAS)	M	Enterprises with main economic activity in secs G, H, I, J, L, M and N of the Nace Rev. 2 classification	Stratified random sampling in sectors featuring a substantial number of enterprises - Random sampling for other sectors	Unit of Economic Activity
Industrial producer prices (PPI)	M	Products included in Sections from B to E36 of the CPA classification - Enterprises with main economic activity in secs B, C, D and E36 of the Nace Rev. 2 classification	Sample annually updated- Reasoned sample and cut-off criterion	Enterprises
Industrial production (IPI)	M	Enterprises with main economic activity in secs B, C and D of the Nace Rev. 2 classification	Reasoned sample – Cut-off criterion	Local unit
Industry turnover (FATT)	M	Enterprises with main economic activity in secs B and C of the Nace Rev. 2 classification	Cut-off criterion for enterprises with less than 20 employees - Reasoned sample for enterprises with at least 20 employees	Unit of Economic Activity
Import prices (PREIMP)	M	Products listed in sections B, C and D of the CPA classification -Enterprises with main economic activity in secs B, C, D, E and G of the Nace Rev. 2 classification	Sample annually updated- Reasoned sample and cut-off criterion	Enterprises
Job vacancies and hours worked (VELA)	Q	Enterprises and private institutions with employees operating in secs B-S, excluding O of the Nace Rev. 2 classification	Stratified and random sampling for enterprises with less than 500 employees	Enterprises and private institutions with employees

Istat

4. Data and indicators in the analysis: survival analysis methods

The standardization of the data collection processes and tools represented by the BSP, along with the uniform methodological rules governing the STS, allows for the observation of enterprise response behaviour across all surveys as a whole and over the entire period under consideration. In this context, the use of survival curves is intended to analyse the burden on respondents and their behaviour over time by analysing the profiles of respondents and non-respondents.

Kaplan-Meier survival curves are a statistical analysis tool used to plot the relationship between the probability of survival and the time observed and to measure the risk of a particular event occurring (Cox et al. 2018). It is crucial for survival analysis to set the 'event' variable to indicate whether an event has occurred and the 'survival' or 'time' variable to measure the duration of observation.

The concept behind Kaplan-Meier is conditional probability, i.e. the probability of surviving to a given point in time is conditional on the probability of being alive in earlier periods. Letting $S(t)$ be the survival function at time t, the Kaplan-Meier estimate of the survival function at time t_i is the cumulative product

$$\hat{S}(t_i) = P(T > t_i) = \prod_{j=1}^{i}\left(1 - \frac{d_j}{Y_j}\right) \tag{1}$$

where $t_1 < t_2 < ... < t_D$ represents the distinct event times, for each $i=1,...,D$, Y_i is the number of surviving units (the size of the risk set) just prior to t_i and d_i is the number of units that fail at t_i.

The method distinguishes between events and censoring: an event indicates that the unit experienced the event being studied during the observation period, while censoring refers to units that leave the study for reasons other than the event.

The versatility of survival analysis allows it to be used not only in medical research but also in industrial durability testing and in fields ranging from physics to econometrics. By examining how different variables influence survival outcomes, researchers can better understand the effectiveness of treatments and identify important prognostic factors. An important aspect of survival data analysis is the comparison of survival curves. It is crucial to determine whether the underlying population groups have identical survival functions. Several tests can be used for this purpose, including the log-rank test, the Wilcoxon test, the Tarone-Ware test and the Peto-Peto test. In this application, the log-rank test was used.

In this study, the reference population consists of the units participating in short-term business surveys through the BSP. Each unit was thoroughly observed from 2016 to 2023, covering all STS and related survey occasions as a cohesive lifecycle.

In order to allow the contextual use of data from several surveys with different reference units (e.g. enterprises, local units, functional units, etc.), it was decided to use the enterprise as the statistical unit for all the surveys. For this purpose, in surveys where the reference units are parts of the enterprise, the enterprise is considered to have fallen if no reference unit responded on the occasion of the survey. The time is represented by the number of survey occasions in which each enterprise participated. Time T1 is therefore defined as the first opportunity for each enterprise to be interviewed: it is not necessarily the same for all units. We considered two possible events: 'first fall', defined as the first survey occasion when the unit does not respond, and "definitive fall', defined as the survey occasion when the enterprise stops cooperating. The censored units are those enterprises that are no longer included in any sample of a short-term survey and are therefore no longer required to cooperate with ISTAT.

The analysis included 163,097 enterprises. Table 3 shows the extent to which the enterprises considered were involved in STS during the observation period in terms of the number of surveys in which they were asked to participate. The number of times an enterprise is asked to respond depends not only on its duration in the samples over time but also on the type of survey in which it is involved, whether monthly (12 times a year) or quarterly (4 times a year). During the observation period, the highest number of survey occasions on which the enterprises were asked to participate was 530. It can be observed that a small number of enterprises were involved in more than five surveys, probably due to the sampling design used for short-term business surveys. These enterprises are typically large (more than 250 employees).

Table 3 – *Distribution of enterprises registered in the Business Statistical Portal by number of short-term surveys in the period 2016-2023.*

N. of short term surveys (absolute value)	N. of enterprises (absolute value)	Average number of interview occasions each company participated in (absolute value)	Average response rate (percentage value)	Percentage of enterprises with at least one fall event (percentage value)	Percentage of enterprises with a definitive fall event (percentage value)
1	127,529	15.1	62.8	48.8	40.3
2	25,065	49.3	86.3	41.8	16.8
3	6,785	100.0	92.0	50.1	9.9
4	1,940	187.5	95.1	57.7	5.5
5	981	271.8	96.5	63.3	2.3
6	586	351.8	97.8	67.9	1.5
7	198	432.3	98.3	67.7	2.0
8	12	392.5	98.6	66.7	-
9	1	184.0	98.9	100.0	-

Elaboration of data from "Business Statistical Portal"

It can also be observed that cooperation increases with the number of surveys in which the enterprises participate: those participating in only one survey have an average response rate of 62.8%, those participating in two surveys have an average response rate of 86.3% and those participating in three or more surveys have an average response rate of over 92%.

5. Results

Figure 1 shows the Kaplan-Meier survival curve for the first fall event: the steep decline corresponding to the first survey occasion is evident. In fact, the probability of survival at time T1 is about 70%, while the probability of maintaining the collaboration until the end of the observation period is about 18%. These results suggest that a large proportion of enterprises interrupt their cooperation by not responding to one of the surveys in which they are involved at least once.

Figure 1 – *Kaplan-Meier survival curve for the first fall event.*
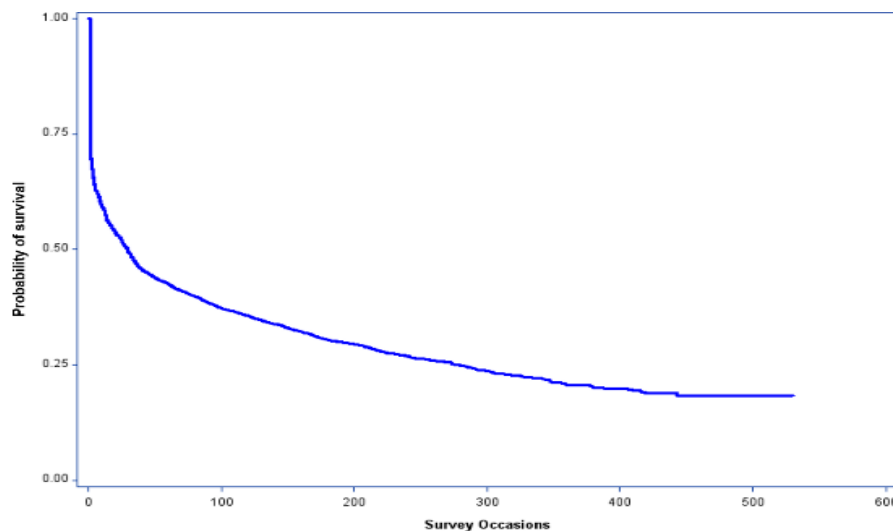
Figure 2 shows the Kaplan-Meier survival curve for the definitive fall event: again, a sharp drop at time T1 can be observed, but in this case the probability of survival at time T1 is about 77%. However, the most important finding is that the probability of continuing to cooperate until the end of the period is about 50%. This leads us to conclude that the fact that an enterprise does not continuously participate in the surveys does not necessarily imply a decision to stop cooperating in the long

run. For this reason, we focused the survival analysis on the definitive fall event and examined some factors that could influence the decision of enterprises to stop participating in ISTAT surveys. We used the Kaplan-Meier survival curve method stratifying by the selected factors; the comparison of the curves was consistently supported by a significant log-rank test ($p < 0.05$).

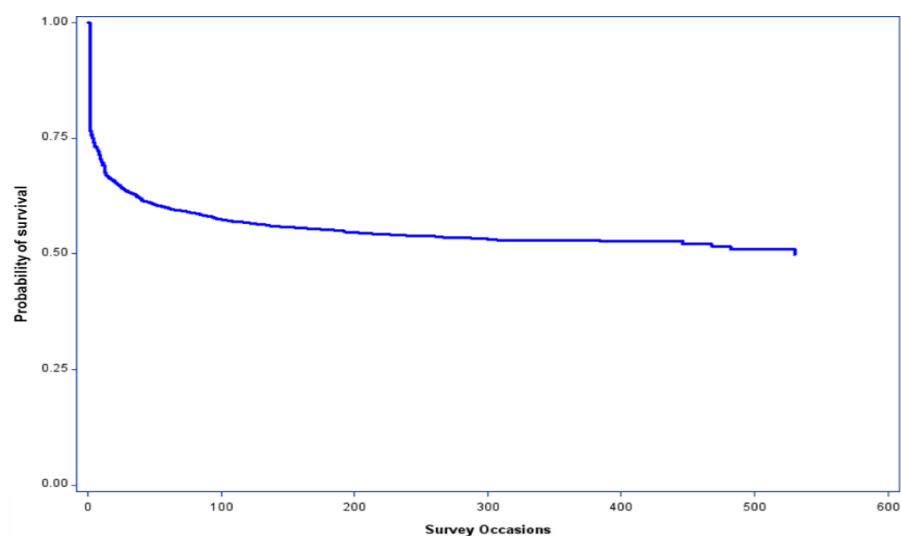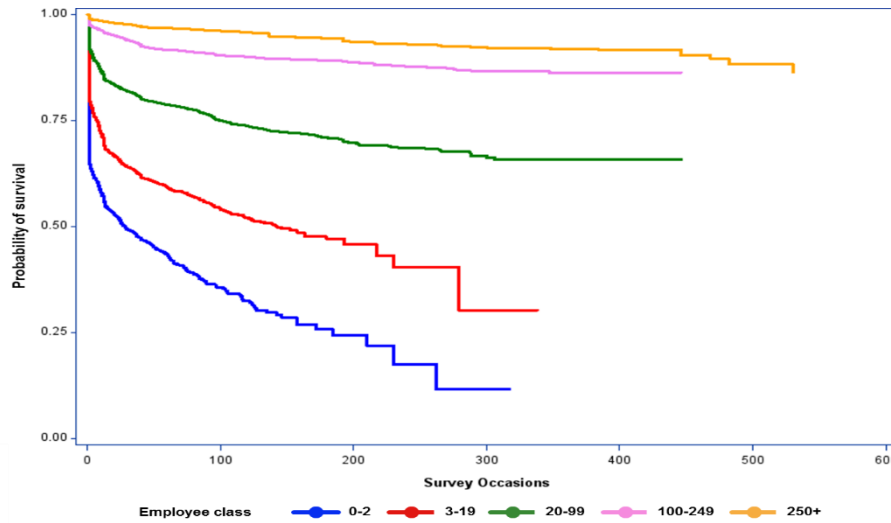**Figure 2 –** *Kaplan-Meier survival curve for the definitive fall event.*

Figure 3 shows the Kaplan-Meier survival curves for the definitive fall event by employee class: it is noteworthy that enterprises in the 0-2 employee class have a much lower probability of survival at time T1 than the other categories, around 65%. Furthermore, although these enterprises were asked to participate in fewer survey occasions than the others (at most 317 occasions), they are much less likely to continue to cooperate until the end of the observation period (only about 12%). On the other hand, enterprises in the 100-249 and 250+ employee classes have a higher probability of survival at time T1 (97% and 99% respectively) and a similar probability of survival at the end of the observation period (around 86%).

Figure 3 – *Kaplan-Meier survival curves for the definitive fall event by employee class.*

Figure 4 – *Kaplan-Meier survival curves for the definitive fall event by geographical area.*
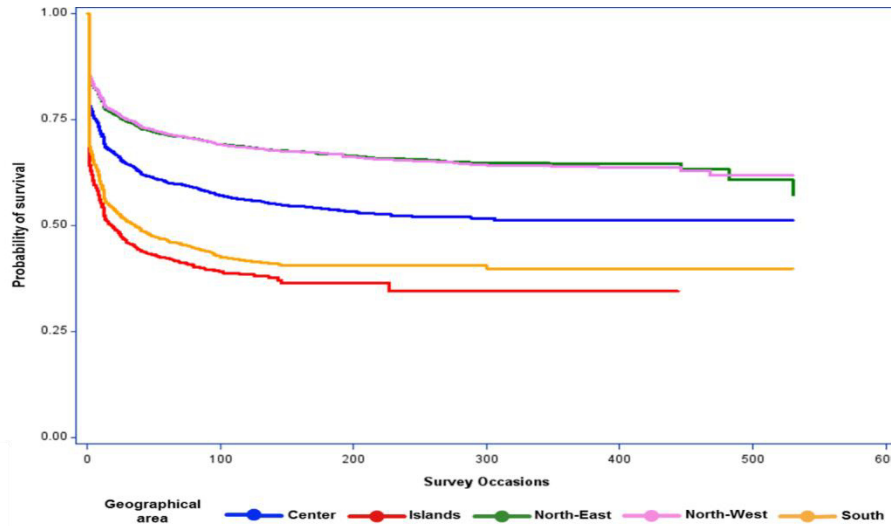

Figure 4 shows the Kaplan-Meier survival curves for the definitive fall event by geographical area. Enterprises located in the North-West and North-East areas have a very similar response behaviour: in fact, their curves partially overlap, although

the North-East enterprises have a lower probability of survival at the end of the observation period compared to the North-West enterprises (57% and 62% respectively). Enterprises located in the South of Italy, especially on the Islands, have the worst performance curves, while those in the Center area remain in an intermediate position, with a survival of more than 50% at the end of the observation period.

Figure 5 shows the Kaplan-Meier survival curves for the definitive fall event by number of short-term surveys in which the enterprises were asked to participate. As shown in Table 1, the willingness to cooperate seems to increase with the number of surveys in which a company is involved. In particular, enterprises involved in only one survey have a probability of survival at time T1 of around 71%, compared to around 95% for enterprises involved in two surveys. Furthermore, for enterprises involved in 6 or more surveys, the first definitive fall events occur at the 97th survey occasion.

Figure 5 – *Kaplan-Meier survival curves for the definitive fall event by number of short-term surveys in which the enterprises were asked to participate.*
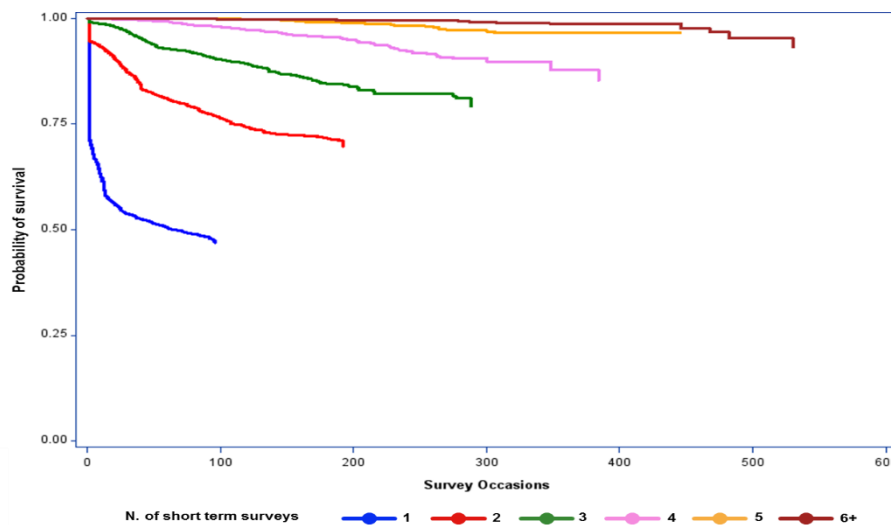
6. Conclusion

The lack of cooperation observed during the initial survey occasions should prompt us to consider enhancing our communication methods and tools to improve company participation, with a particular focus on small and medium-sized enterprises.

The medium to long-term decline in the number of enterprises initially willing to collaborate should prompt us to reconsider the statistical burden on businesses.

This work, in addition to the specific improvements that we can make in relation to each individual survey, gives us the opportunity to provide some general considerations that are valid for all surveys.

Undoubtedly, the dimensions of the phenomenon are manifold and work must certainly be carried out in relation to communication on: the reduction of the statistical burden on respondents, simplifying both the specific questionnaire and general questionnaires; the integration of the surveys with other statistical sources; and, no less important, the return of information that can be useful to the respondents.

References

FAZIO N.R., MURGIA .M, NUNNARI A. 2013. The Business statistical Portal: a new way of organizing and managing data collection processes for business surveys in Istat. *Working Papers 14*, Seminar on Statistical Data Collection. Unece - Conference of European statisticians, 25-27 September 2013, Geneva, Switzerland.

BELLINI G., BINCI S., DE GAETANO L., MONETTI F., PAPA P. 2019. Effects of Istat CDC (Centralised Data Collection) approach on the reduction of the Total Survey Error: experiences in data collection implementation field. In *Workshop on Statistical Data Collection 'New Sources and New Technologies'*. Unece - Conference of European statisticians, 14-16 October 2019, Geneva, Switzerland.

COX, DAVID ROXBEE 2018. *Analysis of survival data*. Chapman and Hall/CRC.

_____

Silvia BINCI, Italian National Institute of Statistics, binci@istat.it
Katia BONTEMPI, Italian National Institute of Statistics, katia.bontempi@istat.it
Claudio CECCARELLI, Italian National Institute of Statistics, clceccar@istat.it
Francesca MONETTI, Italian National Institute of Statistics, francesca.monetti@istat.it
Francesca ROSSETTI, Italian National Institute of Statistics, frrosset@istat.it

EMPLOYER BRANDING IN PUBLIC ADMINISTRATION.
THE ISTAT CASE

Antonella Bianchino, Irma De Marco

Abstract. The National Recovery and Resilience Plan (PNRR) and the digital transformation are imposing on the Public Administration (PA) the need to accelerate the modernization process, which also involves improving the technical-scientific skills of its employees. It will therefore be important for the PA to develop an effective culture of Employer Branding (EB). Istat's recruitment and employer branding strategies were studied in this work. In order to understand the appeal of the Istat as a potential employer, a survey was carried out on a voluntary sample of about 600 students, Istat's recruitment and employer branding strategies were identified through a questionnaire drafted online by the General Director.

1.   Employer Branding

1.1. Theoretical reference models

The employer branding is a "Marketing strategy aimed at creating a corporate image consistent with the company's identity as an employer (workplace), in tune with the reference target and clearly distinct from that of competitors, through which to attract and retain talented people (E. Amendola 2008). According Bonaiuto et al. (2010) this Strategy is developed in relation to two distinct targets, potential candidates and employees and follows two main guidelines: present the company as an attractive workplace in the eyes of the target audience (attraction); minimize conflict between colleagues and maximize the sense of belonging to the company (retention).

Among the main theoretical reference models for understanding and investigating the components of EB, Lievens (2007) highlights how "attractiveness towards an employer is influenced by instrumental attributes and to a greater extent by symbolic ones: the first are the aspects that describe the job or the employer in an objective, concrete and tangible way (remuneration, location, organizational structure); the second are the subjective, abstract and intangible aspects that derive from the evaluations and inferences of the subjects". Berthon et al. (2005) also analysed the components of the attractiveness of employers by developing an EB measurement scale, Employer Attractiveness Scale, defined by the Authors as "the benefits of an organization perceived by potential candidates as the best place to work" and

includes five dimensions: interest value, economic value, social value, development value and application value".

The interest value measures the attractiveness of an organization linked to the work content, the innovativeness of the working methods and the stimulating nature of the working context; social value measures the attractiveness of the employer based on the possibility of creating positive working relationships with one's superiors, with one's team and of having a working context that favours interpersonal relationships; economic value evaluates how the attractiveness of the company depends on factors such as remuneration, safety at work and any promotions; development value considers the dimensions of personal development and career advancement; finally, the application value represents the attractiveness of an organization based on its ability to offer the opportunity to apply its knowledge and transmit it to others.

1.2. Employer branding in Public Administration

Private organizations have long understood the importance of EB to survive in a globalized and competitive market, while the public is only recently showing interest in this strategy.

"Theories of motivation for public work make an important contribution to the construction of EB policies in the recruitment phase. The first studies identify some factors that would make people available to work in the public sector, such as: working for the common good and the progress of society, the absence of profit logic, the protection of national interests, the value of public service, social justice, the attraction for public policies" (Ingrassia R. 2017). Over time, the concept of Public Service Motivation (PSM) has developed in the literature. "Public service motivation is a form of motivation that refers to an individual's desire to contribute to society. More specifically, Perry and Hondeghem (2008) define PSM as "an individual's orientation to provide services to people for the purpose of benefiting others and society." According to the OECD, the "positioning of the public administration as an employer of first choice, through the promotion of a brand that recalls the values, motivation and pride of contributing to the public good among candidates" (2019) is one of the levers on which it is necessary to invest in order to develop an effective and reliable public sector.

2. The Istat Case

2.1. Introduction

Being a public research authority and, at the same time, the main producer of official statistics, a public good to support citizens and public decision-makers and

an essential tool for the development of democracy, allows Istat to focus on attractiveness factors that surpass the rigidities of the purely economic.

Furthermore, the results of the competitions announced by Istat, go in a completely different direction of the recent competitions managed by FormezPA: total coverage of positions with a high percentage of those hired with a Stem degree or in the economic field (Camisasca M., Screpante I., 2023). Therefore, the analysis can represent an interesting case study.

2.2. *The appeal of working at Istat for young university students*

In order to understand what Istat's appeal is as a potential employer and therefore what organizational factors it must monitor to attract and retain young people, a survey was conducted on a voluntary sample of students from public and private universities. The student survey was conducted in the months of April and May 2023 by completing online questionnaire implemented on the Google Forms platform.

The questionnaire was structured into four sections:
1. Information on the study path, which contains information relating to the University and the degree course
2. Knowledge of Istat, which detects knowledge of Istat and the area in which it operates, possible participation in the Institute's activities and the use of statistical data.
3. Interest in working at Istat. In the section, reserved for those who had declared to know Istat, the appeal of Istat as a potential employer of the interviewees is highlighted. Both in case of a positive and negative response, were asked to specify the reasons. The items of motivations favorable to working at Istat were structured taking into account the Employer Attractiveness Scale defined by Berthon, Ewing and Lian Hah. In particular, 11 response methods have been identified, aggregated into 5 categories, according to the scheme shown in Table 1.
4. Data on the student, in which the student's age, gender, high school diploma obtained, and region of residence were recorded.

2.3. *Characteristics of the respondents*

584 students from 18 universities participated in the survey. The distribution of respondents by university attended and region of residence is affected by the student recruitment method that had to be adopted. Two out of three students attend universities in Campania (377 students, 64.6%), with the University of Salerno in the lead (180 students, 30.8%). Considering the southern universities as a whole, the share of students rises to 78.8%; there are 122 students from universities in the Centre-North, mostly attending private universities (the "Luigi Bocconi"

Commercial University, 70 students and the Catholic University Cattolica del Sacro Cuore, 23 students).

Table 1 – *Reasons for interest in working at Istat, by categories of the Employer Attractiveness Scale.*

Item response	Category
1. To work in stimulating atmosphere	
2. To have the chance smart working	
3. To work for innovative organizations	Interest value
4. To work for research-oriented organizations	
5. Seren working environment	Social value
6. Work life - balance	
7. Employment stability	Economic value
8. Appropriate career development	Development value
9. To have the opportunity to develop skills and competencies	
10. Pertinence to the learning path	Application value
11. Interesting work	

Table 2 - *Students by university attended.*

University	Students		University	Students	
	v. a.	%		v. a.	%
University of Salerno	180	30,8	University Cattolica del Sacro Cuore – Milan	23	3,9
University of Campania "Luigi Vanvitelli"	88	15,1	University of Basilicata	16	2,7
University "Luigi Bocconi" – Milan	70	12,0	University of Bologna	10	1,7
University of Bari "Aldo Moro"	60	10,3	University of Milan "Bicocca"	9	1,5
University "Federico II" – Naples	57	9,8	University of Pavia	6	1,0
University of Naples "Parthenope"	52	8,9	Other	13	2,2
			Total	584	100,0

Source: our processing of sample survey data

The sample is made up of 55.1% females and 44.9% males. The average age is 22 years. A third of the students achieved a scientific high school diploma, 11.1% an

economic-administrative high school diploma; followed by classical high school diplomas (8.9%) and linguistic high school diplomas (8.2%).

Of the 584 students who filled out the questionnaire, 472 are attending a three-year degree course, 109 are attending a master's degree course, 2 are enrolled in a doctorate course and only one is attending a single-cycle course. The most represented degree courses are those in economics-business (60.1%) and statistics (14.9%). Other fields of study include Tourism Sciences (6.2%), Political Sciences and International Relations (6.8%), Public Administration Sciences (3.3%).

2.4. Knowledge of Istat

The survey shows an excellent positioning of Istat as the reference body for statistical production in our country. In fact, only 23 students, of which 15 enrolled in the first year of a three-year degree course, declared that they did not know ISTAT. 96% of respondents, however, know the Institute. The level of knowledge grows as a function of study progress. In fact, the share of students enrolled in a three-year degree course who declare that they know the institute rises from 90.1% of first-year students to 97.7% of third-year students.

Table 3 - *Knowledge of Istat by type of degree course and year of course.*

Knowledge of Istat	Year of course					Total
type of degree course	I	II	III	IV subsequent ones	Out of course	
No	15	4	4			23
Bachelor	15	4	4			23
Yes	181	166	176		38	561
Bachelor	136	106	173		34	449
Master	44	59	2		4	109
Single cycle			1			1
PhD	1	1				2
Total	**196**	**170**	**180**		**38**	**584**

Source: our processing of sample survey data

Of the 561 students who declared that they knew Istat, 95% were also aware of the area of activity in which it operates and 72.5% used Istat data. Proportionately, master's students used Istat data more: 89.0% compared to 68.4% of bachelor's students. 87 students (15.5%) also participated in initiatives/activities of the Institute: seminars to promote statistical culture (33.9%), conventions and conferences (28.8%) organized by Istat or collaborated in the activities of data collection in censuses or sample surveys (26.3%).

Figure 1 - *Students who participated in Istat activity initiatives by type of activity (percentage values).*

Contest	0,8
Activities of data collection in censuses or sample surveys	26,3
Conventions and conferences	28,8
Seminars to promote statistical culture	33,9
Internship	10,2
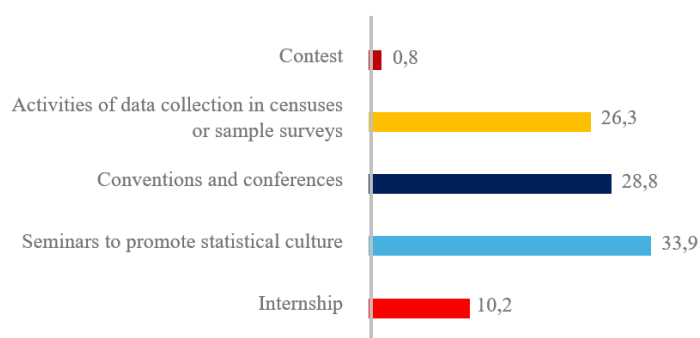
Source: our processing of sample survey data

2.5. Interest in working at Istat

Of the 561 students who declared they knew Istat, 397 (70.8%) were interested in working there. On the other hand, there are 164 (29.2%) interviewees who do not find a job at Istat interesting, because they are not attracted by the type of activity carried out (50.3%) or not interested in working in the Public Administration (44.7%). As documented by Collins' studies (2006), the interest in working for an organization is influenced by the direct knowledge that potential candidates have of it. In fact, the share of students interested in working at Istat rises to 82.8% among those who have had a direct relationship with the Institute or mediated by other bodies and reaches 100% among those who have participated in training internships

Table 4 - *Interest in working at Istat.*

	Interest in working at Istat		
	No	yes	Total
Absolute values	164	397	561
Percentage values	29,2	70,8	100,0
Participation in ISTAT initiatives/activities (percentages)			
No	31,4	68,6	100,0
Yes	17,2	82,8	100,0
of which, students who participated:			
- to censuses and sample surveys as municipal surveyor/manager	29,0	73,3	100,0
-to seminars, conventions/conferences	14,7	85,3	100,0
-to seminars, conventions/conferences	12,5	87,5	100,0
-to training internships	-	100,0	100,0

Source: our processing of sample survey data

The interest in working in the Institute, like the knowledge of it, grows according to the progress in the studies. In fact, the share of students who look to Istat as a possible employer rises from 66.4% of bachelor's students to 89.9% of master's students. Significant differences are recorded when analysing the responses by nature of the university. Only 28.6% of students enrolled in non-state universities are interested in working at Istat. This result is quite predictable if one considers the greater orientation of these universities towards the private sector and the consolidated network of relationships with the same for the purposes of professional opportunities for their students. On the contrary, almost 80% of students enrolled in state universities are interested in working at Istat.

Figure 2 - *Interest in working at Istat, by gender, nature of the university, type and disciplinary area.*
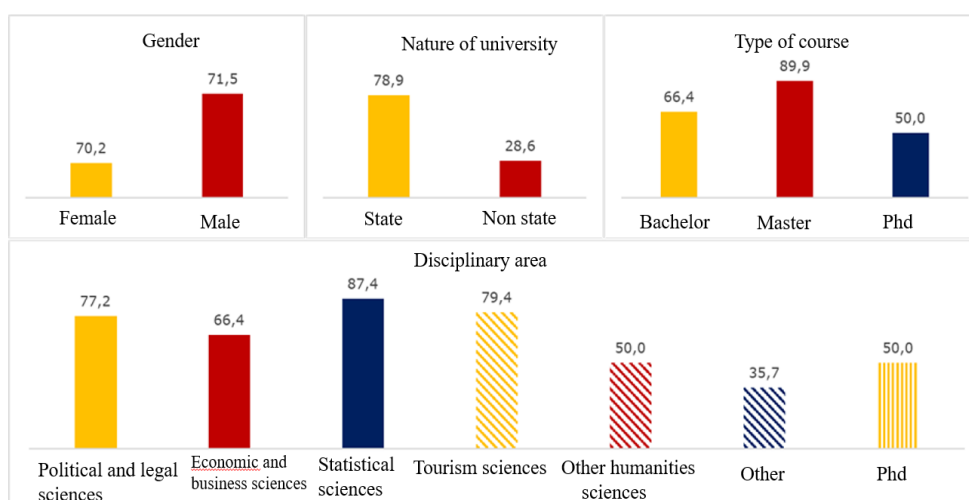
Source: our processing of sample survey data

Finally, looking at the disciplinary areas of the degree courses, the majority of Statistical Sciences students (87.4%) see Istat as a potential employer, followed by Tourism Sciences students (79.4%), Political and legal sciences (77.2%) and Economic and business sciences (66.4%). As already highlighted, the reasons for the interest in working at Istat were revealed with a multiple-choice question. From the answers provided, it emerges that young people are interested in working at Istat because they believe that it offers the possibility of developing skills and competences (65.5%) and that it is an activity consistent with their studies (57.4 %),

carried out in a research-oriented institution (53.1%), with an interesting work content (50.6%). However, factors such as job security (28.2%), the opportunity for smart working (23.2%), the possibility of working in a peaceful working environment (16.4%) or to reconcile work with the needs of private life (20.4%).

Figure 3 - *Motivation of interest in working at Istat.*
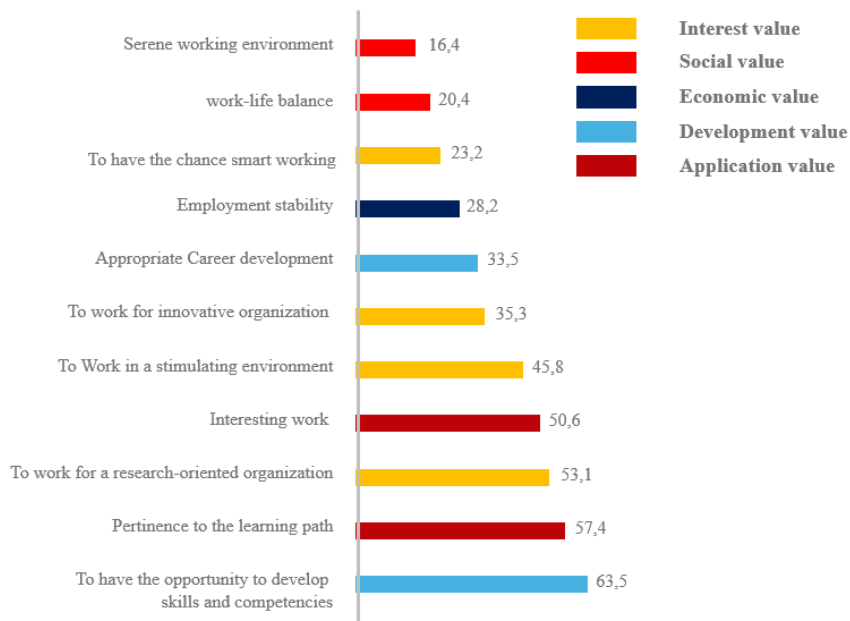
Source: our processing of sample survey data.

The distribution of motivations according to the main classification variables (sex, nature of the university, type and disciplinary area of the course of study) highlights some specificities. The possibility of developing skills and competences, for example, is more important for students of public universities (64.2%) than for those of private universities (53.8%); instead, working in a research institution is more important for those who attend a private university (65.4%, versus 52.3%). Relevance with the study path has a more relevant role for males (62.8%), for those enrolled in a public university (58.5%) and for those following a master's degree course (67.3%) or doctorate (100%). Significant differences also emerge from the analysis of the motivations according to the disciplinary area of the course of study. For those enrolled in a degree course in statistics, consistency with their studies (92.1%) is more important than the possibility of developing skills and competences (63.2%). Even in the case of students in the political-legal area, the possibility of

developing skills and competence (62.3%) ranks second in the ranking of motivations, surpassed by the opportunity to work in a research-oriented organization (67.2 %). As expected, given that they represent 55.7% of students interested in working at Istat, the impact of the motivations of students in the economic-business area closely follows the average values of the sample interviewed.

2.6. Recruiting and employer branding in Istat

Istat's recruiting and employer branding strategies were surveyed through a structured questionnaire, completed online by the General Director. The interview was aimed at understanding how Istat positions itself with respect to the variegated PA panorama and to analyse any overlaps between student expectations and the organisation's strategies.

For the interview was used the same questionnaire as the survey: "Attracting talent and enhancing people: employer branding strategies in the Public Administration[1]", in order to be able to compare the position of Istat with that of the 67 public administrations that participated in the survey conducted by FPA Indeed. The questionnaire was aimed at capturing the recruiting strategies, the specific EB activities carried out in the last two years and the organisation's assessment of the levers to be activated to improve recruiting and the organisation's attractiveness. Regarding candidate search channels, Istat, unlike the majority of organizations interviewed in the Attracting talents and enhancing people survey, uses sponsorship channels for tenders and competitions in addition to those provided for by the legislation. In particular, social networks are used, but also solutions of a more sectoral nature such as job supply and demand matching portals and other institutional portals, the latter solutions not very widespread among the 27 organizations that declared they make use of different promotion channels from institutional ones. With reference to employer branding activities, it emerges from the interview with the General Director that Istat, like the majority of respondents to the Attracting talents and enhancing people survey, recognizes the importance of activities aimed at promoting the image of the company organization with employer. From the FPA-Indeed survey, however, the contradiction between the importance recognized by the organizations in EB activity and the actions undertaken is evident. In fact, only 21 organizations declared that they had carried out EB activities in the

---

[1] Survey, carried out in April 2023 by FPA on behalf of Indeed, on a non-representative sample of 67 human resources managers from as many public administrations, selected from the main central and local administrations and public companies in our country. See: https://www.forumpa.it/webinar/attrattare-talenti-valorizzate-le-persone-quali-strategie-di-employer-branding-nel-settore-pubblico

last two years, mostly using traditional methods (e.g. dedicated sections of the organisation's portal).

Istat, on the other hand, constantly carries out corporate communication initiatives to "speak its story" and make itself known also through the use of innovative methods.

In particular, the Institute, in addition to scientific conferences aimed at a specialist audience, organizes seminars and dissemination events aimed at promoting statistical culture and presenting its activities and dissemination data warehouse. The curricular training internships which take place at the Istat offices are also very important. Istat has started the Employee Advocacy project, which makes employees voices and face of the Institute. In this way, in line with what is expressed in the relevant literature, employees become "ambassadors" of the Istat brand. Istat is therefore strongly engaged in corporate and EB communication activities both towards direct external audiences and towards indirect external audiences, i.e. towards those who have no interest in working at the Institute but who, in any case, making an positive idea of the organization can promote it as a workplace.

With regard to growth prospects and the levers for improving recruiting and the attractiveness of the organization in general, Istat's position reflects the modal values revealed by the FPA-Indeed survey. The interview with the Director General of Istat confirms the significant role of recruiting and EB policies in the strategic choices of the Institute. In fact, in line with the staff development policies already highlighted previously, all 11 areas of improvement of the working environment examined in the FPA-Indeed survey are considered by Istat to be quite or very important. The culture of the centrality of the person and the recognition of human resources as an "intangible" asset essential for achieving objectives are now consolidated assets of the organisation.

Like most of the entities that participated in the FPA-Indeed survey, Istat believes it is very important to develop empowerment and delegation to employees, provide prospects for professional growth and increase their loyalty. In the General Director's assessment, however, Istat must also focus heavily on the speed of personnel selection times, on work-life balance, on intangible benefits that allow bridging the reward and benefit gaps typical of public work, on digitalization of processes, all areas that the majority of human resources managers interviewed do not consider priorities for improving the working environment

Figure 4 - *Importance attributed to the areas of improvement of the working environment by Istat and by the participants in the survey "Attracting talent and enhancing people" by FPA-Indeed (*).*
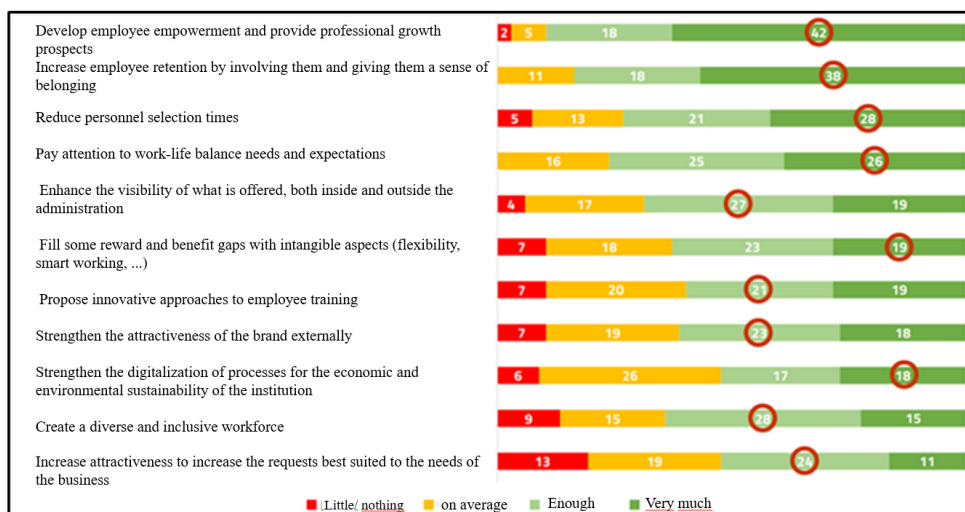
Source: our processing of sample survey data

(*) The symbol ◯ *identifies the response of the Director General of Istat*

Discussion

In a general framework of a not yet fully mature PA about the adoption of EB policies, Istat seems to differentiate itself on choices and paths taken. In light of what has been analysed so far, what emerges is the Institute's desire to promote the corporate image and a clear ability to "know how to tell its story" and to develop, through various initiatives, a good "reputation". From the analysis carried out, several strong points emerge including a clear vision and mission; a working context oriented towards organizational well-being, employee empowerment and professional growth prospects; careful internal communication and external, the promotion of work-life balance. The data of the survey to the students, moreover, shows Istat's optimal positioning as the agency of reference of the statistical production in our Country. It is also interesting to note how the areas of improvement of the working environment in which Istat considers it a priority to engage directly influence some of the factors (possibility of developing skills and competences, working for a research-oriented and innovative organisation, which offers interesting in a stimulating environment) indicated by students as potential elements of attraction of working in the Institute. A possible future application of this work may include implementing a stratified

probabilistic sample to investigate the observed results employing inferential statistics tools.

References

AMENDOLA E. 2008. *Corporate recruiting Employer branding e nuove tendenze*, Bologna, Anthea Consulting s.r.l.

BERTHON P., EWIG M, LIAN H. 2005, Captivating Company: dimensions of attractiveness in employer branding, *International Journal of Advertising*, No. 2, pp. 151 -172.

BONAIUTO M., GIACOMANTONIO M, PUGLIESE E., LIZZANI G. 2010, Employer branding: how to measure its efficacy, *MICRO & MACRO MARKETING*, Bologna, No. 1, pp 7-26.

CAMISASCA M., SCREPANTE I. 2023, Human resources recruitment in italian public sector post covid 19: demographic characteristic, gender compositions, education for a new public employer branding. Focus on Istat experience, *Rivista Italiana di Economia Demografia e Statistica,* Vol. LXXVII No. 1, pp. 109-120.

COLLINS C.J. 2006, The interactive effects of recruitment practicesand product awareness on job seekers'employer knowledge and application behaviorus, *Journal of applied psychology*, Vol. 92, No. 1, pp. 180-190.

INGRASSIA R. 2017. L'Employer branding nelle organizzazioni pubbliche, *Rivista Trimestrale di Scienza dell'Amministrazione,* No. 2, pp. 22- 40.

LIEVENS 2007, Employer Branding in the Belgian Army: The Importance of Instrumental and Symbolic Beliefs for Potential Applicants, Actual Applicants, and Military Employees, *Human Resource Management*, Vol. 46, No.1, pp. 51-69.

OECD 2019, *OECD, Recommendation of the Council on Public Service Leadership and Capability*, OECD/LEGAL/0445

PERRY J., HONDEGHEM A. 2008, Building Theory and empirical evidence about public service motivation, *International Public Management Journal,* Vol. 11, No. 1, pp. 3-12.

_____

Antonella BIANCHINO, Istat, bianchin@istat.it
Irma   DE   MARCO,   Università   Commerciale   Luigi   Bocconi, irma.demarco23@gmail.com

ATTIVITÀ DELLA SOCIETÀ

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).