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Facing Scale, Space, and Time in Population Ageing: Tales from the Italian Laboratory

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ABSTRACT

Population ageing is reshaping demographic structures across advanced economies. Italy, with one of the most aged populations globally, represents a particularly relevant case. This paper investigates the evolution of the spatial distribution of people aged 75 and over between 1991 and 2021, adopting a multiscale approach that combines national census data for all Italian municipalities with inequality and spatial autocorrelation measures. First, we apply the Theil entropy index to evaluate how the spatial distribution of the older population diverges from that of the total population. Its decomposition, aligned with Italy's administrative hierarchy, shows that inequality has gradually shifted from macro-territorial divides to within-province variation. Second, we analyse local ageing intensity using the municipal share of residents aged 75 and over. Despite decreasing aggregate inequality, global and local spatial autocorrelation statistics reveal strong and persistent spatial clusters that continue to shape the national pattern. High-ageing clusters have expanded across inland and mountain areas; low-ageing clusters persist in major urban and metropolitan regions. Overall, the findings indicate that population ageing is now a pervasive national phenomenon, yet its spatial imprint remains deeply structured and locally resilient.

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1. Introduction

One of the most pressing challenges facing advanced economies today is the political and social management of population ageing (Harper 2014). This is particularly true for Italy, which ranks among the oldest countries in the world. This outcome stems both from exceptionally high longevity and from persistently low fertility levels that have long remained far below the replacement threshold — indeed, among the lowest globally (Billari and Kohler 2004; Perez and Livi-Bacci 1992). As of 2025, Italy records 207.6 older people (aged 65 and over) for every 100 young people (aged 0–14), with older adults accounting for nearly one quarter of the total population (24.7 per cent).

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According to the official demographic projections of the Italian National Institute of Statistics (ISTAT), under the median scenario, by 2080 the share of individuals aged 65 and over will rise to 37 per cent of the total population, with an ageing index of 314.

While the demographic drivers of ageing, as well as many of its socioeconomic and demographic consequences, are well documented, much less is known about its spatial dimension and how this dimension interacts with temporal dynamics. This issue is particularly relevant in Italy, where territorial disparities — including demographic ones — are deep-rooted and persistent, to the extent that some scholars describe them as a distinctive feature of the Italian context (Billari and Tomassini 2021). A growing body of research has explored ageing in Italy from a territorial or spatial perspective (Basile et al. 2023; Benassi, Buonomo, and Strozza 2025; Reynaud and Miccoli 2018, 2023; Reynaud et al. 2018). Recent work has also highlighted strong local spatial heterogeneities in demographic structures, showing how ageing patterns relate to accessibility and settlement configurations (Armenise et al. 2024; Benassi, Tomassini, and Di Felice 2025a). Yet, important aspects remain underexplored, particularly the multiscalar nature of ageing-related disparities and whether ageing should be interpreted as a spatial diffusion process. This paper focuses on two specific aspects of ageing, understood as a spatial phenomenon:

i. Whether the growth of the older population (here defined as individuals aged 75 and over)[1] can be interpreted as an issue of inequality across territories, and how this inequality varies across different geographical scales — from macro to micro levels.
ii. whether, at the micro scale, the ageing process can be described as a spatial diffusion[2] phenomenon or not.

These issues are examined in the Italian context using official ISTAT population census data at the local (municipal) level. The analysis spans from 1991 to 2021. The study builds on two main ideas.

[1]The debate on the age threshold defining the entry into old age is broad and continuously evolving. In advanced economies, there has been a progressive shift towards raising this threshold above the traditional 65+ limit, which increasingly appears to be primarily a demographic and institutional construct (Natale et al. 2024), especially in contexts characterised by high longevity. In this line of research, Ryder (1975) and later Sanderson and Scherbov (2005, 2007) propose a dynamic definition of old age based on survival probabilities. For Italy, a particularly long-living context, contributions such as Demuru and Egidi (2016) and Strozza et al. (2024) highlight the need to raise the conventional threshold. Further developments are found in the literature on 'positive demography' (Vignoli and Paterno 2025), which suggests that entry into old age occurs at increasingly older ages. In this perspective, the increase of the threshold from 65 to 75 years was also discussed at the 63rd National Congress of the Italian Society of Gerontology and Geriatrics (SIGG 2018). Consistent with these indications and with the empirical evidence of this study, we adopt the 75-year threshold to define the elderly population. This group, often referred to as the 'oldest old' or 'fourth-age' population, is particularly relevant for analyses of health, dependency, and healthcare expenditure, given the higher prevalence of functional limitations and long-term care needs compared with the 65+ population. The European Commission also adopts the 75+ threshold in its analyses of Long-Term Care when defining the elderly population relevant for care needs (Belmonte et al. 2023, 2024).

[2]By spatial diffusion we refer to the process by which a demographic phenomenon spreads progressively across geographic space over time. The literature commonly distinguishes three main modes: contagious diffusion, in which the phenomenon spreads outward from an origin to geographically adjacent areas; hierarchical diffusion, in which it propagates through an urban or administrative hierarchy independently of physical proximity; and network diffusion, in which it follows relational or infrastructural linkages (Cliff and Ord 1973; Voss 2007). In this paper, the Theil decomposition serves as a non-spatial measure of territorial convergence across hierarchical scales, while the global and local spatial autocorrelation statistics allow us to assess whether the distribution of the ageing population exhibits the geographic clustering and path-dependency consistent with contagious diffusion, as opposed to a random or purely convergent redistribution. The distinction between convergence and spatial diffusion is thus built into the methodological design of the paper.

The first is that the increase in the elderly population, particularly marked in Italy, can be interpreted through classical economic approaches, namely as a manifestation of territorial inequality (understood here as the unequal spatial distribution of two population groups: the older and the total population). The hypothesis is that, as ageing intensifies and time passes (over the 30 years observed), inequality will gradually decrease as the older population becomes more evenly spread across the country, due to the convergence of demographic behaviours among different areas. This hypothesis is tested using specific measures, namely the Theil index and its decomposition, which are, however, non-spatial, meaning they do not incorporate spatial weights that account for neighborhood structures among territorial units.

The second idea is that, although ageing has affected all Italian territories, it has done so unevenly — without eliminating relative differences but rather rescaling them to new levels. When the process is analyzed using explicitly spatial measures, both global and local, the results may challenge the notion of a purely diffusive process, revealing instead persistent spatial clustering patterns.

The overarching aim is to demonstrate that a process of major societal and economic significance — demographic ageing — can take on distinct meanings and implications when examined through approaches that explicitly account for, scale, space and time. The findings may contribute to more effectively designing policy interventions that address the spatial and structural effects of demographic ageing. The remainder of the paper is organized as follows. The next section describes the data and methods used in the empirical analysis. This is followed by the presentation and discussion of the results, and finally, by some brief concluding remarks.

2. Data and Methods

The study variables comprise the number of older individuals (aged 75 years and over) and the total resident population for each municipality. The empirical analysis spans from 1991 to 2021 and relies on data produced and disseminated by the Italian National Institute of Statistics (ISTAT). Specifically, the dataset includes the usually resident population by age as enumerated in the demographic censuses (1991–2021), municipality shapefiles, and territorial boundaries for higher-level administrative units (i.e., divisions, regions, and provinces).

It should be noted that the territorial configuration and number of Italian municipalities are harmonised to the 2021 boundaries and are therefore held constant throughout the study period. This harmonisation ensures the consistency and comparability of spatial–temporal analyses across all statistical territorial units.

As for the methods, in the first part of the study the spatial distribution of the two variables (older population and total population) is studied by means of the Theil index (T) and its decomposition in four geographical scales (from Macro to Micro). Please note that this part of the analysis is not explicitly spatial since no spatial weights are introduced in the process of measurement. The aim of this analysis is to understand the level of inequality in the geographical distribution of the older and total population and, in particular, in understanding, through the Theil decomposition, the major contribution made by the different territorial scales in shaping the overall level of inequality and its diachronic evolution.

As is known, the T index (T) proposed by Theil in the late sixties (Theil 1967) is a measure of economic inequality that has recently been found to have applications in population-based studies (Wu, Song, and Yu 2019). Essentially, it is able to capture disparities across a given entire distribution, and it can be decomposed into 'within-group' and 'between-group' components (Akita 2003).

Following the approach proposed in Akita (2003), T can be decomposed so that it allows us to measure how the distribution of the older population (e.g., age 75+) diverges from the total population across territorial units such as provinces, regions, or divisions. Formally, the index can be written as:

$$T = \sum_t \sum_i \sum_j \sum_k \frac{L_{ijkt}}{L} log\left(\frac{L_{ijkt}/L}{P_{ijkt}/P}\right) \tag{1}$$

where L_{ijkt} denotes the number of residents aged 75 and over in municipality k, province j, region i, and division t. P_{ijkt} is the total resident population in the same unit. Aggregate older and total populations at the national level are respectively given as $L = \sum L_{ijkt}$ and $P = \sum P_{ijkt}$. The contribution of each unit to the older population is given by the older population share, (L_{ijkt}/L), whereas (P_{ijkt}/P), represents its share in the total population.

T takes value zero only when the spatial distribution of the older population exactly matches that of the total population; it increases as the two distributions diverge.

A key property of this formulation is its additive decomposability, because it consists of a weighted sum of logarithmic deviations. This property allows total inequality to be partitioned across multiple hierarchical territorial levels. Each territorial unit contributes independently to total inequality, and these contributions can be consistently regrouped at different hierarchical levels. So the index can be partitioned exactly into between-group and within-group components without residual terms, making it particularly suitable for multilevel territorial systems.

Adopting the four-level structure (Figure 1) of the Italian administrative system — divisions (t), regions (i), provinces (j) and municipalities (k) — we use the two-stage nested decomposition proposed by Akita (2003). Total inequality T can be expressed as:

$$T = T^B_{div} + \sum_t \frac{L_t}{L}\left(T^B_{reg|t} + \sum_{i\in t}\frac{L_i}{L_t}\left(T^B_{prov|i} + \sum_{j\in i}\frac{L_j}{L_i}T^W_{mun|j}\right)\right) \tag{2}$$

where T^B_{Div} measures inequality between divisions, $T^B_{Reg|t}$ between regions within divisions, $T^B_{Prov|i}$ between provinces within regions, and $T^W_{Mun|j}$ within each province across municipalities.

For interpretation and for consistency with Figures 2 and 3, the four components can be written synthetically as: $T = T^B_{div} + T^B_{reg} + T^B_{prov} + T^W_{prov}$.

This decomposition quantifies how much each territorial scale contributes to total spatial inequality in the distribution of the older population. Changes in the magnitude of T over time indicate whether the spatial distribution of older residents is becoming more or less aligned with that of the total population, while changes in the relative size of the components reveal whether inequality is increasingly shaped by macro-regional contrasts or by local, municipality-level differences.

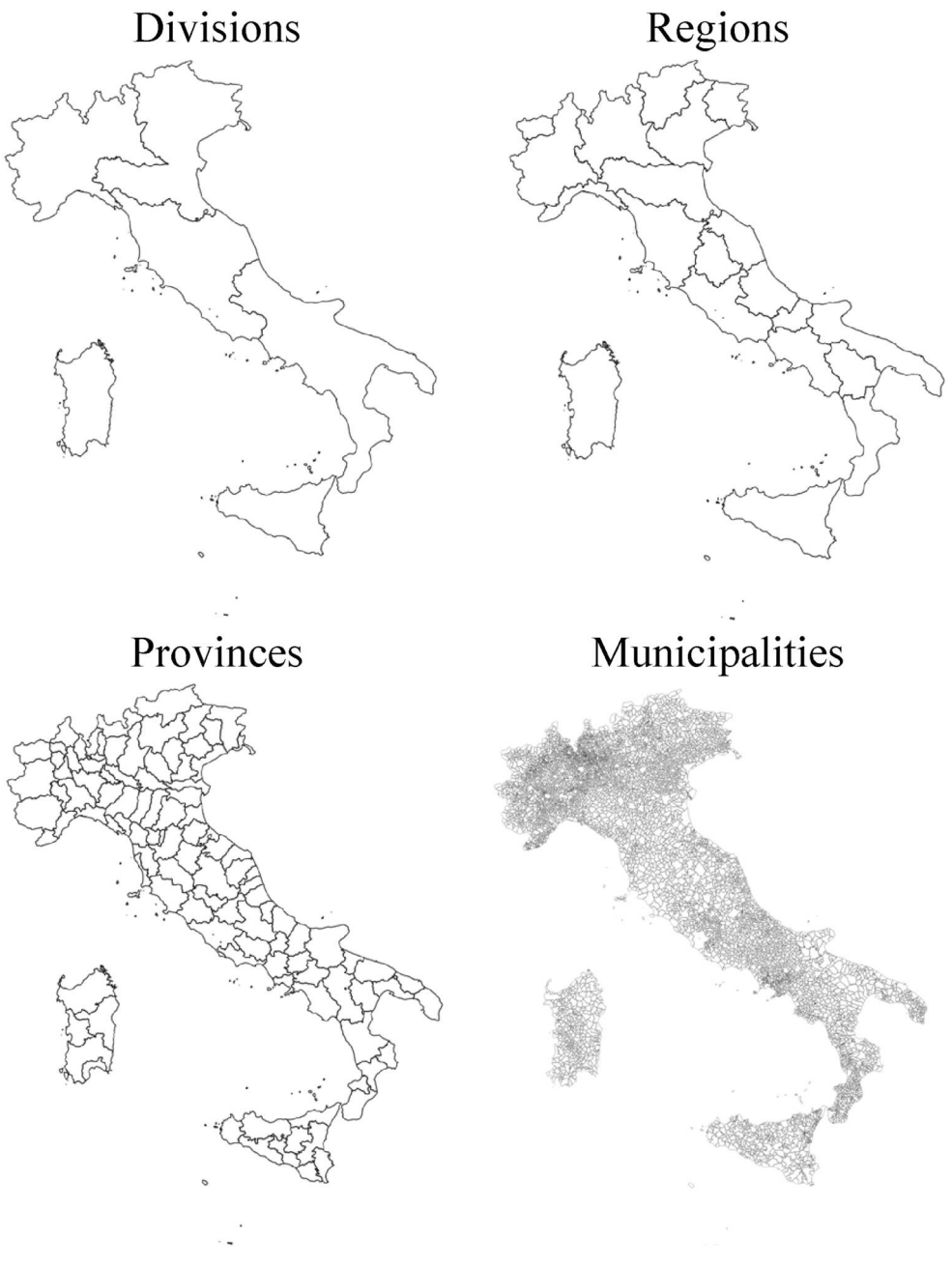

Figure 1. Administrative divisions of Italy. Source: our own elaboration on Istat data.

In the second part of the paper, we focus on the geographical variability (and spatial dependence) of the older population share, calculated as the ratio of the population aged 75 and over to the total resident population in each municipality. In the first section, this indicator — computed for each of the Italian municipalities — is mapped, and its temporal variation is summarized by simple statistical parameters. Again, this

analysis is entirely non-spatial, although it is based upon the use of thematic maps and other tools for geographical representation and visualization.

In a second section, the underlying spatial patterns of the share of the older population are analysed by using two spatial indicators, the Moran's *I* statistics (Moran 1948) and the G_i^* (Getis and Ord 1992; Ord and Getis 1995). Moran's *I* statistic is the most commonly used indicator of global spatial autocorrelation. It measures the degree to which a variable is similar or dissimilar across nearby spatial locations.

$$I = \frac{N}{W} * \frac{\sum_i \sum_j w_{ij}(x_i - \bar{x})(x_j - \bar{x})}{\sum_i (x_i - \bar{x})^2} \tag{3}$$

where:

$$W = \sum_i \sum_j w_{ij} \text{ is the sum of all spatial weights} \tag{3a}$$

N is the number of spatial units, x_i is the value of the variable at location i, $\bar{x}$ is the mean of the variable and w_{ij} is the spatial weight between location i and j (the neighborhood relationship).

The local univariate index G_i^*, computed for each of the years considered, allows us to identify the *hot spots* and *cold spots* and delineate the spatial clusters that describe the territorial distribution and dynamics of the older population. More specifically, this index of local spatial autocorrelation makes it possible to delimit the areas in which comparatively high values of the variable of interest (or comparatively low) values are near each other, creating real spatial clusters. Clusters of comparatively high values (so-called *hot spots*) identify areas with a high share of the older population and therefore are more liable to depopulation and demographic decline. On the contrary, clusters of comparatively low values (so-called *cold spots*) show demographically younger areas, with higher potential for socio-economic development. There is finally a third cluster of areas in which no spatial structure of autocorrelation of the variable is observed (the distribution follows a random pattern). G_i^* index can be written as:

$$G_i^* = \frac{\sum_{j=1}^n w_{i,j}x_j - \bar{X}\sum_{j=1}^n w_{i,j}}{s\sqrt{\frac{\left[n\sum_{j=1}^n w_{i,j}^2 - \left(\sum_{j=1}^n w_{i,j}\right)^2\right]}{n-1}}} \tag{4}$$

where:

$$\bar{X} = \frac{\sum_{j=1}^n x_j}{n} \tag{4a}$$

$$S = \sqrt{\frac{\sum_{j=1}^n x_j^2}{n} - (\bar{X})^2} \tag{4b}$$

G_i^* detects the spatial dependency of a variable at location i, n is the total number of features; x_j is the value of the variable X at location j, $w_{i,j}$ is the weight value between features i and j, describing the spatial relationship between the two features.

In our case, as mentioned, the observed variable x is the share of older population of each municipality; the contiguity matrix for the attribution of spatial weights is of the 'Queen' type of first order.[3]

3. Results

3.1. Multi-scale Disparity in the Ageing Process in Italy

The overall disparity in the geographical distribution of the older population remained relatively low throughout the entire period. Within this framework, the spatial disparity in the ageing process of the Italian population, measured through the nested Theil index decomposition, shows a clear and progressive decline from 1991 (0.064) to 2021 (0.021).

This trend indicates increasing territorial convergence, meaning a progressively more uniform distribution of the older population relative to the total population over the decades analyzed (Figure 2). The data presented in Figure 2 clearly highlight two main patterns: (i) all components (divisions, regions, provinces, and municipalities) exhibit a clear downward trend in disparity over time; and (ii) the *within-province* component (T^{W}prov) consistently represents the largest contributor to overall disparity in all the years considered, underscoring the importance of the local dimension.

When comparing the initial and final Theil index values for the different components (Figure 3), it becomes apparent that the *between-division* component experienced a notable reduction in its share of total disparity, from 18.8 to 14.3 per cent. This indicates that the distance between the North, Centre, and South has narrowed over the past thirty years, supporting the idea of a diffusion process of the older population and, more generally, a convergence of demographic regimes at the macro-territorial scale. The *between-region* component also decreased, albeit more moderately. While remaining the second largest contributor to overall disparity in both 1991 and 2021, it has experienced only a moderate decline in its relative weight (from 20.3 to 19 per cent). A stronger reduction is observed for the *between-provinces* component, whose contribution fell from 15.6 to 9.5 per cent, confirming that this level — already the least relevant in 1991 — has recorded the sharpest proportional reduction among all four components.

Conversely, the *within-provinces* component — that is, the local dimension — has increased its relative weight, from 45.3 to 57.1 per cent, despite the overall decline in total disparity. This finding reflects the persistence of local-level inequalities, which

[3]In this kind of contiguity matrix two spatial units are defined as neighbors if they share either a common border or a vertex. This specification is normally preferred, among other criterion based on the concept of contiguity, particularly in settings characterized by irregular administrative boundaries such as Italian municipalities. This choice is also consistent with the recommendations of LeSage and Pace (2009) for spatial econometric analysis of irregular areal data. A substantial body of empirical work at the local scale, including studies on Italian municipalities and ageing processes, adopts the same contiguity structure (Benassi et al. 2023, 2025; Benassi and Carella 2023; Iglesias-Pascual, Benassi, and Paloma 2022; Salvati et al. 2020; Yang, Noah, and Shoff 2015). An alternative class of specifications relies on distance-based spatial weight matrices, where interaction decays with distance according to functional forms such as the negative exponential or inverse distance functions (Getis and Ord 1992). These approaches impose a continuous decay in spatial interaction governed by tuning parameters, thereby avoiding the discrete nature of contiguity definitions. In this context, however, the Queen specification is preferred. Distance-based weights require the selection of additional parameters, which are not uniquely identified and may materially affect empirical results. Moreover, contiguity provides a more structurally grounded measure of neighborhood than centroid-based distances, as it captures actual administrative adjacency, which is particularly relevant for analysing spatial dimensions of ageing (Anselin 1988).

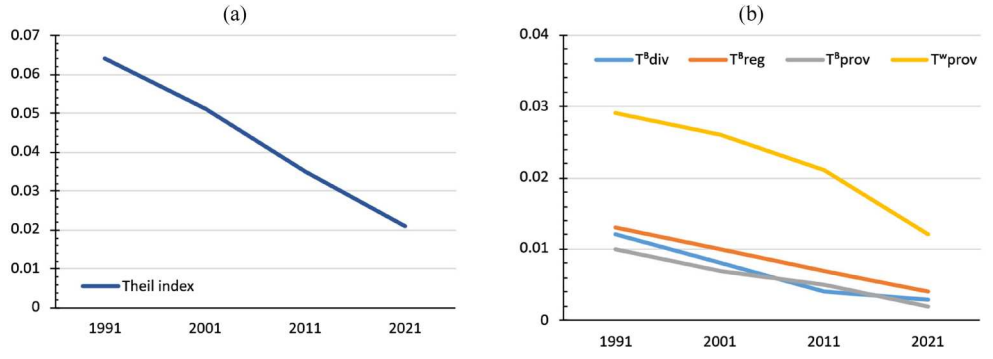

Figure 2. Theil index (a) and its components (b) obtained by the nested decomposition (1991–2021). Source: our own elaboration on Istat data.

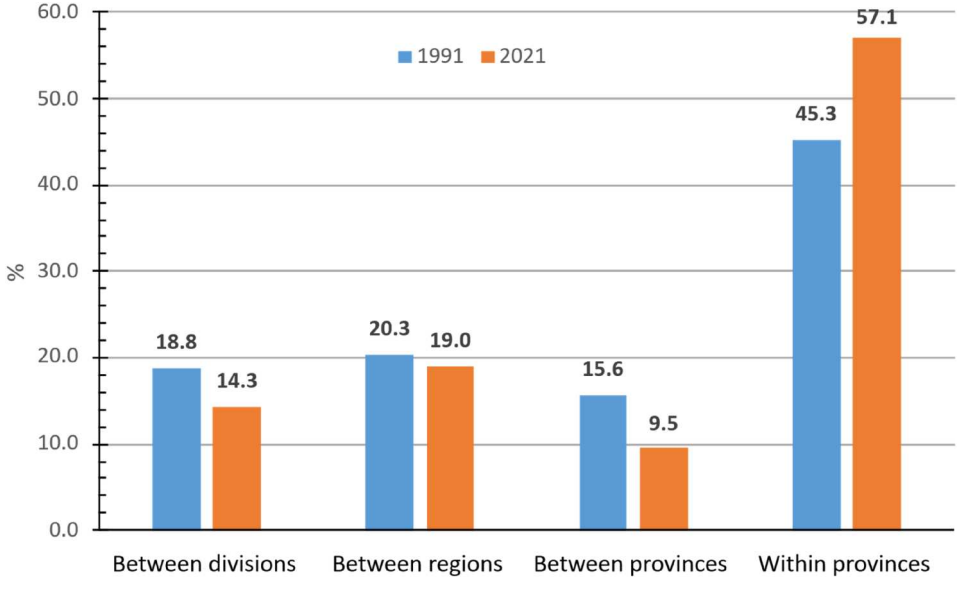

Figure 3. Components' contribution to overall territorial disparity (T). Source: our own elaboration on Istat data.

may be linked to enduring disparities among local contexts within the country — for instance, between rural and urban areas, or between coastal and inland zones.

Several mechanisms may account for this progressive shift of demographic disparities towards the local, within-province scale. First, the selective out-migration of younger cohorts from marginal, rural, and inland areas has persistently aged their resident populations, while urban and metropolitan municipalities have continued to attract younger workers and international migrants, generating sharply divergent demographic profiles even between geographically adjacent communities (Buonomo et al. 2024; Reynaud et al. 2020). Second, differential access to health and social care services — which remain concentrated in urban centres and more accessible settlements — may reinforce local demographic divergence by influencing both residential choices and longevity

outcomes (Benassi, Tomassini, and Di Felice 2025a). Third, morphological and infrastructural constraints, particularly pronounced in mountain and Apennine areas, continue to limit economic connectivity and opportunity, sustaining long-term processes of demographic marginalisation at the municipal level (Armenise et al. 2024). Together, these dynamics suggest that the growing importance of the *within-province* component reflects not merely a statistical rescaling of inequality, but a deepening of structurally rooted local disparities that demand place-sensitive policy responses.

In conclusion, the analysis provides evidence that the process of demographic ageing in Italy has followed a path of progressive territorial convergence. While disparities between macro and intermediate areas — encompassing the traditional North–South divide and differences between regions and between provinces — have gradually declined, inequality has not disappeared. Rather, it has been rescaled and relocated to finer spatial levels. Demographic fragmentation has shifted to the micro and local scale, with municipalities now representing the main arenas of demographic disparity. This finding supports the idea that, although the ageing process has diffused across the national territory, it has done so unevenly, reproducing forms of local clustering that persist despite broader convergence trends. From a policy perspective, these results suggest that strategies aimed at addressing the consequences of demographic ageing should be increasingly designed and implemented at the local level, where differences are most pronounced and where tailored interventions can be more effective than uniform, regionally based approaches.

3.2. The Local (and Spatial) Dimension of the Ageing Process in Italy

The spatio-temporal evolution of the share of the older population shows that the ageing process has progressively and inexorably affected all areas of the country. Over time, a diffusion of ageing across the national territory has been observed, although with varying speed and intensity depending on local contexts (Benassi, Buonomo, and Strozza 2025).

The idea is that the demographic differentials which, particularly in the past, sharply distinguished the major Italian divisions (Bonaguidi 1983) have gradually diminished. This has occurred as a result of persistently low fertility rates that have spread widely across the country (Vitali and Billari 2017) and of increasing longevity regimes — though with some nuances mainly linked to factors exogenous to strictly demographic dynamics (Carboni et al. 2024).

The histograms in Figure 4 illustrate this evolution clearly. The initially quasi-normal distribution of the indicator has shifted markedly to the right, reflecting a substantial increase in the central value of the distribution, from 8.5 to 13.3 per cent, while the dispersion around the mean has remained almost unchanged, as indicated by the stable standard deviation. This finding, whose spatial implications will be discussed later, suggests that the rise in ageing levels, and particularly in the share of the population aged 75 and over, has not been accompanied by a change in the variability of its spatial distribution.

The patterns emerging from the maps are clear and compelling. The share of the older population has become increasingly widespread: in 1991, only 486 municipalities — mostly located in specific parts of the country, such as the Apennine and Alpine areas or other inland zones — had an older population accounting for at least 15 per cent of

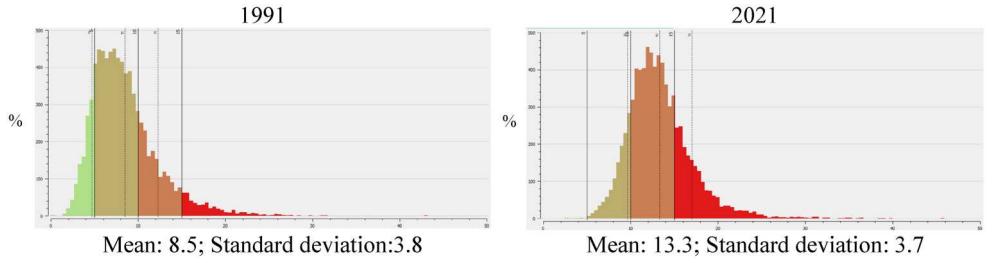

Figure 4. Percentage proportion of older people at the municipal scale. Summary of the distribution. 1991 and 2021. Source: our own elaboration on Istat data.

the total. By 2021, this number had risen to 2,069 municipalities, distributed across the entire national territory, from North to South and from inland to coastal areas (Figure 5).

Nevertheless, the overall increase in the ageing process has been striking, as shown in Figure 6. In 1991, municipalities in which the older population represented no more than 10 per cent of the population accounted for 73.4 per cent of all Italian municipalities. By 2021, this share had collapsed to 15.3 per cent, while those where the older population accounted for at least 10 per cent of the population represented about 85 per cent of all municipalities.

However, when the spatial distribution of the older population and its temporal evolution are analyzed through explicitly spatial methods, it becomes evident that the underlying spatial patterns have remained remarkably stable over time.

The global clustering level of the variable under study, the share of the older population, has remained nearly constant at the national scale, with Moran's I decreasing only moderately from 0.66 to 0.55 from 1991 to 2021. Likewise, the local clustering of the variable — measured in terms of positive spatial autocorrelation and identified as hot and cold spots — reveals geographic patterns that have remained largely stable over time.

More specifically, the local spatial analysis based on the G_i^* statistic identifies hot spots and cold spots that have remained remarkably stable across all four census years (1991, 2001, 2011, and 2021). The main hot spots — areas with a comparatively high share of older population — are concentrated along the Apennine mountain belt of Central and Southern Italy, in the Alpine foothills of the North, and in several inland areas of the South, where out-migration of younger cohorts has long driven demographic ageing. By contrast, the main cold spots — demographically younger areas — correspond to the major metropolitan regions of Rome, Milan, and Naples, as well as coastal and peri-urban zones, which have benefited from sustained in-migration and higher fertility levels. The persistence of these spatial configurations across three decades reinforces the interpretation of path-dependency in Italy's geography of ageing: the relative spatial structure has remained largely unchanged even as overall ageing intensity has increased (Figure 7).

4. Discussion

In recent decades, Italy has experienced a profound transformation in the spatial distribution of its demographic dynamics and processes (Benassi et al. 2023). What once

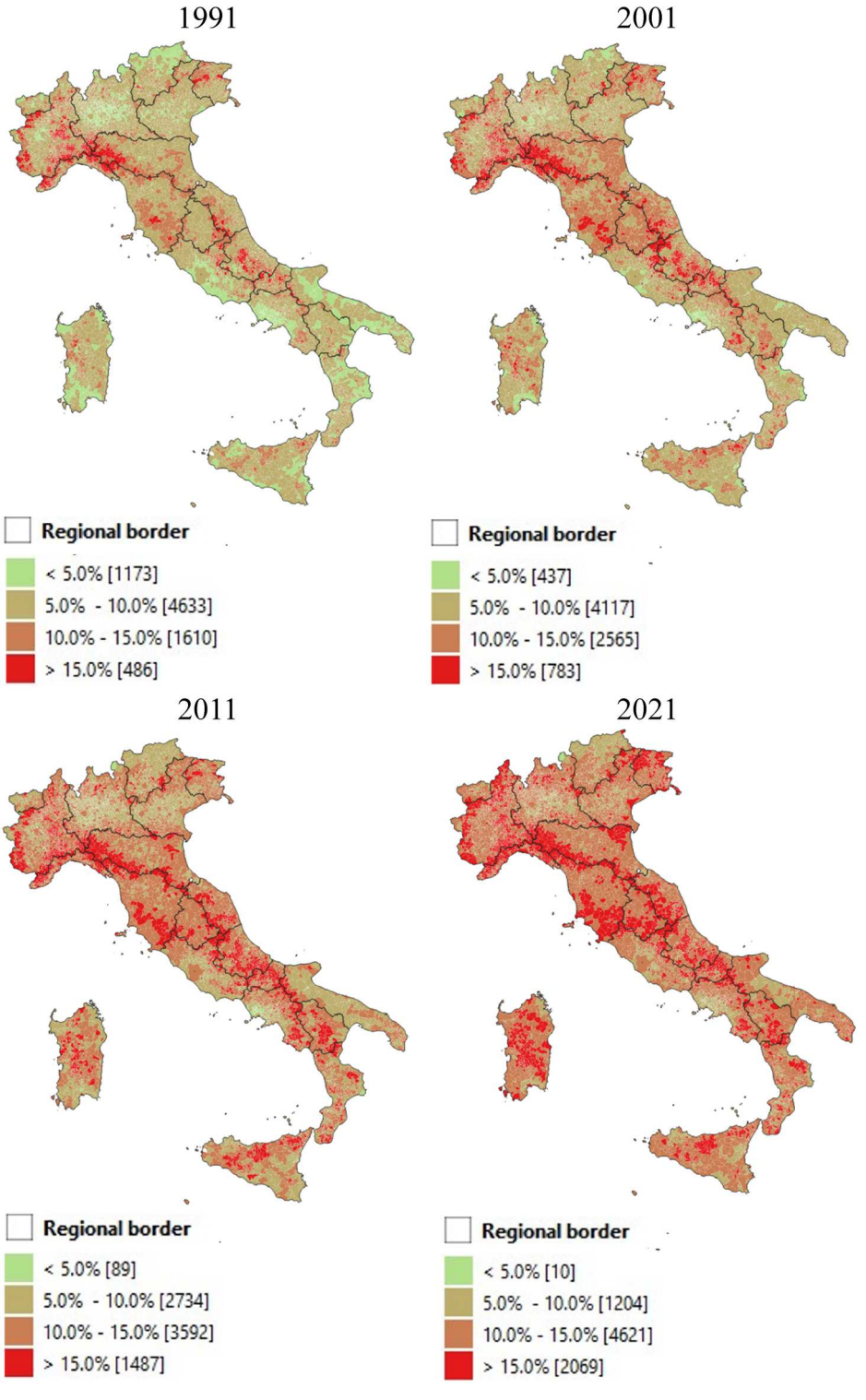

Figure 5. The thematic map of the percentage proportion of the older population. Italian municipalities, 1991–2021. Source: our own elaboration on Istat data.

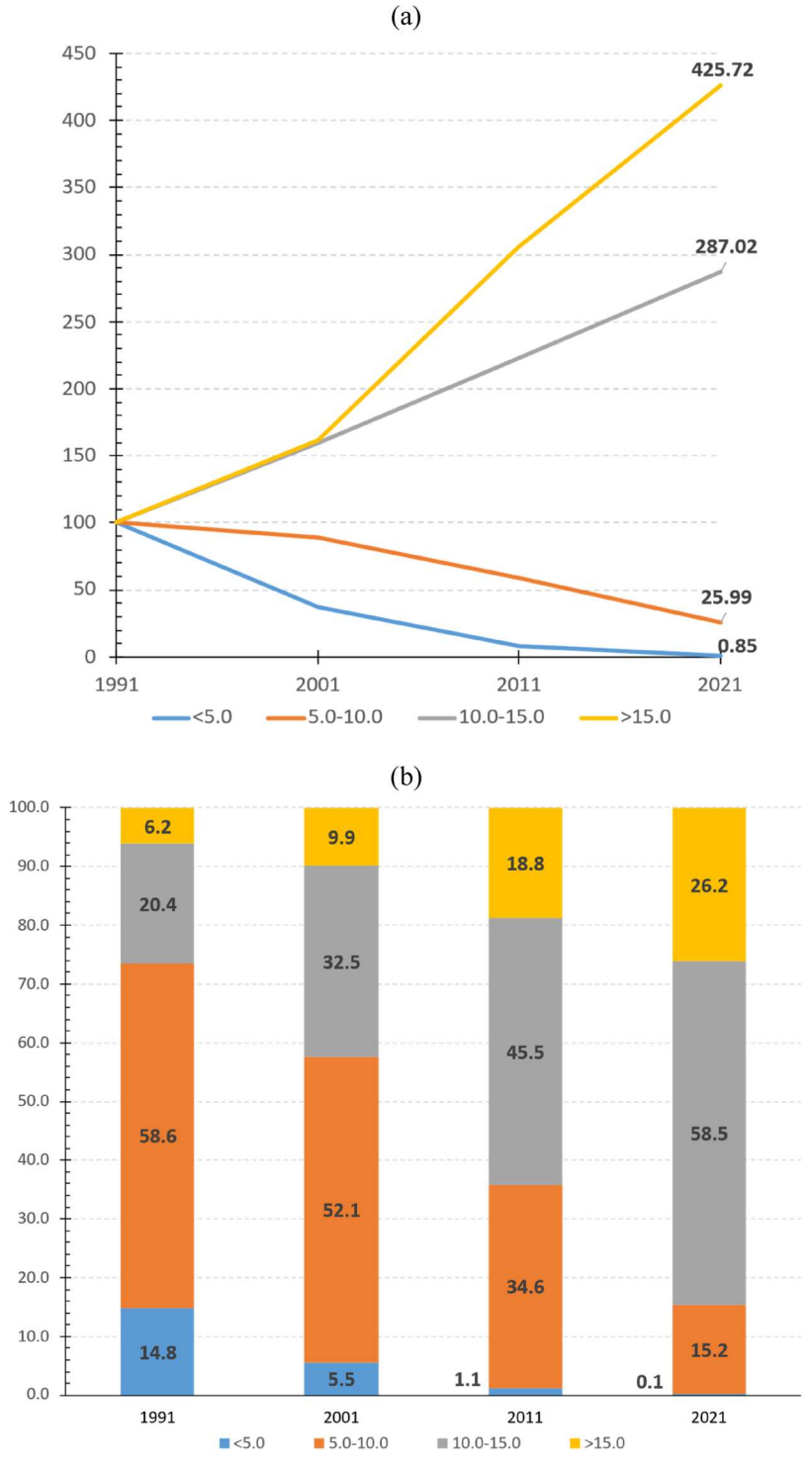

Figure 6. Temporal trends of the percentage of the older population. Index number to a fixed base (1991 = 100) (a) and composition by class categories (b), 1991–2021. Source: our own elaboration on Istat data.

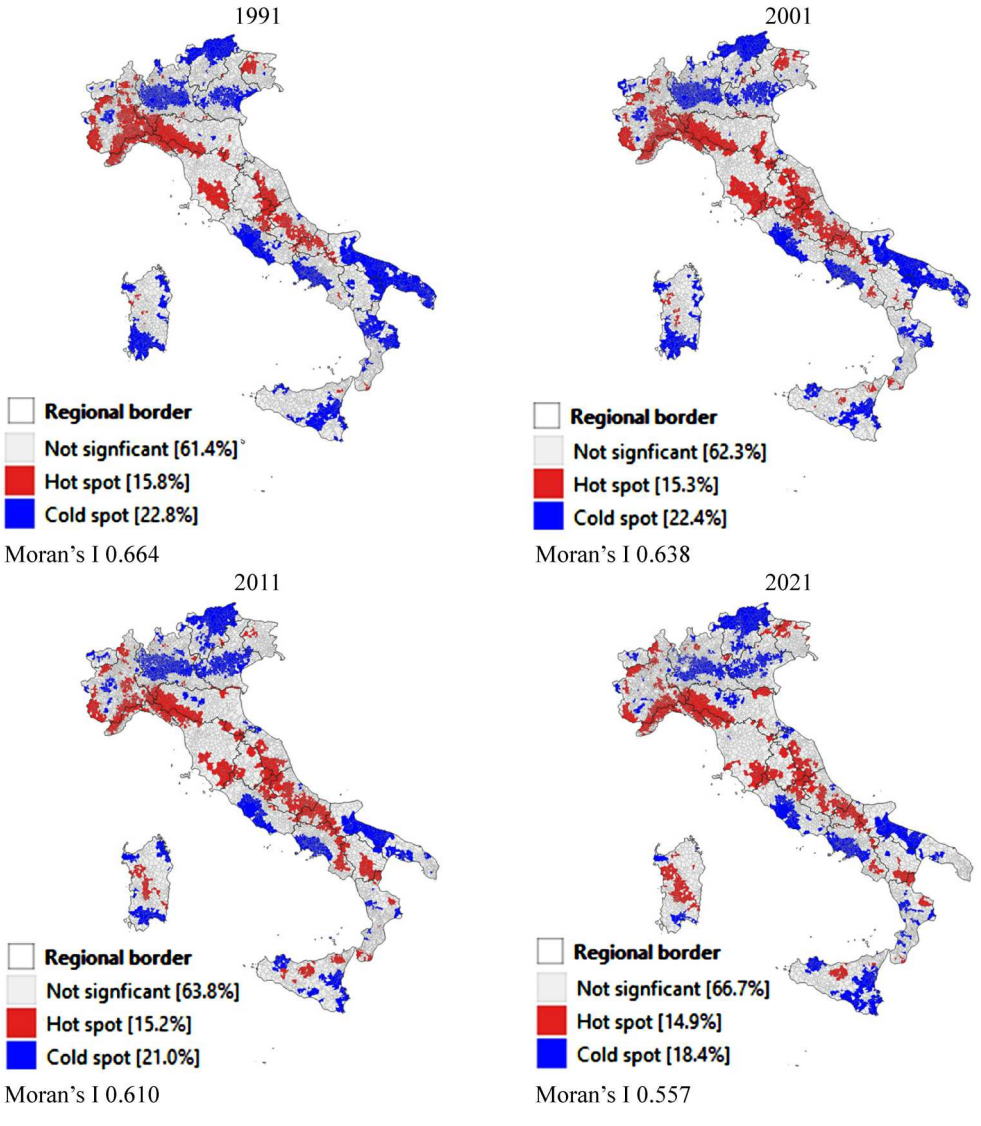

Figure 7. Global level (Moran's I) and local level (G*) of spatial autocorrelation of the percentage of the older population, 1991–2021. Source: our own elaboration on Istat data. Queen contiguity matrix of first-order row standardized weights, *p*-value < 0.05.

appeared as a pronounced regional divide, most notably between the North and the South, has progressively evolved into a more intricate mosaic of differences observable at the micro and local level (Reynaud et al. 2020; Salvati et al. 2020). This shift reflects a broader process of demographic fragmentation, whereby disparities in age structure, fertility, and population decline have become increasingly localized.

If we approach population ageing as an issue related to inequalities in the geographical distribution of older people and total population, we realize that in the last 30 years municipalities have thus emerged as the primary arenas in which demographic disparities manifest. While regional contrasts still exist, they no longer provide a sufficient

framework for understanding the complexity of demographic change in contemporary Italy. Within the same region, adjacent municipalities can exhibit sharply divergent demographic profiles — ranging from rapidly ageing communities to areas still sustaining a relatively balanced population structure. This localization of demographic differentiation signals the waning relevance of the traditional North–South divide that has long characterized Italian territorial analysis. Instead, new patterns of inequality have surfaced within regions, provinces, and even metropolitan areas (Benassi, Tomassini, and Lallo 2024).

As regional and macro-territorial disparities have diminished, the focus of demographic research and policy must correspondingly shift. Designing effective demographic and social policies now requires attention to the local level, where the specificities of communities, infrastructures, and social networks shape population dynamics most directly. Policies aimed at mitigating population decline, supporting active ageing, or revitalizing local economies must therefore be tailored to the distinct needs and capacities of municipalities, rather than conceived through broad regional schemes. In this sense, the future of demographic governance in Italy depends on recognizing and addressing the increasingly fine-grained geography of population change (Busetta et al. 2025).

As for the spatial dimension, we have to say that the ageing process in Italy — captured by the increasing proportion of individuals aged 75 and over — reveals a distinctive spatial dynamic that unfolds primarily at the local scale. Rather than emerging uniformly across the national territory, ageing has diffused through a process akin to contagion, spreading progressively from specific localities outward. This diffusion pattern highlights the relevance of territorial proximity and socio-economic linkages in shaping demographic transformations. Municipalities situated near early-ageing areas tend to follow similar trajectories, suggesting that ageing dynamics are not randomly distributed but follow identifiable geographical paths.

From a strictly spatial perspective, the evolution of the phenomenon points to an intriguing duality. On the one hand, the overall degree of polarization — or clustering — has declined over time, which supports the idea of a spatial diffusion process: regions that were once demographically distinct are now increasingly similar in their ageing profiles. On the other hand, despite this apparent convergence, localized spatial patterns have shown remarkable persistence. Areas that exhibited concentrations of older populations in the early 1990s continue to do so today, revealing a strong path dependency in the geography of ageing.

This apparent paradox can be interpreted as evidence that Italy's ageing process is not characterized by a radical transformation of spatial configurations, but rather by an intensification and territorial expansion of existing patterns. The spatial structures observed three decades ago have not been replaced but reinforced, as ageing has deepened within established clusters and gradually extended to surrounding territories. This continuity suggests that demographic change is closely tied to long-standing socio-economic and infrastructural inequalities, which continue to shape local trajectories of population ageing. Consequently, understanding Italy's demographic future requires not only observing national trends but also paying close attention to these enduring spatial dynamics, recognizing the importance of thinking locally and spatially in demographic studies (De Castro 2007; Fotheringham and Sachdeva 2022; Voss 2007).

5. Conclusion

Population ageing is a defining feature of Italian society, driven by persistently low fertility levels and extraordinary longevity. In many municipalities, high levels of ageing are also accompanied by depopulation processes (Reynaud and Miccoli 2025), which threaten the country's social cohesion and raise crucial questions about how to respond. Some scholars and policymakers advocate continuing *place-based* strategies — such as the National Strategy for Inner Areas — while others, as seen in the Japanese context, have not excluded more radical approaches.'

The present study has shed light on several relevant aspects of the ageing process in Italy that can help inform this ongoing debate. When approached as a phenomenon linked to territorial inequality — here understood as the uneven spatial distribution of the older population relative to the total population — results show that overall disparity has declined over time, pointing to a generalized process of ageing across the country. Yet, within this temporal dynamic, the local dimension emerges as crucial: municipalities continue to display significant relative disparities, reflecting broader patterns of territorial inequality (Benassi et al. 2021).

Indeed, when analyzed at the strictly local level, the process reveals both an increase and diffusion of ageing intensity (measured as the share of the elderly in the total resident population of each municipality), accompanied, however, by a striking stability of spatial patterns over time, as captured by both global and local measures of spatial autocorrelation.

This evidence outlines a distinctive picture: while the intensity of ageing has grown and spread to all Italian territories, the spatial configurations governing the process have remained largely unchanged at the local scale. In other words, from 1991 to the present day, the relative spatial structure of ageing has shown remarkable persistence, suggesting that the geography of demographic ageing in Italy — though evolving in magnitude — continues to be shaped by enduring territorial logics.

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Author Contributions

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