In-between centers and suburbs? Increasing differentials in recent demographic dynamics of Italian metropolitan cities

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Abstract

Verifying the intrinsic stability of demographic processes over time and space is a pivotal task from both science and policy perspectives. Compared with other regions of the old continent, a latent peculiarity of demographic systems in Southern Europe is their persistent heterogeneity over space, especially observed across metropolitan regions. 'Centers' and 'peripheries' are thus becoming representative of, respectively, territories undergoing demographic growth and decline. The former corresponds to urban areas, being attractive for different population segments. The present study illustrates the results of a statistical analysis of total population data over time (2011–2020) and its decomposition in natural increase and net migration rates in 14 metropolitan cities of Italy. Assuming that central and peripheral (e.g., suburbs) locations show differential trends of natural increase and net migration, our analysis verifies whether (i) central locations behave homogeneously in terms of population dynamics, and whether (ii) a North–South gradient holds. Results indicate how (metropolitan) demographic patterns no longer reflect a traditional gap between Northern and Southern regions, while outlining a subtler divide in growing and declining contexts. The few still-growing metropolitan areas were all located in North-Central Italy, and reflect more polarized socioeconomic contexts than in the past. Internal migration was likely the most powerful factor that discriminates growing from declining cities. Such evidence indicates that strengthening the self-restraining capacity of Southern Italian territories contributes to increase their attractiveness of international migration flows, counteracting demographic shrinkage.

Keywords: Urbanization, Population growth, Natural increase, Net migration, Southern Europe

Introduction

Cities are the joint result of modernity and the product of a broader demographic transition determining the intrinsic shift from rural societies to urban ones (Champion & Hugo, 2004). The motivations at the base of the increasing interest on urban demography have been made clear in seminal works, such as Zelinsky (1971) and Keyfitz (1980). It is well-known how urbanization processes began, at least in advanced economies, with the industrial revolution, being in turn associated with

an intense rural–urban exodus. However, cities are spatially heterogeneous and mix demographic and economic changes, likely more evidently than elsewhere (Termote, 2005). Cities are natural attractors of population flows (both internal and international), and actively contribute to territorial rebalancing, by experiencing sequential waves of population growth and decline (e.g., Di Feliciantonio et al., 2018). Gravitational mechanisms attracting population to urban areas involve a set of effects that are both quantitative in nature (e.g., population structure) and qualitative (e.g., lifestyles' change). These effects are evident in cities and, indirectly, also in the surrounding districts, while reducing unless they are incorporated within the metropolitan area (Pumain, 2006).

Urban population growth, and thus urbanization, will continue inexorably, especially in developing countries or in advanced economies under strong immigration pressure (Véron, 2008). Population growth in urban areas of emerging economies may negatively influence the sustainable development path of entire regions or countries, increasing the push factors of international migration (Masini et al., 2019). For the vast majority, these population flows are destined to advanced economies, and basically to their urban areas, triggering a sort of self-propulsive urbanization (Livi Bacci, 2018). The natural growth rate in these countries will continue to decrease and the overall growth rate will tend to stabilize, depending almost exclusively on the international migration balance (United Nations, 2018). Assuming that even in advanced economies, urban population will continue to grow in the future—albeit at a lower rate—a comparative scrutiny of the contribution of natural growth and migration dynamics in population growth seems to be relevant for both science and policy in a changing urban context (Salvati et al., 2013). In this perspective, verifying spatio-temporal stability in demographic processes at the metropolitan scale is meaningful in a multi-disciplinary perspective that encompasses spatial demography, urban geography, applied economics, sociology, and regional planning (Lanfredi et al., 2022; Seifollahi-Aghmiuni et al., 2022; Vinci et al., 2022).

While the impact of migration on urban growth is well-documented in advanced economies (e.g.Kroll & Kabisch, 2012; Lerch, 2013; Pumain, 2006), the natural component seems to have regained—at least in recent times—a fundamental role in urbanization processes, especially in some specific contexts (Menshae Oren & Bocquier, 2021). Adopting a metropolitan observation scale is appropriate in such investigations for two reasons (e.g., Vitali, 1990), namely (i) the long-term attractiveness to the migrant labor force, and (ii) the rapidity of economic, social and demographic changes, assumed to be higher than elsewhere in the country.

In line with the assumptions above, an intrinsic peculiarity of demographic systems in Southern Europe—compared with other regions of the old continent—is their intrinsic spatial heterogeneity. Centers and peripheries are becoming representative of, respectively, territories undergoing demographic growth and decline, displaying marked differences in the specific rates of growth and decline over space (Salvati et al., 2018). Generally speaking, the former areas correspond to urban districts, being attractive for different population segments, while the latter areas reflect inland districts experiencing depopulation and a higher process of aging (Reynaud et al., 2020). Together with other socioeconomic characteristics, this aspect contributes to delineate a sort of 'demographic exceptionalism' typical of some specific population dynamics, and the Italian

case was often recognized as a representative example of such development path (e.g., Billari & Tomassini, 2021).

Translating into deep and persistent territorial gaps in demographic development (Benassi et al., 2021), similar transitions were investigated in specific cases representative of both Spanish and Greek communities, among others (e.g., Zambon et al., 2017). In all these cases, demographically growing contexts were increasingly mixed within relatively small regions with declining ones that became progressively more marginal, peripheral and isolated (Di Feliciantonio & Salvati, 2015). These processes consolidated—for Italy, and likely for other Northern Mediterranean countries (e.g., Gavalas et al., 2014)—a sort of 'demographic malaise' (Golini et al., 2001). However, as some studies have pointed out (e.g., Salvati et al., 2020), the reality is quite complex because even neighboring local contexts have experienced different demographic dynamics. For instance, unlike virtually all other Italian mountainous districts and most urban ones, positive natural growth rates characterized population dynamics in Trentino-Alto Adige, a rural (and low-density) area in Northern Italy—apart from two small cities like Trento and Bolzano (Benassi et al., 2021).

Population growth rates may depend on the geographic scale adopted and on the type any given territory is classified in (Salvati et al., 2020). This heuristic process assumes a continuous variable, such as space, as made discrete and, thus, classifiable into distinct types for operational (e.g., administrative, governmental, or functional) purposes (How-ell et al., 2016). The consequent spatial imbalance has led to a dualistic demographic regime that undermines the prerequisites for sustainable development (Reynaud et al., 2020). Nonetheless, demographic divides into dynamic and depressed contexts have been commonly observed in several other European regions, and increasing efforts were undertaken to counteract demographic shrinkage in such contexts (Muti, 2023; Raugze et al., 2017). Similarly with other Mediterranean countries (Salvati et al., 2018), Italy has long put in place a set of active policies within the National Strategy for Inner Areas aimed at rebalancing territorial gaps in demographic development, facing with depopu-lation of internal, peripheral locations. Socioeconomic contexts with unequal population growth rates have experienced decreasing levels of territorial cohesion, with negative effects on local development and regional competitiveness at large (Istat, 2019).

Studies focusing on major metropolitan areas in Italy (Salvati & Carlucci, 2014; Strozza et al., 2016) are particularly interesting in this perspective. Scholars have high-lighted how, at least in the 2001–2011 census decade, an intense demographic diversi-fication in centers and surrounding municipalities has consolidated, the former being more attractive than the latter, especially as far as foreign population is concerned. How this diversification distributes along the latitudinal gradient in Italy, namely in North-ern and Southern regions, was also investigated, considering Northern regions have been traditionally more attractive to internal and international migration than South-ern regions, albeit with some important distinctions (Reynaud et al., 2020). These results resembled those collected in a more recent study (Benassi et al., 2019a) examining pre- and post- economic crisis internal migration flows of Italians and foreigners in 21 Italian Local Labor Systems classified as the 'main urban realities' of the country (Istat, 2015).

From this perspective, the most recent demographic dynamics of Italian Metropolitan Cities (henceforth MCs) broken down into a central municipality and the surrounding

municipalities belonging to the MCs' ring area (suburbs) have been reconstructed here. Grounded on this analysis, our contribution sheds light on mechanisms regulating how spatial heterogeneity in demographic dynamics reverberates in the local development of individual metropolitan contexts (center *vs* suburbs) and in the overall urbanization of a given country. Operationally speaking, the present study tests a 'differential demography' hypothesis in Italy, verifying whether centers and suburbs have experienced different demographic patterns over the past decade, and whether a difference between centers and suburbs of the Northern MCs compared with the Southern MCs exists. Data from the inter-censual population reconstruction released by Italian National Institute of Statistics (Istat) and the most recent demographic balance data derived from the national population register make it possible to analyze how the different components that contribute to population change have affected the intrinsic dynamics of centers and suburbs in 14 Italian MCs.

A statistical analysis of such data was aimed at evaluating if centers and suburbs show differential trends in natural and migration dynamics, and if centers behave homogeneously in terms of population dynamics or whether, conversely, a North–South divide holds. An exploratory multivariate analysis based on clustering contributed to delineate the relevance of both assumptions in a local to regional perspective. Grounded on descriptive and exploratory analysis of official statistics, the paper is organized as follows. Section "Methodogy" describes data sources, elementary variables, and the statistical methodology adopted, as well as the geographical context of investigation. The empirical results are shown in the "Results" section. Debating broadly the relevance of a comparative demographic analysis of cities and metropolitan areas in light of the findings of this study, some final reflections are provided in the "Discussion" and "Conclusions" sections based on the most recent literature.

Methodology

Study area

The analysis refers to the 14 MCs of Italy, partitioned into central municipalities and the rest of the municipalities (suburbs) composing the whole metropolitan area (Fig. 1). The national law 142/1990 reorganized the structure and function of local authorities into MCs which, however, were effectively implemented as an active player of local governance only since 2012. There are currently 14 MCs in Italy and, in 13 out of 14 cases, their territory coincides with the respective provincial boundaries. The exception is Cagliari where the MC is smaller than the respective province, being composed of just 17 municipalities, the smallest number in our sample. Conversely, Turin's MC includes more than 300 municipalities. Overall, there are 1269 metropolitan municipalities (centers and suburbs) with a total resident population of more than 21 million inhabitants at the beginning of 2020 (36% of Italian resident population). Seven MCs are located in Central-Northern Italy while the remaining seven are located in the Mezzogiorno, albeit with a prevalence for Sicily, which hosts three MCs.

Rome is the MC with the largest population size (more than 4 million residents); the smallest one is Cagliari, just over 420,000 residents (Table 1). In Southern Italy, Naples, just over 3 million residents, was the third largest among the 14 MCs. Some signs regarding the different internal structure of each MC can be glimpsed in the
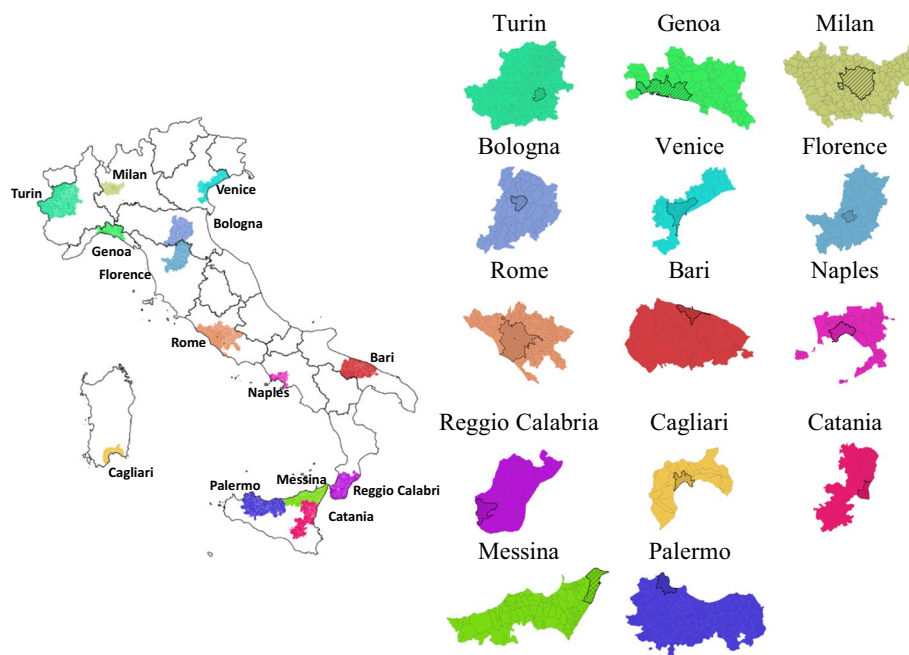
Fig. 1 Spatial location and internal structure of municipalities in Metropolitan Cities (MCs). On the right side, darker-colored polygons identify the central municipality of each MC. Source: our elaboration on Istat data

Table 1 Selected statistics of Italian Metropolitan Cities, at the beginning of 2020[a]

Name	Number of municipalities	Administrative region	Macro-area	Resident population	Pop. in central municipality (%)
Turin	312	Piedmont	North-west	2,230,946	38.5
Genoa	67	Liguria	North-west	826,194	68.5
Milan	134	Lombardy	North-west	3,265,327	43.6
Bologna	55	Emilia-Romagna	North-east	1,021,501	38.7
Venice	44	Veneto	North-east	848,829	30.5
Florence	41	Tuscany	Centre	995,517	36.9
Rome	121	Lazio	Centre	4,253,314	66.0
Bari	41	Apulia	South	1,230,205	25.6
Naples	92	Campania	South	3,034,410	31.3
Reggio Calabria	97	Calabria	South	530,967	32.9
Cagliari	17	Sardinia	Islands	422,840	35.7
Catania	58	Sicily	Islands	1,072,634	27.6
Messina	108	Sicily	Islands	613,887	21.2
Palermo	82	Sicily	Islands	1,222,988	52.9
Total	1269			21,189,003	43.4

[a] The geographies refer to 2019

Source: our elaboration on Istat data

weight that the center holds in relation to the total population residing in the area. From this point of view, the most unbalanced system is Genoa, where 68.5% of the population resides in the central municipality. Not far behind is Rome, with 66% population residing in the central municipality. Palermo, Catania and, in general,

the MCs of Southern Italy registered very low shares of this indicator, reflecting less mono-centric structures than those of North-Central Italy, likely because of the lower attraction of the central municipality with respect to internal and, above all, international migration flows (Strozza et al., 2016). These figures, however, provide a partial snapshot of what has been earlier observed in literature, as a result of heterogeneous demographic dynamics (Benassi et al., 2019a).

Data sources
Data at the municipal level refer to stocks and flows quantifying population dynamics (namely, births, deaths, in-migration and out-migration), and were derived from the inter-censual population reconstruction and the official population balance for the year 2019 and 2020, both released by Istat. It is worth mentioning that (i) demographic balance takes into account the results of the first wave of the so-called permanent census in Italy and that (ii) municipal geographies are stable over the years since they are reconstructed at the most recent date, thus ensuring comparisons over space across time. Municipal boundaries (shapefiles) were made available by Istat.

Indicators and statistical analysis
To assess the distinctive contribution to population growth, demographic rates have been decomposed following Preston et al. (2001). This rationale has found recent application in several contributions concerning Italy (Strozza et al., 2014a, 2016). More specifically, the average annual growth rate (r) is decomposed into the natural increase (ni) and the net migration, both internal (nmi) and international (nma—where 'a' stands for abroad), according with the specification below:

$$r = \frac{\ln \frac{N(t)}{N(0)}}{t} = \frac{(N(t) - N(0))}{\frac{t(N(t)-N(0))}{\ln\left(\frac{N(t)}{N(0)}\right)}} = \frac{{}_{\Delta t}\text{NI} + {}_{\Delta t}\text{NMI} + {}_{\Delta t}\text{NMA}}{\frac{t(N(t)-N(0))}{\ln\left(\frac{N(t)}{N(0)}\right)}} = \text{ni} + \text{nmi} + \text{nma}.$$

(1)

Total population growth rate (r) was calculated as the ratio of population change in the time interval considered (N(t) − N(0)) to the number of person years lived by the population in that interval (t*(N(t) − N(0)) / ln(N(t)/N(0))). Similarly, the rate of natural increase (ni) and those of net migration (nmi + nma) are calculated by placing person years at the denominator of the equation. Equality between the overall rate of increase and the sum of the natural and migration rates is thus ensured.[1]

In the first part of the analysis, demographic rates in central municipalities and suburbs were reported using descriptive statistics and illustrated through thematic maps. In the second part of the analysis, the same demographic rates are used as

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[1] The official population balance for the year 2019 and 2020 released by Istat contains information on cancellations and enrolments from the place of residence for 'other reasons' too. These are statistical estimates of cancellations and enrolments that cannot be ascribed to demographic events (births, deaths and migrations). In the computation of r, we have considered these estimates that, on the contrary, are not considered in the decomposition of r (therefore, they are not included in Eq. 1). This implies that the sum of ni + nmi + nma is not perfectly equal to r. However, it should be considered that on average the inclusion of such detail affects r by only −0.06%. To assess the consistency of our measures, we also calculated the annual rate of natural increase, annual rate of internal migration and annual rate of international migration for the period 2011–2020 of each center and suburbs of the 14 Metropolitan Cities. All results are available upon reasonable request to the authors.

input variables in a cluster analysis classifying the statistical units (1269) in a number of smaller and homogenous groups. More specifically, we run a hierarchical clustering using the Ward's linkage method and the Euclidean distance as the amalgamation function. Prior to clustering, demographic rates were standardized to a Z distribution. Also in this case, the results have been mapped to delineate the geographical distribution of the clusters. Maps have been realized with the Quantum GIS software (Qgis) 'Odense' version 3.20, and the multivariate analysis has been carried out with GeoDa.

Results

Demographic dynamics in the Italian metropolitan cities

Ten MCs experienced demographic decline over the decade 2011–2020 (Table 2). With the exception for Genoa, where the demographic decrease has been intense, a moderate demographic shrinkage characterized some specific contexts (Turin, Venice) in Northern Italy; conversely, all the metropolitan cities in Southern Italy experienced population shrinkage, with particularly high and negative rates in some cases. This result reflects repulsive metropolitan contexts, in line with the economic backwardness of Southern regions. Reggio Calabria and Messina have experienced the most intense population loss in both centers and suburbs among Southern MCs. In Northern Italy, intense losses were recorded in central municipalities of Genoa, Turin, and Venice, while maintaining a slightly positive rate in some cases. Suburbs displayed similar profile, except for Venice, where suburban population grew slightly (+0.6%). Venice was also the only MC in Italy where population changes in central and peripheral locations were discordant in both sign and intensity. The particular conditions of Venice MC and, specifically, of its central municipality, may play a role in such dynamics. Apart from Venice, the full concordance of population dynamics

Table 2 Changes over time (%) in resident population of the 14 Italian MCs, centers and suburbs (2011–2020)

Name	MC	Center	Suburbs
Turin	− 1.9	− 3.6	− 0.8
Genoa	− 4.9	− 5.1	− 4.5
Milan	6.6	11.6	3.1
Bologna	4.2	5.8	3.2
Venice	− 0.4	− 2.5	0.6
Florence	0.8	0.3	1.0
Rome	5.1	5.7	3.8
Bari	− 2.2	− 1.0	− 2.6
Naples	− 1.5	− 1.5	− 1.5
Reggio Calabria	− 4.3	− 3.9	− 4.5
Cagliari	− 0.6	− 1.2	− 0.3
Catania	− 1.8	− 0.1	− 2.4
Messina	− 6.3	− 6.7	− 6.0
Palermo	− 2.4	− 1.9	− 3.0

Source: our elaboration on Istat data

in both sign and intensity between centers and suburbs all over Italian metropolitan regions may indicate how urban contexts seem to attract (or lose) population under the same development trajectory, and not as a result of differential urbanization processes, as delineated in earlier studies (e.g. Benassi & Mantuano, 2017).

Only four MCs in Northern-Central Italy experienced a positive change in resident population. Among them, Milan (near 7%) outperformed the remaining part of the sample, displaying the highest peak in central locations (almost 12%). In line with this result, the most intense population change was associated with central locations in three out of four cases, with the sole exception of Florence. Taken together, these results indicate, on average, that population grew more rapidly in central locations than in suburbs. However, restricting the sample to shrinking metropolitan regions, suburbs have registered the most intense population loss in four to ten cases.

Figure 2 focused on demographic dynamics in centers and suburbs of each MC. In some metropolitan contexts, the evolutionary path of centers and suburbs have been—at least for some years—discordant, and led to slightly different trends.

Fig. 2 Resident population in centers and suburbs of Italian MCs, 2011–2020. Fixed-base index numbers (2011 = 100). Source: our elaboration on Istat data

Toward differential demographic dynamics in centers and suburbs?

In this section, the positive (or negative) contribution of specific demographic rates (natural increase and net migration) to the overall population change (r) are quantified. Maps for each of the MCs (Fig. 3) have been realized treating demographic rates as dichotomous variables, and graphically distinguishing values greater than zero from smaller values equal to zero or negative.
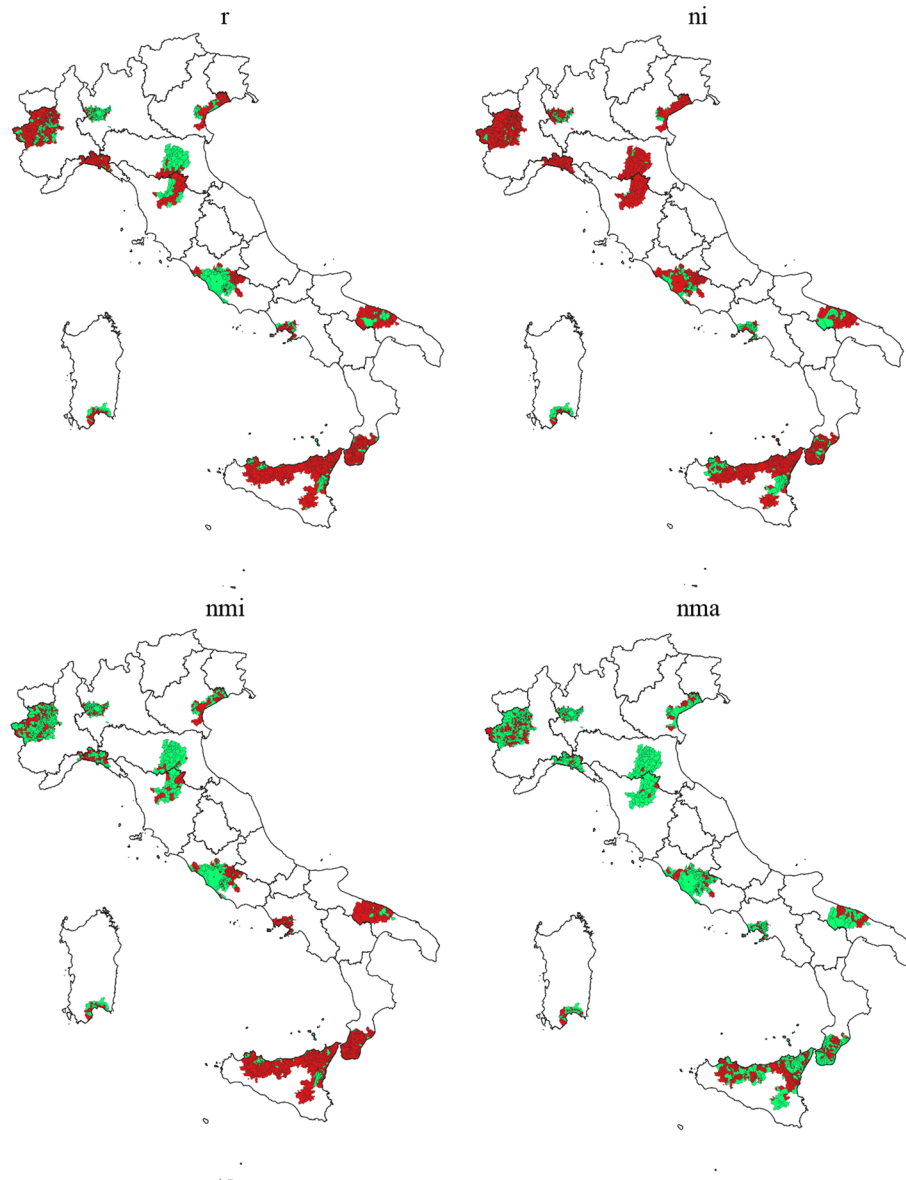

Fig. 3 Total (r), natural (ni), internal (nmi) and international (nma) migration rates of population growth in MCs, 2011–2020. Red indicates negative rate values (< 0), green indicates non-negative rate values (≥ 0). Source: our elaboration on Istat data

As far as Northern-Central metropolitan contexts, some of them experienced negative changes (Turin, Genoa and Venice) while the others grew during the last decade. Natural growth rates were, in turn, even more negative and widespread, with the only exception of Rome and Milan, where a structural belt of municipalities around the central city display non-negative natural growth rates. The capacity to attract internal and international immigration flows characterizes most of the municipalities in Milan, Rome, Bologna and, to a lesser extent, Florence metropolitan areas. Non-positive values of net internal migration rates were found in a few municipalities concentrated at the edge of these MCs. In the rest of Northern MCs, several municipalities recorded non-positive values of the internal migration rate. This occurs also with reference to the international migration rates. This condition is particularly evident for Turin.

In several metropolitan contexts of Southern Italy, population contraction has been widespread and, in some cases, particularly intense (see Table 2). Although with some minor exceptions, the spatial distribution of natural increase rates indicates how non-positive values are widespread throughout the municipalities that belong to Southern MCs. Only in Naples and Cagliari, some hinterland municipalities displayed non-negative natural growth rates, on average. To some extent, the same pattern was observed in the other Southern MCs with the exception of Messina. Compared with the demographic dynamics in Northern-Central Italy, these patterns reduced the attractiveness of metropolitan contexts in Southern Italy. In almost all cases, with the sole exception of Cagliari, central municipalities have displayed negative values of the net internal migration rate confirming—at least indirectly—the low attractiveness of such territories.

The spatial distribution of internal migration rates was relatively more heterogeneous. Since all Southern MCs turned out to demographic shrinkage, the positive contribution of international migration failed to compensate for natural losses (deaths higher than births) and the rapid fall out of internal migration rates. A relatively homogeneity, however, emerges in central municipalities of Southern Italy compared with those of Northern Italy, with all municipalities recording positive values. This aspect outlines that the large cities of Southern Italy are still attracting foreign migrants. Comparatively smaller is the number of non-central municipalities belonging to Southern MCs that record non-negative values of the international migration rate.

Comparing demographic dynamics in central cities: is there (still) a North–South divide?

In this section, we focus on central municipalities, with the aim at verifying the existence of a North–South divide in demographic dynamics of central cities (Fig. 4). In these contexts, migration dynamics have determined the overall decrease (or increase) in metropolitan centers, given the negative contribution of the natural increase. It is precisely in this respect that demographic dynamics in Northern-Central Italy were different from those observed in the South. Taken together, differences between Northern-Central areas and the South of Italy persist and can be explained with the different attractiveness toward migration movements, especially the internal ones. If it is true that, albeit with different intensities, all central municipalities in this study record positive international migration rates, this is not true for internal migration, for which all southern MCs, with the sole exception of Cagliari, negative values were observed, being particularly high in some peripheral contexts such as Reggio Calabria and Messina.
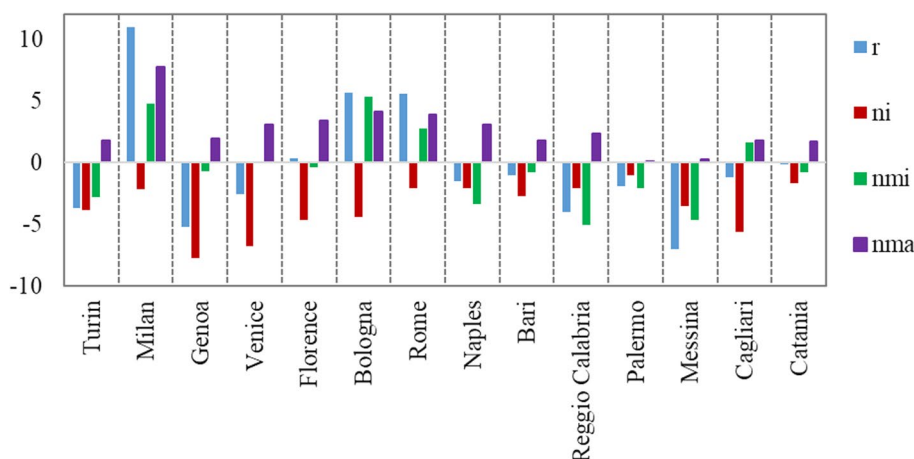
Fig. 4 Total (r), natural increase (ni), internal (nmi) and international (nma) migration rates of resident population in the central municipalities of the 14 MCs of Italy, 2011–2020ª (values per thousand inhabitants). Source: our elaboration on Istat data

Neighbors matter?

In this final section we reflect on a broader issue, considering simultaneously all the municipalities without defining an a-priori hierarchical structure, i.e., without making any kind of distinction between centers and suburbs or between macro-areas (Centre-north *vs* South). Thus, a search is made for their classification that may (or may not) reproduce their position in the urban hierarchy and geographical location. In the analysis, we followed a data-driven approach using a hierarchical supervised clustering based on Ward's linkage method. As the distance function, we used the Euclidean distance and demographic rates have been standardized to a Z distribution before classification. We tested different solutions with the same approach (i.e., different partitions of the dendrogram) also using a non-hierarchical clustering method based on K-means.[2] Assuming both clustering method and approach as important, the direct knowledge of the territory and the observed process is even crucial when identifying the best solution among the theoretically infinite solutions that can be achieved in this kind of analysis (Vickers & Rees, 2007). Based on these premises and after a comparative scrutiny of the different solutions achieved, we chose the optimal partition based on four clusters[3]. The percentage ratio of between-cluster sum of square to total sum of squares is slightly less of 50% (46.3%) and the results are coherent with the ones obtained so far. The summary statistics of the clustering output and the name of each cluster are illustrated in Table 3.

Cluster 1 is composed mainly by small population municipalities, the average demographic dimension in 2011 was about 2.3 thousands per municipality. In the same year more than 750 thousands people (3.5% of the total "metropolitan" population) lived here. It has the highest negative level of the total growth rate (− 11.5‰) and the one related to the natural increase (− 9.9‰), therefore it is characterized by a condition

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[2] All the results are available upon reasonable request to the Authors.

[3] This solution, is based on a good statistical performance and on its usefulness in classifying municipalities with respect to the different patterns of demographic evolution observed in the study. According to Vickers and Rees (2007) usefulness is a very important parameter to consider in spatial classification processes.

Table 3 Clusters names, profiles and characteristics[a]

Clusters	Number of municipalities	Clusters centers[b] (‰)				North	Centre	South	Total	Average municipal pop. size[c]
		r	ni	nmi	nma	%	%	%	%	
1. Depopulation and denatality	326	− 11.5	− 9.9	− 3.0	0.3	27.0	16.7	27.1	25.7	2307
2. Small scale decline	64	− 5.5	− 6.2	− 8.2	7.7	2.5	8.0	7.3	5.0	3207
3. Small decrease due to immigration from abroad	563	− 2.5	− 1.8	− 1.9	0.6	36.3	38.3	56.4	44.4	29,572
4. Increase by immigration	316	4.1	− 1.2	4.8	0.5	34.3	37.0	9.3	24.9	12,159
Total	1269	− 3.6	− 4.0	− 0.9	0.9	100.0	100.0	100.0	100.0	16,882

[a] In the computation of r, the statistical estimates of cancellations and enrollments that cannot be ascribed to demographic events (births, deaths and migrations) are considered. Therefore, the sum of ni + nmi + nma it is not perfectly equal to r (see footnote 1). [b] The values of cluster centers in the total row are obtained by separately calculating the average of r, ni, nmi, nma of all (1269) municipalities considered. [c] Population data refer to 2011

Source: our elaboration on Istat data

of 'depopulation and denatality'. The only positive cluster center is the one referring to international migration flows, while maintaining rather low (the lowest value recorded in the sample was 0.3‰). Around 27% of metropolitan municipalities of both Northern and Southern Italy belong to this cluster. A lower percentage is recorded for the Centre (16.7%). Cluster 2 is the smallest in the sample, being formed of just 64 municipalities. In these municipalities resided 1% of the total population (equal to more than 200 thousand individuals) in 2011. The average municipal population in the same year was equal to more than 3 thousands individuals per municipality. This cluster shows a 'small scale decline' and a high international migration rate (7.7‰). These are very small and isolated municipalities that represent a restricted percentage of the metropolitan municipalities in each macro-area. Cluster 3 represents the largest cluster in terms of municipalities' number and residing population. More than 16 million people (77.6%) resided in these municipalities in 2011. Its average population was more than 29.5 thousand individuals per municipality. All the 14 central municipalities of the MCs belong to this cluster. The cluster is characterized by municipalities that have 'small decrease due to immigration from abroad'. It is characterized by a negative value of all the demographic rates, with the exception of the one related to the international migration flows (that is positive and comparative high). Cluster 3 includes 36.3% of the metropolitan municipalities located in Northern Italy, 38.3% of the metropolitan municipalities of Central Italy, and the vast majority (56.4%) of the ones in Southern Italy. Cluster 4 is formed by a number of municipalities similar to cluster 1. However, compared with Cluster 1, Cluster 4 has a higher average population dimension per municipality (about 12 thousand people) in 2011. The population residing in the municipalities pertaining to this cluster accounted for 18% of the population considered in 2011 (nearly 4 million people). This is the only cluster that shows a positive population growth rate (4.1‰) that is determined by the positive value of both migration growth rates. In other words, this cluster is composed by municipalities that 'increase by immigration'. These municipalities that belong to this cluster attract intense internal migration flows (the internal migration rate is the highest, 4.8‰). Natural growth rate, although negative, was the highest in the sample ($-$ 1.2‰). Only 9.3% of Southern metropolitan municipalities belong to this cluster.

   What is relevant to the aim of our research is understanding the spatial distribution of such clusters. In Fig. 5, we reported two MCs representative of the macroscopic patterns detected for each macro-area. The major distinction between the metropolitan cities of Central-Northern Italy and the ones in Southern Italy is not related to the demographic dynamics at the core of such systems. Indeed, all the central municipalities belong to the same Cluster (3). The crucial difference is instead related to the demographic patterns observed in the municipalities around the central city. In the case of Northern and Central MCs, most of them (especially in the cases of Bologna, Rome and Florence) were classified in Cluster 4, suggesting a high level of attraction in terms of net migration. Please note that the higher shares of municipalities belonging to Cluster 4 are recorded in Northern MCs and, in particular, in Bologna, Venice and Milan. On the opposite, the lower shares are recorded in the Southern MCs especially in Reggio Calabria, Messina, and Bari. In Southern MCs, we find a completely different demographic pattern. In particular, the municipalities around central cities do not belong to Cluster 4 but to the same Cluster 3 of the central city.
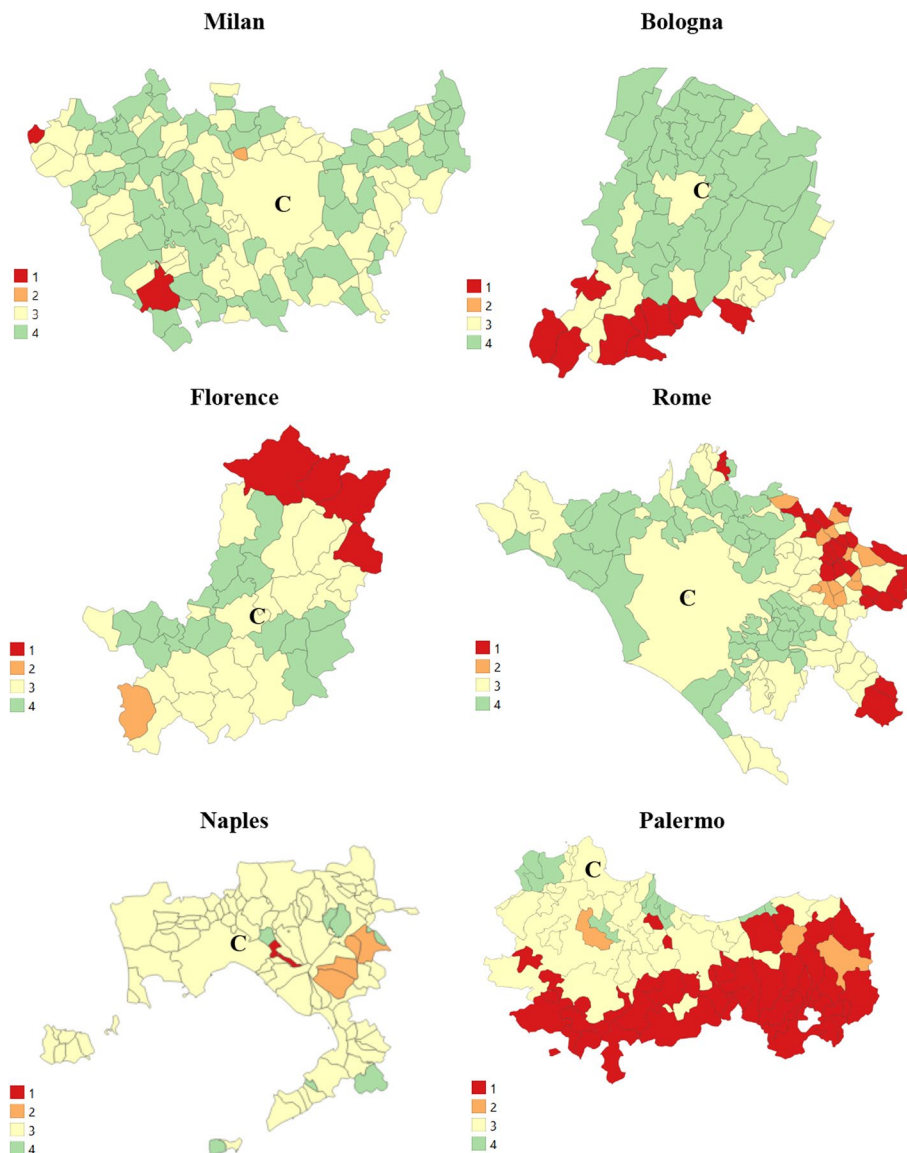
Fig. 5 Clustering results in selected Italian MCs. C stands for central municipality of the MC. Source: our elaboration on Istat data

A high percentage of municipalities of several Southern MCs—Naples, Bari, Palermo, Cagliari and Catania—belong to cluster 3 even if the share of municipalities of Cluster 1 is in some cases (Palermo) quite high. In Reggio Calabria and Messina, the percentage of municipalities of cluster 1 is comparatively high with the former that records the highest value among the Southern MCs.

Discussion

A specific focus on population dynamics in large Italian cities has a long research tradition. In this vein, we first recall two historical pieces of work, namely Botero's investigation on the causes of the greatness and magnificence of cities, dated 1588, and containing some fundamental points of modern demographic thought (Scalone, 2020),

and Mortara's (1908) book analyzing the population of large Italian cities. More recently, several works have dealt with urban demography of Italy, starting from Di Staso (1992). While the set of contributions published over time is particularly ample and articulated, specific issues associated with population dynamics, including residential segregation of native and immigrant population in large Italian cities, have been increasingly investigated over time. Examples can be found for Rome and Naples (Benassi et al., 2019b), Palermo (Busetta et al., 2016), Milan (Rimoldi & Terzera, 2017) and Catania (Mazza & Punzo, 2016) and for some of the main Italian urban contexts (Bitonti et al., 2023). Crisci (2010), Salvati and Carlucci (2014) and Trappolini et al. (2021) provided specific contributions about demography, urban transformations, and differential mortality between foreigners and Italians in Rome. Strozza et al. (2014b) focused on the demography and reproductive behaviors characteristic of Naples' neighborhoods. Grounded on a comparative approach, Barbieri et al. (2019) evaluated demography *vis à vis* socioeconomic inequalities in 14 Local Labor Systems of Italy whose capital city is classified as the central municipality of the related metropolitan region. In this vein, Strozza et al. (2016) investigated the impact of internal and international migration on population growth of the main Italian urban agglomerations.

The empirical results of our study move in line with the abovementioned works, and delineate a coherent demographic development in Italy since the first decades following World War II, with distinctive dynamics in Northern and Southern regions (Reynaud et al., 2020). We discuss such findings in relation with different patterns of (internal and international) migration starting from the seminal work of Bonaguidi (1985). Pivotal socioeconomic changes have occurred in the aftermath of World War II, together with important geo-political and technological transformations respectively typical of the Mediterranean basin and of the most advanced economies in the world (e.g., Morelli et al., 2014). Following the intense financial crisis battling Southern Europe—likely more intensively than the other European regions in the early 2010s (Di Feliciantonio & Salvati, 2015)—COVID-19 pandemic was the most recent external shock affecting residential mobility, reproductive choices, and mortality, in Italy (Blangiardo, 2020a, 2020b), as well as in many other world areas. The lower elasticity of the natural increase to external shocks and the slowing down of international migrations during COVID-19 pandemics may have consolidated such divides. Some (short-term) effects produced by these changes can be—at least in part—reflected (or even anticipated) in the empirical results presented in this study.

The dominant picture stemming from this study classifies the majority of metropolitan areas in a (more or less evident) process of demographic decline (Kroll & Kabisch, 2012). Few exceptions to this general pattern include the most open and globalized MCs—either because of historical and policy tradition (Rome, the administrative capital of Italy) or because of a greater capacity for internalization (Milan, the economic core of Italy). Few other MCs, such as Bologna or Florence, may approach demographic dynamics of the most open and globalized regions thanks to a basic connection to global networks (including tourism), and also because they placed at the forefront of strategic issues such as sustainable mobility, and culture (Zambon et al., 2017). The remaining regions, whether in the North or the South, experienced population shrinkage (Salvati et al., 2020). From this point of view, it seems clear how the level of 'demographic

competition' between territories (namely, competing as attractors of population in turn boosting economic growth) has increased, and this is not just a matter of the North–South divide. Indeed, important towns such as Turin, Genoa and, to a lesser extent, Venice, have not shown enough demographic vitality to counteract the current decline. Certainly, they are particular cities both in terms of their territorial characteristics, such as Genoa and Venice, and thanks to their economic specialization toward industry, such as Turin (Benassi et al., 2021). In this vein, the negative value of the internal migration rate recorded in the central municipality of Turin between 2011 and 2020 is emblematic when compared with past dynamics, since Turin was the main attractor of internal migration flows from Southern Italy between the 1950s and the 1980s (Michielin, 2004).

Conversely, the attractiveness of central municipalities in Southern Italy depends exclusively on foreign migration. With the sole exception of Cagliari, push factors outweighed pull factors of internal mobility. It follows that almost all Southern metropolitan contexts investigated here can be classified in a condition of demographic decline (Di Feliciantonio & Salvati, 2015). One demographic element occurring similarly in all MCs is that central municipalities experienced a systematically positive net international migration. Results of hierarchical clustering may confirm these spatial patterns, while delineating—likely more vividly than the earlier analysis did—the persistence of some spatial heterogeneities at the local scale. In both Northern and Central Italy, the ability of central cities in attracting migrants seems to extend to the surrounding municipalities that act as main attractors to internal migration flows being, therefore, the main player of suburbanization (Salvati, 2014). This could be also explained with the fact that, in such MCs, ring municipalities are well-connected to the central city with appropriate mobility infrastructures. However, the same is not the case in Southern Italian cities, where infrastructures denote some intrinsic limitations in terms of efficiency.

To sum up, we can say that metropolitan demographic patterns no longer reflect a traditional gap between Northern and Southern regions, while outlining a more subtle divide in leading (i.e., growing) and lagging (i.e., declining) contexts (Salvati et al., 2013). The few metropolitan areas that are growing were all located in North-Central Italy, resulting in a more polarized context than in the past (Masini et al., 2019). Internal migration was likely the most powerful factor discriminating growing from declining cities (e.g., Gavalas et al., 2014). At the same time, the lower elasticity of the natural component to external shocks and the slowing down of international migrations during COVID-19 pandemics may have consolidated such divides (Trappolini et al., 2001). These results document the urgent need to strengthen the self-restraining capacity of Southern Italian territories, by increasing their attractiveness (and permeability) to international migration flows. In a few years, this condition—in a business-as-usual scenario, i.e., with no policy intervention—will likely affect the largest part of Northern metropolitan contexts, with the only exception of Milan and Rome, the largest Italian cities with an international projection and a global economic dimension.

Conclusions

A general reflection and some more specific comments about the limitations of this study arise from the comparative analysis of demographic rates carried out before in this paper. First, we should emphasize that the metropolitan contexts analyzed here are

the most dynamic in the country, and incomparable with those territories that are more marginal and isolated from a geographical point of view, undergoing rapid depopulation and/or aging. Precisely for this reason, the issue of population decline in these 'more dynamic' areas becomes even more relevant to regional science and crucial to socioeconomic policy. With this perspective in mind, about the limitations and potential future developments, it should be noted that a more comprehensive analysis should be carried out distinguishing Italians' and foreigners' population dynamics, so to clarify an additional source of heterogeneity, possibly based on ethnic issues. The specific role of population aging should be addressed more carefully, by examining the different age structures within MCs and the differences that exist between them. This issue can be specifically addressed adopting a spatially explicit data mining approach exploring the importance of demographic heterogeneity over time in shaping territorial disparities and socioeconomic divides between centers and peripheries.

Declarations

Ethics approval and consent to participate
Obtaining ethic approval is not applicable.

Competing interests
The authors report there are no competing interests to declare.

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