TERRITORY AND POPULATION: DEMOGRAPHIC TREND OF THE METROPOLITAN CITY OF ROME[1]

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1. Introduction

Since the second half of the twentieth century, Italy has experienced profound changes in its demographic processes (Reynaud and Miccoli, 2021). Due to the continuous decline in births and the parallel decrease in mortality, the natural balance (the difference between births and deaths) has been negative since 1993. The population growth that has occurred since the mid-1990s is therefore attributable exclusively to the net migration (the difference between immigration and emigration). Without the contribution of immigration, the population in Italy would have started to experience a negative variation as early as the mid-1990s (Strozza, 2016).

At the sub-national level, demographic evolution in large cities has also been conditioned by internal migration and counteracted by evolution in the rural territories. Since the World War II, industrial development has reinforced the attractiveness of cities, which have been able to guarantee better opportunities. These sub-populations have grown rapidly, particularly in the North-Central Italy, to the disadvantage of the populations of the rural areas (Celant *et al.*, 1999). In the 1950s and 1960s, Italian cities had very high rates of urban growth (Salvati and Zambon, 2019).

In the 1970s and 1980s, alongside the rural areas, the large cities also began to experience a population decrease, in favour of the surrounding more external municipalities (Dematteis, 1997). In general, during this period, the large redistribution over the territory experienced a short phase of stagnation (Reynaud and Miccoli, 2018).

In the 1990s, cities with more than 100,000 inhabitants began to lose population: a negative natural balance was accompanied by the choices of individuals to move away from the big cities and live in smaller centres. This

[1] Sara Miccoli analysed the data and contributed to literature review, Alessia Naccarato suggested and described the model, Cecilia Reynaud conceptualized the paper. The authors worked collectively to analyse the result of the model. Cecilia Reynaud wrote the introduction and conclusion, Alessia Naccarato wrote data and method, and Sara Miccoli wrote the results.

process has continued during the 2000s. Indeed, all the main Italian metropolitan provinces experienced a population increase, thanks mainly to the growth of the hinterland municipalities (Casacchia and Crisci, 2013). The peri-urbanisation process has thus continued to erode the population of the central cities of urbanized area, intersecting with international migration flows.

The city of Rome and its province have experienced all these phases. Due to its administrative role as the capital of Italy, of the region and of the province, Rome's population has grown rapidly since World War II. The attractiveness of Rome gradually spread to the whole province, which in 2014 became the Metropolitan City of Rome. The population growth of the municipalities of the Metropolitan City of Rome depends substantially on their ability to attract internal and international migration flows, but these municipalities do not show a homogeneous demographic trend (Salvati *et al.*, 2016). Attractiveness tends to decrease in the municipalities located further away from the capital city (Casacchia and Crisci, 2013). Studies on the demographic evolution of the Metropolitan City of Rome have mainly focused on the core/hinterland dichotomy (Casacchia and Crisci 2006; Crisci, 2016). These studies have shown that in recent times the municipalities bordering Rome have become similar to the capital city, often slightly more dynamic. On the other hand, great diversity has emerged in the other municipalities: some continue to attract population and even show a population growth, others experience an important process of population decrease, also due to their characteristics, such as being mountainous municipalities (Reynaud *et al.*, 2020). Therefore, the distance from the capital city is also of great importance (Salvati *et al.*, 2016).

Rome and its neighbouring municipalities are strongly connected due to their geographical proximity and these municipalities tend to be influenced by the capital city from an economic, social and cultural point of view. Despite its large territorial size, Rome has often assimilated neighbouring municipalities. For this reason, municipalities bordering Rome could be considered together with the municipality of Rome as a single area (municipality of Rome and neighbouring municipalities, which we could consider as hinterland). Their demographic dynamics could be compared with municipalities bordering this central area and with municipalities even further away (but still belonging to the metropolitan city).

The aim of this paper is therefore to examine the evolution of the population in the municipalities of the Metropolitan City of Rome (former province of Rome), from 1971 to 2019, distinguishing the municipalities of the central area (capital city and neighbouring municipalities), the municipalities forming a ring around this area, and the other municipalities of the metropolitan city. A descriptive analysis of the intercensal growth rate of the municipalities of the Metropolitan City of Rome will then be carried out. In order to examine demographic evolution, unlike other

studies in the literature, our contribution wants to consider the time dependence structure that plays an important role in the population growth process. In fact, an exploratory analysis will be conducted to assess the effects on the evolution of the population of past demographic dynamics and some characteristics of the municipalities (demographic ones such as the percentage of older population and the incidence of foreigners, but also geomorphological ones, such as the type of municipality and the distance from Rome). The hypothesis is that the demographic trend of municipalities is influenced both by time-invariant geo-morphological characteristics of municipalities and by past population dynamics (Hp. 1). Since the dynamics of a population in a certain place also depend on what happens in the other areas simultaneously and asynchronously, the relationship between dependent and independent variables is estimated through a system of simultaneous equations. Municipalities, which are diverse in both demographic and territorial dimensions, represent the most detailed administrative units and, therefore, an analysis at municipal level makes a detailed comparison possible. All this allows to make explicit the inertia that is typical of demographic phenomena. An in-depth analysis of the demographic evolution of the Metropolitan City of Rome is of enormous interest in order to better understand the demographic changes taking place in and around large cities.

2. Data and method

The data used refers to 121 municipalities (LAUs)[2] in the Metropolitan City of Rome (NUTS 3). These data come from those provided by the Italian National Institute of Statistics (ISTAT) on municipalities population size in the censuses from 1971 to 2019. The 2019 data stem from the last census carried out by ISTAT in that year and conducted with a new strategy based on a sample survey. An effort was made to define a comparable territorial breakdown and the data refer to 2011 census boundaries. In particular, we used the total resident population data and calculated the intercensal population growth rate for the periods 1971-1981, 1981-1991, 1991-2001, 2001-2011, and 2011-2019, as follows:

$$\mathrm{r}_{i(t,t+n)} = \ln\left(\frac{P_i(t+n)}{P_i(t)}\right)/n \qquad (1)$$

[2] Italy is divided into 110 provinces (NUTS 3), in the 20 regions (NUTS 2). Each province has a capital city. Since 2014, the 14 largest and most urbanized provinces have been transformed into metropolitan cities. The metropolitan city includes the capital city and the municipalities (LAUs) that were already part of the province.

where i is the $i-$th municipality; t is the considered census data and $t+10$ is the subsequent census data; P is the total resident population. The growth rate is the endogenous variable in the estimated model.

With regard to demographic characteristics, we used as exogenous variable (that is, the indicator of the age structure) the ageing index at the beginning of the considered periods (AI_t). Since 1991 (the first year for which census data on the non-national resident population are available) we considered –as a second exogenous variable- the incidence of the non-national resident population at the beginning of the considered periods (NN_t). For the time-invariant geomorphological characteristics, the exogenous variables are: the altitude of the municipalities (alt) and whether or not they are coastal municipalities (coa). As previously mentioned, we divided municipalities according to the distance from the pole. In this way, we have three groups of municipalities: (1) capital city and neighbouring municipalities, which compose the centre; (2) municipalities surrounding the central area, which compose the first ring; (3) the other municipalities of the Metropolitan City, which compose the other area. Therefore, two dummy variables were created: "first ring" (I ring) and "other area", using the centre as term of comparison.

We applied a simultaneous equation model (SEM) where the endogenous variables are the intercensal growth rate of the municipal resident population in different decades. Within this context it is not possible to disregard the idea that the intercensal growth rate in a certain decade depends on that of the previous decade and has an effect on that of the following decade. The estimation of a SEM (Greene, 2003), in which the endogenous variable of an equation becomes an explanatory variable of the remaining equations, allows us to capture the effect of dependence over time of the intercensal population growth rate. This relationship justifies the choice of a system of simultaneous equations that takes into account the link between the different equations in the estimation procedure of the unknown parameters. Such parameters have been estimated with Three Stage Least Squares (3SLS) procedure (Zellner and Theil, 1962). The estimated model is:

$$r_{71\,81} = alt + I\,ring + other\,areas + AI_{71} + \varepsilon_{71\,81}$$

$$r_{81\,91} = alt + I\,ring + other\,areas + AI_{81} + r_{71\,81} + r_{71\,81} * I\,ring + r_{71\,81} * other\,area + \varepsilon_{81\,91}$$

$$r_{91\,81} = alt + I\,ring + other\,areas + AI_{91} + NN_{91} + r_{71\,81} + r_{71\,81} * I\,ring + r_{71\,81} * other\,areas + r_{81\,91} + r_{81\,91} * I\,ring + r_{81\,91} * other\,areas + \varepsilon_{81\,91}$$

$$r_{01\,11} = alt + I\ ring + other\ areas + AI_{01} + NN_{01} + r_{71\,81} + r_{71\,81} * I\ ring + r_{71\,81} * other\ areas + r_{81\,91} + r_{81\,91} * I\ ring + r_{81\,91} * other\ areas + r_{81\,91} + r_{91\,01} * I\ ring + r_{91\,01} * other\ areas + \varepsilon_{01\,11}$$

$$r_{11\,19} = alt + I\ ring + other\ areas + AI_{11} + NN_{11} + r_{71\,81} + r_{71\,81} * I\ ring + r_{71\,81} * other\ areas + r_{81\,91} + r_{81\,91} * I\ ring + r_{81\,91} * other\ areas + r_{81\,91} + r_{91\,01} * I\ ring + r_{91\,01} * other\ areas + r_{01\,11} + r_{01\,11} * I\ ring + r_{01\,11} * other\ areas + \varepsilon_{11\,20}$$

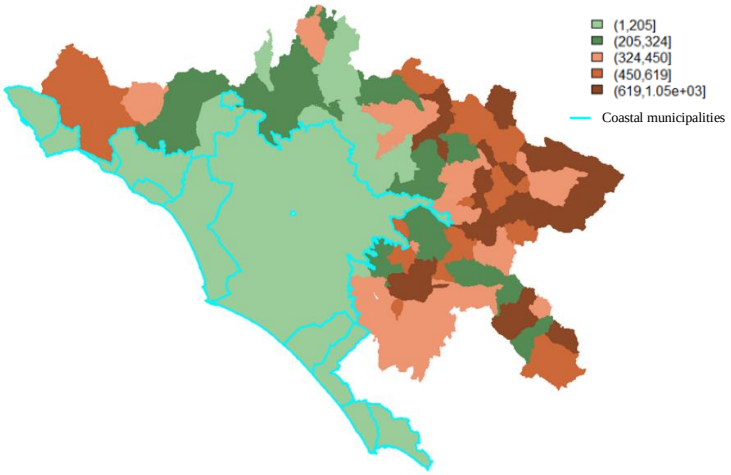
The already mentioned explanatory variables have been included following some assumptions. First of all, we have hypothesised that the most aged municipalities experience a further process of depopulation, and therefore a decrease in population, compared to the other municipalities (Hp. 2) (Reynaud and Miccoli, 2018). On the contrary, we hypothesized that municipalities that have attracted non-national resident population experience a greater dynamism, compared to the other municipalities (Hp. 3), both because of the pull effect of immigration itself (Casacchia *et al.*, 2019), and because of the higher fertility of foreigners (Mussino and Strozza, 2012). Secondly, since some studies have already shown that mountain municipalities are subject to a greater population decrease process while coastal municipalities are more dynamic, we assumed that these time-invariant geomorphological characteristics are relevant in explaining municipalities demographic evolution (Hp. 4), even more than the geographical position, expressed as the distance from the capital city. Finally, we hypothesized that the other explanatory variables can be affected according to the geographical position of the municipalities (Hp. 5). The two dummy variables (I ring and other area) allow the distinguishing of the effect of the explanatory variables in the five equations according to the geographical distribution of the municipalities. They have therefore been introduced into the system of equations, either individually to evaluate their effect on the model constant or multiplied by the exogenous variables to evaluate the different effect of these variables as the geographical position varies. In general, we have assumed that geo-morphological and demographic characteristics are decisive equal geographical location, but that the previous dynamic is the one that has the greatest association with population variation.

3. The Metropolitan City of Rome: characteristics

3.1 Descriptive analysis

The Metropolitan City of Rome consists of 121 municipalities which we have grouped into three categories. Thirty municipalities belong to the centre: these are Rome and the 29 neighbouring municipalities; 27 municipalities belong to the first ring: these are the municipalities bordering the municipalities of the centre; 64 municipalities belong to the other area. Of these 121 municipalities, 10 are coastal municipalities, 73 are hill municipalities (altitude between 200 and 600 metres), and 26 are mountain ones (altitude above 600 meters) (Figure 1).

Figure 1 – *Municipalities of the Metropolitan City of Rome, for altitude and coastline.*

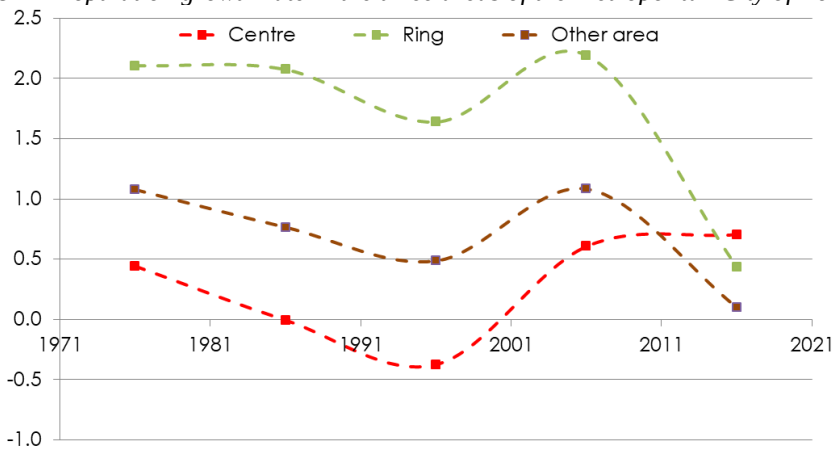


Source: our elaboration on ISTAT *data.*

The population of Rome Metropolitan City increased from 3.5 million in 1971 to 4.3 million in 2019. However, from 1971 to 2019, the population grew differently by intensity and trend within the metropolitan city. Although at different levels, in all periods considered the trend was similar for municipalities in the ring and the other area. Central municipalities, on the other hand, followed the same trend until 2008, when they experienced a recovery. The population living in the municipalities of the ring has always recorded the highest growth rate, except in the period 2011-2019 when the centre experienced the highest rates, following the recovery that began a few years earlier (Figure 2). In the last period, the natural balance of most of these central municipalities has continued to be negative and the

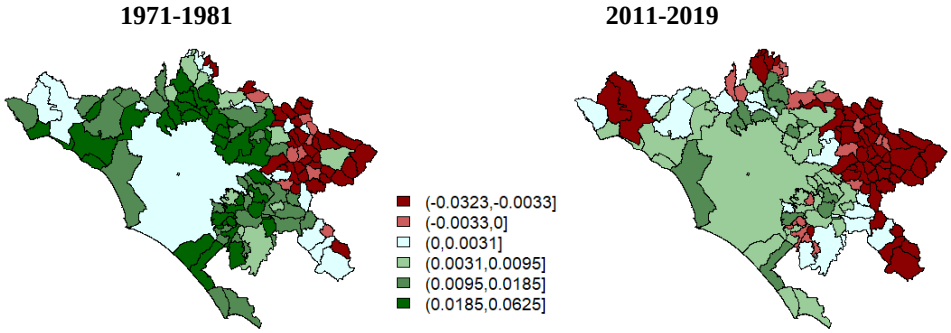
recovery was therefore mainly driven by the net migration and thus by a recovery in attractiveness compared to previous periods. In particular, the growth rate has been positive in the municipality of Rome and in a few other municipalities. However, in the previous decades, Rome's growth rate was equal to 0 and several municipalities of the Centre showed a positive growth rate (Figure 3).

Figure 2 – *Population growth rate in the three areas of the Metropolitan City of Rome.*



Source: our elaboration on Istat data.

Figure 3 – *Population growth rate for the Metropolitan City of Rome municipalities. Period 1971-1981, 2011-2019.*



Source: our elaboration on Istat data.

3.2 Results of the model

The model's goodness of fit was superior to 0.5 (R^2 adjusted = 0.59). This result therefore leads to the conclusion that to consider the effect of the demographic evolution of previous periods is right. The coefficients relating to the growth rates in previous periods are often statistically significant and positive. Therefore, the increase in population in one period leads to an increase in the next period. This is particularly true for the period 1991-2001 but not for the period 2001-2011, where the association with the growth rate of the previous period 1991-2001 is not statistically significant. As hypothesized (Hp. 1), it seems that there is a typical demographic inertia effect, despite it is not always the immediately preceding period that is most relevant. With regard to the characteristics of the municipalities, the variable concerning the coastline was not included in the final model because it was never statistically significant. Altitude, on the other hand, is significant in the first (-0.00002), second (-0.00001) and fourth (-0.00001) periods and, as assumed, always has a negative coefficient: the higher the altitude of the municipality, the less population growth occurs as we hypothesized (Hp. 4). Demographic characteristics at the beginning of the period are not statistically significant, contrary to our hypotheses (Hp. 2 and 3), with the exception of ageing on 1.1.1971 (-0.0029), which negatively affects growth in the period 1971-1981. In the other periods, for the Metropolitan City of Rome, the geographical position counts more than the population structure. Contrary to what has been assumed, the growth capacity of the municipalities (determined in these phases mainly by their ability to attract immigrants) seems to be determined more by their geographical position than by their characteristics (Hp. 5).

The municipalities in the ring experienced a more intense demographic growth than those in the centre only in the period 1991-2001 (0.00735), while in the last period the coefficient is negative (-0.00463), thus confirming what was observed in the descriptive analysis. As regards the municipalities in the remaining area, compared to the municipalities in the centre, growth is lower in both the first (-0.01084) and the last period (-0.00617), and higher in the period 1991-2001 (0.00572). These results allow us to state that especially in the period 1991-2001 the growth of the Metropolitan City of Rome no longer depends only on the centre but involves more the other area. Rome continues to attract population, but in this period, both because of the higher costs of the big city and because of better living conditions in the countryside areas, the gravity area of Rome has extended its boundaries involving municipalities even more distant than those of the centre.

The interaction between the growth in the previous periods and the geographical position do not show statistically significant differences: the coefficients of these interactions are often not significant. In 1991-2001, the only statistically significant

interaction is between the growth rate of the previous period and the rest of the area (-0.44092): here the effect of the demographic evolution of the previous periods was less strong than in the other two areas of the city. In 2001-2011, the link with the 1971-1981 growth rate is different from that of the centre: in the ring the effect is smaller (-0.37025), while in the others the effect is greater (0.26905). Finally, in 2011-2019, the 1991-2001 growth rate is more important for the rest of the area (0.37251).

Table 1 – *Results of the simultaneous equations system*

Variables	**1971-1981**	**1981-1991**	**1991-2001**	**2001-2011**	**2011-2019**
constant	0.03997***	0.01467***	-0.00265	0.01645***	0.00401
r(71-81)		0.34175***	0.07969	-0.12319	0.15882***
r(81-91)			0.77534***	0.53240**	-0.07804
r(91-01)				0.10627	-0.09447
r(01-11)					0.25215**
Altitude	-0.00002***	-0.00001*	-0.00001	-0.00001**	-0.000001
Ageing index	-0.00029***	-0.00003	0.000001	-0.00002	-0.00001
Foreign population (%)			0.00001	-0.00002	0.00002
Area of metropolitan city					
Ring	-0.00327	-0.00232	0.00735**	0.00315	-0.00463*
Other area	-0.01084***	-0.00153	0.00572**	-0.00197	-0.00617***
r(71-81) * Ring		0.17859	-0.19770	-0.37025*	-0.12297
r(71-81) * Other area		-0.04309	0.17914	0.26905*	0.02361
r(81-91) * Ring			-0.06545	0.04759	0.19549
r(81-91) * Other area			-0.44092***	-0.12619	0.15948
r(91-01) * Ring				0.28796	0.25017
r(91-01) * Other area				-0.08250	0.37251**
r(01-11) * Ring					-0.14752
r(01-11) * Other area					-0.20905
R^2 adjusted	0.59009	0.55104	0.65200	0.59760	0.69477

*Signif. Codes: 0'***'0.001'**'0.01'*'0.05'.'0.1' '*
Source: our elaboration on Istat data.

Although some of our hypotheses have therefore not been tested, the model confirm that population growth is often conditioned by territorial and demographic characteristics and, above all, by previous demographic dynamics (Hp. 1).

4. Conclusion and discussion

In the Metropolitan City of Rome, the demographic evolution of the municipalities is not at all homogeneous. The increase in population in the municipalities of the Metropolitan City has certainly been influenced by the distance from the capital city, which has had and still has a strong capacity to attract both immigration from other areas of the country and from abroad (Crisci and Santacroce, 2019). In recent times, the municipality of Rome attracts population and in the last period has experienced a population increase higher than that of the Italian population as a whole. Despite these developments, the huge surface area of the municipality of Rome -which is the largest municipality in Italy- has not been sufficient for population growth to be greater than that of other municipalities in the Metropolitan City. Neighbouring municipalities have developed an important attractiveness, which is certainly dependent on the importance of Rome. This phenomenon has recently extended to more distant municipalities, especially in 1991-2001, when the resident population in Italy seemed to be stagnating. In a complex model, in which both the past evolution of the population and the demographic and geomorphological characteristics are taken into account, the geographical position with respect to the capital was important in explaining the demographic dynamics of the various municipalities of the Metropolitan City. This result shows the peculiarity of this area and the importance of investigating the causes and effects of the demographic trend in such an important area for the country in general.

Although this study is preliminary and needs to be further investigated, the initial results constitute a starting point for further investigation, with the integration of additional social and economic components, into the evolution of the sub-populations inhabiting the territory of Rome and the surrounding areas. In-depth studies on the topic could constitute useful tools for administrations to elaborate and implement really effective housing or mobility policies.

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SUMMARY

Territory and population: demographic trend of the Metropolitan City of Rome

Since the 1970s, in Italy, there have been deep changes in demographic processes that have led to the Italian population has experienced firstly a slight growth, then a growth due only to immigration, and, in recent years, a demographic decline. The demographic trends of the large cities was different, also influenced by internal migration and opposed to the trends of the rural territories. In particular, Rome has grown rapidly and its attractiveness has spread to the entire province, which in 2014 became the Metropolitan City of Rome.

The aim of this paper is therefore to examine the evolution of the population in the municipalities of the Metropolitan City of Rome, from 1971 to 2019, distinguishing the municipalities of the central area, the municipalities forming a ring around this area, and the other municipalities of the Metropolitan City. A descriptive analysis of the inter-censual growth rate of the municipalities of the metropolitan city of Rome was then be carried out. Then, we applied a simultaneous equation model where the endogenous variable is the inter-censual growth rate of the municipal resident population. This allowed us to take into account that the population trend observed in each of the intercensal periods depends on the intensity and geographical distribution of the same phenomenon in the previous decade.

In the Metropolitan City of Rome, the demographic evolution of the municipalities is not at all homogeneous. The increase in population in the municipalities of the metropolitan city has certainly been influenced by the distance from the capital city. In our model, in which both the past evolution of the population and the demographic and geomorphological characteristics are taken into account, the geographical position with respect to the capital resulted in being important in explaining the demographic dynamics of the various municipalities of the metropolitan city. This result shows the peculiarity of this area.

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