

Population growth and the economic crisis: understanding latent patterns of change in Greece, 2002–2016

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Abstract Recent population dynamics in Europe have been influenced by multifaceted processes, including the second demographic transition, international migration, and rising counter-urbanization driven by economic crisis. Using a data mining framework, the present study investigates population growth and decline (2002–2016) in 51 prefectures with the aim to assess how economic cycles have influenced population dynamics along the urban gradient in Greece. Spatial patterns of population growth diverged along the study period in two homogeneous time windows reflecting economic expansion (2002–2007) and recession (2008–2016). Population increased during expansion in areas with urban centers hosting upper economic functions (university, international airport) far away from the Greek capital. During recession, population increased in coastal areas with tourism specialization, medium–low population density and moderate accessibility. Income levels and changes over time had no influence on population re-distribution over Greek prefectures, indicating a substantial decoupling of demographic growth from income growth. Although persistent density gaps are still observed in Greece, a moderate redistribution of population was observed during recession along a spatial gradient from economically-strong mainland areas to medium- and low-density coastal districts concentrating tourism activities. These findings outline how recent spatial re-distribution of Greek population was driven by distinct socioeconomic factors. Evidence of our study support further investigation on the role of economic cycles in present and future population trends at regional and local scales.

Keywords Spatial disparities · Demography · Multivariate analysis · Mediterranean

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1 Introduction

Demographic regimes have changed in developed countries as a consequence of economic and social transformations, differing from those observed in the immediate aftermath of World War II and continuing to evolve (Tapinos et al. 1997; Chen 2009; Cechella et al. 2012). Economic cycles have significantly impacted population structures shaping demographic dynamics and determining social disparities and a spatially-polarized distribution of economic activities. Demographic transitions have reflected socioeconomic processes that influence urban–rural configurations, shaping socio-spatial gradients and altering the distribution of economic functions over large regions (Dyson 2013; Del Bono et al. 2015; Li et al. 2016; Walford and Kurek 2016).

Taken as a long-term trend with key socioeconomic implications, heterogeneous population dynamics associated with the ‘second demographic transition’ have involved new family relations, less and later marriage, declining fertility rates, population ageing, postponement of child-bearing and smaller households (Billari and Kohler 2004; Haase et al. 2010; Kreyenfeld et al. 2012; Caltabiano 2016). Adding to these general trends, long-term urban patterns—including cycles of urbanization, suburbanization and re-urbanization (Kulu et al. 2009; Kabisch and Haase 2011; Salvati et al. 2016a, b) or less evident urban-to-rural internal movements reflecting latent counter-urbanization processes (Gkartzios and Scott 2015)—lead to the conclusion that a simplified and linear explanation of the factors shaping population dynamics would result inadequate to represent the emerging complexity of regional demography (Isik and Melih Pinarcioglu 2006; Falagas et al. 2009; Salvati et al. 2016a).

Demographic dynamics and population redistribution at regional and country scales have been studied in different ways adopting a vast set of indicators, quantitative and qualitative analysis’ techniques and multiple levels of investigation varying in time and space (Haase et al. 2010; Kabisch and Haase 2011; Kroll and Kabisch 2012). In these regards, factors affecting population redistribution over large areas include the second demographic transition, international migration and rising counter-urbanization as a possible outcome of economic expansions and recessions (Serra et al. 2014; Carlucci et al. 2017; Cuadrado-Ciuraneta et al. 2017). These factors have been often divided in two groups interacting at different spatial scales: (1) demographic processes at continental and national scale—possibly determining spatially-heterogeneous impacts at regional scale under specific territorial contexts—and (2) local-scale socioeconomic processes with a direct influence on demographic structures and dynamics, and generating differential impacts e.g. along urban–rural gradients (e.g. Biasi et al. 2015; Mavrakis et al. 2015; Zambon et al. 2017). Population re-distribution over space reflected an altered density gap along specific geographical gradients (Sobotka et al. 2011).

Demographic indicators are widely used in the analysis of regional disparities and processes of population re-distribution along urban–rural gradients driven by cycles of economic expansion and stagnation (Salvati et al. 2013; Rontos et al. 2016; Walford and Kurek 2016). Identifying similarities and differences in basic demographic indicators is necessary to shed lights on short-term demographic transformations under

volatile business cycles (Palloni and Tienda 1992; Tapinos et al. 1997; Kroll and Kabisch 2012).

Reducing territorial disparities in socio-demographic aspects, including divides in population density, has been considered a fundamental objective for the European common policy. However, regional disparities persist at the continental scale; one example is provided by southern Europe (Benyaklef 1997), where important socioeconomic gaps are still observed among neighboring regions and a large part of marginal, inland areas exhibit a stagnant economy (Leontidou and Marmaras 2001). Studies focusing on macro-scale factors such as urban hierarchy, economic structures, market-state interactions and institutional changes indicate that territorial disparities have persisted over the last decades and are more intense in regions with a traditional economic base, population aging and low-quality human capital (Salvati 2016).

Studies on the spatial evolution of socioeconomic disparities and population divides among regions have sometimes disregarded the impact of external shocks on local-scale demographic contexts (Storper 2011). Local systems confronted with long-term economic stagnations are characterized by a varying ability to resist short-term shocks and the consequence of these shocks also varies across regions (Sobotka et al. 2011). A number of empirical studies have analyzed the impact of sequential expansions and recessions waves on different socioeconomic processes, trying to identify resilient regions and ascertain characteristic territorial attributes (Salvati 2016).

Economic recessions have added spatial complexity to changes in population structure and dynamics, shaping local-scale outcomes of the second demographic transition (Sobotka et al. 2011; Simou and Koutsogeorgou 2014; Stuckler et al. 2015). Mechanisms through which recessions may influence demographic patterns include the effects of economic uncertainty (Hofmann and Hohmeyer 2013), job instability and displacement (Modena et al. 2014), unemployment of native and migrant population (Vignoli et al. 2012; Tragaki and Bagavos 2014; Cazzola et al. 2016), changes in the housing market and mortgage foreclosures (Schneider 2015), increased mortality (Luo et al. 2011; Lusardi et al. 2015; Stuckler et al. 2015), and factors that influence fertility indirectly such as marriage postponement (Goldstein et al. 2013) or declining marriage rates (Caltabiano et al. 2009; Kreyenfeld et al. 2012; Lee and Painter 2013).

Due to its global extent and severity, the 2007 financial crisis has been considered a major turning point in regional economic systems (Connaughton 2010). This event has negatively influenced regional growth shaping population dynamics, depressing construction industry, and influencing labor markets as a consequence of increased social disparities and polarized distribution of economic firms (Garcia 2010; Pérez 2010; Gil-Alonso et al. 2013). Empirical evidence on the short-term impact of the 2007 recession on demographic dynamics and spatial population rebalance are still restricted to specific territorial contexts, mostly urban areas (Salvati and Carlucci 2016). However, because of the diversification in place-specific factors, empirical results are still mixed (Carson et al. 2016) and no consensus was reached on the effects of recession on population dynamics in the European countries.

Unraveling impacts of the 2007 crisis on population dynamics, demographic structure and urbanization paths, is particularly interesting in the Mediterranean regions, likely one of the most affected in Europe. Moreover, the combined effect of multiple drivers of change (inter)acting at different spatio-temporal scales, such as demographic

transition, international migration and counter-urbanization, has been rarely investigated in southern Europe. At the same time, a such kind of study may contribute to the debate on socioeconomic resilience and territorial disparities, reconnecting a particularly interesting and novel topic in regional economics to demographic issues. With this perspective in mind, population growth can be interpreted as a proxy of resistance to economic shocks or post-shock recovery (Salvati et al. 2016b).

By linking changes over time in population distribution with the (evolving) urban–rural gradient, this study provides insight in the geography of population growth and decline in Greece and identifies distinct territorial factors shaping socioeconomic disparities during economic expansions and recessions as a contribution to designing fine-tuned local development policies. Being one of the countries where the recession impact was most visible, Greece is actually a lagging economy in Europe with evident socioeconomic divides (Monastiriotis 2011). Economic stagnation has slowed processes of change in regional production structures, impacting considerably social contexts and driving unemployment rate up to 26% with even higher percentage of young unemployment (Rontos et al. 2016). Compared to other Mediterranean countries, Greece has displayed genuine urbanization-suburbanization trends for a long time (Salvati et al. 2013), differing from more articulated and spatially-contrasting population dynamics derived from a mix of dis-urbanization and re-urbanization processes, such as those observed in Italy and Spain (Bonifazi and Heins 2003). The Greek urban system evolved rapidly since the early 1990s through alternating waves of urbanization, suburbanization and re-urbanization and a continuous trend toward coastalization (Leontidou and Marmaras 2001), offering an interesting opportunity to test differential urbanization (and population dynamics) models over distinct economic cycles (Di Felicianantonio and Salvati 2015).

Our study attempts to provide a comprehensive picture of the spatial structure of population growth and decline in Greek prefectures over 2000–2016 using descriptive and correlation statistics, hierarchical clustering, Principal Component Analysis and a multiple regression model. Population dynamics in Greece were derived from annual vital statistics at the spatial scale of prefectures. Population rates of change were computed over time intervals distinguishing economic expansion (2002–2007) and recession (2008–2016). Our approach allows identification of socioeconomic attributes as powerful factors influencing demographic dynamics and determining population redistribution at the country scale. Distinguishing regional-scale from local-scale demographic changes provides an informative base to evaluate the crisis' impact on recent socioeconomic transformations along urban–rural gradients in divided countries.

2 Methodology

2.1 Study area

The investigated area extends the whole of Greece (131,982 km²). We considered 51 prefectures ('nomi') corresponding to the NUTS-3 territorial level adopted by Eurostat, the Statistical Office of European Union, as spatial units. Prefectures in Greece

are an intermediate administrative level between regions and municipalities useful to evaluate changes in population and economic geography of the country, possibly as a function of urban–rural, coastal–inland and accessibility gradients. The Greek urban–rural gradient is satisfactorily outlined by the administrative partition selected in this study (Salvati 2016). Metropolitan areas of Athens and Thessaloniki concentrate nearly half of Greek population (Pili et al. 2017) The Athens’ metropolitan region hosts more than 30% of country’s population (3.5 million inhabitants), and mostly coincides with Attica region (Zitti et al. 2015). Medium-size cities (Iraklio, Patras) and provincial head towns (Larissa, Volos, Kalamata, Chania, Kavala, Ioannina) grew in recent decades (Zambon et al. 2017). Internal, rural areas are exposed to depopulation and contrast with dynamic, tourism-specialized areas including islands in both Ionian and Aegean sea (Carlucci et al. 2017).

2.2 Statistical data

We used a homogenized time-series data of registered population at the scale of Greek prefectures (NUTs-3 level of the European Territorial Statistical Nomenclature) disseminated annually by the Hellenic Statistical Authority (ELSTAT). The analysis covers a time frame of 15 years between 2002 and 2016 encompassing cycles of economic expansion and recession in turn influencing urbanization patterns, with early expansion and late decline of metropolitan areas (Athens, Thessaloniki, Larissa, Patras) and moderate settlement dispersion along coastal districts (Couch et al. 2007). Annual population growth rates (‘p0207’ and ‘p0716’) were used in the statistical analysis and standardized by mean subtraction and division by standard deviation of the spatial series prior to apply multivariate techniques. Population density (inhabitants per km²) was finally calculated by prefecture and year.

2.3 Background variables

To profile the local socioeconomic context and delineate (apparent or latent) relationships with population dynamics investigated at the prefecture scale, a dataset was compiled from official statistics by calculating 9 variables: (1) income growth (percent annual rate) during economic expansion (2002–2007, ‘Inc0008’) and recession (2008–2013, ‘Inc0813’), (2) per-capita disposable income (‘Incpc’, Euros) and (3) population density (‘PopDens’, inhabitants/km²), both observed at the end of economic expansion (2008), distance from (4) Athens (‘DistAth’) and (5) Thessaloniki (‘DistSal’), calculated as the linear distance between prefectural centroids, (6) proximity to the sea coast (‘Sea’), assessed with a dichotomic variable indicating coastal (1) or internal (0) prefectures and, finally, presence of upper economic functions and infrastructures such as (7) international airports (‘IntAirp’), (8) universities (‘Univer’) and (9) tourism attractiveness (‘Tourism’). Variables (7–9) were assessed using dummies classifying prefectures with (1) or without (0) the respective function. Variables were derived from official statistics disseminated by ELSTAT and Hellenic Ministry of Finance or calculated directly from ELSTAT maps using tools available in a Geographic Information Systems package.

2.4 Statistical analysis

Maps were developed on the final data matrix of annual rate of population growth (or decline) by year and prefecture with the objective to identify areas with homogeneous demographic dynamics. A hierarchical clustering (Euclidean distances, Ward's amalgamation rule) was run on the same data matrix with the aim to classify separately temporal units (years) and spatial units (prefectures) in homogeneous groups for population dynamics over the investigated time period. A non parametric correlation analysis was run between percent annual rate of population growth (or decline) and background variables described in Sect. 2.3 using pair-wise Spearman coefficients testing at $p < 0.05$ after Bonferroni's correction for multiple comparisons (Colantoni et al. 2016). Population growth rates over economic expansion (2002–2007) and recession (2008–2016) were also correlated using Spearman coefficients and illustrated through scatterplots.

A Principal Component Analysis (PCA) was run on a data set including the 9 background variables illustrated in Sect. 2.3 for each prefecture of the study area. PCA was used to reduce redundancy and to assess changes over time in the relationship between variables. The PCA identified few latent axes representative of the spatial structure of short-term population dynamics in Greece. Components with eigenvalue > 1 were chosen based on decomposition of the correlation matrix (Salvati et al. 2008).

A multiple linear regression was run separately for expansion and recession times to identify the background variables most characterizing population dynamics in Greece. A forward stepwise approach was developed with population growth rate as the dependent variable and 8 background variables as predictors, included in the model when the p -level associated to the respective Fisher–Snedecor F test was below 0.01. Results include slope coefficient estimates and the associated significance level (testing for the null-hypothesis of non significant regression coefficient) based on Student t statistics at $p < 0.05$. The goodness-of-fit of each regression model was measured using adjusted R^2 and tested for significance (against the null hypothesis of non significant model) through a Fisher–Snedecor F test with $p < 0.001$. Variables were standardized prior to analysis (Zambon et al. 2018).

To assess the shift over time of population density in Greek prefectures towards spatial equilibrium, a set of 10 statistical indexes originally proposed by Salvati et al. (2016a) were derived annually from the database described above by computing measures of central tendency, dispersion and asymmetry (skewness and kurtosis). Decreasing values of dispersion and asymmetry indexes over time indicate a reduced deviation from the spatial distribution observed in the year before, outlining a process of population redistribution at the regional scale (Serra et al. 2014).

3 Results

3.1 Exploratory analysis of annual population growth rates

Resident population in Greece reached a maximum peak in 2011 declining slightly in the following years. Metropolitan Athens' primacy was the highest in 2007 (nearly

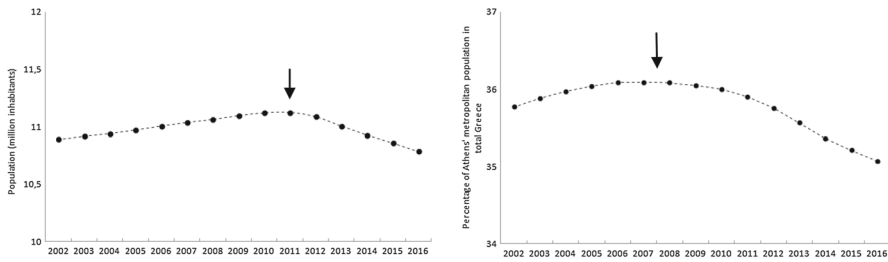


Fig. 1 Total resident population in Greece (left) and percent share of population living in metropolitan Athens to Greek population (right) by year, 2002–2016 (arrow indicates the maximum peak of each time series)

36% of Greek population was residing in that region) declining sharply up to 2016 (Fig. 1). Population growth and decline was heterogeneously distributed in Greece during the study period (Fig. 2). Internal prefectures in central and southern Greece displayed population decline between 2002 and 2006; metropolitan prefectures of Athens and Thessaloniki, coastal prefectures in central Greece and the largest island archipelagos (Kyklades, Crete, Dodekanisos) totalized positive growth rates over the pre-crisis period. The highest number of prefectures with growing population was observed during 2007–2011, with negative rates found in coastal and internal areas of the Ionian side of Greece with low population density, rural land-use and limited accessibility from Athens and Thessaloniki. However, the metropolitan region of Patras was included in this group. The number of prefectures with declining population increased sharply since 2011 including both metropolitan regions of Athens and Thessaloniki, urban regions of Patras and Larissa, internal and rural regions in central and southern Greece as well as peripheral and low-density regions in northern Greece. During crisis, persistently positive population growth rates were observed in some coastal and island prefectures including western Crete (Chanià, Rethymno, Iraklio), Dodekanisos (Rhodes), Kyklades as well as Chalkidiki and Pieria in northern Greece, two areas surrounding Thessaloniki. Around Athens, Viotia and Korinthia prefectures showed mixed annual rates of growth and decline over time, totalizing a slightly negative rate during crisis.

To identify homogeneous spatio-temporal patterns in demographic dynamics at both regional and local scale, a hierarchical clustering was run on the data matrix including annual population growth rates at the prefectural level in Greece, 2002–2016 (Fig. 3). Using a 70% similarity threshold, clustering discriminated three groups of years with homogeneous spatial patterns in the distribution of population growth and decline in Greece: 2002–2007, 2008–2011 and 2012–2016 (left panel). These groups reveal divergent demographic patterns during economic expansion (2002–2007) and recession (2012–2016) with an intermediate time period (2008–2011) characterized by changes in the demographic profile of most Greek prefectures (passing from a more or less rapid population increase to generalized trends of population decrease). Using the same similarity threshold, four clusters of Greek prefectures were identified with similar demographic patterns: (1) a group of coastal and island areas (from Chanià to Dodekanisos) scattered across Greece and including international tourism destinations

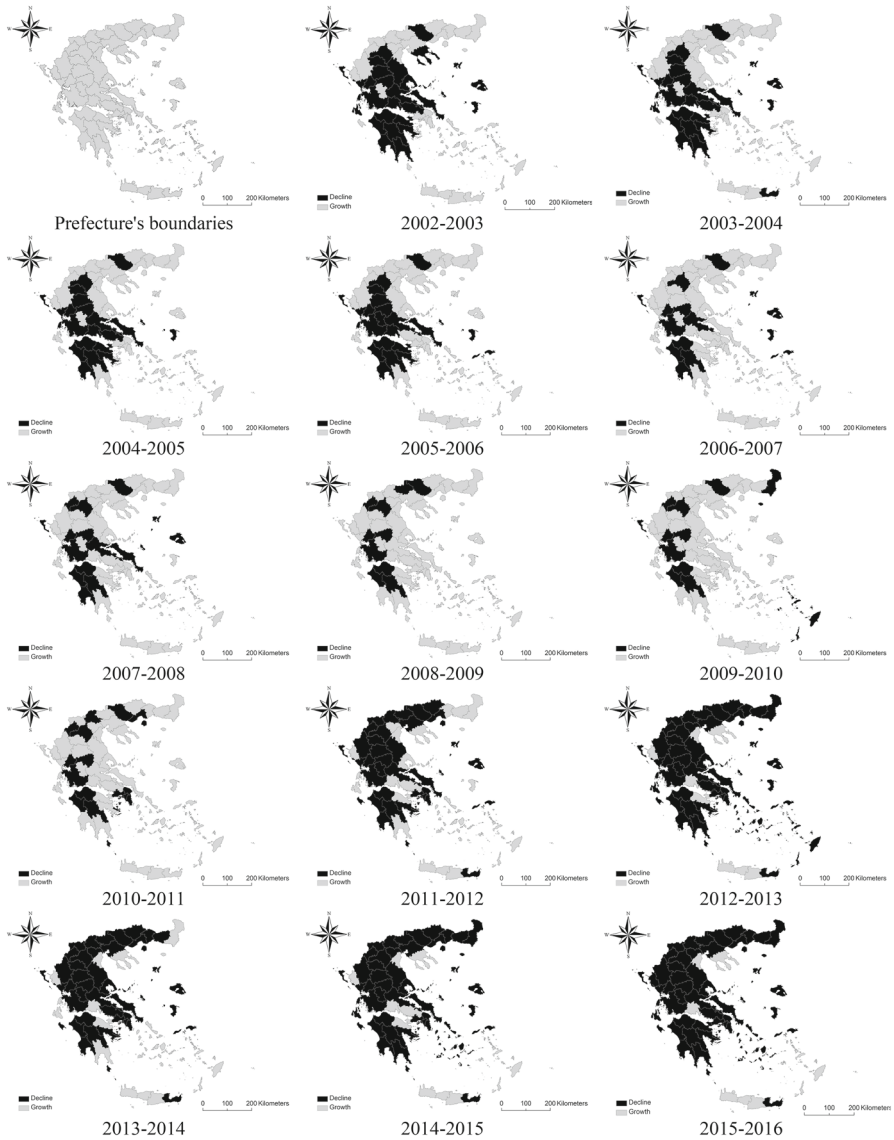


Fig. 2 Percent rate of population growth (or decline) in Greek prefectures by year

(such as Rhodes, Mykonos and some districts of Crete), displaying an overall positive rate of population growth over both time periods, especially during recession; (2) a group of coastal and internal areas (from Arta to Etoloakarnania) with varying population density (ranging from hyper-rural districts of Karditsa and Etoloakarnania to the metropolitan area of Patras in Achaia) and a persistent population decline during both expansion and recession times; (3) a group of prefectures (from Preveza to Viotia) with diversified socioeconomic characteristics (from rural areas of Fokida to coastal,

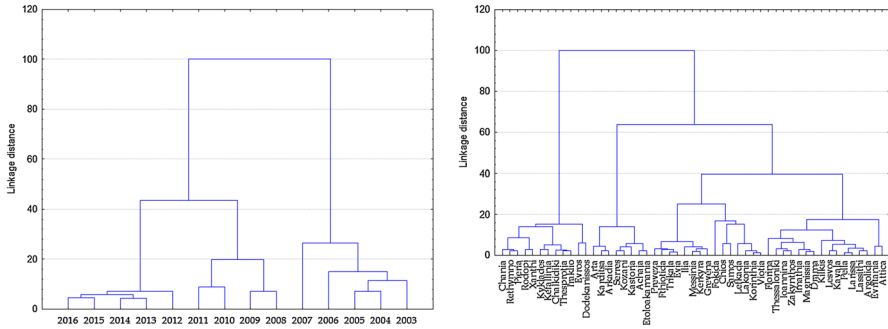


Fig. 3 Hierarchical clustering (Ward's agglomeration rule, Euclidean distances on standardized data) of annual population growth rate, 2002–2016 (left) and Greek prefectures (right)

touristic districts in Messinia, Samos and Chios) and heterogeneous population trend over time (moderate to high increase during economic expansion and moderate to low decrease during recession); and, finally, (4) a group of prefectures (from Florina to Attica) with intermediate urban–rural characteristics (including the metropolitan regions of Athens and Thessaloniki) and moderate to high population increase during economic expansion and a generalized decline during recession.

3.2 Population growth and decline during economic expansion and recession

According to the results of hierarchical clustering, we analyzed the spatial distribution of aggregated population growth rates during economic expansion (2002–2007) and recession (2008–2016), considering together a first, transitional phase (2008–2011) and the stagnation period (2012–2016). During economic expansion, the highest negative rates were observed in internal, rural prefectures in central and southern Greece (Fig. 4). The reverse pattern was observed during the second time period, with the highest negative rates observed for metropolitan Athens and some coastal and internal regions of Peloponnisos, central-western Greece and north-eastern Greece. Overall, we observed a moderately positive correlation between population growth rates during the two investigated time periods (Fig. 5), with some prefectures deviating considerably from the average pattern (e.g. Fokida, declining considerably during economic expansion; Attica, central Makedonia, Evritania, Florina and Kastorià, declining rapidly during recession). Spatial heterogeneity in population growth rates increased during recession in respect to economic expansion.

3.3 Spatial patterns of population growth and socioeconomic background

A non-parametric correlation analysis was run with the aim to identify relevant socioeconomic attributes of prefectures associated to the respective rates of population growth or decline (Fig. 6). Per-capita disposable income was positively correlated with population growth rate during 2005–2006. Population growth rates increased significantly with the distance from Athens during the time period 2002–2006 and

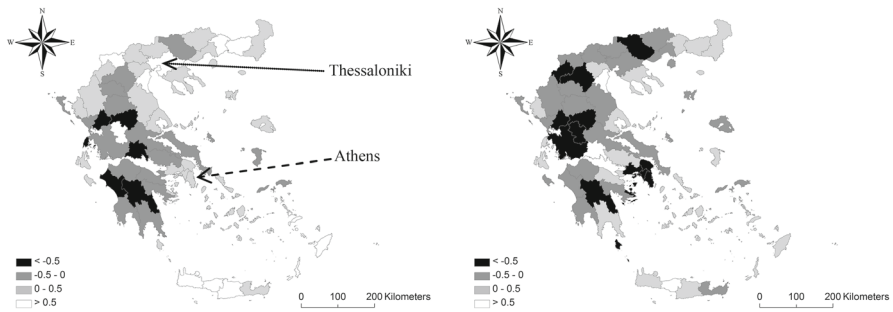


Fig. 4 Spatial distribution of population growth or decline (percent annual rate during 2002–2007, left and 2008–2016, right) in Greek prefectures (the geographical position of Athens and Thessaloniki, the main urban centers in the country, was highlighted)

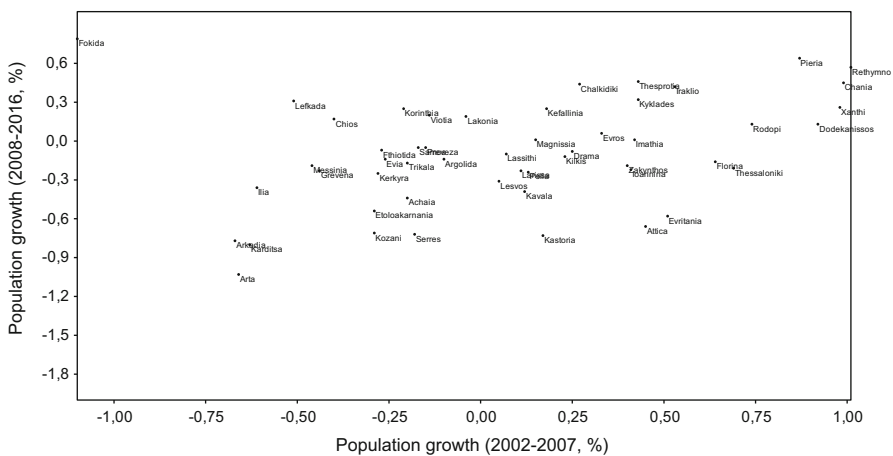


Fig. 5 Population growth (percent annual rate) during economic expansion (2002–2007) and recession times (2008–2016) in Greek prefectures (Spearman rank correlation coefficient, $r_s = 0.40$, $p < 0.05$, $n = 51$)

decreased significantly with the distance from Thessaloniki during 2002–2005, confirming that the highest population growth was concentrated in northern Greece during economic expansion. Conversely, population growth rates increased significantly with the distance from Thessaloniki in 2014–2015. Population increased in coastal areas between 2012 and 2016. During economic expansion, population increased significantly in prefectures with upper functions such as universities (2003–2006) and airports (2005–2006). The highest rates of population growth were observed in tourism districts during 2011–2016.

Considering population growth rates aggregated over time (Table 1), Spearman correlation analysis confirmed the findings presented above. During economic expansion (2002–2007), population increased the most in prefectures far away from Athens with upper socioeconomic functions (universities); during recession (2008–2016), population increased the most in coastal prefectures hosting tourism-specialized places.

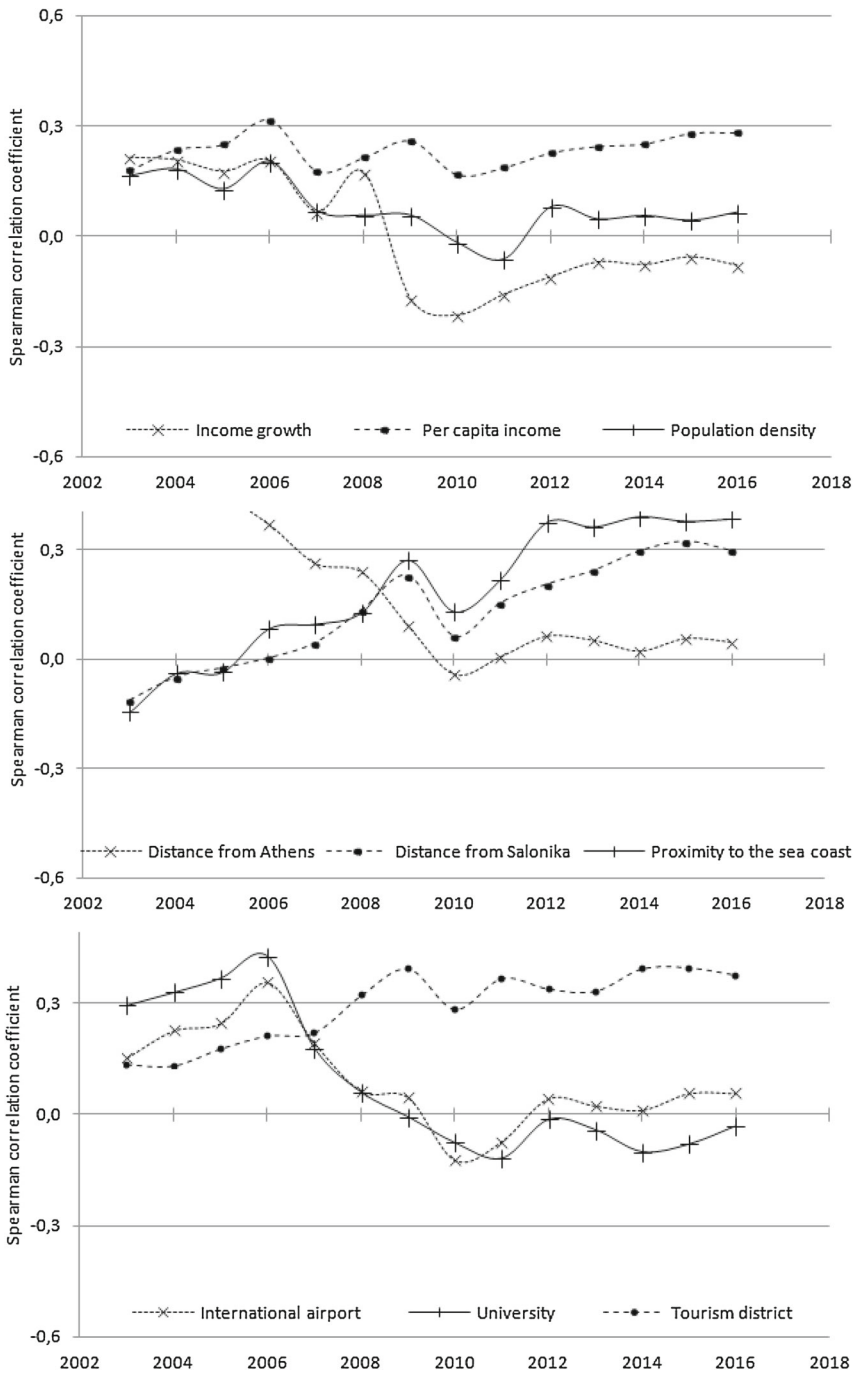


Fig. 6 Spearman rank correlation coefficients between percent annual rate of population growth and selected territorial and socioeconomic indicators in Greek prefectures, 2002–2016 ($r_s > 0.30$ indicates a significant coefficient at $p < 0.05$ after Bonferroni's correction for multiple comparisons)

Table 1 Spearman rank correlation coefficients between percent annual rate of population growth during economic expansion (2002–2007) and recession (2008–2016) times and selected territorial and socioeconomic indicators in Greek prefectures

Variable	2002–2007	2008–2016
Income growth	0.17	– 0.11
Per-capita income	0.25	0.26
Population density	0.16	0.03
Distance from Athens	0.44	0.04
Distance from Thessal.	– 0.05	0.25
Proximity to the sea	– 0.03	0.35
International airport	0.25	– 0.01
University	0.34	– 0.08
Tourism specialization	0.16	0.38

Bold indicates significant coefficients at $p < 0.05$ after Bonferroni's correction for multiple comparisons

A multivariate analysis of population growth rates and socioeconomic background indicators confirms our previous findings (Fig. 7). A Principal Component Analysis (Table 2) extracted three axes explaining a cumulated variance of 65% in the total matrix variance. Population growth rates during both expansion and recession received insignificant loadings to component 1. This axis discriminated Greek prefectures based on personal income growth during expansion (negative loading) and recession (positive loading). Population density, level of per-capita income, proximity to the sea coast, distance from Thessaloniki and upper socioeconomic functions (university, airport, tourism specialization) all received negative loadings to component 1. Component 2 and 3 attributed high loadings to population growth respectively during recession and expansion. Population density received negative loadings to component 2; the reverse pattern was observed for distances from Athens and Thessaloniki and tourism districts. Distance from Athens, together with the presence of upper socioeconomic functions such as universities and international airports, received positive loadings to component 3. The reverse pattern was observed for coastal areas, that received negative loadings. The ordination of Greek prefectures over the component scores' plot (Fig. 7, right plot) confirms the spatially-varying demographic patterns observed during the study period, evidencing a group of prefectures with a persistent population increase (I quadrant), a large number of areas scattered over the second and third quadrant and displaying heterogeneous demographic trends with alternating population increases and decreases during expansion and recession and, finally, a small number of medium and large metropolitan regions (Athens, Thessaloniki, Patras, Larissa, Argolida) with continuous population decline during recession time.

A forward step-wise multiple regression was finally run to identify the most important context variables accounting for the largest spatial variability in population growth rates during expansion and recession (Table 3). Regression analysis identified distance from Athens, per-capita disposable income and the presence of universities as characteristic attributes of prefectures with the highest population growth rate during economic expansion in Greece. Although with a less performing model's goodness-

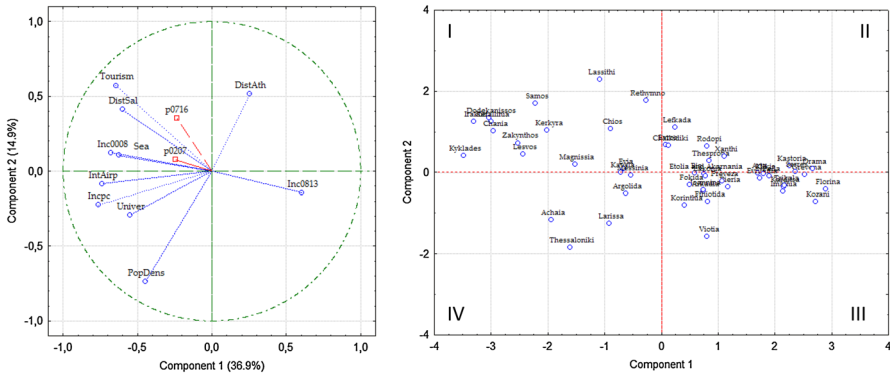


Fig. 7 Principal Component Analysis of territorial and socioeconomic indicators (active variables, circles) and population growth rates (supplementary variables, squares) over the study period (2002–2007: economic expansion; 2008–2016: recession) in Greek prefectures (left: loadings’ plot; right: scores’ plot); see Sect. 2.3 for variables and acronyms

Table 2 Distribution of relevant indicators’ loadings to selected components

Variable	PC 1	PC 2	PC 3
Income growth (2000–2007)	-0.68		
Income growth (2008–2013)	0.61		
Per-capita disposable income	-0.76		
Population density	-0.44	-0.73	
Distance from Athens		0.52	0.67
Distance from Thessaloniki	-0.60	0.41	
Proximity to the sea coast	-0.63		-0.45
International airport	-0.74		0.35
University	-0.55		0.50
Tourism district	-0.65	0.57	
Population growth (2002–2007)*			0.40
Population growth (2008–2016)*		0.35	
Explained variance %	36.9	14.9	12.9

*Indicates supplementary variables; significant coefficients >|0.35|

of-fit, tourism specialization, proximity to the sea coast and low population density were the most relevant territorial attributes of prefectures with the highest population growth rate during recession.

Table 3 Results of a forward step-wise multiple regression with annual population growth rate during economic expansion (2002–2007) or recession (2008–2016) as dependent variable and selected territorial and socioeconomic indicators as predictors

Variable	Beta	SE	$t_{(47)}$	p level
<i>2002–2007: Adj-R² = 0.375; F_(3,47) = 11.0; p < 0.0001</i>				
Distance from Athens	0.56	0.12	4.66	0.000
Per-capita disposable income	0.39	0.13	3.10	0.003
University	0.23	0.12	1.99	0.052
<i>2008–2016: Adj-R² = 0.176; F_(3,47) = 4.56; p < 0.007</i>				
Tourism district	0.26	0.14	1.89	0.065
Proximity to the sea coast	0.26	0.14	1.87	0.068
Population density	– 0.21	0.13	– 1.62	0.099

3.4 Temporal evolution of regional disparities in population growth rates

By displaying an inverted U-shaped trend over time in average population density of Greek prefectures (Table 4), the ratio of median to arithmetic mean population density increased in Greek prefectures between 2002 and 2011, possibly indicating that economic expansion contributed to re-balance population distribution at the country scale. Conversely, variability indexes (coefficient of variation, range-to-median) indicated that spatial heterogeneity in population density was the highest in 2002, remaining quite stable up to 2007 and decreasing progressively during recession time. Kurtosis and asymmetry followed a similar pattern, possibly documenting a more balanced urban hierarchy following crisis. This evidence is in line with the reduction of metropolitan Athens' primacy. The same trend was observed for Thessaloniki prefecture and was associated to a recent, generalized population decline in the largest urban agglomerations of Greece. These general trends are in some way driven by economic dynamics, with special reference to the negative performances of urban areas in terms of unemployment and poverty.

4 Discussion

Empirical evidence demonstrate how advanced countries are undergoing a complex demographic transition promoting new family relations and determining less and later marriage, declining fertility rates, population ageing, postponement of child-bearing and smaller households (Billari and Kohler 2004; Surkyn and Lesthaeghe 2004; Lesthaeghe and Neidert 2006). Moreover, European regions are being populated with multiple migration trends and new household structures connected to the second demographic transition, with implications for population dynamics at the regional scale (Champion and Hugo 2004; Billari et al. 2007; Pison 2011; Reher 2011). By contrast, empirical evidence on short- and medium-term impacts of the 2007 crisis on demographic dynamics are still occasional (Palloni and Tienda 1992; Garcia 2010; Pérez 2010). Understanding linkages between economic cycles and demographic processes contributes to a better definition of mechanisms through which economic conditions

Table 4 Descriptive statistics assessing spatial distribution of population density in Greek prefectures (inhabitants/km²), selected years, 2002–2016

Variable	2002	2007	2011	2016
Average population density	79.1	80.1	80.9	78.7
Median-to-mean (%)	58.6	59.1	59.9	59.9
Armonic mean	41.6	41.6	42.1	41.3
Geometric mean	50.8	51.0	51.6	50.7
25° percentile	36.4	36.4	37.1	37.0
75° percentile	64.0	63.7	65.4	64.4
Coefficient of variation	2.09	2.12	2.10	2.05
Range-to-median	25.6	25.7	25.1	24.5
Asymmetry	6.46	6.46	6.45	6.40
Kurtosis	43.92	43.87	43.74	43.27
Wilcoxon test (t ₁ vs. t ₀ , *p<0.05)		0.56	4.48*	3.64*

have an impact on recent population trends (Cherlin et al. 2013; Goldstein et al. 2013; Lee and Painter 2013).

Greece has provided a key opportunity to examining short-term demographic dynamics over alternated expansion and recession waves (Rontos 2010; Gavalas et al. 2014; Remoundou et al. 2016). Although with a moderate demographic fall at the country scale, spatially-heterogeneous population increases and decreases were observed in Greece, diverging during expansion and recession times (Tragaki and Bagavos 2014). This study identified short- and medium-term changes in the spatial distribution of Greek population, focusing on differential speed and direction of demographic growth and decline during expansion and recession, in relation to selected socioeconomic background indicators (e.g. Salvati et al. 2016a, b). Results of the multivariate analysis run in our study showed a sharp differentiation in population dynamics between urban and rural areas based on location factors, regional income, economic specialization and functions (Serra et al. 2014).

Aided by an heuristic framework, tentative hypotheses have been proposed to identify and interpret multiple impacts of the 2007 recession on population structure and dynamics. It was largely demonstrated how structural divides consolidated as the spatial outcome of a polarized economic growth coupled with persistent social inequalities and divergences in population density (Goerlich and Mas 2008; Davies 2011; Dijkstra et al. 2015). However, recession was demonstrated to influence regional disparities in multiple ways, widening or containing them according to a (more or less) balanced distribution of economic investments and a mix of human capital, infrastructures, accessibility, amenities and land resources (Connaughton 2010; Kroll and Kabisch 2012; Koutsampelas and Tsakoglou 2013). In recent decades, socioeconomic disparities shaped by asymmetric growth of wealthier and disadvantaged regions have been exalted by demographic factors (Tapinos et al. 1997; Rodríguez-Pose and Fratesi 2007; Storper 2011).

For Greece, our study suggests that population growth was spatially-decoupled from economic growth; with recession, demographic changes have determined a less spatially-polarized population distribution (Fuchs and Demko 1983). After a time period of substantial stability in population density, a less intense gap between urban and rural areas was observed between 2008 and 2016. Mechanisms of population re-distribution were spatially-heterogeneous (Lerch 2016): population increased in low-density rural areas (tourism-specialized coastal areas, large and medium-size islands, a few plain agricultural regions); conversely, inland and marginal areas (e.g. in northern Greece) experienced a moderate population decline during both economic expansion and recession (Salvati 2016). Our analysis partly supports earlier evidences presented by Gkartzios (2013); urban-to-rural internal movements as a result of progressive counter-urbanization due to worse socioeconomic conditions in urban areas, especially Athens, were documented by Gkartzios and Scott (2015) since 2008 with impact on urban hierarchy and population re-balancing along urban–rural gradients (Zambon et al. 2017).

The largest spatial variation in the rate of population growth or decline was observed along coastal-inland and urban–rural gradients as a result of different socio-demographic and economic processes. Mitigating socioeconomic disparities along geographical gradients is not only a target for regional development policies *per sé*, but also an important condition for promotion of spatially-balanced, demographically-cohesive and socially-inclusive settlement models (Benyaklef 1997; Di Felicianantonio and Salvati 2015; Cazzola et al. 2016).

By introducing an exploratory data approach in the analysis of demographic disparities, this paper focused on the spatial dynamics of population density, a sensitive indicator to external shocks (e.g. Salvati et al. 2016b). Results of multivariate statistics run in our study provide a comprehensive interpretation of short-term population growth and decline spatial patterns, intended as a possible measure of territorial disparities and resilience to economic shocks (Salvati and Carlucci 2016). An improved knowledge of population dynamics allows investigating selected socioeconomic characteristics of areas performing better during expansion or recession (Sobotka et al. 2011). Empirical evidence of this study emphasize the role of economic cycles in shaping population redistribution at regional scale. In this regard, the time period between 2007 and 2011 was recognized as a turning point from spatial regimes characterized by clusters of districts with persistently high (or low) population density to a more heterogeneous spatial regime, mixing districts with high, intermediate and low population density at regional scale.

Taken together, our results definitely highlight the increasingly complex population geography of Greece (Rontos 2010). Population decline in economically-growing regions slowed down with recession, contributing to a generalized decrease of between-regions variability in the rate of demographic growth and to lower disparities in population density. At the same time, recession determined an enlarged dichotomy in population density between internal, peripheral rural areas and more accessible coastal districts and tourism-attractive islands, as observed in other Mediterranean countries such as Spain (Serra et al. 2014) and Italy (Ferrara et al. 2017).

While recession has undoubtedly created favorable conditions for a process of divergence between economically-strong and weaker districts (Salvati 2016), our findings indicate that population in urban, industrial and intensive agricultural districts increased during 2002–2007 (Gavalas et al. 2014), demonstrating to be less resistant to recession shocks than coastal, rural areas with an economic base centered on tourism—which have displayed a continuous population increase during 2008–2016 (Karamesouti et al. 2015).

The economic vulnerability of urban, industrial and agricultural regions in Greece is probably due to a mix of factors that include fragmentation of a competitive industrial sector, lack in advanced urban functions, persistence of informal activities in tertiary sectors and strong dependence of agriculture on European Union subsidies (Leontidou and Marmaras 2001; Koutsampelas and Tsakloglou 2013; Kosmas et al. 2016). These factors may explain the peculiar dynamics of some low-density Greek districts compared with marginal rural areas, reflecting the ‘multiple heterogeneity’ characteristics of the productive structure of Greece (Monastiriotis 2009, 2011).

The progressive reduction in population disparities over the study period, and especially under economic stagnation, was coupled with a reduction in the gap between Athens’ metropolitan area and the rest of Greece (Mavrakis et al. 2015). Such a polarization adds to the already complex mix of factors shaping territorial disparities and a direct result of worse socioeconomic conditions in urban areas (Porter and Howell 2009; Peck 2012; López-Gay 2014). While becoming an advanced district for high-return economic sectors such as real estate, telecommunications, banking and financial services, the Athens’ metropolitan region has recently experiencing rising unemployment, enlarged income disparities, increasing poverty among large families as a consequence of austerity policies in response to global recession and national debt crisis (Maloutas 2007; Arapoglou and Sayas 2009; Souliotis 2013; Chorianopoulos et al. 2014; Rontos et al. 2016; Salvati et al. 2016a). In accordance with evidences from earlier studies (Pérez 2010; Gil-Alonso et al. 2013; Salvati et al. 2013; De Rosa and Salvati 2016), interpreting recession effects on regional disparities requires an in-depth understanding of the role of place-specific factors and basic geographical gradients.

Understanding and qualifying opportunities for developmental policies and regional planning opened up by new population scenarios is a pivotal issue and a continuously debated question in demographic studies (e.g. Walford and Kurek 2016). On the one hand, population re-distribution over larger metropolitan regions is the result of a complex interplay between regional-scale and local-scale processes, making predictions of population trends particularly volatile at spatially-disaggregated levels (Kreyenfeld et al. 2012; Hofmann and Hohmeyer 2013; Simou and Koutsogeorgou 2014). On the other hand, internal urban-to-rural movements, reduced foreign immigration flows and declining marriage and fertility rates, indirectly stimulated by spatially-heterogeneous living conditions under recession, suggests rethinking policy strategies for sustainable urbanization and polycentric development, with the promotion of direct measures improving competitiveness and attractiveness of regions more exposed to economic crisis (Dyson 2011; Lerch 2014; Stockdale 2016). A comparative analysis of spatially-detailed and updated population data is required to assess newly-emerging demographic patterns associated to complex socioeconomic processes acting at dif-

ferent spatial scales (Caldwell 2006). A comprehensive investigation on the role of functional transformations (including the negative impact of recession on regional and local socioeconomic structures) at the base of these patterns is particularly meaningful to get insight future population trends in post-crisis European regions.

5 Conclusion

The present study provides insights in the analysis of recent demographic dynamics with empirical evidence that contribute to a better comprehension of mechanisms underlying population redistribution along urban–rural gradients in 51 Greek prefectures during economic expansions and recessions. These spatial units were demonstrated to be a sufficiently detailed analysis' domain to explore population redistribution in Greece under different economic cycles, showing appreciable features that fill the need for data integration, reliability and relevance to regional issues. Our results indicate a complex territorial patchwork, that can be better interpreted using an exploratory analysis, with diversified research dimensions identified by use of multidimensional statistical techniques.

A regional analysis of demographic transitions is particularly appropriate in a context of changing socioeconomic relationships among relevant territorial actors. Short-term population dynamics were mutually influenced by a mix of socioeconomic processes acting at different spatial scales as a consequence of supra-national factors, such as the second demographic transition and uneven migration flows from Africa and the Middle East, country-based phenomena such as the demographic outcomes of recession, including urban–rural internal migration, and local-scale processes such as alternated cycles of suburbanization and re-urbanization. While impacting drastically the spatial organization of urban and rural areas in Greece, likely more than in any other European Mediterranean country, a slow but progressive rebalancing of population divides was observed as an indirect consequence of the 2007 economic crisis.

As a matter of fact, the traditional urban–rural polarization observed up to the early 2000s in Greece has more recently shifted toward a spatial pattern that reflects increased divides between high-density metropolitan areas and low-density, coastal and tourism-attractive districts. These findings justify the use of an exploratory analysis of complex socio-demographic systems and bring insights on the debate over future trends in population re-distribution along urban–rural gradients in economically-developed and socially-divided countries.

A comparative analysis of recent population and economic dynamics reconnecting demography to regional studies in countries affected by 2007 recession, will definitely contribute to a more precise forecast of future demographic trends, informing spatial policies aimed at a spatially-balanced and cohesive regional development. Further investigation should contribute to identification of comprehensive criteria that may discriminate short-term population dynamics in urban and rural areas, according to external variables evaluating the local background context.

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