Eur J Population (2019) 35:1–28
https://doi.org/10.1007/s10680-017-9462-0

Re-urbanizing the European City: A Multivariate Analysis of Population Dynamics During Expansion and Recession Times

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Received: 7 October 2016 / Accepted: 29 December 2017 / Published online: 29 January 2018

Abstract After a long phase of suburbanization promoting economic decentralization and uneven expansion of urban rings, re-urbanization has been observed in an increasing number of European cities. However, a comprehensive analysis of demographic dynamics underlying spatial patterns—and factors—of re-urbanization is still lacking for the European continent. This study contributes to fill this knowledge gap by proposing a comparative analysis of population dynamics at two spatial scales ('inner cities' and 'large urban zones') in 129 European metropolitan regions under economic expansion (2000–2007) and recession (2008–2014). Non-parametric correlations, principal component analysis, and stepwise multiple regressions were used to identify different spatial patterns of population growth at continental and regional scale in Europe. The number of cities studied that showed a trend towards re-urbanization increased from 36 in 2000–2007 to 47% in 2008–2014. Positive rates of population growth in inner cities were found to be associated with high levels of disposable per capita income at the metropolitan scale. During recession, spatial differences in population growth rates were suggestive of a moderate rearrangement towards re-urbanization in northern and central

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Europe and less polarized metropolitan regions, with declining population in inner cities of southern and eastern Europe. Based on peculiar demographic dynamics found in the study area, the analysis performed brings useful insights to the debate about the future development of European cities.

Keywords Population dynamics · Inner city · Large urban zones · Data mining

1 Introduction

With half of the world's population living in urban areas, population dynamics in metropolitan regions are becoming progressively more complex and less dependent on economic dynamics (Cohen 2006; Florida et al. 2008; Angel et al. 2011). Multiple and contradictory demographic shifts from growth to decline and vice versa have been observed for an increasing number of cities (Hohenberg and Lees 1985; Cheshire 1995; Champion 2001; Andersen et al. 2011). Change in the population of an inner city and, respectively, of the surrounding areas over time has been used to describe the development of metropolitan regions in urban cycles (Buzar et al. 2007; Beauregard 2009; Bayona-Carrasco and Gil-Alonso 2012). A cycle is the period of time during which a demographic phase emerges, peaks, and declines in a defined spatial unit (Fielding 1982). Thus, the relationship between urbanization and population dynamics at local and regional scales could be brought under the framework of the life cycle theory of urban growth (Hall 1997), introduced by Klaassen et al. (1981), and first adopted by van den Berg et al. (1982).

Based on empirical analysis of positive or negative changes in the direction and rate of population growth in the urban core relative to ring areas, van den Berg et al. (1982) identified four life cycles, namely 'urbanization', 'suburbanization', 'counter-urbanization', and 're-urbanization'. Although criticized for an extreme simplification of urban patterns and poor alignment with economic theories (Nyström 1992; Henderson and Venables 2009; Haase et al. 2010; Kabisch and Haase 2011), the life cycle paradigm remains a reference framework to describe the growth and decline of contemporary cities (Hall and Hay 1980; Cheshire and Hay 1989; Pacione 2005).

Until recently, re-urbanization has been the least studied of the four life cycles (Heikkilä and Kaskinoro 2009). Re-urbanization occurs when the core city starts re-attracting population and economic activities after a long period of decline, while suburbs still experience demographic loss or particularly low rates of growth (Lever 1993). This usually occurs when urban re-development projects take place in inner cities, ameliorating housing conditions and the quality of the urban environment and promoting a more dynamic local job market (Martinez-Fernandez et al. 2012). Changes in the economic structure of metropolitan regions are additional factors driving re-urbanization (Partridge et al. 2009). Above all, the development of advanced services together with the rising cost of energy and transportation brings the economic activity back to inner cities (Rink et al. 2012). Re-urbanization is thus understood as a process of populating and diversifying urban cores with a variety of residential groups of different ages and socioeconomic backgrounds (Rérat 2012).

According to Pacione (2005), early signs of population reversal between urban and rural areas after a long wave of suburbanization were first identified in the USA during the 1980s, and similar trends have been subsequently detected in other advanced nations, including Canada and Australia (Couch et al. 2007; Bettencourt et al. 2007; Beauregard 2009). Following suburbanization and counter-urbanization, waves of re-urbanization have occurred in Europe (Buzar et al. 2007), intensifying after the 2007 global financial crisis (Bouzarovski et al. 2010; Kabisch et al. 2010; López-Gay 2014). Drivers of change in long-established urban trends seemed to differ by region, leading to the conclusion that a single explanation for the factors determining this new urban phase in Europe would be too simplistic and result inadequate (Heikkilä and Kaskinoro 2009; van Criekingen 2010; Haase et al. 2013).

However, a general consensus has been reached on the pivotal role of demographic transformations as a factor of change in urban dynamics (Haase et al. 2010). The demographic regime has changed (more or less rapidly) in European regions, being now substantially different from those observed in the immediate aftermath of World War II and still continuing to evolve (Leontidou 1995; Longhi and Musolesi 2007; Hatz 2009; Kroll and Kabisch 2012). At the same time, settlement systems show a significantly altered spatial structure, with the emergence of polycentric urban configurations reflecting a slow decline of compact cities and a progressive lowering of urban–rural divides at the metropolitan scale (Longhi and Musolesi 2007; Turok and Mykhnenko 2007; Schneider and Woodcock 2008; Marchetti et al. 2014; Bencardino 2015).

Population redistribution along the urban gradient in response to economic cycles has been extensively studied in Europe, a region with more than 70% of the population living in urban areas today, possibly increasing to 85% by 2050 (Kabisch and Haase 2011; Kroll and Kabisch 2012). Since World War II, European cities were characterized by multiple growth paths determining the proliferation of compact cities, with consolidated dense settlements and radio-centric expansion up to the late 1960s (Kasanko et al. 2006; Schneider and Woodcock 2008; Salvati and Carlucci 2015). Suburbanization took place in the 1960s and 1970s, with a time gradient between western and northern Europe (early) and eastern and southern Europe (later). Exurban development has reflected economic de-concentration of inner cities, increased social inequalities, and urban continuums with mixed land use (Catalàn et al. 2008; Arapoglou and Sayas 2009; Salvati 2013).

Although many cities in Europe have experienced a continuous process of urban growth, a number of metropolitan regions underwent long periods of shrinkage over recent decades and, in between, some cities have displayed less pronounced or mixed expansion trajectories (Haase et al. 2013; Salvati and Gargiulo Morelli 2014; Dijkstra et al. 2015). A ‘turnaround’ from urban shrinkage towards stabilization and, possibly, recovery in population numbers, has been increasingly observed in recent years (Andersen et al. 2011). Leipzig in Germany and Liverpool in the UK are probably the most studied cities that underwent a phase of long-term shrinkage from the 1930s, reversed since the late 1990s by a moderate population growth dependent on external public investments (Kabisch et al. 2010; Rink et al. 2012).

Rérat (2012) addressed re-urbanization in Swiss cities, which gained inhabitants since 2000 thanks to international migrants, young adults, non-family households, and some parts of the middle to upper class. Southern European cities did not escape this general trend, with inner cities in Spain experiencing signs of re-urbanization since the early 2000s (Serra et al. 2014) because of internal migration and residential mobility (López-Gay 2014). Salvati and Carlucci (2016) reported some evidences of re-urbanization for Rome, as an indirect response to economic crisis. Early evidence of re-urbanization was also reported for Athens (Gargiulo Morelli et al. 2014).

Although the demographic dimension of such residential shifts is gradually being acknowledged by urban scholars, empirical evidence for re-urbanization processes in Europe is still sparse and, in some ways, contradictory (Kroll and Kabisch 2012). Linkages between population dynamics and urban growth need further analysis, especially with regard to the role of household-driven processes in the stabilization of inner-city neighbourhoods and the reshaping of residential perceptions, wants, and needs (Buzar et al. 2007). In these processes, distinct demographic factors seem to play a major role in inner-cities' population growth (Van Gent and Musterd 2016): internal and foreign migration (López-Gay 2014), an ageing population (Lauf et al. 2012), and the emergence of 'non-traditional' households (Bouzarovski et al. 2010), such as single-parent households and cohabitant flat-sharers, or, more generally, the increase in 'adult-centred' families, less attracted by the space availability provided by suburban settlements (Rérat 2016). Housing preferences expressed by the elder population, young migrants, and new kinds of households 'foster the current re-urbanization processes in inner-city residential areas' (Lauf et al. 2012).

Based on the assumption that recent demographic dynamics for both inner cities and ring areas are still not fully explored in Europe, this study aimed to investigate re-urbanization patterns in European metropolitan regions, linking metropolitan cycles with latent transformations of inner cities. This analysis benefits from a comparison of population dynamics during economic expansion (2000–2007) and recession (2008–2014). Although the 2007 financial crisis has had a heterogeneous impact on western economies—heavier in southern Europe than elsewhere in the continent—recession has undoubtedly influenced urban growth, altering building cycles and shaping house and labour markets, as a consequence of social disparities and a polarized distribution of firms (Capello et al. 2015). With comparative analysis of the crisis' impact on population dynamics being mostly occasional and restricted to local contexts (Salvati et al. 2016), identifying similarities and differences in short-term population growth before and during recession is meaningful to shed light on the most recent transformations of European cities and regions.

2 Methodology

2.1 Study Area

We studied a set of metropolitan regions from 23 European countries ("Appendix 1"). Metropolitan boundaries were identified according to the large urban zones (LUZs) delineated by Eurostat urban audit (UA). The UA program was aimed at collecting homogeneous statistical data for metropolitan regions with more than 100,000 inhabitants (Fig. 1). This program assures a diachronic and coherent data collection for comparisons at continental, national, and local scale (Salvati and Carlucci 2015). Demographic dynamics were studied using data on population residing in the 'inner cities' and LUZs during two time intervals, 2000–2007 and 2008–2014, for the 129 metropolitan regions with complete statistical data covering the study period. A LUZ represents a functional urban area consisting of a city and its commuting zone. An 'inner city' is a local administrative unit where the majority of the population lives in an urban centre of at least 50,000 inhabitants.

Regional classifications of cities have been used extensively as a reference framework for generalizing morphological patterns and discussing the underlying socioeconomic trends (Angel et al. 2011). Although European cities are generally difficult to categorize because of their variable size and specialized functions (Hall 1997), we have partitioned the metropolitan areas investigated in this study into five macro-regions following the classification provided by Hall and Hay (1980) and subsequently applied by others (Hohenberg and Lees 1985; Cheshire and Hay 1989; Couch et al. 2007; Salvati and Carlucci 2015). This approach has identified European macro-regions with similar attributes on the base of population and economic trends, housing characteristics, urban planning, and developmental policies.

Based on this classification, we grouped the 129 selected cities into five macro-regions: *C*, central Europe (34 cities in Germany); *E*, eastern Europe (41 cities in Bulgaria, Czech Republic, Estonia, Latvia, Leetonia, Romania, Slovakia, and Slovenia); *N*, northern Europe (18 cities in Sweden, Finland, Norway, and Denmark); *S*, southern Europe (20 cities in Portugal, Spain, Italy, Malta, Greece, and Cyprus); and *W*, western Europe (16 cities in UK, France, Luxembourg, and Switzerland).

2.2 Indicators

Population growth (annual percentage rate) was calculated for two time intervals reflecting different economic phases ('expansion': 2000–2007; 'recession': 2008–2014) at both 'inner city' and 'LUZ' scales. To provide an in-depth assessment of local contexts, 12 ancillary variables were calculated for each city: (a) population density at LUZ scale (inhabitants/km^2) by year (2000, 2007, 2014), (b) city-to-LUZ percentage ratio of resident population by year, (c) LUZ surface area (km^2), (d) LUZ perimeter-to-area ratio (measuring regularity in the shape of each metropolitan region), and eight dummy variables, indicating (e) metropolitan regions with $>$ 500,000 inhabitants, (f) European capital cities, and (g–k) classification of

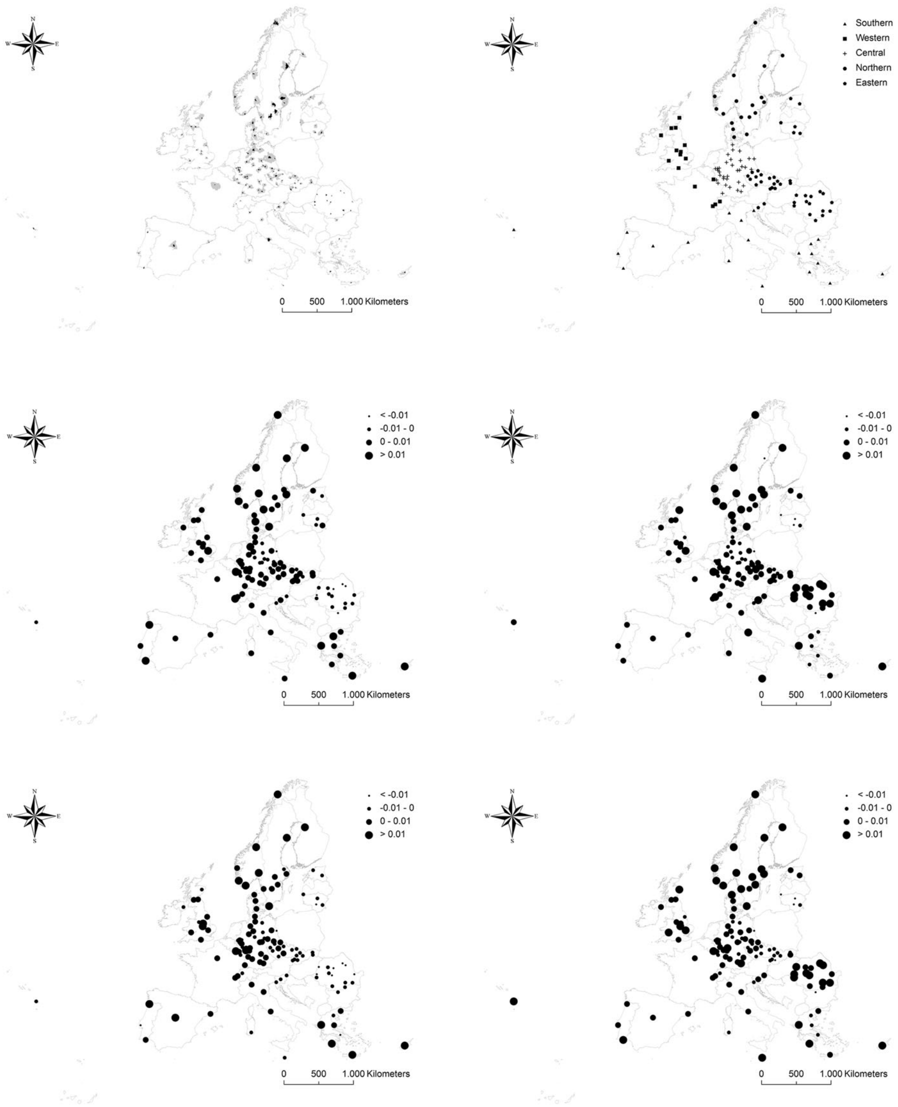

Fig. 1 Spatial location of the investigated metropolitan regions in Europe (upper left) and surface area (black and grey indicate inner cities and LUZs, respectively); annual rate of population growth (%) at the city scale in 2000–2007 (middle left) and 2008–2014 (middle right) and at the LUZ scale in 2000–2007 (lower left) and 2008–2014 (lower right)

each city into one of the five European macro-regions described in Sect. 2.1, and (l) metropolitan regions with population growth concentrated in inner cities. The latter variable aimed to identify cities most likely experiencing re-urbanization processes and regions that had experienced inner-city population growth at rates higher than those observed at the LUZ scale, in any given time interval (expansion or recession).

Indicators reflecting changes in personal income (Euros) at local scale were finally calculated as percentage annual growth rate of per capita disposable income at both ‘inner city’ and LUZ scale during ‘expansion’ and ‘recession’, per capita disposable income (LUZ scale), and city-to-LUZ percentage ratio of disposable income for 3 years (2000, 2007, 2014). Due to missing data for some cities in the Eurostat UA database, personal income indicators were derived for a sub-sample of cities covering all the investigated regions (Salvati and Carlucci 2015).

2.3 Data Analysis

The objective of this study was to provide a comparative analysis of recent re-urbanization patterns in Europe based on individual cities’ population dynamics, distinguishing local-scale from regional-scale trajectories and identifying the contribution of different socioeconomic contexts to urban expansion. Annual rates of population growth at the spatial scale of inner city and LUZ were considered as key variables assessing trends towards population decline or recovery. A dummy variable considering changes over time in population growth rates at both spatial scales was also constructed to identify cities with a specific trend towards re-urbanization. A data mining strategy including descriptive statistics, principal component analysis (PCA), non-parametric Spearman correlations, and stepwise multiple regression was developed to provide a comprehensive profile of re-urbanizing cities, compared with the rest of European metropolitan regions.

2.3.1 Descriptive Statistics and Spatial Analysis

Digital maps provided by Eurostat and representing boundaries of inner cities and LUZs were used to illustrate population growth in European urban areas (Fig. 1). Descriptive statistics (average and coefficient of variation) were calculated to assess basic patterns of population increase and decrease in European cities under economic expansion and recession. Descriptive statistics of percentage annual rate of change in resident population were tabulated by European macro-regions, population size (LUZs > 500,000 inhabitants), and capital cities. Metropolitan regions were classified according to the positive or negative growth rates observed in ‘inner cities’ and the surrounding LUZ; frequency tables were provided separately for times of expansion and recession. Convergence (or divergence) in population growth rate over time and space was studied using scatterplots and Pearson linear correlation analysis testing for a significant relationship ($p < 0.05$) between inner city and LUZ rates during (a) expansion and (b) recession, and by synchronic comparison of demographic rates during times of expansion and recession times, separately, for (c) inner cities and (d) LUZs.

2.3.2 Principal Component Analysis

The PCA was run on the data matrix composed of 15 variables: four demographic rates (Sect. 2.3.1) and the first 11 background indicators (Sect. 2.2) calculated for the 129 metropolitan regions in Europe. Relevant components were chosen according to the scree-plot criterion, fixing the minimum eigenvalue threshold to 1.

Component loadings (variables) and scores (cities) were used to profile spatial variability in population dynamics at the metropolitan scale in Europe. Aimed at transforming high-dimensional data into lower-dimensional data, PCA allows identifying different spatial patterns of population growth in European cities, based on the intrinsic correlation between variables assessing demographic change and selected socioeconomic indicators characterizing the diversified metropolitan contexts at the continental scale. The joint analysis of input variables and observations (cities) justifies the use of a PCA over other clustering techniques commonly used in geo-demographic studies, such as the *k*-means strategy.

2.3.3 Regression Models

Multiple linear regressions were developed with the aim of defining models that describe the most relevant background conditions associated with population growth (or decline) in European cities. Separate regression models were run using four dependent variables (annual population growth rate at both inner city and LUZ scale under expansion and recession times). As in the PCA, the first 11 background indicators (Sect. 2.2) were used as regression predictors. Each model was run using a forward stepwise approach to identify and rank the importance of the most relevant factors associated with population dynamics, using adjusted R^2 as the model's diagnostic test. Fisher–Snedecor F-statistic testing for significant contribution of each indicator entering the regression model was run prior to regression on a standardized data matrix. Predictors were included in a regression model when the p value associated with the respective Fisher–Snedecor test was < 0.01. Results of each regression model are presented using standardized coefficients and tests of significance for each variable (overall Fisher–Snedecor F-statistic testing for the null hypothesis of a non-significant model and Student's t-statistic testing for the null hypothesis of a non-significant regression coefficient).

2.3.4 Non-parametric Correlations

Spearman non-parametric correlations were run in two separate steps, with the aim to identify (a) significant pair-wise relationships between the dummy variable indicating metropolitan regions with growing inner cities and ten background indicators (dummies for N, C, S, W, E cities in Europe, LUZ surface area, LUZ population density and city-to-LUZ population share, and dummy variables for capital cities and cities with $> 500{,}000$ inhabitants) and (b) significant pair-wise relationships between selected income indicators (per capita disposable income at LUZ scale, percentage rate of change in disposable income at both city and LUZ scale, city-to-LUZ disposable income ratio) and 16 territorial and demographic variables (all 12 background indicators *plus* 4 demographic rates, described in Sect. 2.2). Significance was tested at $p < 0.05$ after Bonferroni correction for multiple comparisons.

3 Results

3.1 Population Distribution in the European Metropolitan Regions

Population density at the LUZ scale was particularly high in southern Europe and declined in western, central, and eastern Europe, reaching the lowest values in northern Europe (Table 1). Spatial variability in metropolitan population density was relatively low in all European macro-regions. Conversely, the share of population living in inner cities to population residing in LUZs was variable across metropolitan regions, spanning from 39 (western Europe) to 69% (eastern Europe). Values increased over time in all regions except eastern Europe, where inner cities concentrated, on average, 69 and 66% of total LUZ population in 2000 and 2014, respectively.

3.2 Population Growth and Decline in European Cities (2000–2014)

Population growth during the expansion period was higher in LUZ areas, compared with inner cities, in 73% of the studied metropolitan regions (Table 2). The reverse pattern was observed during recession, with growth rates being higher in urban cores in 64% of the regions. With economic expansion, population increased in 68 metropolitan regions at both city and LUZ scale (at a respective rate of 0.2 and 0.8% per year). In four metropolitan regions, population grew in inner cities (0.5%) while declining in the respective LUZ (− 0.2%). In 25 cases, population increased in the LUZ (0.3%) while declining in the respective inner city (− 0.4%) and, finally, a negative growth rate at both city (− 0.4%) and LUZ scale (− 0.7%) was observed in 32 cases. With recession, population increased in 83 metropolitan regions at both city (1.0%) and LUZ scale (0.9%). A growing population in inner cities (0.5%) with declining population at the LUZ scale (− 0.5%) was observed in 11 metropolitan regions. In 17 cases, population grew in the LUZ (0.2%) while declining in the respective inner city (− 0.3%) and, finally, a negative growth rate at both city (− 0.9%) and LUZ scale (− 0.9%) was observed in 18 cases.

3.3 Spatial Variability in Population Dynamics Over Expansion and Recession

Population dynamics in the European metropolitan regions were investigated by comparative analysis of growth rates during waves of expansion and recession at the spatial scale of inner cities and LUZs (Table 3). Population growth rates were spatially heterogeneous at both city and LUZ scale (Fig. 1): during economic expansion, the highest growth rates were observed in cities of northern and western Europe, declining slightly in southern and central Europe and assuming the lowest values in eastern Europe.

A similar spatial pattern was observed for European LUZs; the highest growth rates were observed in northern Europe. Population dynamics during recession were similar to the ones observed in the preceding time interval at the city scale, with the highest growth rates observed in northern, western, and southern Europe. Population

Table 1 Statistical distribution of selected population variables by geographical division in Europe (2000–2014)

Variable	Southern Europe		Western Europe		Central Europe		Northern Europe		Eastern Europe		LUZs > 500,000 inhabitants		Capital cities	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Population density (LUZ scale, inhabitants/km^2)														
2000	793	0.96	543	0.79	392	0.86	67	0.84	343	1.12	548	1.06	675	0.89
2007	812	0.95	563	0.79	395	0.85	72	0.84	329	1.11	561	1.05	690	0.88
2014	823	0.95	587	0.79	391	0.84	77	0.84	348	1.16	572	1.05	715	0.90
City-LUZ population ratio (%)														
2000	0.55	0.37	0.39	0.26	0.47	0.46	0.60	0.29	0.69	0.28	0.44	0.36	0.51	0.45
2007	0.55	0.40	0.39	0.26	0.48	0.46	0.58	0.30	0.67	0.29	0.43	0.36	0.50	0.46
2014	0.56	0.40	0.39	0.26	0.48	0.44	0.60	0.30	0.66	0.30	0.44	0.35	0.50	0.45
No. of large urban zones	20		16		34		18		41		47		16	

CV coefficient of variation

Table 2 Number of growing (or declining) metropolitan regions and the related average annual rate of population increase at both inner city and large urban zone (LUZ) scale in Europe (2000–2014)

↓Population dynamics	LUZ→	Declining	Increasing
Inner cities	*Number of cities*	2000–2007	
2000–2007	Declining	32	25
	Increasing	4	68
		2008–2014	
2008–2014	Declining	18	17
	Increasing	11	83
	Avg. population growth rate (city scale, %)	2000–2007	
2000–2007	Declining	− 0.0042	− 0.0042
	Increasing	0.0048	0.0024
		2008–2014	
2008–2014	Declining	− 0.0086	− 0.0027
	Increasing	0.0048	0.0097
	Avg. population growth rate (LUZ scale, %)	2000–2007	
2000–2007	Declining	− 0.0070	0.0031
	Increasing	− 0.0020	0.0075
		2008–2014	
2008–2014	Declining	− 0.0087	0.0019
	Increasing	− 0.0053	0.0090

increase in European LUZs was spatially heterogeneous: eastern and central metropolitan regions experienced the highest positive and negative growth rates, respectively, in Europe. Population growth rates in European regions during economic expansion were also highly differentiated: the largest spatial variability was observed at the city scale in both southern and central Europe and decreased considerably during recession. Heterogeneity in population growth rates was evident also at the LUZ scale, with the highest spatial variability found in metropolitan regions of central and eastern Europe.

The relationship between population growth rate at the inner city and LUZ spatial scales (Fig. 2, upper panels) showed higher spatial heterogeneity in the first ('expansion') period. Population growth rates at the two spatial scales were positively correlated in both time intervals, displaying increasing coefficients during recession. A scatterplot comparing population dynamics across times of expansion and recession at both city and LUZ scale illustrates a nonlinear trend characterized by a substantial heterogeneity in metropolitan growth rates in European macro-regions (Fig. 2, lower panels). Conversely, patterns of growth and decline were similar at city and LUZ scale: western cities in Europe clustered in the first quadrant, indicating positive growth rates in both expansion and recession times and at both spatial scales; the reverse pattern was observed for eastern cities.

Table 3 Summary population dynamics by geographical division in Europe (2000–2014)

Variable	Southern Europe		Western Europe		Central Europe		Northern Europe		Eastern Europe		LUZ > 500,000 inhabitants		Capital cities	
	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV	Mean	CV
Population growth rate (city scale, %)														
2000–2007	0.32	3.52	0.55	1.18	0.16	3.41	0.89	0.46	− 0.62	0.78	0.30	2.40	0.17	6.65
2008–2014	0.62	1.38	0.84	0.76	0.21	2.58	1.54	0.35	0.11	9.10	0.52	1.35	0.81	1.23
Population growth rate (LUZ scale, %)														
2000–2007	0.57	1.00	0.61	0.68	0.08	7.48	1.21	0.73	− 0.26	2.40	0.46	1.31	0.58	0.94
2008–2014	0.47	1.46	0.77	0.56	− 0.14	− 3.33	1.12	1.05	0.45	2.35	0.436	1.83	0.88	1.01
No. of inner cities or LUZ	20		16		34		18		41		47		16	

CV coefficient of variation, *LUZ* large urban zones

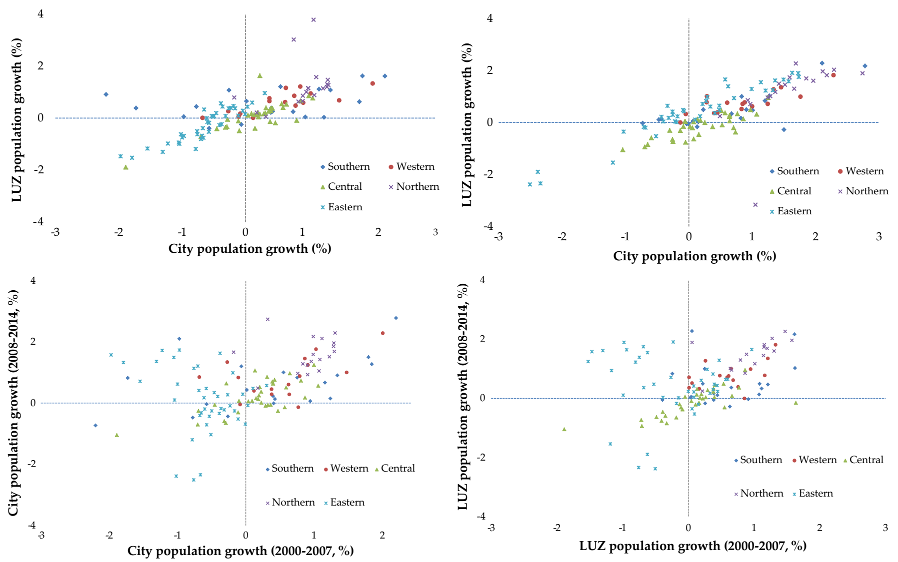

Fig. 2 (Upper panels) Relationship between population growth rate at the spatial scale of cities and large urban zones (LUZs) in 2000–2007 (left) and 2008–2014 (right); (lower panels) relationship between population growth rate over 2000–2007 and 2008–2014 at the spatial scale of inner cities (left) and LUZs (right)

3.4 Principal Component Analysis

A summary analysis of the spatial variability of population growth rates in the 129 European cities studied, according to the spatial distribution of background indicators, was developed using PCA (Table 4). Three principal components (PCs)

Table 4 Results of a principal component analysis applied to population changes between 2000 and 2014 in European metropolitan regions (variables with loadings > |0.45| were reported)

Variable	PC 1	PC 2	PC 3
LUZ > 500,000 inhabitants		– 0.49	
Southern Europe			0.50
Central Europe		– 0.65	
Northern Europe	0.63		
Eastern Europe	– 0.61		
Surface area (LUZ scale)	0.79		
Perimeter-to-area ratio (LUZ)	0.57		
Population density (LUZ) 2000	– 0.46		0.80
City-to-LUZ population ratio (%) 2000		0.45	
Population growth (city) 2000–2007	0.77		
Population growth (city) 2008–2014		0.69	
Population growth (LUZ) 2000–2007	0.80		
Population growth (LUZ) 2008–2014		0.76	
% Explained variance	25.7	17.1	15.0

LUZ large urban zone, *PC* principal component were extracted, explaining 58% of the total variance. PC1 (26%) identified metropolitan regions with above-average rate of population growth at both city and LUZ scale during economic expansion. Our analysis indicates that the highest growth rates were associated with large LUZs characterized by regular morphology (low perimeter-to-area ratio) and medium–low population density. Urban regions with these characteristics were observed more frequently in northern Europe and less frequently in eastern Europe. PC2 (17%) identified metropolitan regions with an above-average rate of population growth at both city and LUZ scale during recession. The highest growth rates were observed for metropolitan regions $< 500{,}000$ inhabitants, mainly situated in central Europe. PC3 (15%) identified cities along a population density gradient, with the highest loading observed for southern European regions and showing no relationship with population dynamics.

The score plot drawn for PC1 and PC2 classified cities according to positive or negative population growth rates during economic expansion (PC1) and recession (PC2). Two groups were identified along PC1 (Fig. 3). A group of 15 metropolitan areas situated in northern Europe (except for Luxembourg, Ioannina, and Lefkosia) clustered along positive values of both components 1 and 2, indicating continuous population increase at both inner city and LUZ scales. Another group situated in eastern Europe (except for Trieste, Italy, which is quite close to the borders of eastern Europe) clustered along negative values of PC1 and positive values of PC2, being characterized by demographic decline during economic expansion and a progressive population recovery during recession at both inner city and LUZ scales. Large metropolitan regions such as Paris, Berlin, and Madrid clustered in the second quadrant and received positive and negative scores to components 1 and 2, respectively, evidencing rapid increase and moderate decline in resident population during expansion and recession, respectively.

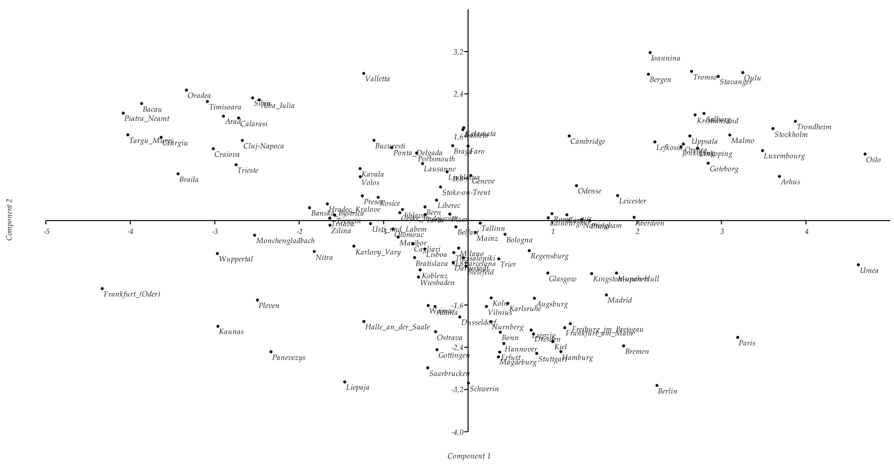

Fig. 3 Principal component analysis score plot

3.5 Modelling Population Dynamics Using Stepwise Regression

The influence of background socioeconomic factors on population dynamics was studied using stepwise multiple regressions (Table 5). During economic expansion, population growth rates in inner cities decreased significantly with population density (LUZ scale) and, more generally, in cities of eastern and central Europe. At the LUZ scale, population growth increased significantly in northern, southern, and western Europe and in cities with > 500,000 residents, but decreased in metropolitan regions with low starting population density and city-to-LUZ population ratio. Under recession, population growth rates at both inner city and LUZ scales increased significantly in northern Europe and, more generally, in the metropolitan regions of capital cities, but decreased in central Europe and in regions with > 500,000 inhabitants. Goodness of fit was higher for regression models calculated in the expansion period than in the subsequent recession time. These results suggest that factors of change that influenced population dynamics under recession may have been more complex than during the expansion wave.

Table 5 Results of stepwise multiple regressions with population growth at the city or LUZ level as dependent variables and selected independent predictors (see Sect. 2.3)

Variable	Beta	SD	*t* test	*p* level
Population growth, inner cities (2000–2007): Adj-R^2 = 0.43; $F_{(3,125)}$ = 33.3, $p < 0.001$; D.W. = 1.79				
Eastern Europe	– 0.661	0.073	– 9.044	0.000
Population density (LUZ), 2000	– 0.281	0.067	– 4.175	0.000
Central Europe	– 0.183	0.074	– 2.485	0.014
Population growth, LUZs (2000–2007): Adj-R^2 = 0.48; $F_{(6,122)}$ = 20.9; $p < 0.001$; D.W. = 1.84				
Northern Europe	0.422	0.078	5.386	0.000
Population ratio (City/LUZ, %), 2000	– 0.192	0.074	– 2.588	0.011
Southern Europe	0.357	0.068	5.208	0.000
Western Europe	0.262	0.070	3.753	0.000
Population density (LUZ), 2000	– 0.329	0.086	– 3.825	0.000
LUZ > 500,000 inhabitants	0.192	0.075	2.559	0.012
Population growth, inner cities (2008–2014): Adj-R^2 = 0.29; $F_{(4,124)}$ = 14.2; $p < 0.001$; D.W. = 1.78				
Northern Europe	0.610	0.086	7.132	0.000
Western Europe	0.205	0.075	2.714	0.008
Surface area (LUZ)	– 0.255	0.087	– 2.931	0.004
Capital cities	0.174	0.077	2.256	0.026
Population growth, LUZs (2008–2014): Adj-R^2 = 0.23; $F_{(4,124)}$ = 10.4; $p < 0.001$; D.W. = 1.81				
Central Europe	– 0.210	0.086	– 2.438	0.016
Northern Europe	0.387	0.095	4.058	0.000
Surface area (LUZ)	– 0.254	0.096	– 2.645	0.009
Capital cities	0.206	0.084	2.466	0.015

LUZ large urban zone, *SD* standard error, *D.W.* Durbin–Watson test

3.6 Characterizing Metropolitan Regions with Growing Inner Cities

A total of 46 metropolitan regions out of 129 (35.6%) displayed positive rates of population growth (city scale) and a positive city-to-LUZ ratio of population growth under expansion, increasing to 61 regions (47.3%) in the following recession (Fig. 4). In these areas, annual population growth rates during expansion were relatively high at both inner city (0.8%) and LUZ scale (0.5%), increasing in the following recession phase to 1.0% (inner city) and 0.6% (LUZ). A pair-wise Spearman correlation analysis was run with the aim to identify significant relationships between a dummy variable indicating growing inner cities and selected background variables (Fig. 5). Under economic expansion, growing inner cities were relatively common in central Europe and quite scarce in eastern Europe. With recession, the population of inner cities grew fast in large metropolitan regions of northern Europe.

3.7 Population Dynamics and Personal Income

Pair-wise correlations between population dynamics and selected indicators of disposable income at both inner city and LUZ scale were carried out separately for times of expansion and recession (Table 6). Population growth at the city level was positively correlated with average per capita disposable income at LUZ scale ($r_s = 0.49$ and 0.51 during expansion and recession, respectively). In line with these findings, the annual rate of population growth at LUZ scale decreased with the share of city-to-LUZ per capita disposable income ($r_s = -0.52$). Population density (LUZ scale) increased with LUZ per capita disposable income in the base year during expansion ($r_s = 0.44$) and recession ($r_s = 0.55$). Population density (LUZ scale) was also negatively correlated with the annual rate of income growth (LUZ scale) under recession ($r_s = -0.59$) and the share of city-to-LUZ disposable income ($r_s = -0.45$). During recession, the share of city-to-LUZ population

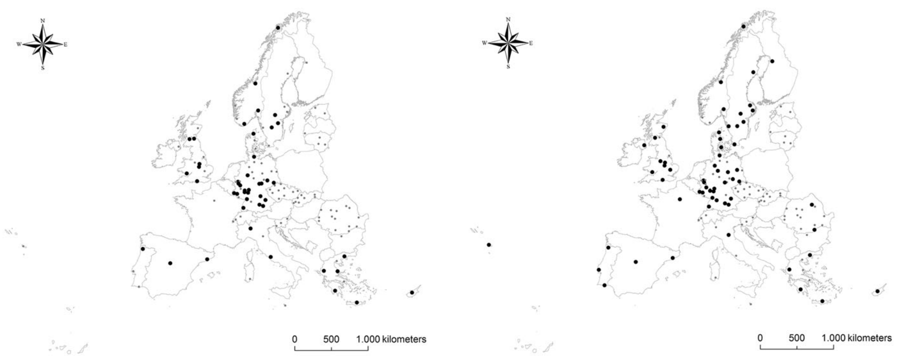

Fig. 4 Spatial distribution of metropolitan regions with growing inner cities (black dots) in Europe, comparing positive population growth rate (inner-city scale) and higher population growth rate at the inner-city scale with the related growth rate at LUZ scale. Small grey dots indicate the remaining cities in the studied sample

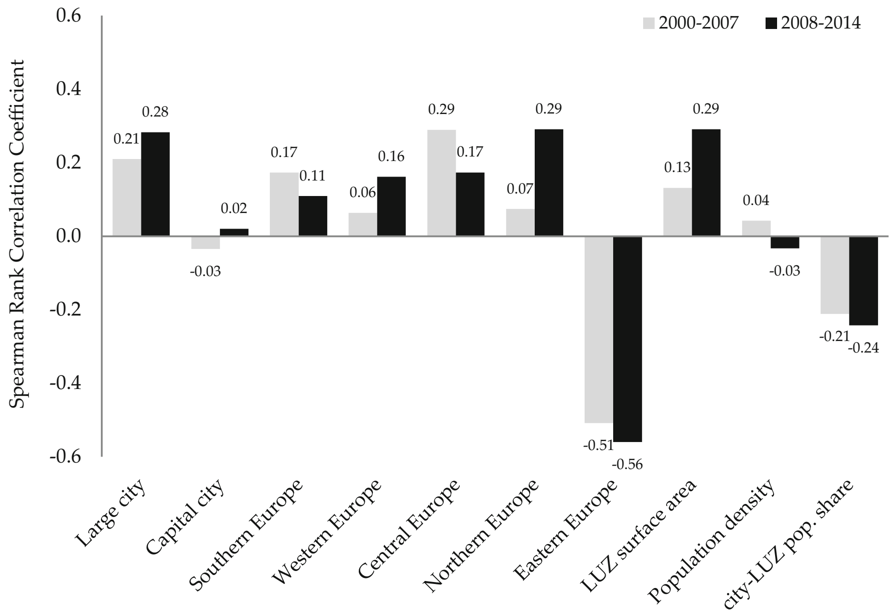

Fig. 5 Pair-wise Spearman rank correlation analysis between a dummy variable indicating metropolitan regions with growing inner cities (Sect. 2.2) and ten territorial and demographic variables by time period (coefficients > |0.28| significant at $p < 0.05$ after Bonferroni correction for multiple comparisons; *LUZ* large urban zone)

increased together with the annual rate of income growth at LUZ scale ($r_s = 0.47$) and decreased with per capita disposable income at the same spatial scale ($r_s = -0.54$).

4 Discussion

After having lost population for some decades, many cities in Europe are experiencing a new growth wave, characterized by demographic recovery of inner cities and renewed socioeconomic polarizations along urban–rural gradients. Based on empirical evidence that inner cities are increasingly regaining attractiveness after years of decline, this study looked at the underlying dynamics of re-urbanization in a selected set of European metropolitan regions. Diversified population trajectories for core cities and fringe areas were identified from demographic data for the study period, 2000–2014. We considered population dynamics as a reliable proxy of differential speed and direction of urban growth during expansion and recession, distinguishing local-scale from regional-scale patterns of change, and highlighting the contribution of spatially varying socioeconomic contexts to urban growth (Kabisch and Haase 2011; Rérat 2012; Carlucci et al. 2016). The results of this exploratory approach can contribute to the implementation of policies that address the emergence of a new urbanization phase in Europe (Andersen et al. 2011). In rapidly changing socioeconomic contexts (Martinez-Fernandez et al. 2012), policies

Table 6 Spearman rank correlation analysis between per capita disposable income and demographic indicators at both inner city and LUZ (large urban zone) scale in Europe (2000–2014)

Variable	Disposable income (% chg, LUZ)		Disposable income (% chg, city)		City-LUZ ratio of disposable income		Per capita disposable income (LUZ)	
	2000–2007	2008–2014	2000–2007	2008–2014	2000	2007	2000	2007
Population growth (city)							0.49	0.51
Population growth (LUZ)					– 0.45			
Metropolitan regions with growing inner cities[a]							0.48	0.53
Population density (LUZ)		– 0.59				– 0.45	0.44	0.55
City-LUZ population ratio (%)		0.47					– 0.52	– 0.54
LUZ > 500,000 inhabitants		– 0.37		– 0.41				0.38
Eastern Europe	0.69	0.63	0.56				– 0.70	– 0.70
Central Europe	– 0.84		– 0.66				0.79	0.70

Significant coefficients at $p < 0.05$ after Bonferroni correction for multiple comparison

[a]Dummy variable identifying metropolitan regions with positive population growth rate (inner-city scale) and higher population growth rate (inner city) compared with the related growth rate at large urban zone (LUZ) scale, calculated separately for expansion and recession times

merging sustainable development and containment of urban expansion with targets for economic growth, attraction of skilled jobs, and reduction in social divides between urban and rural areas may promote local competitiveness, re-launching inner cities in global urban arenas (Storper and Scott 2009).

4.1 Metropolitanization and Recent Changes in Population Distribution in Europe

While population redistribution along urban gradients has been investigated in a number of theoretical models and empirical approaches (Henderson and Venables 2009; Dijkstra et al. 2015; Kazemzadeh-Zow et al. 2016), stability or change in population dynamics during different economic cycles has been relatively less studied in cities characterized by complex and nonlinear patterns of growth (Buzar et al. 2007; Haase et al. 2010; Kabisch et al. 2010; Rontos et al. 2016; Cuadrado-Ciuraneta et al. 2017). Findings of our study indicate that the number of metropolitan regions with growing population in the urban core increased during recession, with a reduced spatial heterogeneity compared to the preceding expansion phase. Northern and western European cities experienced re-urbanization patterns more frequently than southern cities. Central cities showed a mixed pattern, alternating from slight decline to moderate growth during economic expansion and recession, respectively. Eastern cities shared the diffused decline of inner cities and LUZs during the early 2000s and were less responsive to re-urbanization thereafter. However, some of these cities showed signs of population recovery more recently. Multivariate analysis differentiated demographic dynamics during expansion and recession: the former economic phase was characterized by population increase in the largest metropolitan regions with medium–low settlement density, distinguishing northern and central European cities from eastern cities undergoing demographic decline. The recession phase resulted in population increases concentrated in metropolitan regions of fewer than 500,000 inhabitants with a relatively high city-to-LUZ population ratio. Correlation analysis indicated that positive rates of population growth in inner cities were associated with high levels of disposable income at metropolitan scale in both expansion and recession times. However, the same relationship was not observed for population growth rates at metropolitan scale. During recession, less dense urban regions experienced the greatest increase in disposable income, suggesting that denser central cities were less resilient to crisis than smaller cities (Partridge et al. 2009; Capello et al. 2015; Dijkstra et al. 2015). Under economic expansion, the spatial distribution of metropolitan regions with growing inner cities has reflected a gradient distinguishing central from eastern European cities. Recession has moderately affected this gradient, further separating northern from eastern European cities. Large metropolitan regions concentrated the highest proportion of growing inner cities in the present study.

4.2 Population Distribution and Economic Cycles in European Cities

Multiple, place-specific factors may explain the population dynamics observed under expansion and recession: (a) a decline in housing prices oriented along the urban gradient (Delladetsima 2006; Pérez 2010; Helbich 2015), with the highest reductions observed in core cities, as suggested by Salvati et al. (2016); (b) a progressive reduction in wages with impact on households' disposable income, limiting travel-to-work movements (for example); (c) an intrinsic response to employment de-concentration following delocalization of economic activities; (d) a slow decline in anti-urban location preferences of households; and (e) improved technology and specific urban rehabilitation programs, especially in western, central, and northern Europe (Allen et al. 2004; Buzar et al. 2007; Martin 2011; Rink et al. 2012).

In this line of thinking, the mutual interplay between economic and socio-demographic factors is at the base of patterns and processes of re-urbanization in European cities (Rérat 2016). The supply of new dwellings in central cities was sustained by new construction that saturated urban voids, the authorized enlargement of existing buildings in residential areas, re-structuring of abandoned settlements previously used for residential purposes, and transformation of industrial settlements into residential buildings. Initially, re-urbanization processes were dominated by the middle-class residents, mainly one-person households attracted by urban ways of life, and also with an important gendered dimension (Kern 2010). Other social groups have gained an increasing role, including young families and even retirees seeking affordable housing (Lever 1993). With the most recent crisis, re-urbanization was seen as a result of lifestyle decisions made in response to changes in land prices, housing regimes, and local labour markets (Rérat 2012). However, re-urbanization processes remain rather ambiguous and sometimes difficult to explain, given the mixed empirical evidence gathered (van Criekingen 2010). The contrasting results presented by Cheshire (1995) and Pacione (2005) help to illustrate the confusion over the true nature of this process. Moreover, population re-densification of central cities frequently been observed without a specific link to local or regional policies aimed at promoting urban densification and reversing settlement dispersion (Salvati and Carlucci 2016).

4.3 Suburbanization and Re-urbanization: A Reflection on 'Urban Cycles'

In line with earlier studies, our analysis definitely indicates that the demographic evolution of European cities is not adequately explained by the 'stages of urban development' model that tends to consider urban regions as closed systems (Bettencourt et al. 2007; Heikkilä and Kaskinoro 2009; Bayona-Carrasco and Gil-Alonso 2012; Martinez-Fernandez et al. 2012). Our study points out the existence of multiple evolutionary stages of urban development in which emerging re-urbanization and decreasing suburbanization coexist (Kroll and Kabisch 2012) in a socioeconomic context influenced more by place-specific patterns of change than by traditional factors of growth reflecting common mechanisms and systemic properties (Haase et al. 2010).

To interpret the increasing heterogeneity in urban trajectories, theories describing metropolitan growth as a response to individual or household preferences must be integrated with an in-depth understanding of the economic geography of production, focusing on the complex recursive interactions between the location of firms and the movements of labour (Capello et al. 2015). These evidences are in line with prominent approaches to urbanization outlining the role of (individual) location choice in response to amenity values as the engine of contemporary metropolitan growth (Hall 1997; Florida et al. 2008; Henderson and Venables 2009). Reinforcing these assertions, large urban centres have exerted a positive effect on the growth of nearby communities of less than 250,000 people (Storper and Scott 2009). At the same time, contributions grounded in the New Economic Geography paradigm have outlined the growth shadows cast by the largest urban areas on proximate medium-sized metropolitan areas, enhancing competition between small metropolitan areas at the same time (Partridge et al. 2009).

Based on these premises, re-urbanization should be analysed by unfolding the underlying mechanisms, such as housing consumption and in–out migration flows (Van Gent and Musterd 2016). Earlier evidence indicates that inner cities have gained inhabitants mainly thanks to migrants, young adults, non-family households, and segments of the middle to upper class (Hatz 2009; López-Gay 2014; Sander 2014; Sabater 2015; Rérat 2016). Although families' residential behaviour remains the driving force of suburbanization even in re-urbanizing cities (Rérat 2012), the contribution of family households in inner-city re-growth was acknowledged in some cases, especially in cities experiencing rapid declines in house prices (Salvati and Carlucci 2016). Overlaps and differences between re-urbanization and the concept of gentrification could be better discussed (e.g. Mudu 2006; Butler 2007). Haase et al. (2010) argued that, although partly driven by similar dynamics, the two processes are qualitatively distinctive (see also van Criekingen 2010).

According to Bouzarovski et al. (2010), the term 're-urbanization' has been—improperly—accused to have been 'adopted by urban developers as a discursive method of camouflaging the adverse social impacts of gentrification'. In this view, re-urbanization encompasses more dimensions than the purely economic processes through which the middle-class 'gentrifiers have increasingly come in competition with lower class urbanites… [resulting] in replacement and displacement of population segments and new patterns of segregation' (van Gent and Musterd 2016). In other words, while gentrification characterizes substitution processes leading towards the so-called suburbanization of poverty (Hochstenbach and Musterd 2017), re-urbanization refers to real growth processes, involving the complex interplay of population change, urban renovation and housing markets (Bouzarovski et al. 2010), as well as local authorities' involvement (Rae 2013; Barke and Clarke 2016).

Demographic growth is only one of the factors indicating re-urbanization (López-Gay 2014), since an increase in resident population may be caused by different processes (e.g. mortality, fertility, migration) and does not necessarily imply a change in the attractiveness of an area, an important aspect at the base of metropolitan recovery (Salvati et al. 2016). Studies integrating multisource data that evaluate joint demographic dynamics, land use, construction and housing markets, and socioeconomic transformations at large are increasingly required to provide a comprehensive overview of re-urbanization patterns and processes in Europe and, more generally, in developed countries (Bettencourt et al. 2007; Beauregard 2009; Angel et al. 2011).

4.4 Re-urbanization and Economic Recession in Europe

From a functionalist point of view, although large metropolitan regions continue playing a role as economic attractors due to the development of infrastructure, quality of production factors hosted, and density of external linkages and cooperation networks, inner-city population growth has concentrated in these areas during economic expansion (Rérat 2012). With recession, population growth in inner cities becomes spatially decentralized and concentrated in medium- and small-size urban agglomerations, irrespective of their geographical location and administrative role (Garcia 2010). Although capital cities are now central to the problems faced by national economies in Europe, our results indicate that these agglomerations are rarely ‘re-urbanization leaders’, in line with the key vision provided by Dijkstra et al. (2015): ‘a development strategy primarily focused on leading metropolitan regions, as represented in many cases by capital cities, could lead to more volatile and potentially lower growth, than a more spatially balanced development strategy’.

Recession has undoubtedly stimulated re-urbanization in Europe, determining subtle changes in the geography of growing cities. How this process may have indirectly lowered the gap between leading and lagging metropolitan regions (from both demographic and economic points of view) is an important research issue that needs further investigation based on integrated analysis of long-term social trends (Longhi and Musolesi 2007). In this sense, urban pictures are definitely complicated by heterogeneous population dynamics associated with the ‘second demographic transition’, which involves new family relations, less and later marriage, declining fertility rates, population ageing, postponement of child-bearing, and smaller households (Champion 2001; Arapoglou and Sayas 2009; Bayona-Carrasco and Gil-Alonso 2012; Salvati 2013). Such dynamics are having a powerful transformative effect on inner cities, diversifying and re-densifying their social landscapes; analysis of population dynamics in a sample of cities in Germany, Slovenia, Italy, and Spain revealed that cities are being populated with, and fragmented by, multiple migration trends and new household structures connected with the second demographic transition (Buzar et al. 2007).

Based on these considerations, re-urbanization remains a heterogeneous process both within and between metropolitan regions (Kabisch and Haase 2011). Under both economic expansion and recession, the spatio-temporal distribution of relevant indicators in selected case studies indicates a stratification of different factors contributing to re-urbanization (Kabisch et al. 2010). In contrast to a prevailing tendency to understand re-urbanization as an expression of ‘back-to-the-city’ movements—relating more to housing than lifestyle preferences—the role of changing socioeconomic and demographic factors requires further investigation (Storper and Scott 2009), identifying driving forces and impacts on inner cities, housing markets, and socioeconomic structure at large (Bouzarovski et al. 2010).

Without effective tools promoting regional development, cities under recession are increasingly competing for economic resources (Garcia 2010) because of the decline of private investments and the reduction in financial transfers from the state and the European Union. However, Florida (2011) emphasized how the global financial crisis allows a revisiting of 'sprawled' and 'polycentric' development modes and the elaboration of a more sustainable and (possibly resilient) way of growth that promotes inner-city rehabilitation, moderate densification with urban containment, reduced land consumption (Lauf et al. 2016), and economic growth (Schneider et al. 2010). Spatially heterogeneous population dynamics may reflect differences between cities in their response to crisis. Although metropolitan regions hosting financial activities have been severely hit during recession (Dijkstra et al. 2015), hard and soft territorial capital (physical accessibility, access to information/knowledge, advanced functions, agglomeration economies) that distinguishes large metropolises from medium and small cities will contribute to adjustments to crisis in the near future (Capello et al. 2015).

4.5 Concluding Remarks

A comprehensive analysis of population dynamics based on spatially detailed and updated data integrating socioeconomic indicators, demographic variables, and settlement and land-use patterns may be particularly useful to identify re-urbanization as an emerging phenomenon in Europe. Analysis of re-urbanization patterns and processes should take account of increasing evidence that this phenomenon is now global and multidimensional—but also not fully understood in all its manifestations. Future research is required to match the diversity of analytical perspectives and country-based studies with the aim to profile distinct types of re-growing cities and to understand the role urban policies have played in the regeneration of these metropolitan regions. Distinguishing urban expansion fuelled by innovation from growth driven by economies of scale is crucial to understand conditions for the sustainable development of cities. In this sense, a comparative analysis of population dynamics under economic expansion and recession is particularly useful to characterize re-urbanization processes driven by internal or external factors and to predict future paths of urban expansion in contemporary cities. An improved knowledge of socioeconomic factors influencing demographic patterns definitely contributes to shed light on the complex linkage between the heterogeneous population dynamics and nonlinear patterns of growth typically observed in the European cities.

Appendix 1: List of Metropolitan Regions Considered in this Study

Metropolitan region	Country code	Urban audit code	Metropolitan region	Country code	Urban audit code
Pleven	Bulgaria	BG005L	Bologna	Italy	IT009L
Bern	Switzerland	CH004L	Cagliari		IT027L
Geneva		CH002L	Milano		IT002L
Lausanne		CH005L	Roma		IT001L

Metropolitan region	Country code	Urban audit code	Metropolitan region	Country code	Urban audit code
Lefkosia	Cyprus	CY001L	Trieste		IT015L
Ceske Budejovice	Czech Republic	CZ008L	Kaunas	Lithuania	LT002L
Hradec Kralove		CZ009L	Panevezys		LT003L
Jihlava		CZ014L	Vilnius		LT001L
Karlovy Vary		CZ013L	Luxembourg	Luxembourg	LU001L
Liberec		CZ007L	Liepaja	Latvia	LV002L
Olomouc		CZ006L	Valletta	Malta	MT001L
Ostrava		CZ003L	Bergen	Norway	NO002L
Plzen		CZ004L	Kristiansand		NO005L
Praha		CZ001L	Oslo		NO001L
Usti nad Labem		CZ005L	Stavanger		NO004L
Augsburg	Germany	DE033L	Tromso		NO006L
Berlin		DE001L	Trondheim		NO003L
Bielefeld		DE017L	Braga	Portugal	PT003L
Bonn		DE034L	Faro		PT009L
Bremen		DE012L	Lisbon		PT001L
Darmstadt		DE025L	Ponta Delgada		PT007L
Dresden		DE009L	Alba Iulia	Romania	RO014L
Dusseldorf		DE011L	Arad		RO008L
Erfurt		DE032L	Bacau		RO007L
Frankfurt (Oder)		DE029L	Braila		RO005L
Frankfurt am Main		DE005L	Bucharest		RO001L
Freiburg im Breisgau		DE027L	Calarasi		RO012L
Gottingen		DE021L	Cluj-Napoca		RO002L
Halle an der Saale		DE018L	Craiova		RO004L
Hamburg		DE002L	Giurgiu		RO013L
Hannover		DE013L	Oradea		RO006L
Karlsruhe		DE035L	Piatra Neamt		RO011L
Kiel		DE039L	Sibiu		RO009L
Koblenz		DE042L	Targu Mures		RO010L
Koln		DE004L	Timisoara		RO003L
Leipzig		DE008L	Goteborg	Sweden	SE002L
Magdeburg		DE019L	Jonkoping		SE004L
Mainz		DE037L	Linkoping		SE007L
Monchengladbach		DE036L	Malmo		SE003L
Munich		DE003L	Orebro		SE008L
Nurnberg		DE014L	Stockholm		SE001L
Regensburg		DE028L	Umea		SE005L
Saarbrucken		DE040L	Uppsala		SE006L

Metropolitan region	Country code	Urban audit code	Metropolitan region	Country code	Urban audit code
Schwerin		DE031L	Ljubljana	Slovenia	SI001L
Stuttgart		DE007L	Maribor		SI002L
Trier		DE026L	Banska Bystrica	Slovakia	SK003L
Weimar		DE030L	Bratislava		SK001L
Wiesbaden		DE020L	Kosice		SK002L
Wuppertal		DE016L	Nitra		SK004L
Aalborg	Denmark	DK004L	Presov		SK005L
Arhus		DK002L	Trencin		SK008L
Odense		DK003L	Trnava		SK007L
Tallinn	Estonia	EE001L	Zilina		SK006L
Tartu		EE002L	Aberdeen	UK	UK016L
Barcelona	Spain	ES002L	Belfast		UK012L
Madrid		ES001L	Cambridge		UK017L
Oulu	Finland	FI004L	Cardiff		UK009L
Paris	France	FR001L	Edinburgh		UK007L
Athens	Greece	GR001L	Glasgow		UK004L
Ioannina		GR007L	Kingston-upon-Hull		UK026L
Irakleio		GR004L	Leicester		UK014L
Kalamata		GR009L	Nottingham		UK029L
Kavala		GR008L	Portsmouth		UK023L
Thessaloniki		GR002L	Stoke-on-Trent		UK027L
Volos		GR006L			

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