Population Research and Policy Review (2024) 43:27
https://doi.org/10.1007/s11113-024-09871-w

ORIGINAL RESEARCH

Population Dynamics and Policies in Europe: Analysis of Population Resilience at the Subnational and National Levels

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Received: 23 May 2023 / Accepted: 15 February 2024

Abstract
While previous research has focused on the relationship between population dynamics and policies in Europe, there has been scarce attention on dynamics at the NUTS-3 level. By looking at the population measures at subnational regions in Europe we seek to identify average population dynamics since year 2000. We group subnational regions by countries in terms of average population dynamics and assess the connection between population policies in 1996 and average population dynamics in 2000–2017 using data from World Population Policy database, the UN Population Division, the World Bank's World Development Indicators and Eurostat. We find that urban areas and Western and Northern Europe exhibit population growth whilst rural areas and Central, Eastern, and Southern Europe have more depopulating regions. Our analyses also suggest a negative association between fertility policies and population growth.

Keywords Population dynamics · Fertility · Migration · Policy · Europe

Introduction

In the past two decades, the history of the European population witnessed several watershed changes. First, the Eastern Enlargement of the European Union (EU) in 2004 and 2007 expanded the EU population from 381 to 494 million (Eurostat, 2020a). This expansion entailed that an additional 100 million people could more easily move across countries as EU citizens, providing a strong source of internal migration in Europe. Another momentous change for the European population came from external migration, coinciding with the European Migrant Crisis that started in 2015. Only in 2015 more than a million refugees reached Europe constituting the largest ever inflow of asylum seekers in Europe (PEW, 2016). In addition to the structural change introduced by the EU expansion and the mass migration flows that

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necessitated great adjustments for many European countries, the Great Recession of 2008 had a significant impact on the lives of many people in Europe, which in turn had consequences for the general population.

On no account European population dynamics are limited to the unique events of the beginning of the twenty-first century, but are also defined by the long term processes of population ageing, mortality, fertility, and migration. Europe has one of the highest proportions of older persons in its populations in the world (Vobecká et al., 2013; European Commission, 2020). The increase in the proportion of the elderly in European populations has drawn scholarly efforts to identify challenges in socio-economic development of the continent (Bloom et al., 2015). With increasingly ageing populations, the national pension, social, and healthcare systems in the EU are expected to face sustainability challenges (Christensen et al., 2009; Ediev, 2014; Rechel et al., 2013). Hand in hand with ageing comes fertility of the EU member states. In general, the fertility rate of the EU has been below the replacement rate since the beginning of the twenty-first century (Frejka & Sobotka, 2008). Yet regional fertility rate differences exist. While Western Europe and the Nordics have relatively higher fertility rates, some of the Southern and Central and Eastern European countries barely pass the lowest-low fertility threshold of 1.3 (Billari & Kohler, 2004; Goldstein et al., 2009; Human Fertility Database, 2023). Migratory tendencies are heterogeneous across Europe as well. First, demographers have shown that free movement in the EU has magnified intra-European migratory flows (Castro-Martín & Cortina, 2015) and changed cohort migration patterns (Bernard, 2017). Second, international migration in Europe has been growing steadily (Fassmann & Munz, 1992; van Mol & de Valk, 2016). Extra-EU migration is expected to either contribute to population growth or slow down depopulation in Europe (van Nimwegen & van der Erf, 2010). However, internal migration is a crucial component defining subnational populations (Rees et al., 2012, 2017).

Population policies have also played a role in defining the current demographic state of Europe. Facing declining fertility rates and ageing societies, many countries in Europe have introduced various family policies in order to smoothen the socio-economic challenges of the future and in some cases to bolster their demographic resilience of their populations (Ainsaar & Rootalu, 2016; De Souza, 2015). Countries with the prospect of population decline may experience changes ranging from national identity (Teitelbaum & Winter, 1998) to long term economic growth prospects (Bloom et al., 2015). Population ageing is closely connected to social security and pension concerns that are frequent in industrialised countries (Kinsella & Phillips, 2005). Policies that address ageing have mostly focused on fiscal aspects of the matter whilst more controversial ideas such as replacement migration policies have faced public scrutiny (May, 2012). On the other hand, fertility policies that focus on the pro-natalist aspect receive support from governments, but usually fail to deliver expected results as not only the fertility rates do not increase, but the decline in fertility barely slows down when policies are enacted (Grant et al., 2004). Immigration policies seem to have contributed the most with respect to mediating the population ageing or decline in Europe. Yet the European governments aim to balance the need of immigration and concerns it raises among native populations by introducing quotas or qualification requirements (Martin & Zürcher, 2008; van Houtum & Pijpers, 2007).

Population studies have largely overlooked Nomenclature of Territorial Units for Statistics level 3 (NUTS-3) as a unit of analysis at the European level. NUTS-3 constitute relatively smaller regions that are deemed useful for socio-economic analyses that focus on specific diagnoses (Eurostat, 2020b). This is because NUTS-3 provide granular regional data that can be used for more precise analyses than those relying on the larger NUTS-1 and NUTS-2 regions. NUTS-3 regions vary in both population and area providing a considerable degree of variation to explore. There exists a considerable body of research that has looked at subnational population dynamics in Europe, the work either focused on one of the components of population change (e.g. Kashnitsky et al., 2017, 2021) or has utilised higher level statistical units (e.g. Rees et al., 2012). To the best of our knowledge, we are the first to explore the patterns of natural population change, measured as the difference between the number of live births and deaths in a year, and net migration at NUTS-3 level using the longest period time frame from 2000 to 2017. Analysing the population dynamics at NUTS-3 level provides an overview of the recent population status of the continent, highlights the potential of areas for policies ranging from subnational to supranational levels in Europe, and expands on the literature by using all NUTS-3 units rather than selected NUTS-3 or more local level samples in European countries (Gregory & Patuelli, 2015; Gutiérrez Posada et al. 2018; Sabater et al., 2017). We also propose a four-point typology that allows us to identify NUTS-3 regions as highly depopulating, depopulating, exhibiting population growth, and highly growing. Using this typology we produce a map that captures the snapshot of average population dynamics in Europe for the period of 2000—2017. Our four-point typology helps to address policy matters in Europe. This is especially relevant in the light of demographic resilience debate that juxtaposes population size (and related policies) against a government's ability to capitalise on the population structure (e.g. De Souza, 2015). As population policies are largely crafted at the national level, we assign countries rather than NUTS-3 regions to the four types of population dynamics to check if there exists a connection between population policies adopted in the 1990s and the current average demographic state of European countries. In this way we contribute to the efforts evaluating population policies in Europe (e.g. Ainsaar & Rootalu, 2016). We also expand the broader literature on population policies in fertility (e.g. De Silva & Tenreyro, 2017; Tsui, 2001) and migration (e.g. May, 2012).

This paper outlines the differences in population growth or decline across 2239 NUTS-3 regions across Europe for which Eurostat data on population size, natural population change, and net migration exists over the period of 2000–2017. It also looks at the associations between the population policies adopted in the 1990s and the current state of population dynamics in Europe by employing the data from the United Nations (UN) World Population Policy database, the UN Population Division and the World Bank's World Development Indicators. This study encompasses EU-28 countries (including the UK) and countries in the European Economic Area (Norway and Iceland), Switzerland as well as potential EU candidate countries (Albania, North Macedonia, Serbia, and Turkey).

Background of Population Dynamics in Europe

Mortality

Mortality patterns in Europe are often discussed through the lens of divergence between Eastern and Western European countries (Hertzman & Wiens, 1996). It is argued that Europe can roughly be divided into two groups of higher life expectancy in the West and lower in the East (Meslé & Vallin, 2017). In more detail, the demographic literature focuses on mortality tendencies within a selected sample of countries. For instance, Vallin and Meslé (2004) have indicated that not only there exists a difference in life expectancy between Western and Eastern Europe, but have shown that a similar tendency is also present within the region of Central and Eastern Europe where Central European countries (e.g. Poland, Czechia) have higher life expectancy and faster life expectancy improvement in years than Eastern Europe (e.g. Russia, Ukraine). Looking at post-Soviet countries Grigoriev et al. (2010) have found life expectancy differences between countries where more radical socio-economic changes have led to higher life expectancies. Jasilionis et al. (2011) investigated the mortality rates in the Baltic sub-set of post-Soviet countries to find that countries with relatively similar mortality rates have diverged with an improvement in Estonia, stagnation in Latvia, and worsening in Lithuania. A recent study that incorporated countries from Central Europe (Poland), Eastern Europe (Russia), and the Baltic states (Lithuania) has shown that mortality rates not only vary between countries, but within countries as well (Grigoriev et al., 2020).

Population Age Structures

At the European level, population age structures have been found to become more similar over time in Western, Eastern, and Southern Europe. Yet the population age structure differences between subnational regions across Europe have gotten starker (Kashnitsky et al., 2021). These differences can either hold in terms of the centre-periphery, country border territories or migration origin and destination regions. A large proportion of the working age population is found to live in urban areas[1] while peripheries suffer from out-migration (Kashnitsky & Schöley, 2018). Similar findings have been confirmed by studies that looked at the subnational regions in selected countries. Sabater et al. (2017) have found an increasing segregation over time between older and younger groups across neighbourhoods in England and Wales. The divergence suggested a more pronounced gap between north and south of the countries. It is worth noting that all European populations are experiencing ageing, however differences in the speed of ageing exist across countries and regions (Kashnitsky et al., 2017).

[1] Hereafter any reference to an urban or rural area follows the Eurostat (2023) urban-rural typology that classifies NUTS-3 regions and bases the classification on the share of a region's urban and rural population.

Literature has shown that the main determinant of population ageing in Europe was fertility decline in the first half of the twentieth century, which shifted to mortality improvement and increasing life expectancy starting from the second half of the century (Murphy, 2017). Countries in later stages of demographic transition, which is the case for the developed countries as well as most developing countries, exhibit the same pattern and the importance of mortality improvement overshadows the importance of fertility decline in terms of population ageing (Preston & Stokes, 2012).

Fertility

Overall, fertility patterns and trends in Europe are extremely diverse (Frejka & Sobotka, 2008). Comparative analyses looked at total fertility rates and cohort fertility trends across European countries to establish patterns in childbearing and fertility timing across Europe (Billari & Kohler, 2004; Kohler et al., 2002, 2006). The recent pan-European fertility trends have been generalised as a 'dual reproductive system' where Southern European and German speaking countries exhibit lower fertility than that of Western, Northern and some of the Central and Eastern European countries (Lesthaeghe, 2020).

Other work sought to show that countries and regions play a specific role in determining fertility rates and types across Europe (Coale & Watkins, 1986; Klüsener et al., 2013; Lesthaeghe, 1980; Thomson et al., 2014). In Central and Eastern as well as Southern Europe fertility rates have been low since the 1990s (Billari & Kohler, 2004). Western Europe and Nordic countries, however, had been exhibiting close to replacement fertility rates until recently. Nonetheless, many countries with relatively high fertility have been witnessing a decline in period fertility rates since 2010 (Human Fertility Database, 2023). This holds with respect to Nordic countries where declining period fertility is expected to turn into a smaller cohort fertility (Hellstrand et al., 2020). The return of the lowest-low fertility (Billari, 2008) to Southern Europe has also been documented with evidence from subnational regions (Caltabiano et al., 2019; Comolli, 2017).

The fertility differences across European societies are often attributed to a plethora of aspects (see Balbo et al., 2013). Welfare regimes for example have a complex link to fertility through a variety of labour markets and educational systems that translate into fertility differences (Neyer, 2013). For example, in low fertility countries educational, labour market and housing policies have had a positive effect in advancing childbearing (Rindfuss & Brauner-Otto, 2008). Economic uncertainty has been found to not only affect people's fertility through policies and welfare regimes, but also through the way people perceive the future (Vignoli et al., 2020). Increasing gender equality has been seen as a factor that could converge fertility rates in the future (Esping-Andersen & Billari, 2015). The UN's projections indicate that the sub-replacement fertility will become a norm everywhere but in Africa, in turn quickening population ageing (Lutz et al., 2008).

International and Internal Migration

The scholarship on migration in Europe is divided into two general strands. First, demographers have shown that free movement in the EU has magnified intra-European migratory flows (Castro-Martín & Cortina, 2015) and changed cohort migration patterns (Bernard, 2017). For instance, nearly two million EU citizens changed their countries of residence in 2008. The largest migration flow has been found to be from the new member states to the EU-15, in real terms migrant flows from Poland to Germany made for the biggest share of intra-EU migration (van Mol & de Valk, 2016). During the Great Recession outmigration from Bulgaria and Romania to EU-15 remained the highest even in comparison to Central and Eastern European countries that joined the EU in 2004 (Kahanec et al., 2016). This migratory pattern was reciprocated by outmigration from Southern European countries to the rest of the EU. For instance, outmigration of Italian and Spanish residents grew during the Great Recession (Anelli & Peri, 2017; Izquierdo et al., 2016).

Second, another strand of demographic literature looks at extra-EU migration. To start with, extra-EU migration is expected to either contribute to population growth or slow down depopulation in Europe (van Nimwegen & van der Erf, 2010). Predominantly immigrants come to the EU from China, India, and Morocco while the nationality of non-EU migrants residing in the EU most often is Turkish, Moroccan or Chinese (van Mol & de Valk, 2016). The non-EU migrants not only add up to the total population, but also have been found to have more children than locals at least in the first generation (Milewski, 2010; Garssen & Nicolaas, 2008). There is also evidence that shows the importance of immigration to sub-regions in Europe. Sub-regions receiving immigrants are predicted to have larger populations in the future (Rees et al., 2012).

Fertility and Migration Policies in Europe

Fertility

The determinants of fertility rate differences translate into difficulties when constructing fertility policies. Challenges to counter the reasons why people choose not to have children are complex. Among other things they consider that marital status, the cost of raising a child, the household income, childcare, the opportunity costs, and compatibility with workforce participation for women are important factors defining the (lack of) success of fertility policies (Chawla et al., 2007; Gauthier & Philipov, 2008; Vobecká et al., 2013). Public policies have not been seen as completely effective because they slow down the demographic trends as opposed to stopping or reversing them (Grant et al., 2004). May (2012) argues that the policy specialist consensus orbits around the negligible effect of transfer-based pro-natalist policies. Money transfers and tax breaks are only perceived as monetary benefits that are not sufficient to raise a child from the viewpoint of families. These measures are also very costly for governments and temporary benefits of such policies do not deliver expected long term results. In addition, current fertility policies may have a potentially detrimental impact on sexual and reproductive health and gender equality (Gietel-Basten et al., 2022). For fertility policies to be effective they need to incorporate long-term measures together with short term tools. More precisely these policies should combine financial incentives with work and family arrangements as it has been done in Scandinavian countries and support sexual and reproductive health as well as human rights as in France, Germany, and Estonia (Chawla et al., 2007; Gietel-Basten et al., 2022; May, 2012; McDonald, 2002).

Migration

In terms of policies, immigration is arguably the most controversial topic in social policy public debates. Unsurprisingly migration remains a constrained policy field despite the need for global mobility because of both population and labour decline (Pritchett, 2006). Immigrants are often seen as a threat to receiving countries' low-skilled workers and even cultural and religious values, an argument often used by the extreme political right (Le Bras, 1998; Martin & Zürcher, 2008). Many immigration policies in European countries have taken these concerns into account by embracing restrictions and greater selectivity of immigrants in both number and skill (May, 2012). Nonetheless, immigration is a measure that could address and mitigate not only the labour needs but also low fertility and population ageing in industrialised settings such as Europe, as suggested by the replacement migration framework (Craveiro et al., 2019; Marois et al., 2020). The United Nations (UN) has prepared estimations of a yearly number of immigrants necessary to maintain the population size throughout the period of 2000–2050 (UN, 2000). The estimates for the EU have shown that 949,000 immigrants would be necessary every year to keep the EU population constant whilst 1.5 m would be needed annually to maintain constant the 15–64 age group, and 13.5 m would be needed every year to maintain a constant ratio of the 15–64 to the 65+age groups. These estimates were later revisited, evaluated and virtually confirmed to conclude that the replacement migration remains a valid option to address population decline in Europe (Bijak et al., 2008). For a set of Western European countries recent immigration flows were found to be higher than predicted by the UN and yet not sufficient to slow down the population change (Craveiro et al., 2019). These results were unexpected in Europe and have indicated an urgent need to address population issues (May, 2012). In fact, in recent years, governments have adjusted policies in order to promote the immigration of the particular types of individuals they need and limit other forms of immigration. The UN's inquiry into governments' immigration policies has indicated that governments aim at managing migration rather than curb it (United Nations,). The data has also confirmed that over the time migration policies became more liberal and yet more sophisticated in terms of selectivity (Czaika & Parsons, 2017; de Haas et al., 2019). For example, the EU has opened its borders to selected migrants due to an increasing need for certain types of skills (van Houtum & Pijpers, 2007).

Data, Typology, and Methods

Data

The descriptive part of this paper uses Eurostat data on natural population change and net migration plus statistical adjustment (Eurostat, 2020c) across Europe. This study encompasses EU-28 countries (including the UK) and countries in the European Economic Area (Norway and Iceland), Switzerland as well as EU candidate and potential candidate countries (Montenegro, North Macedonia, Serbia, Turkey and Albania). The data is aggregated at the NUTS-3 level, version of 2016 (Eurostat, 2020d); NUTS refers to Nomenclature of Territorial Units for Statistics. Our data covers the NUTS-3 regions for the period of 2000–2017.

We do not exclude the non-European territories of France, Portugal, and Spain,[2] but we acknowledge they are geographical outliers (Kashnitsky et al., 2017). In addition, the data does not equally cover all the NUTS-3 regions throughout the period of the study. Some NUTS-3 of EU countries and candidate countries lack data for selected years.[3] Our final working sample consists of 2239 NUTS-3 regions across Europe and its territories for the 2000–2017 period.

[2] France: Guadeloupe FRA10, Martinique FRA20, Guyane FRA30, La Réunion FRA40, Mayotte FRA50. Portugal: Região Autónoma dos Açores PT200, Região Autónoma da Madeira PT300. Spain: Ceuta ES630, Melilla ES640, El Hierro ES703, Fuerteventura ES704, Gran Canaria ES705 862, La Gomera ES706, La Palma ES707, Lanzarote ES708, Tenerife ES709.

[3] NUTS -3 missing of: Albania: (years 2000–2011) all NUTS-3. Germany: (years 2000–2010) Gottingen DE91C, Meißen DED2E, Sächsische Schweiz-Osterzgebirge DED2F, Erzgebirgskreis DED42, Mittelsachsen DED43, Vogtlandkreis DED44, Zwickau DED45, Leipzig DED52, Nordsachsen DED53, Dessau-Roßlau, Kreisfreie Stadt DEE01, (years 2000–2007) Jerichower Land DEE06, Börde DEE07, Harz DEE09, Saalekreis DEE0B. Denmark: (years 2000–2006) Byen København DK011, Københavns omegn DK012, Nordsjælland DK013, Østsjælland DK021, Fyn DK031, Vestjylland DK041, Nordjylland DK050. France: (years 2000–2012) Guadeloupe FRA10, Mayotte FRA50. Hungary: (years 2000–2012) Budapest HU110, Pest HU120. Ireland: (years 2000–2011) all NUTS-3. Lithuania: (years 2000–2012) all NUTS-3. The Netherlands: (years 2000–2013) Noord-Friesland NL124, Zuidwest-Friesland NL125, Zuidoost-Friesland NL126, (years 2000–2002) Noord-Drenthe NL131, Zuidoost-Drenthe NL132, Zuidwest-Drenthe NL133, Zuidwest-Overijssel NL212, Twente NL213, Zuidwest-Gelderland NL224, Achterhoek NL225, Arnhem/Nijmegen NL226, Kop van Noord-Holland NL321, IJmond NL323, NL332 Agglomeratie's-Gravenhage, Agglomeratie Leiden en Bollenstreek NL337, Zeeuwsch-Vlaanderen NL341, West-Noord-Brabant NL411, Noordoost-Noord-Brabant NL413, Zuidoost-Noord-Brabant NL414, Midden-Limburg NL422, Zuid-Limburg NL423, (years 2000–2013) Oost-Zuid-Holland NL33B, Groot-Rijnmond NL33C. Norway: (years 2000–2004) all NUTS-3. Poland: (years 2000–2009) Koszalinski PL426, Szczecinecko-pyrzycki PL427, Szczecinski PL428, Nyski PL523, Opolski PL524, Grudziadzki PL616, Swiecki PL618, Wloclawski PL619, Slupski PL636, Chojnicki PL637, Starogardzki PL638, (years 2000–2013): Miasto Lódz PL711, Lódzki PL712, Piotrkowski PL713, Sieradzki PL714, Skierniewicki PL715, Kielecki PL721, Sandomiersko-jedrzejowski PL722, Bialski PL811, Chelmsko-zamojski PL812, Lubelski PL814, Pulawski PL815, Krosnienski PL821, Przemyski PL822, Rzeszowski PL823, Tarnobrzeski PL824, Bialostocki PL841, Lomzynski PL842, Suwalski PL843, Warszawski wschodni PL912, Warszawski zachodni PL913, Radomski PL921, Ciechanowski PL922, Plocki PL923, Ostrolecki PL924, Zyrardowski PL926. Serbia: (years 2000–2016) all NUTS-3. Turkey: (years 2000–2006) all NUTS-3. UK: (years 2000–2012): NUTS-3 in Scotland and Northern Ireland. Depending on the variable, the missing values constitute from 12.44 to 14.44 percent of all values.

The analytical part of this paper employs the UN World Population Policy database, the UN Population Division and the World Bank's World Development Indicators data for 1996 together with the Eurostat data for 37 countries in Europe for which we can connect the aforementioned datasets.

The UN World Population Policy database collects data on governmental policies regarding key population issues such as population size growth, fertility, reproductive health and family planning, health and mortality, internal and international migration. The data is collected for the period 1976–2015, and it is revised every two years starting from 2001. The policy variables under the UN World Population Policy database are constructed based on the analysis of four types of sources. First and foremost of these sources is the United Nations Inquiry among Governments on Population and Development, which includes detailed information provided by each country. The UN makes further use of official position documents of governments, information from international organisations and UN agencies as well as news articles and academic publications to determine the position of each country for each indicator (UN, 2020). From this large pool, we focus on fertility and migration policies and make use of two indicators, namely "policy on fertility level" and "policy on immigration". In particular, while *policy on fertility level* indicates the availability of governmental policies influencing fertility level, *policy on immigration* states the existence of governmental policies targeting the level of documented immigration in a given country. Both indicators contain five response categories; "raise", "maintain", "lower", "no intervention" and "no official policy".

The UN Population Division data is used for the median age in a country in 1996 while the World Bank's World Development Indicators database is the source for the urban population as a percent of total population, the GDP per capita, and the unemployment rate.

Population Dynamic Score Typology and Methods

We establish a novel typology which permits placing subnational European regions (NUTS-3) and countries within a specific group according to population dynamics (population growth or decline) and drivers (natural population change and migration). A NUTS-3 region or a country is considered to be extremely depopulating if both negative natural population change and negative net migration occur in the unit of analysis. A region or a country is treated as depopulating if it has a negative natural population change even if the net migration in these units is positive, but not big enough to counter the negative natural population change. If a region or a country experiences population growth via positive natural population change and its tendencies in outmigration are smaller than the natural population growth, a unit is considered populating. A NUTS-3 or a country is marked as extremely populating if it exhibits both positive natural population change and positive net migration.

Using the aforementioned definitions, each NUTS-3 region-year and country-year is assigned a number: (1) high depopulation, (2) depopulation, (3) population growth, and (4) high population growth. An arithmetic average is derived for each NUTS-3 region-year and country-year assigned to a NUTS-3 region and a

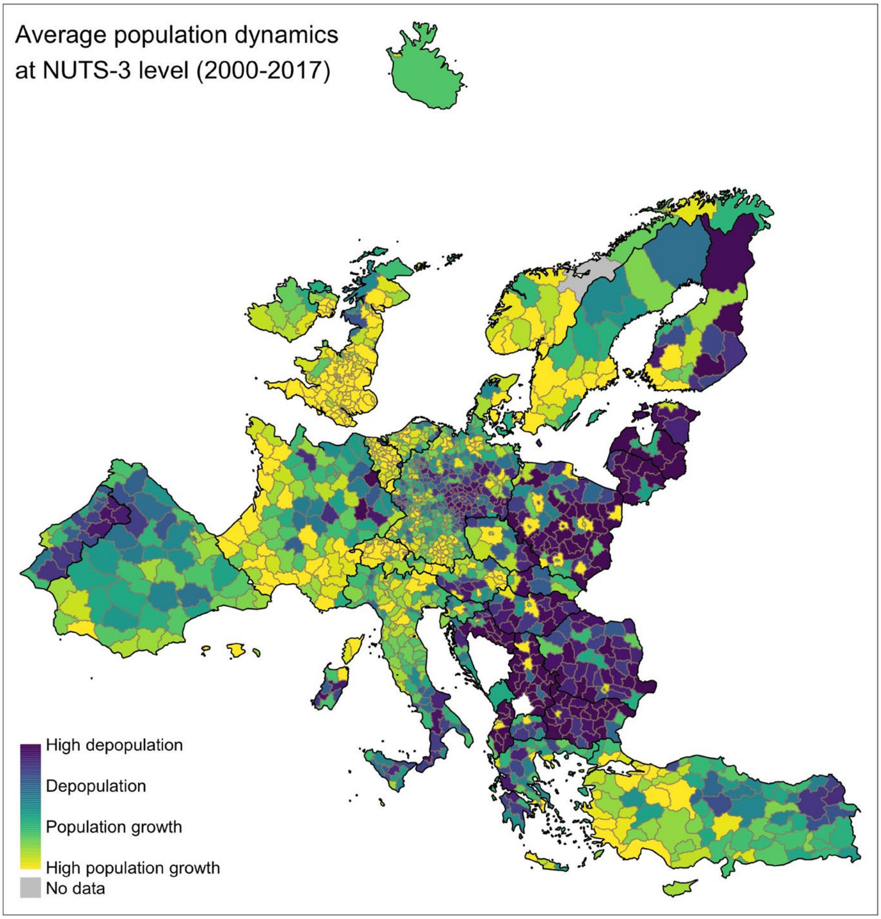

Fig. 1 Average population dynamics in NUTS-3, 2000–2017. 1 (purple)—high depopulation, 2 (turquoise)—depopulation, 3 (green)—population growth and 4 (yellow)—high population growth. Source: Eurostat (2020a, 2020b, 2020c, 2020d)

country to indicate average population dynamics of each unit for the timeframe of 2000–2017. The average population dynamic scores of the NUTS-3 regions over the years 2000–2017 are plotted in Fig. 1, using the *tmap* package on R software. The population dynamics scores of NUTS-3 regions for each year in the above mentioned time frame are also plotted separately and merged as a short animation on R software. A video is included in the supplementary materials for the online edition. The categorisation of countries based on the dominant score of NUTS-3 regions can be observed in Table 1.

In the analytical part, we use the UN World Population Policy database (policy on fertility level coded as missing if there was no official policy at the time, − 1 = lower; 0 = no intervention; 1 = maintain; 2 = raise and policy on immigration coded as missing if there was no official policy at the time, − 1 = lower; 0 = no

Table 1 Average population dynamics in European countries, 2000–2017

High depopulation (1)	Depopulation (2)	Population growth (3)	High population growth (4)
Albania	Estonia	Germany	Austria
Bulgaria	Hungary	Greece	Belgium
Croatia	Poland	Montenegro	Cyprus
Latvia	Serbia	North Macedonia	Czechia
Lithuania		Portugal	Denmark
Romania		Slovakia	Finland
		Spain	France
			Iceland
			Ireland
			Italy
			Liechtenstein
			Luxembourg
			Malta
			Netherlands
			Norway
			Slovenia
			Sweden
			Switzerland
			Turkey
			United Kingdom

Source: Eurostat (2020a, 2020b, 2020c, 2020d)

intervention; 1 = maintain; 2 = raise), median age in population, available for 1995 by the UN Population Division data and log GDP per capita, percentage of urban population, and unemployment expressed as a share of total labour force for year 1996 by World Development Indicators of World Bank as main determinants. We also include a categorical variable capturing whether a country is part of the EU-15 (more developed economies in EU in Western, Northern and Southern Europe) and European Economic Area (EEA), EU-28 (all EU countries before 2020) and EEA, or not as a control. We estimate the association between fertility and migration policies enacted in 1996 and average population dynamics in the period of 2000–2017 via OLS regression with robust standard errors. The time frame between 1996 and 2017 is chosen purposely in order to be able to capture a connection (if any) between the population policies and their possible influence on population dynamics.

Results

Average Population Dynamics in 2000–2017

Here we refer to groups of NUTS-3 regions that coincide with regional definitions provided by the EU's multilingual and multidisciplinary thesaurus, the EuroVoc

(2020).[4] Four regions are defined: Western Europe, Central and Eastern Europe, Southern Europe, and Northern Europe. These regions encompass both countries inside and outside of the EU.

In Fig. 1 we present descriptive results of population dynamics on NUTS-3 in Europe from 2000 to 2017. Over the period of 17 years population patterns emerge. To start with, we find descriptive evidence that the centre-periphery concept holds whether at national level where urban areas exhibit population growth whilst rural areas depopulate, or at European level where Western European and Scandinavian NUTS-3 regions have been growing whereas Central and Eastern European and Southern European NUTS-3 have been mostly depopulating (Kashnitsky & Schöley, 2018).

NUTS-3 in Central and Eastern Europe as well as the Baltic States exhibit a pronounced tendency of depopulation by both negative natural population change and outmigration (1—purple). Similar tendencies can be observed in Southern European countries. However, they are less strongly pronounced. Depopulation takes place through the channel of negative natural population change, but net migration in these NUTS-3 is positive (2—turquoise). These regions are mostly found in all European regions but Central and Eastern Europe. In Central and Eastern Europe turquoise depopulating regions arguably coincide with urban areas (e.g. Romanian NUTS-3). NUTS-3 in Western Europe and parts of Northern Europe (Scandinavia) indicate opposite dynamics. Regions in green (3) show population growth via positive natural population change and outmigration. The most intensive population growth is marked with yellow (4) representing NUTS-3 regions that grow in size due to both positive natural population change and immigration. Yellow regions are predominantly major urban centres or national capitals. The latter especially stands out in Central and Eastern Europe in which a large majority of NUTS-3 regions have been experiencing depopulation. There also exists an evident West–East, North–South divide where many more NUTS-3 regions exhibit population growth in the West and North in comparison to the East and South of Europe. Turkey, however, stands out as an outlier in the context of Southern Europe. Its western NUTS-3 regions indicate a high population growth which is only characteristic to some parts of Northern Italy. Also, only a limited number of subnational regions in Turkey mostly located in the north-eastern part of the country depopulate strongly.

In Table 1 we summarise the average population dynamics by country using the same four-point typology as for the NUTS-3 regions. Some geographic patterns emerge where most Central and Eastern European countries experienced depopulation while remaining parts of Europe grew in 2000–2017.

[4] Western Europe: Austria, Belgium, France, Germany, Ireland, Liechtenstein, Luxembourg, the Netherlands, Switzerland, the United Kingdom. Central and Eastern Europe: Albania, Bulgaria, Czechia, Croatia, Hungary, Montenegro, North Macedonia, Poland, Romania, Serbia, Slovakia, Slovenia. Southern Europe: Cyprus, Greece, Italy, Malta, Portugal, Spain, Turkey. Northern Europe: Denmark, Estonia, Finland, Latvia, Lithuania, Norway, Sweden.

Table 2 Association between average population dynamics and population policies

	DV: Average population dynamics					
	(1)	(2)	(3)	(4)	(5)	(6)
Policy on fertility level (1996)	− 0.477***	− 0.361**			− 0.295**	
	(0.169)	(0.153)			(0.141)	
Policy on immigration (1996)			− 0.279	− 0.205		− 0.145
			(0.244)	(0.178)		(0.188)
Median age		− 0,0458		− 0.098***	− 0.028	− 0,034
		(0.036)		(0.031)	(0.049)	(0.047)
Urban population as % of total		0,007		0,019	0,007	0,014
		(0.013)		(0.014)	(0.014)	(0.016)
Ln(GDP per capita)		0.534***		0.524**	0.488**	0.422*
		(0.157)		(0.218)	(0.185)	(0.213)
Unemployment rate (% total labour force)		0.01		0.009	0.006	− 0.012
		(0.027)		(0.033)	(0.027)	(0.028)
EU/EEA status (0—not EU/EEA, 1—EU-15/EEA, 2—EU-28)					− 0.223	− 0.493
					(0.347)	(0.350)
Observations	34	34	34	34	34	34
R-squared	0.216	0.651	0.044	0.559	0.659	0.618

Ordinary least squares regression, robust standard errors in parentheses

Source: Eurostat, UN World Population Policy database, UN Population Division, World Bank's World Development Indicators

Policies and Average Population Dynamics

In Table 2 we show the results of the association estimation between fertility and immigration policies in 1996 and average population dynamics score, defined in the previous section, in the following decades. The regressions are reported with and without controls for covariates traditionally used in the literature (Alvarez-Diaz et al., 2018; Luci-Greulich & Thévenon, 2013), such as mean population age, urbanisation, and GDP per capita. Columns 1 and 2 report a statistical association between fertility policies in 1996 and subsequent average population dynamics in Europe. Columns 3 and 4 show the connection between immigration policies and the average population dynamics in Europe. Columns 1 and 3 indicate the estimation of the relationship without controls while columns 2 and 4 include the covariates, columns 5 and 6 take into account whether a country belongs to the EU-15 or EEA, EU-28 or EEA, or not. We find a negative statistical association between fertility policies in 1996 and average population dynamics in Europe between 2000 and 2017. In practical terms this indicates a presence of a statistical relationship suggesting a connection between fertility policies and higher population decline in Europe. This relationship holds once the controls are included; the association does not change after controlling for a country's status in terms of its membership in the EU and EEA. The estimation between immigration policies in 1996 and average population dynamics in 2000–2017 does not indicate a statistical association in neither of the models.

Sensitivity Analysis

In order to evaluate the robustness of the results we took the following steps. In a set of estimations reported in Table 3 columns 1 and 2 Turkey was excluded from the sample. As a country with a large number of populating NUTS-3 units and an outlier in terms of its fertility and migration terms when compared to other European countries, it may have led to result overestimation. We find that excluding Turkey from the sample does not change the previously established negative statistical relationship between fertility policies and population decline in Europe.

Additionally, connections between policies and population change can be time sensitive and perform divergently in different portions of the study timeframe that was set for 2000–2017. We have re-estimated the model by dividing the analytical period into two parts (2000–2009 and 2010–2017). We find that there is no statistical association between fertility policies and average population dynamics controlling for a set of covariates in 2000–2009, but there is a statistical association between the two focal variables in the period of 2010–2017. The findings for average population dynamics and migration policies remain unchanged in comparison to original estimations (see Table 3 columns 3, 4, 5, and 6).

Furthermore, policies on fertility or immigration may be linked to natural population change and migration measures respectively. To test that, we have introduced interaction terms between policies on fertility and population change as well as policies on immigration and net migration to the model. The estimations reported prove the main analysis to be robust (see Table 3 columns 7 and 8).

Table 4 reports the results of a robustness check relying on spatial regression models, focused on identifying spillovers across countries. We do so only for countries, rather than for NUTS-3 levels, as our focal covariates (fertility and immigration policies) are defined at the national level and uniform across sub-national units, and therefore do not warrant spatial regressions at the NUTS-3 levels.

We rely on a spatial autoregressive model, with spatial lags on both the dependent variable and the error term. The results in Table 4 corroborate the main analysis results, the coefficient for fertility policy in 1996 is stably negative and statistically significant (at the $p < 0.05$ threshold) within the spatial autoregressive model. The decomposition of coefficients highlights that there is a direct effect of each country's policy on its own average population dynamics (direct), while the indirect effect (gauging potential spillovers across countries) is not statistically different from zero, although it is similarly negative (see Table 5). Furthermore, the spatial lag coefficient for average population dynamics is not statistically significant, suggesting that there is little correlation between different countries' average population dynamics over the study period.

We further test the robustness of our results by changing the dependent variable to population change rate. The population change rate data for the 37 countries included in the analysis come from the UN Population Division Data Portal. The results for the replication of our model using the average population change rate as

Table 3 Association between average population dynamics and population policies, sensitivity tests

	DV: Average population dynamics							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Policy on fertility level (1996)	− 0.287**		− 0.198		− 0.413**		− 0.239**	
	(0.145)		(0.173)		(0.184)		(0.098)	
Policy on immigration (1996)		− 0.122		− 0.134		− 0.149		− 0.024
		(0.207)		(0.204)		(0.201)		(0.188)
Median age	− 0.021	− 0.024	0.003	− 0.004	− 0.054	− 0.058	− 0.016	− 0.004
	(0.061)	(0.066)	(0.063)	(0.017)	(0.065)	(0.069)	(0.026)	(0.039)
Urban population as % of total	0.007	0.013	− 0.001	0.005	0.015	0.024	0.009	0.012
	(0.015)	(0.017)	(0.016)	(0.017)	(0.020)	(0.019)	(0.008)	(0.009)
Ln(GDP per capita)	0.049**	0.430*	0.532**	0.481**	0.412*	0.328	0.014*	0.029
	(0.193)	(0.230)	(0.191)	(0.212)	(0.222)	(0.243)	(0.078)	(0.203)
Unemployment rate (% total labour force)	0.002	− 0.01	0.006	− 0.004	− 0.005	− 0.022	− 0.01	0.001
	(0.028)	(0.028)	(0.028)	0.031	(0.42)	(0.036)	(0.013)	(0.017)
EU/EEA status (0—not EU/EEA, 1—EU-15/ EEA, 2—EU-28)	− 0.221	− 0.488	− 0.421	− 0.594	− 0.055	− 0.446	0.043	− .0307
	(0.349)	(0.362)	(0.402)	(0.367)	(0.383)	(0.412)	(0.131)	(0.230)
Turkey included	No	No	Yes	Yes	Yes	Yes	Yes	Yes
Estimation for 2000–2009			Yes	Yes	No	No		
Estimation for 2010–2017			No	No	Yes	Yes		
Policy on fertility level X Population change							0.208	
							(0.163)	
Population change							0.050***	
							(0.172)	
Policy on immigration X Net migration								0.040
								(0.248)

Table 3 (continued)

	DV: Average population dynamics							
	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)
Net migration								0.081***
								(0.043)
Observations	33	33	34	34	34	34	34	34
R-squared	0.656	0.614	0.598	0.585	0.549	0.474	0.912	0.802

Ordinary least squares regression, robust standard errors in parentheses

Source: Eurostat, UN World Population Policy database, UN Population Division, World Bank's World Development Indicators

*$p < 0.10$, **$p < 0.05$, ***$p < 0.01$

Table 4 Spatial autoregressive model sensitivity test: GS2SLS estimates

Variables	DV Average population dynamics
Policy on fertility level	− 0.309*
	(0.124)
Policy on immigration	− 0.130
	(0.139)
Median age	− 0.076
	(0.048)
Urban population as % of total	0.010
	(0.011)
Ln(GDP per capita)	0.514***
	(0.120)
Unemployment rate (% total labour force)	0.002
	(0.027)
EU/EEA status (0—not EU/EEA, 1—EU-15/EEA, 2—EU-28)	− 0.165
	(0.221)
Constant	0.070
	(1.175)
Spatial regression parameters	
Spatial lag coefficient—average population dynamics	0.298
	(0.160)
Spatial autoregressive error term	− 1.093
	(1.384)
Wald test of spatial terms	chi2(2) = 3.61 Prob > chi2 = 0.1643
Observations	34

Spatial autoregressive model with lags for dependent variable and error term

Standard errors in parentheses

***p < 0.001, **p < 0.01, *p < 0.05

the dependent variable are reported in Table 6 in the Appendix. The results corroborate with the results of our initial results (Table 2) and show a negative and statistically significant association between fertility policy status in 1996 and the average population rate between years 2000–2020. Immigration policy status is similarly observed to be insignificant.

In the final step of sensitivity checks, we expand the dataset over the years 2000–2020 instead of relying on the average values, in order to observe the association between the population change rate and policy status in a dynamic approach. The policy data are obtained from the UN World Population Policy database and includes fertility and immigration policy status by country for nine years between

Table 5 Spatial autoregressive model sensitivity test: decomposition of coefficients

Variables	Decomposition of Coefficients		
	Direct	Indirect	Total
Policy on fertility level	− 0.309*	− 0.079	− 0.389*
	(0.124)	(0.060)	(0.161)
Policy on immigration	− 0.131	− 0.033	− 0.164
	(0.140)	(0.042)	(0.177)
Median age	− 0.077	− 0.020	− 0.096
	(0.048)	(0.022)	(0.068)
Urban population as % of total	0.010	0.003	0.013
	(0.011)	(0.004)	(0.015)
Ln(GDP per capita)	0.515***	0.132	0.647**
	(0.121)	(0.101)	(0.192)
Unemployment rate (% total labour force)	0.002	0.000	0.002
	(0.027)	(0.007)	(0.034)
EU/EEA status (0—not EU/EEA, 1—EU-15/EEA, 2—EU-28)	− 0.166	− 0.042	− 0.208
	(0.222)	(0.061)	(0.277)

Decomposition of coefficients, conducted with estat impact in STATA 17 after spatial autoregressive model with lags for dependent variable and error term

Standard errors in parentheses

***p < 0.001, **p < 0.01, *p < 0.05

1996 and 2015.[5] The dataset, thus, covers 37 countries and 21 years. We match the policy year and the observation year for the dependent variable and controls with two-, three- and four-year lags. In other words, we test the association of the fertility and immigration policy status in year P with the population change rate (and other controls) in year P + 2, P + 3 and P + 4 respectively. The results of the OLS regression with country and year fixed-effects are reported in Table 7 in the appendix. The negative and statistically significant relationship between fertility policy status and population change rate is also confirmed by this approach, in line with our initial findings. Additionally, the immigration policy status originally found as positive but insignificant becomes significant when observed over the years. We find no changes in the direction or significance of fertility and immigration policies with respect to the time lags between the year of policy status and observation of population change. However, the relationship is observed to be at its strongest for a three-year gap between fertility policies and population change, whereas it is four-years for the immigration policies and population change. This time difference may be attributed to longer decision-making processes needed for migration (especially international), however, future research may shed more light on this interpretation.

[5] The policy reporting years are; 1996, 2001, 2003, 2005, 2007, 2009, 2011, 2013 and 2015.

Discussion and Conclusions

In the beginning of the twenty-first century Europe has experienced several waves of population change. The Eastern Enlargement of the EU has established a channel of intra-EU migration that many have used. The Great Recession and the Sovereign Debt Crisis has encouraged European populations to move and work in other EU member states as well (e.g. Anelli & Peri, 2017). Also, the European Migrant Crisis has provided an unprecedented population influx into the continent. However, Europe has also been undergoing a period of ageing and low fertility. Even if age structures across European countries have been converging, age differentials are found at the subnational level (e.g. Kashnitsky et al., 2021). In addition, life expectancy in Europe is distributed unequally. Higher life expectancy is recorded in Western Europe in comparison to Eastern Europe (e.g. Meslé & Vallin, 2017). Fertility differential across Europe stands as an important factor of European population dynamics (e.g. Billari & Kohler, 2004).

This paper is an original effort to marry the measures of fertility and mortality through the concept of the natural population change as well as migration in order to provide a snapshot of how European sub-regional populations have changed since the beginning of the twenty-first century. For that matter we have established a typology that allows us to better understand the average population dynamics in Europe from 2000 to 2017. We have used Eurostat data on natural population change and net migration to demonstrate how the subnational NUTS-3 regions fare in terms of population growth or decline.

Our findings contribute to the literature on differences in fertility, mortality, ageing, and migration. We find evidence that the centre-periphery concept holds (e.g. Kashnitsky & Schöley, 2018). Nationally, urban centres exhibit population growth whilst rural areas have been found to be mostly depopulating. At the level of supranational European regions, more NUTS-3 in Western Europe and parts of Northern Europe (Scandinavia) have experienced population growth than decline. The opposite holds for Central and Eastern European as well as Southern European NUTS-3. Turkey stands out as an exception as a large number of its NUTS-3 regions has been growing on average. This can be partially attributed to the success of family and fertility policies through local welfare provisions (Aksoy & Billari, 2018). We have also established an existing negative statistical association between fertility policies in 1996 and average population dynamics in 2000–2017. There might be several underlying mechanisms that could explain this negative statistical association. First of all, fertility policies and high investment in pro-natalist means do not always ensure population resilience in the face of declining births (Botev, 2015). For instance, while policies regarding public childcare provision and generous parental leave are efficient in increasing birth rates (Bergsvik et al., 2021), other interventions such as cash transfers or tax incentives may fall short in reversing declining fertility trends (Andersen et al., 2018). We also know the influence of fertility policies may vary across different socio-economic groups within a population (Spéder et al., 2020) and relying on macro-level indicators may mask certain local and positive effects. Moreover, the countries which had implemented fertility policies in 1996, might be those that were already experiencing pressing concerns regarding fertility level, hence reversing the declining fertility trends could have been even more challenging. Lastly, the fertility effect of the Great Recession, both in terms of quantity and timing, was sizable among Southern, Central and Eastern European countries (Ayllón, 2019; Matysiak et al., 2021). As a result, any potential positive effects of a fertility policy implemented in 1996 could have been reversed by the substantial drop in fertility in the post-2008 period.

We found no statistical association between average population dynamics and immigration policies contrary to estimations that show slowing down of population decline when immigration is accounted for (e.g. Bermingham, 2001). The latter finding needs to be interpreted cautiously, considering the structural change these countries underwent, directly or indirectly, during the 1990s and 2000s, with the dissolution of the Soviet Union, ethnic conflicts in Balkan countries and the enlargement of the European Union. Observing the change in population dynamics in relation to fertility policies would take time, but immigration policies may have more immediate consequences. In this study, to enable consistency and observe long-term indications, we used 1996 as the year for both fertility level and immigration policies. But considering the insignificant results the latter has shown, future studies may analyse the potential effects of immigration policy at different time intervals, bearing in mind the turbulent nature of these two decades and changing perspectives towards migration across countries. Furthermore, future studies may explore the topic in more recent times, in light of the European Migrant Crisis. Furthermore, our statistical regression analysis focused on the effectiveness of policies at the national level in the 1990s for population outcomes in the 2010s, controlling for socio-demographic and economic covariates at the same geographic level. Relying on our four-fold typology for NUTS-3 units, future research may focus more specifically on how local-level dynamics in the domains of labour market, environment and climate, and welfare affect population change dynamics at the NUTS-3 level, grounding our national results with a more granular scope.

The relationship between migration policies and population dynamics appeared positive but statistically not significant in our analysis. This result may stem from our analytical strategy to use the policy status in 1996 as the benchmark for the next two decades. While this approach works and is corroborated by sensitivity checks for fertility policies, it is not the case for immigration policy. The reason for this could be that the 1996 policies are not sufficient to account for the migration flows within and from outside of Europe that occurred due to the EU expansion in 2004 (Fihel et al., 2006) as well as 2007 and 2013, the Great Recession in 2008 (Lafleur & Stanek, 2017) and the European Migrant Crisis 2014 onwards, in our period of focus. We tackled this possibility using a dynamic approach that includes the change of policies into our statistical analysis, and observed that the relationship between immigration policy status and population dynamics remained positive and became significant. These findings indicate that countries maintaining and increasing their policies to attract migrants, witnessed an increase in population change rates and population dynamics in general, while countries with more restrictive policies, less attractive for migrants experienced the opposite over time.

There are limitations that hamper the outreach of the paper. A number of NUTS-3 regions did not have data for the full period from 2000 to 2017. Therefore, labelling of such NUTS-3 regions should be done cautiously. This too counters the efforts to demonstrate meaningful year specific population dynamics on the whole continent as some countries or subnational regions are not represented due to data limitations. Moreover, the conceptualisation of depopulation or population growth is not unique and it may depend on the indicators used or the geographical context (Newsham & Rowe, 2023). In terms of assessing the population policies, this paper has presented associative results. The connection between population policy variables (fertility and migration) as reported in 1996 and average population dynamics in 2000–2017 needs to be handled with caution. That holds in particular taking into account huge economic and societal changes that were undergoing in countries of Central and Eastern Europe or Western Balkans at that time. These dynamics could not be captured by macro level variables used in this study. Methodological hazards such as reverse causality and endogeneity only allow for an interpretation that incorporates the direction and statistical association between the variables rather than causal links.

Another limitation of our study comes from the nature of official data on population change with respect to the coverage of migrants. We consider our results to be relevant for regular migration patterns, as our reference point is official data that only capture migrants with legal status. Asylum seekers may appear on official data with significant delays due to long bureaucratic processes and irregular migrants are not covered as part of the population data, if at all. Therefore, we are cautious extending this interpretation of our findings to the consequences of the European Migrant Crisis and the irregular migration flows that the region experienced in the second half of 2010s.

In conclusion, Europe has diverse population dynamics that are defined by differences in natural population change and migration. The distinction is particularly visible between urban and rural regions nationally. Supranationally, Western and Northern Europe differ from Central and Eastern Europe and Southern Europe in terms of average population dynamics. Knowing these population dynamics at the granular level of NUTS-3 can contribute to tailor made policies for specific populations of certain demographic characteristics as opposed to policies that can be associated with an even larger population decline.

Appendix

See Tables 6 and 7.

Notes on Fig. 1.

Following NUTS-3 regions were excluded from the descriptive analysis, for they are considered as geographical outliers (Kashnitsky et al., 2017), although they are included in the statistical analysis;

FRY20—Martinique, France

FRY30—Guyane, France

FRY40—La Réunion, France

Table 6 Association between average population change rate and policy status (2000–2020)

	(1)	(2)
Policy on fertility level (1996)	− 0.301*	− 0.228*
	(0.150)	(0.120)
Policy on immigration (1996)	− 0.315**	0.114
	(0.139)	(0.0951)
Median age		− 0.116***
		(0.0226)
Urban population (%)		0.00728
		(0.00754)
Unemployment rate		0.0161
		(0.0134)
EU/EEA status (0—no EU/EEA, 1—EU-15/EEA, 2—EU-28)		0.167
		(0.164)
ln(GDP)		0.743***
		(0.131)
Constant	0.444**	− 3.198***
	(0.209)	(1.096)
Observations	37	36
R-squared	0.145	0.808

Ordinary Least Squares regression

Robust standard errors in parentheses

***p < 0.01, ** p < 0.05, * p < 0.1

PT200—Região Autónoma dos Açores, Portugal
PT300—Região Autónoma da Madeira, Portugal
ES630—Ceuta, Spain
ES640—Melilla, Spain
ES703—El Hierro, Spain
ES704—Fuerteventura, Spain
ES705—Gran Canaria, Spain
ES706—La Gomera, Spain
ES707—La Palma, Spain
ES708—Lanzarote, Spain
ES709—Tenerife, Spain

Following NUTS-3 regions are excluded from the descriptive analysis for they are considered as geographical outliers. They are also not present in the statistical analysis due to missing data.

FRY10—Guadeloupe, France
FRY50—Mayotte, France
NO0B1—Jan Mayen, Norway
NO0B2—Svalbard, Norway

Table 7 Dynamic approach: the association between population change rate and policy variables (2000–2020)

DV	Population change rate					
	Policy year + 2		Policy year + 3		Policy year + 4	
	(a)	(b)	(a)	(b)	(a)	(b)
Policy on fertility level	0.0258	− 0.135***	0.00247	− 0.140***	0.00197	− 0.126***
	(0.0351)	(0.0244)	(0.0336)	(0.0236)	(0.0331)	(0.0244)
Policy on immigration	0.0583***	0.0383**	0.0656***	0.0404**	0.0789***	0.0519***
	(0.0168)	(0.0156)	(0.0185)	(0.0162)	(0.0189)	(0.0174)
Median age	− 0.125***	− 0.172***	− 0.124***	− 0.163***	− 0.124***	− 0.156***
	(0.00691)	(0.0246)	(0.00694)	(0.0237)	(0.00698)	(0.0212)
Urban opulation (%)	0.00711***	0.0350***	0.00685***	0.0341***	0.00669***	0.0341***
	(0.00243)	(0.00745)	(0.00238)	(0.00732)	(0.00226)	(0.00735)
ln(GDP)	0.576***	0.678***	0.576***	0.684***	0.570***	0.699***
	(0.0341)	(0.108)	(0.0334)	(0.108)	(0.0322)	(0.108)
Unemployment rate	− 0.00476	− 0.0279***	− 0.00431	− 0.0288***	− 0.00467	− 0.0301***
	(0.00400)	(0.00523)	(0.00391)	(0.00513)	(0.00387)	(0.00514)
EU/EEA status (0—no EU/EEA, 1—EU-15/EEA, 2—EU-28)	− 0.109***	− 0.577	− 0.0953***	− 0.626*	− 0.0909***	− 0.736**
	(0.0326)	(0.361)	(0.0332)	(0.356)	(0.0347)	(0.353)
Constant	− 0.976***	− 1.869**	− 1.003***	− 2.116**	− 0.920***	− 2.406***
	(0.325)	(0.933)	(0.328)	(0.915)	(0.334)	(0.878)
Observations	724	724	732	732	756	756
R-squared	0.653	0.864	0.655	0.865	0.657	0.864
Country FE	NO	YES	NO	YES	NO	YES
Year FE	NO	YES	NO	YES	NO	YES

Ordinary Least Squares regression, including country and year fixed-effects in columns (b)

Robust standard errors in parentheses

***p < 0.01, **p < 0.05, *p < 0.1

Supplementary Information The online version contains supplementary material available at https://doi.org/10.1007/s11113-024-09871-w.

Acknowledgements All authors wish to thank Francesco C. Billari, Anne H. Gauthier, Vitalija Gaučaitė Wittich, and Hill Kulu for support and useful input.

Data availability All the data used in this study comes form public data sources. Data used in the descriptive analysis can be accessed from the Eurostat database. Data used in the analytical part of the study can be accessed from the UN World Population Policy database, UN Population Division database and the World Bank's database of World Development Indicators.

Declarations

Conflict of interest All authors declare that they have no conflicts of interest.

References

Ainsaar, M., & Rootalu, K. (2016). European demographic change and welfare challenges. In K. Schubert, P. de Villota, & J. Kuhlmann (Eds.), *Challenges to European Welfare Systems* (pp. 793–806). Springer.

Aksoy, O., & Billari, F. C. (2018). Political Islam, marriage, and fertility: Evidence from a natural experiment. *American Journal of Sociology, 123*(5), 1296–1340.

Alvarez-Diaz, M., Dhombres, B., Ghisetti, C., Pontarollo, N., & Dijkstra, L. (2018). *The determinants of population growth: Literature review and empirical analysis*. Publications Office of the European Union.

Andersen, S. N., Drange, N., & Lappegård, T. (2018). Can a cash transfer to families change fertility behaviour? *Demographic Research, 38*, 897–928.

Anelli, M., & Peri, G. (2017). Does emigration delay political change? Evidence from Italy during the Great Recession. *Economic Policy, 32*(91), 551–596.

Ayllón, S. (2019). Job insecurity and fertility in Europe. *Review of Economics of the Household, 17*(4), 1321–1347.

Balbo, N., Billari, F. C., & Mills, M. (2013). Fertility in advanced societies: A review of research. *European Journal of Population/revue Européenne De Démographie, 29*(1), 1–38.

Bergsvik, J., Fauske, A., & Hart, R. K. (2021). Can policies stall the fertility fall? A systematic review of the (quasi-) experimental literature. *Population and Development Review, 47*(4), 913–964.

Bermingham, J. R. (2001). Immigration: Not a solution to problems of population decline and aging. *Population and Environment, 22*(4), 355–363.

Bernard, A. (2017). Levels and patterns of internal migration in Europe: A cohort perspective. *Population Studies, 71*(3), 293–311.

Bijak, J., Kupiszewska, D., & Kupiszewski, M. (2008). Replacement migration revisited: Simulations of the effects of selected population and labor market strategies for the aging Europe, 2002–2052. *Population Research and Policy Review, 27*, 321–342.

Billari, F. C. (2008). Lowest-low fertility in Europe: Exploring the causes and finding some surprises. *Japanese Journal of Population*, 2–18.

Billari, F., & Kohler, H. P. (2004). Patterns of low and lowest-low fertility in Europe. *Population Studies, 58*(2), 161–176.

Bloom, D. E., Chatterji, S., Kowal, P., Lloyd-Sherlock, P., McKee, M., Rechel, B., Rosenberg, L., & Smith, J. P. (2015). Macroeconomic implications of population ageing and selected policy responses. *The Lancet, 385*(9968), 649–657.

Botev, N. (2015). Could pronatalist policies discourage childbearing? *Population and Development Review, 41*(2), 301–314.

Le Bras, H. (1998). *Le démon des origines: Démographie et extrême droite*. FeniXX.

Caltabiano, M., Dreassi, E., Rocco, E., & Vignoli, D. (2019). A subregional analysis of family change: The spatial diffusion of one-parent families across Italian municipalities, 1991–2011. *Population, Space and Place, 25*(4), e2237.

Castro-Martín, T., & Cortina, C. (2015). Demographic issues of intra-European migration: Destinations, family and settlement. *European Journal of Population, 31*(2), 109–125.
Chawla, M., Betcherman, G., & Banerji, A. (2007). *From red to gray: The "Third Transition" of aging populations on Eastern Europe and the former Soviet Union*. The World Bank.
Christensen, K., Doblhammer, G., Rau, R., & Vaupel, J. W. (2009). Ageing populations: The challenges ahead. *The Lancet, 374*(9696), 1196–1208.
Coale, A. J., & Watkins, S. C. (Eds.). (1986). *The Decline of Fertility in Europe*. Princeton University Press.
European Commission (2020). *Report on the Impact of Demographic Change*. Retrieved from https://ec.europa.eu/info/strategy/priorities-2019-2024/new-push-european-democracy/impact-demographic-change-europe_en#documents
Comolli, C. L. (2017). The fertility response to the Great Recession in Europe and the United States: Structural economic conditions and perceived economic uncertainty. *Demographic Research, 36*, 1549–1600.
Craveiro, D., De Oliveira, I. T., Gomes, M. S., Malheiros, J., Moreira, M. J. G., & Peixoto, J. (2019). Back to replacement migration. *Demographic Research, 40*, 1323–1344.
Czaika, M., & Parsons, C. R. (2017). The gravity of high-skilled migration policies. *Demography, 54*(2), 603–630.
de Haas, H., Czaika, M., Flahaux, M. L., Mahendra, E., Natter, K., Vezzoli, S., & Villares-Varela, M. (2019). International migration: Trends, determinants, and policy effects. *Population and Development Review, 45*(4), 885–922.
De Silva, T., & Tenreyro, S. (2017). Population control policies and fertility convergence. *Journal of Economic Perspectives, 31*(4), 205–228.
De Souza, R. M. (2015). Demographic resilience. *The SAIS Review of International Affairs, 35*(1), 17–27.
Ediev, D. M. (2014). Why increasing longevity may favour a PAYG pension system over a funded system. *Population Studies, 68*(1), 95–110.
Esping-Andersen, G., & Billari, F. C. (2015). Re-theorizing family demographics. *Population and Development Review, 41*(1), 1–31.
Eurostat (2020a). Population change - Demographic balance and crude rates at national level[demo_gind]. Retrieved October 10, 2020, from http://appsso.eurostat.ec.europa.eu/nui/show.do?query=BOOKMARK_DS-054722_QID_-66B46454_UID_-3F171EB0&layout=TIME,C,X,0;GEO,L,Y,0;INDIC_DE,L,Z,0;INDICATORS,C,Z,1;&zSelection=DS-054722INDICATORS,OBS_FLAG;DS-054722INDIC_DE,JAN;&rankName1=INDICATORS_1_2_-1_2&rankName2=INDIC-DE_1_2_-1_2&rankName3=TIME_1_0_0_0&rankName4=GEO_1_2_0_1&sortR=DND_-1&prRK=FIRST&prSO=PROTOCOL&sortC=ASC_-1_FIRST&rLShi=0:1-14,15:0&rStp=&cStp=&rDCh=&cDCh=&rDM=true&cDM=true&footnes=false&empty=false&wai=false&time_mode=NONE&time_most_recent=false&lang=EN&cfo=%23%23%23%2C%23%23%23.%23%23%23
Eurostat (2020b). Background. Retrieved November 2, 2020 from: https://ec.europa.eu/eurostat/web/nuts/background
Eurostat (2020c). Population change—Demographic balance and crude rates at regional level (NUTS 3). Retrieved January 10, 2020, from https://ec.europa.eu/eurostat/databrowser/view/DEMO_R_GIND3__custom_144965/default/table?lang=en
Eurostat (2020d). History of NUTS. Retrieved October 26, 2020, from http://ec.europa.eu/eurostat/web/nuts/history
Eurostat (2023). Urban–rural typology. Retrieved from https://ec.europa.eu/eurostat/statistics-explained/index.php?title=Glossary:Urban-rural_typology
EuroVoc (2020). 7206 Europe. Retrieved October 28, 2020, from https://op.europa.eu/en/web/eu-vocabularies/th-concept-scheme/-/resource/eurovoc/100277?uri=http://eurovoc.europa.eu/100277
Fassmann, H., & Munz, R. (1992). Patterns and trends of international migration in Western Europe. *The Population and Development Review, 18*, 457–480.
Fihel, A., Kaczmarczyk, P., & Okólski, M. (2006). *Labour mobility in the enlarged European Union: international migration from the EU8 countries* (No. 14/72). CMR working papers.
Frejka, T., & Sobotka, T. (2008). Overview Chapter 1: Fertility in Europe: Diverse, delayed and below replacement. *Demographic Research., 19*, 15–46. https://doi.org/10.4054/DemRes.2008.19.3
Garssen, J., & Nicolaas, H. (2008). Fertility of Turkish and Moroccan women in the Netherlands: Adjustment to native level within one generation. *Demographic Research, 19*, 1249–1280.
Gauthier, A. H., & Philipov, D. (2008). Can policies enhance fertility in Europe. *Vienna Yearbook of Population Research, 2008*, 1–16.

Gietel-Basten, S., Rotkirch, A., & Sobotka, T. (2022). Changing the perspective on low birth rates: why simplistic solutions won't work. *BMJ*. https://doi.org/10.1136/bmj-2022-072670
Goldstein, J. R., Sobotka, T., & Jasilioniene, A. (2009). The end of "lowest-low" fertility? *Population and Development Review, 35*(4), 663–699.
Grant, J., Hoorens, S., Sivadasan, S., van het Loo, M., DaVanzo, J., Hale, L., Gibson, S., & Butz, W. P. (2004). *Low fertility and population aging: Causes, consequences, and policy options*. Santa Monica: RAND Europe.
Gregory, T., & Patuelli, R. (2015). Demographic ageing and the polarization of regions—An exploratory space–time analysis. *Environment and Planning A, 47*(5), 1192–1210.
Grigoriev, P., Jasilionis, D., Klüsener, S., Timonin, S., Andreev, E., Meslé, F., & Vallin, J. (2020). Spatial patterns of male alcohol-related mortality in Belarus, Lithuania, Poland and Russia. *Drug and Alcohol Review*.
Grigoriev, P., Shkolnikov, V., Andreev, E., Jasilionis, D., Jdanov, D., Meslé, F., & Vallin, J. (2010). Mortality in Belarus, Lithuania, and Russia: Divergence in recent trends and possible explanations. *European Journal of Population/revue Européenne De Démographie, 26*(3), 245–274.
Gutiérrez Posada, D., Rubiera Morollón, F., & Viñuela, A. (2018). Ageing places in an ageing country: The local dynamics of the elderly population in Spain. *Tijdschrift Voor Economische En Sociale Geografie, 109*(3), 332–349.
Hellstrand, J., Nisén, J., Miranda, V., Fallesen, P., Dommermuth, L., & Myrskylä, M. (2020). Not just later, but fewer: Novel trends in cohort fertility in the Nordic countries. *Max Plank Demographic Research Institute, Rostock, MPIDR-Working Paper*, *7*.
Human Fertility Database. (2023). Retrieved from, www.humanfertility.org
Hertzman, C., & Wiens, M. (1996). Child development and long-term outcomes: A population health perspective and summary of successful interventions. Social Science & Medicine, 43(7), 1083–1095. https://doi.org/10.1016/0277-9536(96)00028-7.
Izquierdo, M., Jimeno, J. F., & Lacuesta, A. (2016). Spain: From massive immigration to vast emigration? *IZA Journal of Migration, 5*(1), 10.
Jasilionis, D., Meslé, F., Shkolnikov, V. M., & Vallin, J. (2011). Recent life expectancy divergence in Baltic countries. *European Journal of Population/revue Européenne De Démographie, 27*(4), 403.
Kahanec, M., Pytlikova, M., & Zimmermann, K. F. (2016). The free movement of workers in an enlarged European Union: Institutional underpinnings of economic adjustment. In M. Kahanec, & K. F. Zimmermann (Eds.), Labor migration, EU enlargment, and the great recession (pp. 1–34). Berlin: Springer.
Kashnitsky, I., de Beer, J., & van Wissen, L. (2017). Decomposition of regional convergence in population aging across Europe. *Genus, 73*(1), 2.
Kashnitsky, I., de Beer, J., & van Wissen, L. (2021). Unequally ageing regions of Europe: Exploring the role of urbanization. *Population Studies, 75*, 221–237.
Kashnitsky, I., & Schöley, J. (2018). Regional population structures at a glance. *The Lancet, 392*(10143), 209–210.
Kinsella, K., & Phillips, D. R. (2005). Global aging: The challenge of success. *Population Bulletin, 60*(1), 3–40.
Klüsener, S., Perelli-Harris, B., & Gassen, N. S. (2013). Spatial aspects of the rise of nonmarital fertility across Europe since 1960: The role of States and regions in shaping patterns of change. *European Journal of Population/revue Européenne De Démographie, 29*(2), 137–165.
Kohler, H. P., Billari, F. C., & Ortega, J. A. (2002). The emergence of lowest-low fertility in Europe during the 1990s. *Population and Development Review, 28*(4), 641–680.
Kohler, H. P., Billari, F. C., & Ortega, J. A. (2006). Low fertility in Europe: Causes, implications and policy options. *The Baby Bust Who Will Do the Work, 56*, 48–109.
Lafleur, J. M., & Stanek, M. (2017). *South-North migration of EU citizens in times of crisis* (p. 224). Springer.
Lesthaeghe, R. (1980). On the social control of human reproduction. *Population and Development Review, 6*(4), 527–548.
Lesthaeghe, R. (2020). The second demographic transition, 1986–2020: Sub-replacement fertility and rising cohabitation—A global update. *Genus, 76*(1), 1–38.
Luci-Greulich, A., & Thévenon, O. (2013). The Impact of family policies on fertility trends in developed countries: L'influence des politiques familiales sur les tendances de la fécondité des pays développés. *European Journal of Population/revue Européenne De Démographie, 29*, 387–416.

Lutz, W., Sanderson, W. C., & Scherbov, S. (2008). *The end of world population growth in the 21st century: New challenges for human capital formation & sustainable development*. Earthscan.

Marois, G., Bélanger, A., & Lutz, W. (2020). Population aging, migration, and productivity in Europe. *Proceedings of the National Academy of Sciences, 117*(14), 7690–7695.

Martin, P., & Zürcher, G. (2008). Managing migration: The global challenge. *Population Bulletin, 63*(1), 3–20.

Matysiak, A., Sobotka, T., & Vignoli, D. (2021). The great recession and fertility in Europe: A subnational analysis. *European Journal of Population, 37*(1), 29–64.

May, J. F. (2012). *World population policies: Their origin, evolution, and impact*. Springer.

McDonald, P. (2002). Sustaining fertility through public policy: The range of options. *Population-E, 57*(3), 417–446.

Meslé, F., & Vallin, J. (2017). The end of east–west divergence in European life expectancies? An introduction to the special issue. *European Journal of Population, 33*(5), 615–627.

Milewski, N. (2010). Immigrant fertility in West Germany: Is there a socialization effect in transitions to second and third births?. European Journal of Population/Revue europé enne de Dé mographie, 26(3), 297–323.

Murphy, M. (2017). Demographic determinants of population aging in Europe since 1850. *Population and Development Review, 43*, 257–283.

Newsham, N., & Rowe, F. (2023). Understanding trajectories of population decline across rural and urban Europe: A sequence analysis. *Population, Space and Place, 29*(3), e2630.

Neyer, G. (2013). Welfare states, family policies, and fertility in Europe. In G. Neyer, G. Andersson, H. Kulu, L. Bernardi, & C. Bühler (Eds.), *The Demography of Europe* (pp. 29–53). Springer.

PEW (2016). Number of Refugees to Europe Surges to Record 1.3 Million in 2015. Retrieved from: https://www.pewresearch.org/global/2016/08/02/number-of-refugees-to-europe-surges-to-record-1-3-million-in-2015/

Preston, S. H., & Stokes, A. (2012). Sources of population aging in more and less developed countries. *Population and Development Review, 38*(2), 221–236.

Pritchett, L. (2006). Let their people come: Breaking the gridlock on global labor mobility. Brookings Institution Press.

Rechel, B., Grundy, E., Robine, J. M., Cylus, J., Mackenbach, J. P., Knai, C., & McKee, M. (2013). Ageing in the European union. *The Lancet, 381*(9874), 1312–1322.

Rees, P., Bell, M., Kupiszewski, M., Kupiszewska, D., Ueffing, P., Bernard, A., Charles-Edwards, E., & Stillwell, J. (2017). The impact of internal migration on population redistribution: An international comparison. *Population, Space and Place, 23*(6), e2036.

Rees, P., van der Gaag, N., de Beer, J., & Heins, F. (2012). European regional populations: Current trends, future pathways, and policy options. *European Journal of Population/revue Européenne De Démographie, 28*(4), 385–416.

Rindfuss, R. R., & Brauner-Otto, S. R. (2008). Institutions and the transition to adulthood: Implications for fertility tempo in low-fertility settings. *Vienna Yearbook of Population Research/vienna Institute of Demography, Austrian Academy of Sciences, 2008*, 57.

Sabater, A., Graham, E., & Finney, N. (2017). The spatialities of ageing: Evidencing increasing spatial polarisation between older and younger adults in England and Wales. *Demographic Research, 36*, 731–744.

Spéder, Z., Murinkó, L., & Oláh, L. S. (2020). Cash support vs tax incentives: The differential impact of policy interventions on third births in contemporary Hungary. *Population Studies, 74*(1), 39–54.

Teitelbaum, M. S., & Winter, J. M. (1998). A Question of Numbers: High Migration, Low Fertility and the Politics of National Identity. New York: Hill and Wang.

Thomson, E., Lappegård, T., Carlson, M., Evans, A., & Gray, E. (2014). Childbearing across partnerships in Australia, the United States, Norway, and Sweden. *Demography, 51*(2), 485–508.

Tsui, A. O. (2001). Population policies, family planning programs, and fertility: The record. *Population and Development Review, 27*, 184–204.

United Nations (2000). *Replacement migration: Is it a solution to declining and aging populations?* New York: United Nations, Department of Economic and Social Affairs, Population Division.

United Nations. (2006). *International migration report 2006: A global assessment*. United Nations, Department of Economic and Social Affairs, Population Division.

United Nations (2010). *World population aging 2009*. New York: United Nations, Department of Economic and Social Affairs, Population Division

United Nations (2020). *Sources for Policy Variables*. United Nations website. Retrieved May 26, 2022, from https://esa.un.org/poppolicy/Sources.aspx.
Vallin, J., & Meslé, F. (2004). Convergences and divergences in mortality: A new approach of health transition. *Demographic Research, 2*, 11–44.
van Mol, C., & de Valk, H. (2016). Migration and immigrants in Europe: A historical and demographic perspective. In *Integration processes and policies in Europe* (pp. 31–55). Springer, Cham.
van Houtum, H., & Pijpers, R. (2007). The European union as a gated community: The two-faced border and immigration regime of the EU. *Antipode, 39*(2), 291–309.
van Nimwegen, N., & van der Erf, R. (2010). Europe at the crossroads: Demographic challenges and international migration. *Journal of Ethnic and Migration Studies, 36*(9), 1359–1379.
Vignoli, D., Guetto, R., Bazzani, G., Pirani, E., & Minello, A. (2020). A reflection on economic uncertainty and fertility in Europe: The Narrative Framework. *Genus, 76*(1), 1–27.
Vobecká, J., Butz, W., & Reyes, G. (2013). *Population Trends and Policies in the UNECE Region: Outcomes, Policies and Possibilities*. UNFPA and IIASA Report.

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