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CHANGES IN ACTUAL POPULATION GROWTH ACROSS EUROPEAN SUBREGIONS (NUTS 3) IN THE YEARS 2018-2021

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Abstract

This article examines changes in population growth across subregions of European countries (NUTS 3) between 2018 and 2021. The research period is divided into two subperiods, allowing for a comparative analysis that takes into account the health crisis triggered by the outbreak of the COVID-19 pandemic. The study highlights the growing demographic polarization between subregions within European countries, manifested in the territorial concentration of both population growth and decline. During the analysed period, countries exhibited divergent trends in natural population change, which – especially during the crisis period – showed the strongest correlation with the level of socio-economic development.

Keywords

Webb's typology • actual growth • natural increase • migrations • NUTS 3 • COVID-19

Introduction

Population structures in Europe reflect political, socio-economic and spatial conditions, though they are at times disrupted by crisis events. One such event was the COVID-19 pandemic, which has been widely recognised as a global test of the resilience of socio-economic and territorial systems (Lee et al., 2002; Sargento & Lopes, 2024). The effects of the pandemic were spatially differentiated across the European countries, although in demographic terms, the period was particularly marked by a decline in the number of births, an increase in the number of deaths, and changes in the directions and intensity of migration (Balbo et al., 2020)

Since the 1960s, Western Europe has experienced a decline in fertility (Kotowska et al., 2021) According to the Second Demographic Transition theory, the main drivers of this trend include the postponement of family formation and the increasing career aspirations of women (van de Kaa, 1987; Lesthaeghe, 2014). The decision to have children is often based on a rational evaluation of costs and benefits

(Becker, 1992). Among the contemporary factors contributing to declining fertility are high living costs (McDonald, 2006), labour market instability (Billari & Liefbroer, 2010), insufficient state support for care services (Gauthier, 2007; Thévenon, 2011), and a diminishing significance of traditional marriage (Lappegård, 2000; Rønsen, 2013). During the COVID-19 pandemic, psychosocial factors such as uncertainty, stress, and economic insecurity were the main reasons for declining birth rates (Luppi et al., 2020; Aassve et al., 2020; Pomar et al., 2022; Sobotka et al., 2024).

Europe is undergoing a profound demographic shift towards an ageing population, which significantly influences mortality patterns. During the COVID-19 pandemic, excess mortality was particularly pronounced in European regions characterised by a high proportion of elderly residents and limited access to healthcare services (Hajdu et al., 2020; Galmiche et al., 2024). These patterns often exacerbated existing disparities between growth centres and peripheral areas (Armillei et al., 2021; Śleszyński, 2022; Igari, 2023; Bonnet et al., 2024). Studies analysed the relationship between excess mortality during the COVID-19 pandemic and a range of factors, such as the level of economic development (Lupu & Tiganasu, 2022; Abbasi et al., 2025), the quality of healthcare systems (Liang & Chen, 2021), population density, and the degree of urbanisation (Hradsky & Komarek, 2021). Sannigrahi et al. (2020) demonstrated that population ageing constituted one of the key determinants of excess mortality during the COVID-19 pandemic in Europe.

The COVID-19 pandemic also led to a temporary reduction in population mobility. Various state-imposed restrictions on entry and exit played a decisive role in limiting population movement (Sommarribas & Nienaber, 2021). With regard to internal migration, changes in established mobility patterns were observed, including relocations from large urban centres to rural areas, as noted for instance in Spain and Sweden (González-Leonardo et al., 2022; Vogiazides & Kawalerowicz, 2022). It has been investigated that, during the pandemic, the attractiveness of suburban and peripheral areas increased at the expense of densely populated cities, owing to lower housing costs, improved access to green spaces, more favourable living conditions, and the growing feasibility of remote work (Florida et al., 2021). In the European context, the attractiveness of regions to immigrants is shaped by a wide variety of pull factors, which differ significantly across space (Rowe et al., 2019; Viñuela, A. (2021).

The global health crisis has reignited questions concerning the demographic resilience of countries and regions. From a spatial perspective, resilience refers to the capacity of regions to absorb and recover from demographic shocks (Aboelnaga et al., 2022), with particular emphasis on the effectiveness of economic resources and healthcare systems (OECD, 2023; Sagan et al., 2021; Fetzer & Rauh, 2022). The uneven regional impacts of COVID-19 have revived interest in the role of territorially embedded socio-economic potentials (Turgel & Chernova, 2024). This perspective is consistent with the theoretical framework of polarised regional development, which posits that economic growth tends to concentrate in selected regions or urban cores, thereby deepening spatial inequalities (Myrdal, 1957; Friedmann, 1966). In this context, the COVID-19 crisis acted as a magnifier, strengthening resilient regions while exposing and deepening vulnerabilities in declining areas.

Objective and scope of research

The primary objective of this research is to analyse changes in actual population growth in the subregions of European countries (NUTS 3) from 2018 to 2021. The study encompasses two subperiods: 2018-2019 and 2020-2021, due to the outbreak of the COVID-19 pandemic in the latter period. The following research questions were formulated to achieve the primary objective of this study:

1. What changes in natural increase and migration occurred within the NUTS 3 regions of European countries between

2018 and 2021 according to J.W. Webb's typology?
2. How do NUTS 3 regions differ spatially in terms of changes in actual population growth during the two studied periods, 2018-2019 and 2020-2021, according to J.W. Webb's typology?
3. What proportion of the population in the analysed European countries lived in demographically positive (types A–D according to Webb's typology) and negative (types E–H) regions in 2020-2021, and to what extent is the population distribution across these categories correlated with selected economic, socio-demographic, and settlement indicators?

The spatial scope of this research encompasses 1,202 NUTS 3 territorial units across 34 European countries[1].

Research methods and data sources

The main method applied in this study is the typology of actual population growth proposed by J.W. Webb (1963). A spatial unit, defined by the intensity values of migration balance and natural increase – represented on the X and Y axes, respectively – can be plotted on a Cartesian coordinate system. By considering the mutual relationship between the components of actual growth, eight distinct combinations are possible, which define the so-called demographic types[2].

Webb's typology served as the basis for developing a generalized classification that takes into account the direction of demographic change over the studied time periods, allowing for the identification of:

1. **subregions (NUTS 3) with a favourable demographic situation (referred to as "positive types", indicating population growth), including the following transitions in Webb's typology:**
   - positive to positive (no change in type), e.g., A → A;
   - positive to positive (with a change in type), e.g., B → C;
   - negative to positive, e.g., E → C.
2. **subregions (NUTS 3) with an unfavourable demographic situation (referred to as "negative types", indicating population decline), including the following transitions in Webb's typology:**
   - from negative to negative (no change in type), e.g., F → F;
   - from negative to negative (change in type), e.g., F → G;
   - from positive to negative, e.g., C → F.

Subsequently, the results were aggregated at the national level to identify internal demographic disparities within European countries and to examine the statistical association between observed typological changes and selected economic, socio-demographic and settlement indicators. The following variables were included in the analysis:

- **economic indicators:** GDP per capita in Purchasing Power Standards (PPS), total

[1] Included countries are: Austria (35 NUTS 3 units), Belgium (36), Bulgaria (28), Croatia (7), Cyprus (1), Czech Republic (14), Denmark (11), Estonia (3), Finland (19), France (101), Germany (401), Greece (52), Hungary (20), Ireland (8), Italy (102), Latvia (6), Lithuania (10), Luxembourg (1), Malta (2), Netherlands (40), Poland (73), Portugal (25), Romania (42), Slovakia (8), Slovenia (12), Spain (59), and Sweden (21). Additionally, three countries are recognised as EU candidate states: Montenegro (1), North Macedonia (8), and Serbia (25). Four non–EU countries within the Schengen Area are also included: Iceland (2), Liechtenstein (1), Norway (2), and Switzerland (26). The analysis was confined to NUTS 3 units for which complete data was available for all years under consideration. In cases where data was missing or territorial boundaries had changed, the affected units were excluded from the study. This applied to 38 NUTS 3 units from Belgium (8), Croatia (14), Estonia (2), Italy (5), Serbia (4), and Norway (5). Consequently, the study covers nearly 97% of all NUTS 3 units across the selected countries.

[2] Types Representing Population Growth (Types A–D): Type A: Natural Increase (NI) + > Net Migration (NM) -, Type B: NI + > NM +, Type C: NM + > NI +, Type D: NM + > NI -, Types Representing Population Decline (Types E–H): Type E: NI - > NM +, Type F: NI - > NM -, Type G: NM - > NI -, Type H: NM - > NI +

unemployment rate, nights spent at tourist accommodation establishments per 1,000 inhabitants,
- **socio-demographic indicators:** total fertility rate, mean age of women at childbirth and at birth of first child, population by educational attainment level (% of tertiary education: levels 5-8), proportion of population aged 65 and over, excess mortality rate,
- **settlement indicators:** population density, urban population (% of total population).

The 2018-2019 averages were calculated for all of the above indicators, except for excess mortality, which, due to the COVID-19 pandemic, was calculated exclusively for the years 2020-2021. To examine the distribution of variables, the Shapiro–Wilk test was applied. The results of this test determined the use of Spearman's rank correlation method. The data were sourced from Eurostat, World Bank Data, UNECE and national statistics. The study used Excel (Microsoft Office 365), QGIS 2.8.6. and Statistica 13.3.

Results

J.W. Webb's typology of actual population growth in NUTS 3 subregions: structure by natural increase and migration components

During the two studied periods, significant shifts in the actual population growth types, as defined by J.W. Webb, were observed across the NUTS 3 spatial units of the examined European countries. The changes in the types of actual growth can be seen as greater dispersion of points (representing NUTS 3 units) in the coordinate system during the 2020-2021 period (Fig. 1B) compared to the pre-pandemic period of 2018-2019 (Fig. 1A). Notably, there is a marked shift of points towards the sections of the graph corresponding to types C and D, as well as E, F, G, and H. This indicates substantial changes in both favourable and unfavourable demographic trends across the spatial units. Greater dispersion of points on the chart in the second research period indicates increased differentiation of the analysed NUTS 3 units in terms of the structure of the components of actual population growth. This is particularly evident in the growing number

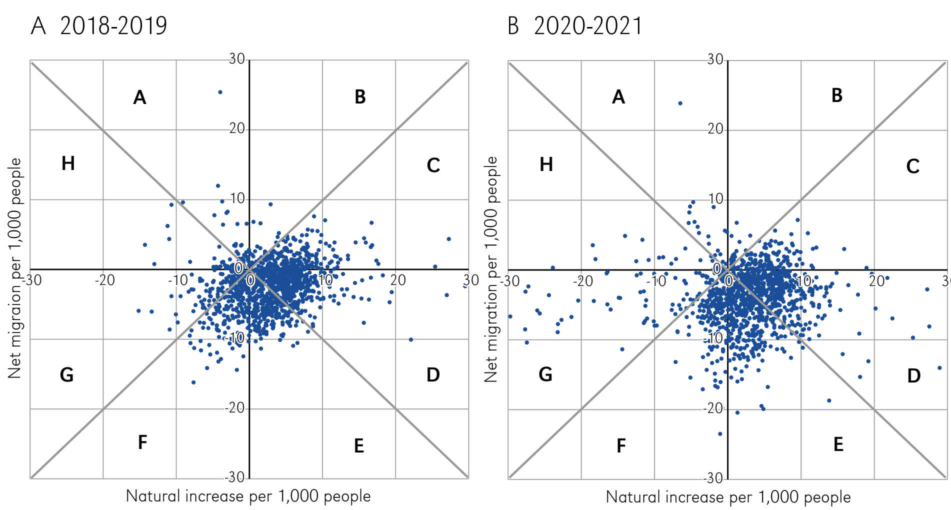

Figure 1. Typology of actual growth according to J.W. Webb for NUTS 3 units in European countries from 2018-2019 and 2020-2021

Source: own elaboration based on Eurostat data

of hyper-immigration units, accompanied by a decline in natural increase values.

In the first study period, the majority of NUTS 3 units were classified as types A–D (53.5%). However, in the second period, this share decreased to 47.3% (Tab. 1). In both analysed periods, type D was the dominant category, with the number of NUTS 3 units in this category increasing to 413 in 2020-2021. The most significant changes in the number of units were observed in types C and E. The number of type C NUTS 3 units fell from 202 in 2018-2019 to 121 in 2020-2021, representing a reduction of 81 units. Conversely, the number of type E units increased from 253 in 2018-2019 to 335 in 2020-2021, an increase of 82 units.

Across all analysed NUTS 3 units (Tab. 1), the natural increase rate declined from -2.2‰ in 2018-2019 to -3.6‰ in 2020-2021, while the migration balance rate increased from 3.1‰ to 3.6‰ over the same period (median values). Natural increase improved only in type A units, rising from 2.7‰ in 2018-2019 to 5.5‰ in 2020-2021. In NUTS 3 units classified as types A–D overall, the natural increase rate decreased from -0.6‰ in 2018-2019 to -1.5‰ in 2020-2021, whereas the migration balance rate rose from 5.2‰ to 6.1‰ in the same period. In contrast, in units indicating population decline (types E–H), the natural increase rate dropped significantly – from -2.2‰ in 2018-2019 to -5.6‰ in 2020-2021 – while a slight increase in the migration balance rate was recorded, from -0.3‰ to 0.3‰. In the 2020-2021 period, migration became an increasingly important driver of demographic growth, partly offsetting the decline resulting from a worsening natural increase, particularly in type A–D units.

The number of live births in the studied countries decreased from 4.48 million

Table 1. Number and structure of NUTS 3 units according to J.W. Webb's typology of actual growth for the years 2018-2019 and 2020-2021

Webb's types	NUTS 3						Median			
	2018-2019			2020-2021			2018-2019		2020-2021	
	number	%	rank	number	%	rank	NI (‰)	NM (‰)	NI (‰)	NM (‰)
A	32	2.7	6	18	1.5	7	2.7	-1.1	5.5	-2.6
B	22	1.8	8	17	1.4	8	2.5	1.4	2.1	0.8
C	202	16.8	3	121	10.1	4	1.3	6.1	1.2	5.4
C/D	1	0.1	9	0	0.0	N/A	N/A	N/A	N/A	N/A
D	391	32.5	1	413	34.4	1	-1.9	5.3	-2.5	6.5
D/E	0	0.0	N/A	1	0.1	10	N/A	N/A	N/A	N/A
E	253	21.0	2	335	27.9	2	-5.5	2.2	-6.4	2.4
E/F	0	0.0	N/A	2	0.2	9	N/A	N/A	N/A	N/A
F	183	15.2	4	169	14.1	3	-5.6	-1.7	-5.6	-1.6
G	87	7.2	5	100	8.3	5	-1.8	-3.9	-4.0	-11.5
H	31	2.6	7	26	2.2	6	0.6	-3.2	1.3	-7.4
Positive types	648	53.9	1	569	47.3	2	-0.6	5.2	-1.5	6.1
Negative types	554	46.1	2	633	52.7	1	-4.5	-0.3	-5.6	0.3
Total	1202	100.0	N/A	1202	100.0	N/A	-2.2	3.1	-3.6	3.6

Notes: NI – natural increase, NM – net migration, N/A – not applicable

Source: own elaboration based on Eurostat data

(2018) to 4.33 million (2021), i.e. by approximately 157 thousand, while the number of deaths increased from 4.93 million (2018) to 5.59 million (2021), i.e. by around 654 thousand, resulting in a negative natural increase of about 1.26 million in 2021[3]. The natural increase was already negative in most countries during both periods and declined even further (Tab. 2). The largest drops in natural increase were recorded in Bulgaria (–5‰ points), North Macedonia (–4.4‰ points), and Serbia (–4.1‰ points). In many countries, however, the negative natural increase was still offset by a positive net migration balance[4], although the values and directions of net migration change show significant variation between countries. When analysing absolute values of immigration and emigration, the greatest declines in both groups were observed in 2020, due to temporary restrictions introduced during the pandemic. The differences in changes in net migration expressed in ‰ points are considerable: some countries, such as Malta and North Macedonia, experienced a very large negative change in ‰ points, while others, including Bulgaria, Cyprus and Lithuania, recorded a significant positive change[5].

The analysed units, both NUTS 3 regions and countries, show increasing internal differentiation in the values of natural increase and net migration components, with the decline in births, rise in deaths, and reduced immigration and emigration occurring in 2020. Given the differences in data sources used to report migration statistics in the studied countries, both relative stability and significant temporal variation in the components of actual population change can be observed. For example, ten countries (e.g. Denmark, Iceland, Ireland, Norway, Sweden) maintained their classification as type C countries according to J. W. Webb's typology across both periods (characterised by high net migration and positive natural increase), while seven countries remained type D (e.g. Finland, Germany, Lithuania, Portugal – positive net migration but negative natural increase). Among countries already classified as negative types in 2018-2019, transitions in 2020-2021 to other types were more

[3] **Total number of live births in the studied countries**: 4,484,502 (2018), 4,403,178 (2019), 4,301,474 (2020), 4,327,313 (2021). The most significant drop occurred between 2019 and 2020 (–101,704), which may be attributed to delayed parenthood decisions in 2020 due to the COVID-19 pandemic. **Total number of deaths in the studied countries:** 4,932,970 (2018), 4,892,534 (2019), 5,453,380 (2020), 5,587,421 (2021). The largest increase in the number of deaths was recorded between 2019 and 2020 and amounted to approximately 561,000 (from around 4.89 million in 2019 to approximately 5.45 million in 2020).

[4] **Total number of immigrants in the studied countries** (no data available for Serbia [2018-2021] and North Macedonia [2021]): 4,121,979 (2018), 4,394,039 (2019), 3,448,318 (2020), 4,264,775 (2021). The largest drop in immigration occurred in 2020, with nearly 950,000 fewer immigrants than in the previous year. This decline in immigration was particularly evident in 2020 due to mobility restrictions related to the COVID-19 pandemic. **Total number of emigrants in the studied countries** (no data available for Serbia [2018-2021] and North Macedonia [2018-2021]): 2,557,968 (2018), 2,712,527 (2019), 2,257,219 (2020), 2,832,521 (2021). The most significant change in emigration numbers was observed between 2019 and 2020, with a decrease of 575,000 individuals. In turn, in 2021, the number of emigrants increased by approximately 575,000 compared to the previous year.

[5] In the study "Quality assessment of European migration data" (Mooyaart, Dańko, Costa, Boissonneault, 2021), the authors indicate that the main problem regarding the comparability of migration data between countries stems from: 1) differences in registration based on **duration** (Eurostat recommends a 12-month threshold, although countries often apply different internal criteria), 2) **undercounting** resulting from varying national rules on registration and de-registration, as well as from the effectiveness of enforcing those rules (e.g., fines for failing to register), 3) **coverage** issues, meaning that the data collection system by design does not capture certain migrant groups (e.g., non-EU immigrants staying irregularly, asylum seekers, international students) and 4) **accuracy**, which depends on the data collection methods. Countries apply different data collection approaches, including: population registers (e.g., Belgium, Denmark, Finland, Norway), administrative registers (e.g., Bulgaria, Greece, Serbia) and mixed methods involving statistical modelling (e.g., Latvia, Romania). Furthermore, the authors point out that immigration data is more reliable than emigration data, for example due to the lack of an obligation to deregister when leaving the country. Moreover, migration data from Scandinavian countries (Denmark, Finland, Norway, Sweden) are considered the most reliable due to strict registration rules, high accuracy, and well-integrated population registers, in contrast to countries that use mixed or model-based methods.

Table 2. Changes in natural increase, net migration and Webb typology of European countries (2018-2021)

Country	Natural increase (‰)		NI change (‰)	Net migration (‰)		NM change (‰)	Webb type change
	2018-2019	2020-2021		2018-2019	2020-2021		
Austria	0.2	-0.8	-1.0	4.3	5.1	0.8	C → D
Belgium	0.8	-0.3	-1.1	4.7	4.4	-0.3	C → D
Bulgaria	-7.0	-12.0	-5.0	-7.2	5.3	12.5	G → E
Croatia	-4.0	-6.1	-2.2	-6.2	-3.1	3.2	G → F
Cypr	3.9	3.7	-0.2	3.7	11.3	7.7	B → C
Czech Republic	0.1	-2.3	-2.3	3.9	3.7	-0.2	C → D
Denmark	1.2	1.1	0.0	2.4	3.3	0.9	C → C
Estonia	-1.0	-3.0	-2.0	4.7	4.1	-0.6	D → D
Finland	-1.4	-1.6	-0.2	2.5	3.7	1.2	D → D
France	2.2	1.1	-1.1	1.2	2.5	1.4	B → C
Germany	-2.0	-2.7	-0.7	4.3	3.1	-1.2	D → D
Greece	-3.5	-4.9	-1.4	2.5	-7.3	-9.8	E → G
Hungary	-3.9	-5.7	-1.9	2.6	1.6	-1.0	E → E
Iceland	5.8	6.4	0.6	16.2	10.0	-6.3	C → C
Ireland	5.9	4.9	-1.0	10.0	9.1	-0.9	C → C
Italy	-3.4	-5.4	-2.0	5.5	0.2	-5.3	D → E
Latvia	-4.8	-7.5	-2.7	-2.2	-1.0	1.2	F → F
Liechtenstein	2.6	1.8	-0.8	5.7	5.4	-0.3	C → C
Lithuania	-4.6	-7.9	-3.3	1.8	7.2	5.5	D → D
Luxembourg	3.2	3.2	0.0	16.5	12.0	-4.5	C → C
Malta	1.5	0.5	-1.0	39.0	4.6	-34.4	C → C
Montenegro	1.1	-1.9	-3.0	-1.5	-1.5	0.0	H → F
Netherlands	1.0	0.3	-0.7	5.6	5.0	-0.6	C → C
North Macedonia	0.3	-4.2	-4.4	0.0	-57.0	-57.0	A/B → G
Norway	2.7	2.5	-0.2	4.1	2.9	-1.2	C → C
Poland	-0.8	-4.2	-3.4	0.6	-10.1	-10.7	E → G
Portugal	-2.5	-4.0	-1.6	4.4	6.3	1.9	D → D
Romania	-3.2	-6.3	-3.2	-2.1	-1.2	1.0	F → F
Serbia	-5.4	-9.5	-4.1	0.0	0.0	0.0	E/F → E/F
Slovakia	0.7	-1.8	-2.4	0.7	-0.4	-1.1	B/C → F
Slovenia	-0.5	-2.3	-1.8	7.5	5.0	-2.6	D → D
Spain	-1.2	-2.8	-1.6	8.4	4.6	-3.8	D → D
Sweden	2.4	1.8	-0.7	7.8	4.2	-3.6	C → C
Switzerland	2.3	1.6	-0.7	4.9	6.0	1.2	C → C
Total	-0.3	-2.0	-1.7	4.6	1.4	-3.1	G → E

Source: own elaboration based on Eurostat data

frequent, though these transitions occurred only within the group of negative types.

Spatial diversity of NUTS 3 in European countries according to J.W. Webb's typology of actual growth

The spatial distribution of NUTS 3 regions according to J.W. Webb's typology reveals considerable changes over the study period. One example of a stable area that retained its type (A → A, 10 NUTS 3 regions) is the entire suburban zone surrounding Paris. For instance, in the department of Seine-Saint-Denis, located to the west of the city, the population increased by nearly 23,500 residents. Type B regions did not form distinct clusters; for example, no more than six regions remained in the B → B category, including the city of Innsbruck.

Type C regions represent areas of exceptionally high immigration within the European context. Their number declined from 202 to 121 during the study period. Regions that remained in the C → C category – i.e. those that did not undergo a typological shift – included major European cities such as Berlin, Dublin, Vienna, and Zurich. Among the C → C regions, the largest shares of population were found in the Netherlands (14.4%), France (12.9%), and Germany (12.4%). Regions that transitioned from type C to D (56 NUTS 3 regions), reflecting a decline in natural population growth, included several large Spanish cities such as Seville, Madrid, and Málaga. Spain played a dominant role in this transition category, with its NUTS 3 regions accounting for 36.1% of the total population within the C → D group, followed by Poland with 20.2%. Meanwhile, cities such as Frankfurt am Main, Düsseldorf, and Cologne were among the many German metropolitan areas that shifted from type C to E, F, G, or H.

Among the most populous D → D regions (272 NUTS 3 units) were, once again, primarily Spanish cities such as Barcelona, Alicante, Valencia, and Granada. Despite having experienced negative natural population growth for years, these areas continue to attract significant numbers of immigrants, resulting in positive overall population growth. Germany, however, played the leading role in this transition category, with its NUTS 3 units accounting for 34.8% of the total population assigned to the D → D type, followed by Spain (22.3%) and France (12.9%). Among the most populous regions transitioning from type D to E, F, G, or H (116 NUTS 3 regions in total) – i.e. to types characterised by unfavourable net population change – were mainly cities in northern Italy, including Bergamo, Milan, and Bologna. In the most numerous transition group, D → E (77 NUTS 3 units), Italy played the dominant role, with its NUTS 3 regions comprising 27.7% of the total population assigned to this transition type, followed by Germany (25.3%).

Among the types characterised by unfavourable demographic conditions, the most populous E → E regions (159 NUTS 3 units) once again included large Italian cities such as Turin, Vicenza, and Treviso. In this transition category, Italy played a dominant role, with its NUTS 3 regions accounting for 35.6% of the total population assigned to this type. E-type regions formed characteristic rings around major metropolitan areas such as Paris, Berlin, and Madrid. A similar pattern was observed in Poland; however, due to the polycentric nature of its settlement network, the spatial arrangement was more dispersed. Interestingly, 51 NUTS 3 units transitioned from the negative E type to the more favourable D type. Among the regions transitioning from C → C, 53.6% of the total population belonged to Germany. F → F units (73 NUTS 3) represent arguably the least favourable demographic profile, as they are characterised by both negative natural change and negative net migration. In the F → F transition, Poland played the leading role, with its NUTS 3 units comprising 31.7% of the total population assigned to this group, followed by Italy (29.5%). The most populous F → F units included Rome in Italy, and the Katowice and Kielce subregions in Poland.

Among the NUTS 3 units classified under type G, the most common transition was from

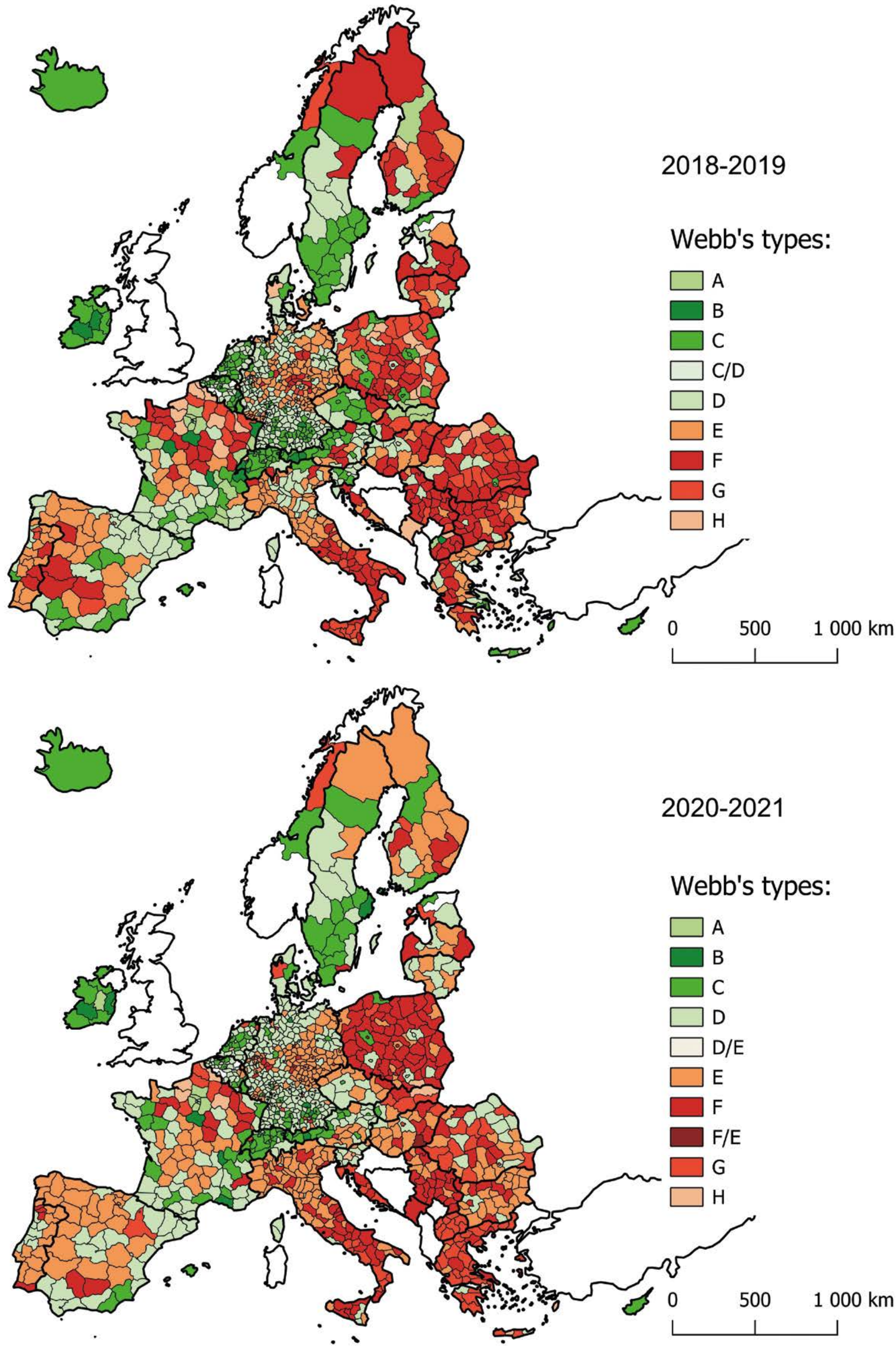

Figure 2. Distribution of NUTS 3 regions in European countries according to J. W. Webb's typology of actual population growth from 2018-2019 and 2020-2021

G → F (45 NUTS 3 units), again dominated by Poland, whose NUTS 3 regions accounted for 52.4% of the total population assigned to this transition type. In the H → H category, the most populous region was, among others, Paris.

In terms of population share (average population for 2020-2021) in the analysed countries, the dominant transitions were as follows[6]:

- **Leading share A-D: Austria:** C → C (49,4%), **Belgium:** D → D (30,6%), **Cypr:** C → C (100%), **Czech Republic:** C → D (29,1%), **Denmark:** D → D (39,1%), **Estonia:** C → C (56,8%), **Finland:** C → C (31,2%), **France:** A → A (18%), **Germany:** D → D (35,1%), **Hungary:** D → D (18,3%), **Iceland:** C → C (100%), **Ireland:** C → C (69,3%), **Liechtenstein:** C → C (100%), **Luxembourg:** C → C (100%), **Malta**: C → C (93,3%), **Netherlands:** C → C (48,1%), **Norway**: C → C (66,5%), **Slovenia:** D → D (41,6%), **Spain**: D → D (39,3%), **Sweden:** C → C (55,3%), **Switzerland:** C → C (66,7%),
- **Leading share E-F: Bulgaria:** F → E (34,6%), **Croatia**: E → G (44,9%), **Greece:** E → G (18,1%), **Italy:** E → E (26,9%), **Latvia**: G → G (32,7%), **Lithuania**: D → E (29,5%), **Montenegro:** H → F (100%), **North Macedonia:** F → G (45,4%), **Poland:** G → F (26,2%), **Portugal:** C → E (27,8%), **Romania:** D → G (18,9%), **Serbia:** F → F (43,2%), **Slovakia**: A → H (15,1%).

In 2020-2021, the largest number of units represented type D (413 NUTS 3 regions), followed by type E (335, see Tab. 3). Comparing the number of NUTS 3 regions must be approached with caution, as these units vary significantly in terms of area, population size, and population density. The range in population size across the examined NUTS 3 regions is vast – from approximately 11,500 inhabitants in El Hierro (Spain) to around 6.8 million in Madrid. Similarly, the lowest population densities are recorded in NUTS 3 regions in Finland and Sweden, where they amount to just a few people per km^2, while in others, such as Brussels or Paris, population densities are extremely high, reaching several or even over ten thousand people per km^2.

In summary, the largest demographic growth during the analysed period was recorded in type C → C regions, where the population increased by approximately 1.1 million (Tab. 3). This indicates that strong migration hubs contributed most significantly to population growth across the studied area. The next largest increases were observed in type D → D regions – primarily characterised by continued positive net migration despite natural decrease – where the population grew by nearly 781,000, as well as in demographically weakening regions classified as C → D (with a population increase of approximately 506,000). These regions experienced a shift from positive to negative natural change, but positive net migration continued to drive population growth. The most substantial population losses occurred in F → F regions (-434,000), followed by E → E regions (-348,000). Overall, population growth during the study period was primarily driven by migration, while the role of natural change diminished or remained negative – in some cases offsetting the positive effects of migration.

Positive and negative types – general classification of transitions in European countries according to Webb's typology

Areas with a favourable demographic situation were predominantly composed of a mosaic of NUTS 3 regions that, during the study period, were characterised not only by a positive total population change (natural increase plus net migration), but also by stability, as evidenced by the lack of change

[6] It should be emphasised, however, that the countries under study are highly internally diversified in this regard, and due to the scale of the analysis, it is not possible to present the share of all combinations. Therefore, it was decided to present only the dominant transition, according to J.W. Webb's typology, in each country.

Table 3. Matrix of typological combinations according to Webb in NUTS 3 for the years 2018-2019 and 2020-2021

Number of NUTS 3												
Webb's types		2018/2019										
		A	B	C	C/D	D	E	F	G	H	total	
2020/2021	A	10	4	4	0	0	0	0	0	0	18	569
	B	2	6	9	0	0	0	0	0	0	17	
	C	7	7	103	0	3	0	0	0	1	121	
	D	1	2	56	0	272	51	10	17	4	413	
	D/E	0	0	0	0	1	0	0	0	0	1	633
	E	0	1	6	0	77	159	80	12	0	335	
	E/F	0	0	0	0	0	2	0	0	0	2	
	F	4	0	3	0	12	24	73	45	8	169	
	G	4	1	9	1	26	17	20	13	9	100	
	H	4	1	12	0	0	0	0	0	9	26	
	total	32	22	202	1	391	253	183	87	31	1 202	
		648					554					

Population change												
Webb's types		2018/2019										
		A	B	C	C/D	D	E	F	G	H	total	
2020/2021	A	134 585	36 065	30 707	0	0	0	0	0	0	201 357	2 722 610
	B	44 777	33 900	108 863	0	0	0	0	0	0	187 540	
	C	25 964	49 305	1 116 567	0	3 047	0	0	0	44	1 194 925	
	D	2 815	6 110	505 518	0	781 290	-17 592	-34 646	-98 962	-5 745	1 138 788	
	D/E	0	0	0	0	417	0	0	0	0	417	-1 579 637
	E	0	403	35 163	0	57 833	-348 449	-269 910	-70 996	0	-595 956	
	E/F	0	0	0	0	0	-3 320	0	0	0	-3 320	
	F	1 506	0	8 696	0	8 654	-72 186	-433 937	-243 190	-17 516	-747 974	
	G	3 768	4 550	15 155	176	16 715	-17 613	-106 165	-136 159	-19 399	-238 972	
	H	3 128	-679	33 990	0	0	0	0	0	-30 272	6 167	
	total	216 543	129 653	1 854 658	176	867 954	-459 160	-844 657	-549 306	-72 889	1 142 973	
		3 068 983					-1 926 011					

in their classification according to J.W. Webb's typology (Fig. 3). In contrast, demographically negative areas present a markedly different spatial image of the processes under investigation. NUTS 3 regions classified as negative (without a change of type) can be described as stagnating regions of Europe. Together with units that transitioned into negative types during the analysed period, they illustrate the deepening demographic disparities

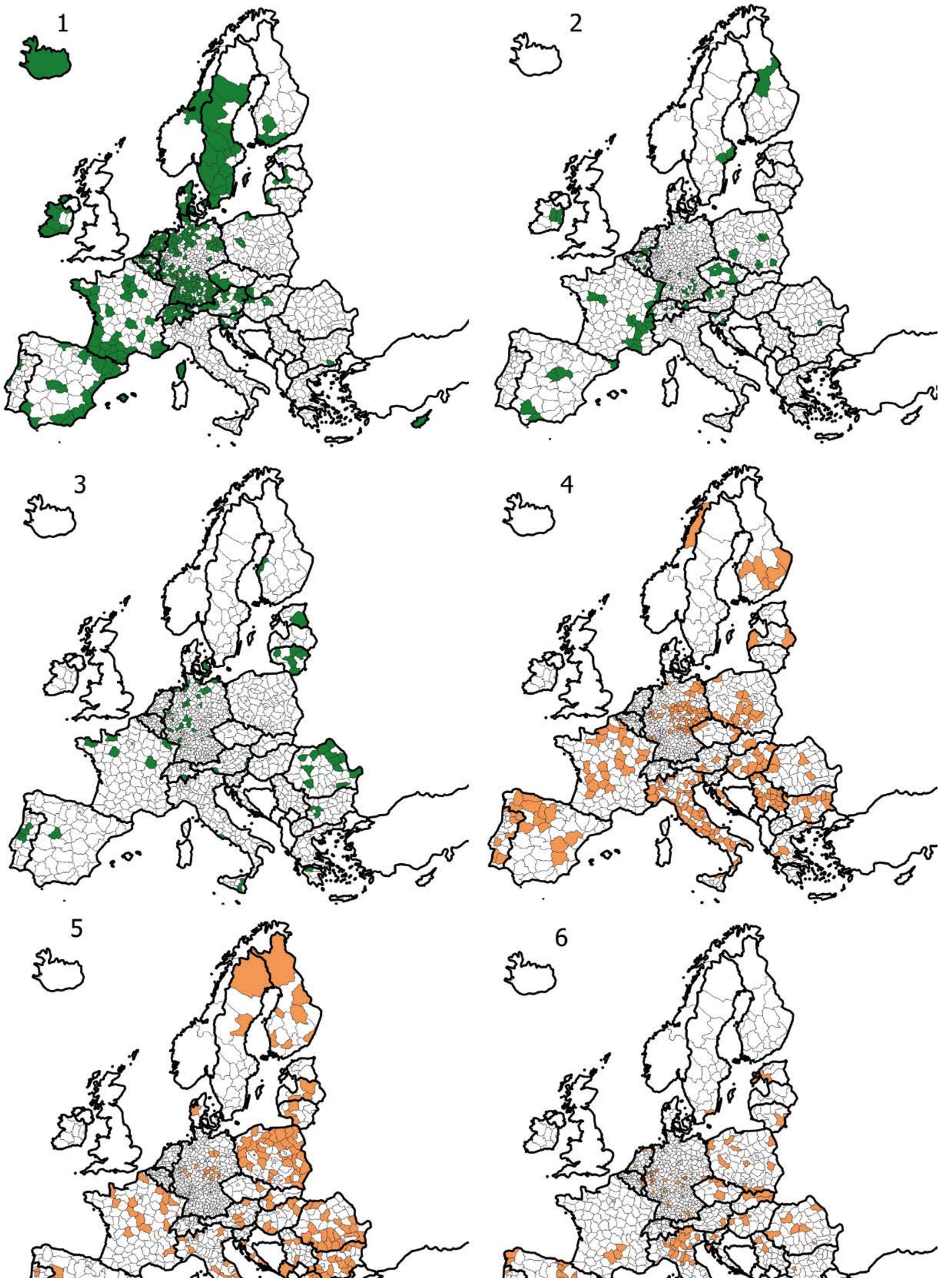

Figure 3. Detailed changes in NUTS 3 according to J. W. Webb's typology in the years 2018-2019 and 2020-2021
1 – P → P (no change), 2 – P → P (change), 3 – N → P (change), 4 – N → N (no change), 5 – N → N (change), 6 – P → N (change)

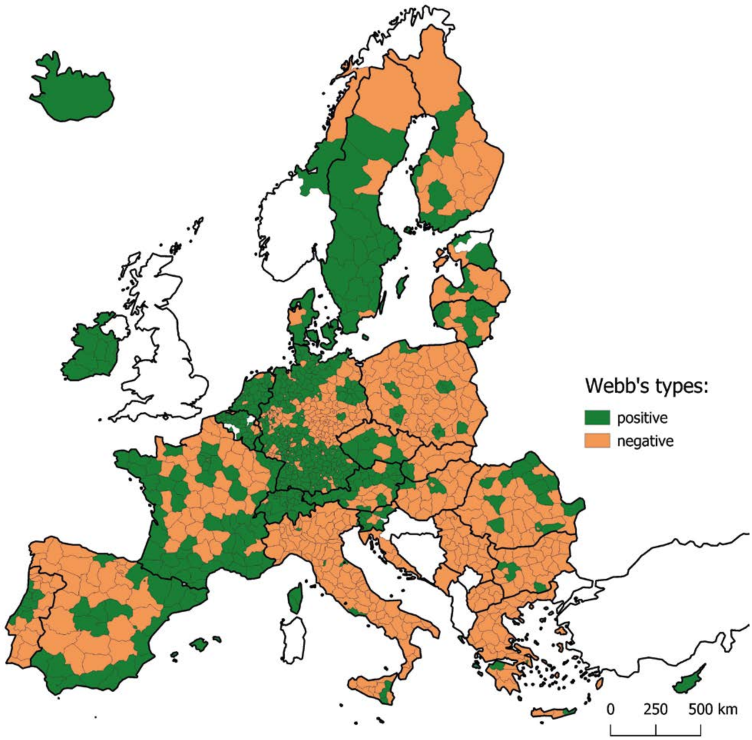

Figure 4. General changes in NUTS 3 according to J. W. Webb's typology in the years 2018-2019 and 2020-2021
Positive – sum 1, 2, 3 (Fig. 3), negative – sum 4, 5, 6 (Fig. 3)

along the West–East axis. Moreover, among the subregions that shifted from positive to negative types – indicating a significant deterioration in their demographic situation – a strong concentration is evident in South-Eastern European countries. It is also worth noting the considerable scale of demographic decline in subregions of Northern Italy.

The generalised spatial distribution of both growing and demographically shrinking areas in Europe reveals a clear dichotomy between Western and South-Eastern European countries. In many countries, there is a marked monocentric dominance of a single urban centre acting as a demographic growth pole. In this context, the influence of major European metropolises such as Madrid, Lisbon, Paris, Berlin, and Prague is particularly visible. Their role manifests not only in the concentration of positive demographic balances in core urban zones but also in the diffusion of this trend into broad suburban belts. In Poland, unlike in countries dominated by a single metropolis, the complex and polycentric settlement structure results in positive population growth being confined to just a few suburban zones around the largest cities. The majority of the country's territory has been experiencing sustained depopulation for some time. The marked spatial contrast between eastern and western parts of Germany stems from both historical conditions and the dominant position of Berlin as the main demographic centre in the eastern Länder. Demographically dynamic regions also include areas with high settlement attractiveness, such as coastal zones, mountainous regions, and other locations perceived as desirable places to live.

Table 4. Distribution of population in positive (P) and negative (N) Webb's Types by country (2020-2021)

Country	P total	P → P (no change)	P → P (change)	N → P	N total	N → N (no change)	N → N (change)	P → N	Total population [2020-2021]
Austria	87,5	75,6	9,9	2,1	12,5	3,4	6,1	3,0	8 916 864
Belgium	91,4	59,1	32,3	0,0	8,6	0,0	0,0	8,6	9 771 613
Bulgaria	5,7	2,3	0,0	3,4	94,3	38,0	37,3	19,0	6 934 015
Croatia	0,0	0,0	0,0	0,0	100,0	10,4	65,3	24,3	1 371 489
Cypr	100,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	892 006
Czech Republic	53,0	24,0	29,1	0,0	47,0	27,0	5,9	14,1	10 697 858
Denmark	92,6	58,8	23,1	10,7	7,4	0,0	7,4	0,0	5 831 404
Estonia	86,2	56,8	0,0	29,4	13,8	0,0	0,0	13,8	1 074 610
Finland	60,0	49,3	7,5	3,3	40,0	20,5	19,4	0,0	5 529 543
France	70,9	46,5	19,2	5,1	29,1	19,0	9,3	0,9	67 571 107
Germany	60,8	44,0	9,8	7,0	39,2	14,7	4,4	20,1	83 160 871
Greece	28,4	9,3	0,0	19,2	71,6	5,5	35,8	30,3	10 698 599
Hungary	18,2	18,2	0,0	0,0	81,8	33,4	20,6	27,8	9 750 149
Iceland	100,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	366 463
Ireland	100,0	79,1	20,9	0,0	0,0	0,0	0,0	0,0	4 985 382
Italy	6,2	2,5	0,0	3,6	93,8	48,2	22,3	23,3	57 838 018
Latvia	19,8	19,8	0,0	0,0	80,2	58,5	21,7	0,0	1 900 449
Liechtenstein	100,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	38 901
Lithuania	53,0	11,5	0,0	41,6	47,0	0,0	17,4	29,5	2 794 885
Luxembourg	100,0	100,0	0,0	0,0	0,0	0,0	0,0	0,0	630 419
Malta	100,0	93,3	6,7	0,0	0,0	0,0	0,0	0,0	515 332
Montenegro	0,0	0,0	0,0	0,0	100,0	0,0	100,0	0,0	621 306
Netherlands	89,5	76,1	13,4	0,0	10,5	4,3	0,0	6,2	17 441 500
North Macedonia	0,0	0,0	0,0	0,0	100,0	0,0	53,9	46,1	2 072 373
Norway	66,0	66,0	0,0	0,0	34,0	34,0	0,0	0,0	709 539
Poland	20,4	3,3	17,1	0,0	79,6	22,0	40,9	16,7	37 899 070
Portugal	35,5	23,8	0,0	11,7	64,5	13,5	19,2	31,8	10 297 081
Romania	24,8	0,0	2,6	22,2	75,2	10,3	39,0	25,9	19 265 250
Serbia	0,0	0,0	0,0	0,0	100,0	51,0	15,5	33,5	6 899 126
Slovakia	22,7	22,7	0,0	0,0	77,3	11,8	23,0	42,5	5 458 827
Slovenia	58,4	41,6	16,9	0,0	41,6	5,4	0,0	36,1	2 102 419
Spain	71,7	46,7	24,7	0,3	28,3	9,5	6,6	12,2	47 365 655
Sweden	93,7	67,8	25,9	0,0	6,3	0,0	4,8	1,5	10 353 442
Switzerland	98,0	72,9	21,0	4,1	2,0	0,0	2,0	0,0	8 638 167
Total	51,1	34,0	12,4	4,8	48,9	18,8	14,9	15,2	460 393 728

In the period 2020-2021, demographically favourable areas (positive total) were inhabited by more than half of the studied population, amounting to 154.2 million residents across the analysed countries. In six countries, 100% of the population lived in areas classified as demographically favourable – including Cyprus, Iceland, Liechtenstein, and Luxembourg (Tab. 4). Similarly, in four countries, 100% of the population resided in areas classified as demographically unfavourable – such as Croatia, Montenegro, North Macedonia, and Serbia. The highest share of the population affected by a shift from positive to negative demographic types was recorded in North Macedonia (46.1%), Slovakia (42.5%), and Slovenia (36.1%).

The results of the study highlight the complex interplay of factors shaping the demographic situation of subregions. Whether a given NUTS 3 unit can be classified as demographically dynamic depends on a range of components, including settlement structure, socio-economic conditions, residential attractiveness, and environmental features such as coastal or mountainous location.

Correlations between the share of population living in positive and negative demographic types and selected socio-economic and settlement characteristics by country

In the analysis of the correlations between the share of the population living in demographically positive and negative areas and selected socio-economic characteristics, statistical significance ($\rho < 0.05$) was found for 7 out of the 10 indicators examined. No significant correlations were identified – either for positive or negative areas – with respect to the old-age dependency ratio, the total fertility rate (TFR), and population density[7]. Detailed correlation coefficients are presented in Appendix A (Tab. A1; https://rcin.org.pl/igipz/dlibra/publication/282872).

The Spearman rank correlation analysis revealed a very strong positive relationship between the share of population living in demographically positive areas **(P total)** and GDP per capita in PPS ($\rho = 0.849$; $p < 0.05$), indicating that higher regional affluence was more frequently associated with a greater proportion of the population residing in areas with a favourable demographic situation. Importantly, the excess mortality rate was also strongly and negatively correlated with GDP per capita in PPS ($\rho = -0.775$; $p < 0.05$). A moderate positive correlation was also observed between P total and the mean age of women at first childbirth ($\rho = 0.583$; $p < 0.05$). Furthermore, the strong positive correlation between the age of women at first childbirth and GDP per capita in PPS ($\rho = 0.690$; $p < 0.05$) confirms that both variables are more prevalent in more developed regions.

In the group of regions classified as **P → P (no change)**, similar correlation coefficients were observed as for P total. Moreover, in P → P regions, a moderate positive correlation was recorded with the number of overnight stays per 1,000 inhabitants, indicating that demographic stability in positive-type regions may coexist with areas attractive to tourism ($\rho = 0.434$; $p < 0.05$). Moderate but statistically significant associations were also identified with selected socio-demographic characteristics, such as the share of population with tertiary education ($\rho = 0.445$; $p < 0.05$), which may suggest that regions with a favourable demographic situation are characterised by a higher level of human and social capital.

In the case of regions classified as **P → P (change)**, only a weak but statistically significant positive correlation was observed with GDP per capita ($\rho = 0.434$; $p < 0.05$). This indicates a possible association between a sustained positive demographic type and a relatively favourable economic situation. In contrast, for regions of the **N → P** type, a moderate positive correlation was identified with proportion of population aged 65 and over ($\rho = 0.486$; $p < 0.05$), which may suggest that an improvement in the demographic situation in certain areas coincides with an advanced age structure of the population.

For all negative-type regions **(N total)**, a very strong negative correlation was identified with GDP per capita ($\rho = -0.849$; $p < 0.05$), indicating a close co-occurrence of an unfavourable demographic situation with lower levels of economic development. A strong

[7] According to the classification of correlation strength, absolute values of the **ρ** coefficient ≥ 0.8 were considered very strong, values between 0.6 and 0.79 as strong, 0.4-0.59 as moderate, and those below 0.4 as weak or very weak. The results focused primarily on moderate correlations, as well as selected weak ones, when they were statistically significant and relevant in the context of the observed spatial distribution of the units.

positive correlation was also observed with excess mortality ($\rho = 0.637$; $p < 0.05$), along with a moderate positive correlation with the share of population aged 65 and over ($\rho = 0.510$; $p < 0.05$), confirming the link between adverse demographic change and an ageing population structure. In the case of **N → N (change)** units, a positive correlation with the share of population aged 65 and over was also observed ($\rho = 0.512$; $p < 0.05$).

In **N → N (change)** units, a very strong negative correlation was identified with GDP per capita ($\rho = -0.771$; $p < 0.05$), as well as a moderate negative correlation with the unemployment rate ($\rho = -0.507$; $p < 0.05$) and the mean age of women at childbirth ($\rho = -0.512$; $p < 0.05$). On the other hand, a moderate positive correlation with the excess mortality rate was observed ($\rho = 0.548$; $p < 0.05$), which may suggest deepening demographic challenges in regions affected by high levels of excess mortality.

In regions where the demographic situation deteriorated **(P → N)**, a strong negative correlation with GDP per capita was identified ($\rho = -0.644$; $p < 0.05$), indicating a co-occurrence of lower levels of economic development and adverse demographic changes. A moderate positive association with the excess mortality rate ($\rho = 0.542$; $p < 0.05$) suggests that regions experiencing increased excess mortality were also more likely to undergo negative typological shifts in demographic terms.

Among the analysed socio-economic characteristics, GDP per capita most frequently demonstrated strong and statistically significant associations with demographic typology, confirming its key role as a differentiating factor in the demographic growth in NUTS 3 regions. Most socio-demographic variables showed moderate correlations, indicating their somewhat lesser importance in explaining the spatial variation of demographic types. Overall, the findings indicate that demographic processes are more strongly linked to the level of socio-economic development than to settlement structure.

Discussion

During the study period, demographic growth in European countries was primarily driven by NUTS 3 regions characterised by positive net migration. The results reveal increasing subregional disparities in terms of total population change. The largest population growth was recorded in stable units (C → C); however, many of these transitioned to type D, indicating a shift from positive to negative natural change. The findings of this analysis confirm the crucial role of migration as the main driver of total population growth in Europe (Rees & Sander, 2020), amidst a widespread decline in natural increase at the subregional level (Newsham & Rowe, 2025). The increased dispersion of data points in the Webb diagram indicates deepening spatial differentiation in the dynamics of demographic components across the analysed European regions, which is consistent with the conclusions of Rees et al. (2012), who identified an ongoing process of demographic polarisation at the regional scale.

The phenomenon of regional depopulation is accompanied by the concentration of population potential in the largest cities, particularly in major European metropolises such as Paris, Berlin, Stockholm, Madrid, and Vienna. As noted by Tintori, Alessandrini and Natale (2018), the concentration of migrants is a primary factor contributing to population growth in metropolitan areas. Wachter and Hornstr (2024) argue that international migrants tend to settle in selected cities, which over time evolve into permanent migration hubs. According to Rowe et al. (2019), around half of European countries are experiencing a trend towards population concentration in urbanised regions, particularly in Northern, Central and Eastern Europe, while countries in the West and South are undergoing population deconcentration. This spatial differentiation is reflected in the patterns of total population change revealed in the present analysis. Curtale et al. (2025) indicate that developmental disparities between NUTS 3 regions in Europe—especially along the urban–rural divide—are likely to deepen in the future, although urban areas are expected to continue experiencing population growth, a trend that was sustained during the 2018-2021 period, as confirmed by the findings of this study.

From a territorial perspective, the results of the analysis confirm particularly adverse demographic changes that affected, during the study period, especially Italy and Poland. Bonnet et al. (2024) demonstrated that in 2020, Italy and Poland recorded similar declines in life expectancy, and that the areas most severely affected by COVID-19 were central Spain, northern Italy, and eastern Poland. The findings presented in this study indicate a moderate negative correlation between the total fertility rate and the mean age at first childbirth, while the latter is strongly and positively correlated with GDP. Interestingly, Mencarini and Vignoli (2018) observed that fertility in Italy is closely linked to economic conditions, particularly women's stable employment, highlighting regional disparities between the South and the North of the country. As noted by Reynaud and Miccoli (2018), regions of Italy previously affected by depopulation are now experiencing advanced population ageing, which, combined with low fertility, contributes to the deepening of the demographic crisis. According to Kotowska et al. (2021), in countries where the connection between marriage and parenthood remains relatively strong – such as Italy and Poland – fertility tends to be low, whereas in countries where marriage and childbearing have become decoupled – such as Norway or Belgium –fertility levels are relatively high in European terms. This study also revealed a moderate but statistically significant correlation between the share of population living in regions long characterised by negative demographic balance and the old-age dependency ratio. A major research challenge remains the further exploration of inter-regional variation in the overlap of adverse demographic phenomena – such as low fertility and demographic ageing – in relation to economic conditions.

Stojkoski et al. (2020) emphasise the importance of economic factors, such as GDP per capita, in shaping morbidity and mortality during the COVID-19 pandemic, while highlighting the limited impact of variables such as population density. Hennebry (2021) found that the resilience of rural European regions to crises was more closely linked to the level of innovation, the presence of the tourism sector, and the availability of public services, pointing to the negligible role of population density (a lack of significant association between demographic change and population density was also identified in the present study). The findings of this research revealed a relationship between the demographic stability of positively classified regions (P total) and the intensity of tourist activity, measured by the number of overnight stays, suggesting that tourism attractiveness may support regional demographic stability. In the context of residential attractiveness for migrants, this observation is supported by the findings of Viñuela (2021). Regarding excess mortality during the COVID-19 pandemic, a strong negative correlation with GDP levels was observed, confirming previous findings by Vestergaard and Pebody (2024). In summary, regions that maintained a positive demographic balance during the study period were characterised by accumulated economic and social potentials, which contributed to their greater resilience to demographic and epidemiological shocks

The present analysis adopts an approach that integrates typological and spatial perspectives, enabling a more comprehensive understanding of the complexity of contemporary demographic transformations in Europe. The identified processes of population growth concentration in selected metropolitan areas, alongside the depopulation of peripheral regions, are consistent with classical theories of polarised development (Myrdal, 1957; Friedmann, 1966). The results of the study may serve as a starting point for designing policies aimed at counteracting depopulation, particularly through enhancing the attractiveness of peripheral regions and investing in the socio-economic resilience of areas at risk of population decline. The observed dispersion of demographic types confirms that classical mechanisms of polarised development remain relevant and may provide a useful theoretical framework for interpreting current population dynamics across Europe.

Conclusions

The conducted analyses confirm that both cross-sectional and temporal studies of demographic change are essential, yet complex, due to the interplay of long-term trends and external shocks such as the COVID-19 pandemic. The results demonstrate that the level of socio-economic development – particularly GDP – plays a key role in shaping the demographic situation of European subregions, acting as the main factor underpinning their resilience. Among all the examined variables, GDP exhibited the strongest and most consistent correlation with changes in total population growth.

Regions with higher levels of socio-economic development demonstrated greater demographic stability during the crisis, as measured by population growth, whereas less developed areas experienced significantly higher mortality rates, further deepening their unfavourable demographic situation. The findings confirm the persistence of adverse demographic trends such as declining fertility, increased mortality, and depopulation processes, all of which were further intensified by the effects of the pandemic – although their intensity and spatial distribution varied across countries. It should be emphasised, however, that migration continued to play a crucial role in maintaining population growth during the analysed period.

Despite limitations such as inconsistent migration data quality or changes in NUTS 3 boundaries, the analysis of actual population change provides valuable insights into demographic processes. It can serve as an important source of knowledge for further research as well as for the development of regional and national policy strategies. This line of research is particularly valuable as it integrates multiple dimensions and can be further developed by examining the determinants of demographic resilience to health crises, taking into account the diversity of economic, socio-demographic, and settlement indicators across countries, in the context of polarised development processes.

Editors' note:
Unless otherwise stated, the sources of tables and figures are the author's, on the basis of their own research.

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