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Immigration and the prospects for long-run population decreases in European countries

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Abstract

Between 2009 and 2018, the total fertility rate fell in most European countries. In 2018, fertility was below the replacement level throughout Europe. Net migration was positive for two-thirds of European countries. This paper illustrates the implications for long-run population growth of observed net migration-fertility-mortality combinations in 20 European countries over the 2009–18 period by comparing the observed net migration to a zero population growth-related 'replacement level' for net migration. The results show that in several northern and north-western European countries, the net migration level has been consistently above this replacement level: if the net migration level and fertility and mortality rates remain constant, the population would increase. However, the findings also indicate that in all of the eastern European countries covered, the net migration level has been consistently below the net migration replacement level. The results further show that in Finland, Norway and Switzerland, the long-run implications of having constant fertility-mortality-net migration levels change from leading to population growth to leading to population decline. The opposite pattern is observed in Germany. The feasibility of preventing long-run population decreases through changes in net migration levels is discussed in light of the results.

Keywords: migration; population decrease; population growth; fertility; population model; Europe

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1 Introduction

In 2018, the total fertility rate (TFR) was below the (approximately 2.1) replacement level in every country in Europe.[1] In the absence of immigration, constant fertility would result in long-run population declines throughout the region (Espenshade et al., 2004; Gietel-Basten and Scherbov, 2020; Matysiak et al., 2021; Rindfuss et al., 2016; Sobotka, 2017). In most European countries, fertility has been below this replacement level for several decades (UNDP, 2019a). The prospect of a decrease in population is a concern in many European countries (Lutz and Gailey, 2020). In 2019, 43% of the European countries that responded to a United Nations inquiry cited ‘countering long run population decline’ as a major underlying reason for their current immigration policy (UNDP, 2019b). Moreover, some news stories and some politicians have portrayed the prospect of population decreases in ‘gloom and doom’ terms (Van Dalen and Henkens, 2011).

Despite their low fertility, population growth remained positive over the 2015-20 period in a majority of European countries (Eurostat, 2021; UNDP, 2019a). In roughly two-thirds of European countries, net migration levels have been positive (De Hass et al., 2019; UNDP, 2019a). Even though these countries have below the replacement level fertility, it is a theoretically possible that a decrease in their national population will never happen if their net migration remains sufficiently high (Coleman, 2002; Parr, 2021).

Should the recent population growth in most European countries be viewed as a temporary artefact of the population age structure, which has been formed by each country’s national history of birth rates, death rates, immigration and emigration (so-called ‘population momentum’)? Or should the growth in some countries be seen in the context of a combination of net immigration, fertility and mortality, which, if sustained, will lead to population increases over the long run? For each country, what is the critical level of ‘replacement net migration’ that would produce zero long-run population growth in combination with constant fertility and mortality at current levels (Espenshade et al., 1982)? And, in light of recent trends, does sustained net migration at this ‘replacement level’ appear feasible in each country? This paper aims to answer these questions, and, in doing so, to provide new perspectives on recent population growth and net migration trends in European countries.

[1] Parr (2021) proposed a ‘migration-adjusted replacement level’ for fertility that is applicable to populations in which the level of net migration has positive values. Here, the term ‘the replacement level’ is used to refer to the replacement level proposed by Dublin and Lokta (1925). In other words, it is used to refer to the fertility level that will result in a population that also has constant mortality rates and zero migration eventually reaching a stationary state. It is not a reference to the measure proposed by Parr (2021).

2 Fertility, mortality, migration and population growth trends in Europe 2009–2018

There are substantial differences between European regions in population growth rates and their components (Wilson et al., 2013; Table 1). The TFR is generally higher in northern and western Europe and lower in southern and eastern Europe (Rindfuss et al., 2016). Between 2009 and 2018, the TFR decreased in roughly two-thirds and increased in the remaining one-third of European countries (Eurostat, 2021; Table 1). The mean age at childbirth increased in every European country. Fertility changes were uneven both between different regions of Europe and between different countries within the same region. The largest reductions in the TFR were in northern European countries, especially in Iceland, Finland and Norway. The TFR also fell in north-western Europe, particularly in Ireland, the United Kingdom (UK), Belgium and the Netherlands. The trends in southern European countries were mixed: in Italy, the TFR fell to a very low level, while in Spain and in Portugal, the TFR changed only slightly. Over the same period, the TFR increased in most eastern European countries, with the largest increases occurring in Hungary, Czechia, Slovakia, Latvia and Lithuania. Among the central European countries, the TFR increased substantially in Germany and, to a lesser degree, in Austria. However, there was little change in the TFR in Switzerland (Eurostat, 2021).

Between 2009 and 2018, life expectancy at birth increased in all European countries, with the larger increases generally occurring in eastern European countries, and the smallest increases occurring in Germany and the UK (Eurostat, 2021; Parr et al., 2016; Table 1). Despite these trends, life expectancies at birth remained below the European average in the eastern European countries.

In 2009, natural increase (i.e., the number of births minus the number of deaths) was positive in 62% of European countries (Eurostat, 2021). The countries where it was negative were mostly in eastern Europe, and also included Austria, Germany, Italy and Portugal. By 2018, the percentage of European countries in which natural increase was positive had fallen to 55%, with Spain, Greece, Finland, Poland and Slovenia joining the list of countries with a negative natural increase, and Austria leaving it.

Net migration to Europe as a whole was positive over the 2009–18 period. The rates of net inflow in the northern and western European countries tended to be higher than in the southern European countries (Eurostat, 2021; UNDP, 2019a). There was substantial migration out of eastern European countries and into northern and western European countries following the 2004 and 2007 expansions of the European Union (EU) (Kahanec and Zimmermann, 2016). Poland and Romania were the eastern European countries with the highest absolute numbers of emigrants (Eurostat, 2021). The outflows from Poland rose between 2009 and 2013 and then diminished somewhat between 2013 and 2018, while the outflows from Romania fell from 2009 to 2013 and then increased between 2013 and 2018 (Eurostat, 2021). Emigration from the Baltic states declined, while emigration from Bulgaria and

Croatia increased. Emigration from Spain, Greece, Portugal and Ireland rose from 2009 to 2013 following the Great Recession, and then fell between 2013 and 2018.

Over the 2009–18 period, Germany and the UK generally received the largest numbers of immigrants (Eurostat, 2021). In 2015, the number of immigrants to Germany was unusually large. This was mainly due a sharp increase in the number asylum seekers, most notably from Syria, and, to a lesser extent, from Iraq and Afghanistan. There were also unusually large asylum seeker inflows to Austria, Belgium and Denmark in 2015, and to Sweden in 2016 (Hagelund, 2020; OECD, 2017; Pew Research Centre, 2016). Immigration to Spain fell steeply during the 2009–2013 period, which was characterised by unfavourable economic conditions and very high unemployment. However, it largely recovered in the years that followed. Indeed, in 2018, Spain replaced the UK as Europe's second most popular destination for immigrants (OECD, 2019). Immigration to Greece, Portugal and Ireland also recovered from post-Great Recession lows. However, immigration to Italy, Norway and Switzerland fell during these years.

Over the 2009–2018 period, the net migration rates were generally highest in the central European countries (Switzerland, Austria and Germany), the Nordic countries (Norway and Sweden) and Luxembourg (Table 1). Belgium, Denmark, the Netherlands, France, the UK and Italy had more moderate rates of net inflow. Most eastern European countries experienced net outflows, with Czechia, Hungary, Russia and Belarus being notable exceptions. In Spain and Ireland, net outflows in the earlier part of this period were followed by net inflows in the latter part (Eurostat, 2021).

In 2009, population growth was positive in all northern, western, central and southern European countries, except Germany and Iceland (Eurostat, 2021; Table 1). In contrast, population growth was negative in a majority of eastern European countries.[2] Between 2009 and 2018, the population growth rate decreased in roughly two-thirds of European countries. In 2018, the list of European countries experiencing population decreases included Greece, Italy, Portugal and a large number of eastern European countries.[3] However, while the populations of Germany and Estonia had previously been declining, the populations of these countries grew in 2018 (Table 1).

3 Review of the literature on replacement migration

It has been demonstrated mathematically that a population that has a constant net immigration level, an amount with a fixed age composition, constant below replacement fertility rates and constant mortality rates will converge over time

2 The exceptions are Russia, Poland, Czechia, Slovakia, Albania, Kosovo, Montenegro, North Macedonia and Slovenia.

3 In Poland, Kosovo and Montenegro, population growth was negative in 2018.

Table 1:
Population growth rate, rate of natural increase, rate of net migration, total fertility rate (TFR) and life expectancy at birth for males and females: Selected European countries 2009 and 2018

Country	Population growth (%)		Natural increase (%)		Net migration (%)		TFR		Life expectancy at birth: Male		Life expectancy at birth: Female	
Year	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**	**2009**	**2018**
Northern Europe												
Denmark	0.4	0.4	0.1	0.1	0.3	0.3	1.83	1.73	76.9	79.1	81.1	82.9
Finland	0.5	0.1	0.2	−0.1	0.3	0.2	1.86	1.41	76.6	79.1	83.5	84.5
Iceland	−0.6	2.4	1.0	0.6	−1.5	1.9	2.33	1.71	79.8	81.3	83.8	84.5
Norway	1.2	0.6	0.4	0.3	0.8	0.3	1.98	1.57	78.4	81.1	83.2	84.5
Sweden	0.9	1.1	0.2	0.2	0.7	0.9	1.93	1.76	79.4	80.9	83.5	84.3
Benelux countries												
Belgium	0.8	0.5	0.2	0.1	0.6	0.4	1.84	1.62	77.4	79.4	82.8	83.9
Luxembourg	1.7	2.0	0.4	0.3	1.3	1.6	1.59	1.39	78.1	80.1	83.3	84.6
Netherlands	0.5	0.6	0.3	0.1	0.2	0.5	1.76	1.59	78.4	80.3	82.5	83.4
Central Europe												
Germany	−0.2	0.3	−0.2	−0.2	0.0	0.5	1.35	1.57	77.8	78.6	82.8	83.3
Switzerland	1.1	0.7	0.2	0.2	0.9	0.5	1.49	1.52	79.9	81.9	84.6	85.7
Southern Europe												
Italy	0.3	−0.2	−0.0	−0.3	0.4	0.1	1.45	1.29	79.1	81.2	84.2	85.6
Baltic states												
Estonia	−0.2	0.4	−0.0	−0.1	−0.2	0.5	1.71	1.68	70.0	74.0	80.3	82.7
Latvia	−2.0	−0.8	−0.4	−0.5	−1.6	−0.3	1.47	1.61	67.5	70.1	77.7	79.7
Lithuania	−1.3	−0.5	−0.3	−0.4	−1.0	−0.1	1.50	1.64	67.1	70.3	78.7	80.7
Central-Eastern Europe												
Czechia	0.4	0.4	0.1	0.0	0.2	0.4	1.52	1.71	74.1	76.2	80.5	82.0
Hungary	−0.2	−0.1	−0.3	−0.4	0.2	0.3	1.33	1.54	70.0	72.7	78.3	79.6
Poland	0.8	−0.0	0.1	−0.1	0.0	0.1	1.41	1.46	71.5	73.7	80.1	81.7
Slovakia	0.2	0.1	0.2	0.1	−0.0	0.1	1.45	1.55	71.4	73.9	79.1	80.8
Balkan countries												
Bulgaria	−0.6	−0.7	−0.4	−0.7	−0.3	−0.1	1.65	1.55	70.2	71.5	77.4	78.6
Croatia	−0.2	−0.7	−0.2	−0.4	−0.0	−0.3	1.59	1.47	72.8	74.9	79.7	81.5

Source: Eurostat (2021).

towards a stationary state with a constant size and age distribution (Espenshade et al., 1982; Pollard, 1973). Espenshade et al. (1982) calculated that, in combination with fertility rates and mortality rates for 1977, an annual net immigration of 840,000 people would be needed to generate a stationary population equal to the 1980 population size for the USA. However, in the almost 40 years that have passed since the publication of Espenshade et al. (1982), surprisingly few studies have estimated ‘replacement migration’ levels using this method, and it appears that none has applied it to an extensive range of populations. A rare example of the use of this method is Gesano (1994), who calculated that a constant net migration of 389,000 people would be needed to generate a stationary population equal to Italy’s 1991 population. While Gesano (1994) dismissed this level as ‘probably unmanageable’, over the 2003–04 and 2007–08 periods, recorded net migration in Italy exceeded this level (Eurostat, 2021).

To date, the most widely known study of the ‘replacement migration’ levels that will prevent long-run population decline under specified scenarios for future fertility rates and mortality rates is undoubtedly the UNDP (2000). The method used in by the UNDP (2000), first, calculates for each of a range of populations the maximum population size and the time point at which it is reached by a population projection that combines the fertility and mortality assumptions used in the United Nations’ 1998 medium variant projection with an assumption of zero international migration. Second, the method calculates for each population the net international migration, which, in combination with the same fertility and mortality assumptions, would maintain the aforementioned maximum population size from the time it was reached to the end of the 2000–2050 time period. The results show that in Europe, the European Union (EU), France, Germany, Italy, Japan, the Republic of Korea, the Russian Federation and the UK (but not in the USA), the ‘replacement net migration’ levels were considerably above the levels for the corresponding countries or region used in the United Nations’ 1998 medium variant projection. However, in the EU, France and the UK, the levels fell within the range of (what was then) recent experience. The method used by the UNDP (2000) to estimate ‘replacement migration’ differed from that of Espenshade et al. (1982). Indeed, as Espenshade (2001) noted, the rationale for the UNDP (2000) method for calculating ‘replacement migration’ is unclear. Whereas Espenshade et al. (1982) calculated the replacement migration level for a recently observed population size, the UNDP (2000) calculation is for a hypothetical future (and likely never-to-be-observed) population scenario. The UNDP (2000) method considered an implausible scenario in which net migration changed abruptly to a zero level, which did not reflect the (at that time) recent experiences of the populations it considered. The UNDP (2000) ‘replacement migration’ is not a synthetic measure, because its value is influenced by the ‘momentum’ inherent in the initial age structure of the projected population. Moreover, the UNDP’s (2000) estimates of the ‘replacement migration’ levels for the UK, Germany, France and Italy were exceeded by the subsequent average net migration levels in these countries over the 1995–2015 period (Craveiro et al., 2019).

For the 2002–2052 period, Bijak et al. (2013) presented cumulative (and constrained to be non-negative) ‘replacement migration’ levels that would maintain a constant population size for the European Union and its (then) constituent countries. Their results reflect the heterogeneity of the population prospects of the countries considered, showing that large volumes of ‘replacement migration’ will be needed to prevent population decreases in eastern and southern European countries (e.g., Romania and Bulgaria) with low fertility and negative momentum, whilst the populations of 10 mostly northern and western European countries are projected to grow throughout the period considered, even with zero migration.

Craveiro et al. (2019) estimated the annual net migration needed to maintain a constant (2015) population size in Germany, the UK, France, Italy and Spain over the 2015–60 period, assuming fertility and mortality rates change in line with the Eurostat (2014) projections. For all five countries, the 'replacement' level for net migration is initially negative and generally increases over the projection period. The authors attributed these changes to reductions in initially positive projected natural increases due to projected population ageing. The trajectories for 'replacement' net migration levels, which start from negative values and vary considerably from year to year, appear implausible in light of recent migration patterns, and unsuitable for incorporation into a coherent and civilised discussion of migration policy options (McDonald and Kippen, 1998).

The aforementioned studies addressed the stability in the total population size (and, in some studies, also the stability of the working-age population and the proportionate age structure). Other studies have focused on the question of whether immigration can maintain either annual birth numbers or the sizes of the cohorts reaching prime reproductive ages (Billari and Dalla-Zuanna, 2011; Wilson et al., 2013). Wilson et al. (2013) found that while there have been either intergenerational increases or at least intergenerational stability in the sizes of cohorts reaching prime reproductive ages in a range of western and northern European countries, there have also been intergenerational decreases in the sizes of these age groups in most of the ex-communist eastern European countries they considered. Total population growth has also been affected by increases in the sizes of successive cohorts reaching older ages. Similarly, Billari and Dalla-Zuanna (2011) demonstrated that the 1980–84 birth cohort had at least replaced the 1950–54 cohort (i.e. its 'mothers' cohort') in Spain, the UK and the USA; and, according to United Nations projections, was on course to replace it in Italy. However, this study also found that neither Germany nor Japan has achieved cohort replacement through net migration. Moreover, neither country will do so in the future, according to the UN projections.

In the description of fertility levels it is routine to compare the fertility level to a synthetically measured (invariant to population age structure) 'replacement level', which has a zero population growth implication under specified conditions (Dublin and Lokta, 1925; Parr, 2021). This paper adopts a parallel approach to describing net migration data. The 'net migration replacement level' against which the recent net migration level is compared is that proposed in a classic paper by Espenshade et al. (1982). It is the first to apply this method to an extensive range of populations. It should be noted this paper's method is quite different from the methods used in other studies that have adopted the term 'replacement migration', including those of the UNDP (2000), Billari and Dalla-Zuanna (2011), Bijak et al. (2013), Wilson et al., 2013 and Craveiro et al. (2019). The following section describes the method of calculation. The final section provides a discussion of the advantages of this method, as well as a summary and a discussion of the results.

4 Method

A population that has a constant volume of net immigration with a fixed age-sex composition, a constant fertility rate that is below the exact replacement level which corresponds to zero migration, and constant age-sex mortality rates will converge towards a stationary state (i.e., zero growth and constant numbers by age and sex) (Espenshade et al., 1982; Pollard, 1973). The stationary population size (denoted P_A) which corresponds to a constant net migration-fertility-mortality combination at the levels for a specified population and time period (denoted by A) can be expressed as the sum of components (Espenshade et al., 1982; Schmertmann, 1992). A person's migrant generation index is based on the most recent foreign-born individual from the set comprising the person plus his/her all female line of ancestry to migrate into a specified population. Thus, a person born in another country belongs to the first generation, a native-born child whose mother was born in another country belongs to the second generation, a native-born child whose mother was native born and whose mother's mother was born in another country belongs to the third generation, and so on. Following Espenshade et al. (1982), the components are labelled in terms of the 'migrant generation' index:[4]

$$P_A = \sum_{i=1}^{\infty} P_{i,A} \tag{1}$$

Where P_A denotes the total size of the stationary population, i is the 'migrant generation' index and $P_{i,A}$ denotes the size of the ith 'migrant generation'.

In the current paper, the calculation of the various migrant generation sizes, and hence of the stationary population size, uses discrete approximations of formulae in Schmertmann (1992), which are readily calculated from widely available national and international statistical agency data. The 'first generation' element in Equation (1) ($P_{1,A}$) is calculated by:

$$P_{1,A} = M_A \sum_{j=1}^{2} \sum_{x=0}^{\omega} m_{x,j,A} e_{x,j,A} \tag{2}$$

Where M_A denotes the constant annual total net migration level for A, $m_{x,j,A}$ denotes the proportion of total net migration contributed by persons of age x (last birthday)

[4] Since the calculations involve net migration (and not immigration), literal correspondence between the components and the immigrant generation groups does not apply. Hence, the names of components are in inverted commas.

and sex j ($j = 1$ denotes female and $j = 2$ male) for A, $e_{x,j,A}$ is the (remaining) life expectancy for age x and sex j for A and ω denotes the maximum age for that population.

The 'second generation' element in Equation (1) ($P_{2,A}$) is calculated by:

$$P_{2,A} = M_A \sum_{j=1}^{2} s_{j,A} e_{0,j,A} \sum_{x=0}^{k} m_{x,1,A} \sum_{t=0}^{k-x} f_{x+t,A\ t}p_{x,1,A} \tag{3}$$

Where $f_{x+t,A}$ represents the age-specific fertility rate (per woman) for age $x + t$, ${}_tp_{x,1,A}$ denotes the probability of a female surviving from x to $x + t$, k denotes the upper limit of the female reproductive age range, $s_{j,A}$ denotes the proportion of births of sex j and $e_{0,j,A}$ denotes life expectancy at birth for sex j.

For all $i \geq 2$

$$P_{i+1,A} = NRR_A P_{i,A} \tag{4}$$

where NRR_A denotes the conventional net reproduction rate for A.[5] The sum of the sizes of the generation-indexed components for generations with indices 2 and above is the sum of a geometric series with initial term $P_{2,A}$ and common ratio NRR_A. Hence, substituting from Equation (4), Equation (1) can be re-expressed as:

$$P_A = P_{1,A} + \frac{P_{2,A}}{(1 - NRR_A)} \tag{5}$$

Since M_A is a scalar value used in the calculation of all the generation-indexed components ($P_{i,A}$) of stationary population size P_A in Equation (1), the *net migration replacement level* ($M_{R,A}$), which, in combination with the specified values for $m_{x,j,A}$, $e_{x,j,A}$, $s_{j,A}$, $f_{x+t,A}$ and ${}_tp_{x,A}$ would generate a stationary population size (P_A) equal to the actual population size for A (POP_A), is:

$$M_{R,A} = \frac{M_A POP_A}{P_A} \tag{6}$$

In a population projection with constant fertility and mortality at the levels for A and net migration at the 'replacement level' for A ($M_{R,A}$), the size of the population may initially depart from its initial (current) value due to 'population momentum' created by the difference between its initial and ultimate age structure. However, over the long run (i.e. if fertility, mortality and replacement level net migration remain constant indefinitely), the population size will return to its initial value (POP_A). In a hypothetical scenario in which fertility, mortality and net migration all remain stable at the levels observed for A, the population size will ultimately converge to a stationary population size (P_A) that exceeds its initial value (POP_A) if and only if the total net migration (M_A) exceeds the *net migration replacement level* ($M_{R,A}$),

5 $NRR_A = \sum_{x=0}^{k} f_{x,A}\ s_{1,A}\ {}_xp_{0,1,A}$.

and will converge to a value of (P_A) below its initial size if and only if net migration remains below the *net migration replacement level migration* ($M_{R,A}$).

This paper compares the recorded values of net migration[6] for 20 European countries for individual years between 2009 to 2018 to the corresponding *net migration replacement level* ($M_{R,A}$) for the country and year (as per Equation (6)). The data were sourced from the Eurostat website (Eurostat, 2021). The countries and the years chosen were limited to those for which all the requisite data inputs for calculating the *net migration replacement level* ($M_{R,A}$) were available from the Eurostat website,[7] and for which fertility was below the replacement level (i.e., NRR less than one).[8,9]

5 Results

Figures 1–7 visually compare the observed net migration to its replacement level for the individual years over the 2009–2018 period for which the requisite data are available and fertility was below the replacement level. It should be noted that the scales differ widely between countries. Table 2 presents the ratio of observed net migration to the net migration replacement level for 2018 only. Equation (6) indicates that this is also the ratio of the stationary population size to the current population size. In addition, Table 2 expresses the 2018 net migration replacement level as a percentage of the 2018 population size.

5.1 Northern Europe

In all of the northern European countries, the net migration replacement level generally increased over time due to reductions in fertility (Figure 1). Net migration in Sweden remained above its replacement level throughout the 2009–18 period, despite the increases in the latter due to a reduction in the TFR. Thus, Sweden's current population growth should not be seen as merely a temporary artefact of the population age structure (Table 1): if fertility, mortality and net migration remain constant at the values for any of the years covered, there would be further population growth over the long run. The ratio of net migration to its replacement level (shown

6 There are differences in the definitions of immigration and population and in data quality between countries (Gendronneau et al., 2019).

7 For Belgium, Bulgaria, Croatia, Czechia, Lithuania, Luxembourg and Slovakia, data on immigration and emigration by age and sex are unavailable from the Eurostat website for some years.

8 Iceland was not covered for 2009 and 2010 because fertility was above the replacement level which corresponds to zero migration. Calculation of the net migration replacement level is not feasible for such fertility levels.

9 An Excel spreadsheet used for calculating the net migration replacement level is freely and publicly available from the author's ResearchGate webpage.

Table 2:
Ratio of net migration to replacement level and net migration replacement level as per cent of the 2018 population: selected European countries 2018

Country	Net migration	Net migration replacement level	Ratio of net migration to replacement level	Net migration replacement level as % of 2018 population
Northern Europe				
Denmark	4,288	44,920	0.10	0.78
Finland	11,965	33,174	0.36	0.60
Iceland	7,458	1,784	4.18	0.54
Norway	20,706	22,565	0.92	0.43
Sweden	85,621	28,390	3.02	0.28
Benelux countries				
Belgium	48,925	38,225	1.28	0.34
Luxembourg	10,659	3,493	3.05	0.58
Netherlands	86,371	67,532	1.28	0.39
Central Europe				
Germany	353,471	326,099	1.08	0.39
Switzerland	14,632	18,687	0.78	0.22
Southern Europe				
Italy	175,364	505,638	0.35	0.84
Baltic states				
Estonia	7,071	9,289	0.76	0.70
Latvia	−4,905	8,078	−0.61	0.42
Lithuania	−3,292	3,433	−0.96	0.12
Central-Eastern Europe				
Czechia	39,168	53,951	0.73	0.51
Hungary	34,759	73,653	0.47	0.75
Poland	24,289	115,495	0.21	0.30
Slovakia	3,955	23,232	0.17	0.43
Balkan countries				
Bulgaria	−3,666	36,585	−0.10	0.52
Croatia	−13,486	19,420	−0.69	0.47

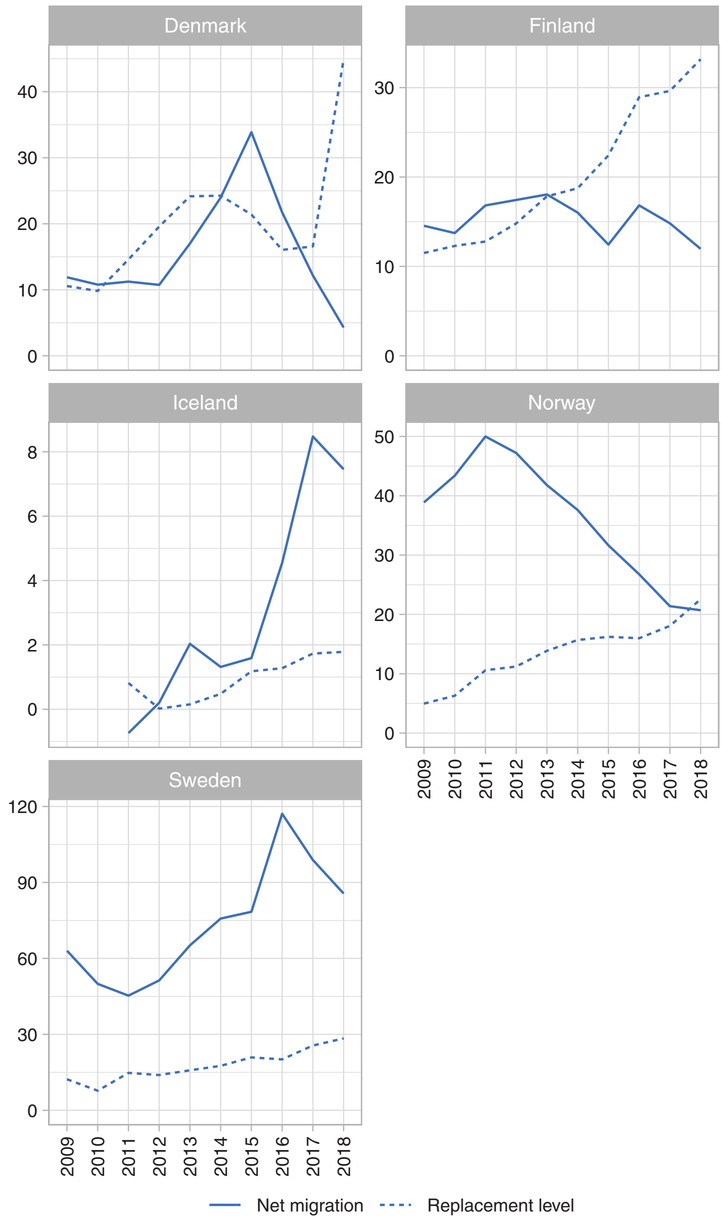
Source: Author's calculations based on Eurostat (2021).

in Column 3 of Table 2) for Sweden for 2018 indicates that if fertility, mortality and net migration remain constant, the population of Sweden would grow (over future centuries and millennia) to over three times its 2018 size.

In Norway in 2009, net migration was nearly eight times its replacement level. The low net migration replacement level for this year was the product of near replacement level fertility.[10] After 2011, the gap between net migration and its replacement level

10 The TFR for Norway in 2009 was 1.98.

Figure 1:
Net migration and net migration replacement level (000s) for Sweden 2009–18, Norway 2009–18, Iceland 2011–18 and Finland 2009–18



Source: Author's calculations based on Eurostat (2021).

narrowed progressively in Norway due to the combined effects of reductions in net migration and decreases in the TFR, which increased the net migration replacement level. In 2018, following the country's adoption of more restrictive immigration policies and border controls and a downturn in the number of asylum seekers, Norway's net migration was actually slightly below its replacement level (Hagelund, 2020; OECD, 2019). While Norway's population was still growing in 2018, albeit more slowly than in 2009, the implication of this below replacement net migration is that under conditions of constant fertility, mortality and migration, it would ultimately fall slightly below (to 92% of) its 2018 size (Table 2).

In Iceland, net migration exceeded its replacement level throughout the 2012–2018 period, but was negative and below the replacement level in 2011.[11] After 2012, Iceland experienced the most rapid fertility decrease of any European country. As the TFR fell, Iceland's net migration replacement level increased. Nonetheless, the gap between actual and replacement net migration widened. In 2018, the ratio of net migration to its replacement level was higher in Iceland than in all of the other countries included in this study (Table 2). If Iceland's fertility, mortality and migration remain constant at 2018 levels, its population would increase to more than four times its 2018 size over the long run (Table 2).

In Finland, net migration was relatively stable between 2009 and 2018. However, the relationship of net migration to its replacement level in Finland was transformed by a reduction in the country's TFR, which was the second largest in Europe over this period (Table 1; Hellstrand et al., 2020).[12] Related to this fertility decline, Finland's net migration replacement level nearly tripled. After 2014, the country's net migration was below replacement level. In contrast to the population of Norway, which will ultimately decrease, under conditions of constant fertility, mortality and net migration at 2018 levels, the population of Finland will ultimately decline to 36% of its 2018 size (Table 2).

In 2009, the TFR in Denmark was only slightly below the rates in Sweden and Norway, but the country's net migration only slightly exceeded its replacement level. The smaller gap between net migration and its replacement level in Denmark can be linked to the country's more restrictive immigration policies (Hagelund, 2020). Over the 2009–2018 period, the relationship between net migration and its replacement level fluctuated in Denmark. Between 2010 and 2013, a decrease in the country's TFR propelled the net migration replacement level above the actual net migration level. In 2015, the net migration numbers in Denmark were swelled by a large inflow of asylum seekers, which led to a migration level that was above the net migration replacement level (Pew Research Centre, 2016; OECD, 2017). In 2017 and 2018, following the country's adoption of more restrictive immigration policies and a

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11 The very low net migration replacement level in Iceland in 2012 is due to the TFR (2.04) being only marginally below the replacement level which corresponds to zero migration.

12 Between 2009 and 2018, only Iceland experienced a larger decrease in the TFR than Finland.

decrease in the number of asylum seekers, net migration in Denmark was below its replacement level (Hagelund, 2020; OECD, 2019).[13]

5.2 Benelux countries

Between 2009 and 2018, the TFR fell in Belgium, the Netherlands and Luxembourg (Figure 2). The decreases in fertility in these countries contributed to increases in their net migration replacement levels. Nonetheless, in Luxembourg and Belgium, net migration exceeded its replacement level in all of the years considered in this study. The ratio of net migration to the replacement level was consistently higher in Luxembourg than in Belgium. In both Belgium and the Netherlands, net migration decreased significantly over the 2012-14 period. However, while net migration remained above its replacement level in Belgium, net migration fell below its replacement level in the Netherlands over this period. Subsequently, over the 2015–18 period, a combination of increases in the number of movers from newer EU member states in eastern Europe and increases in the number of asylum seekers from Syria again propelled net migration in the Netherlands to above its replacement level (OECD, 2017, 2019).

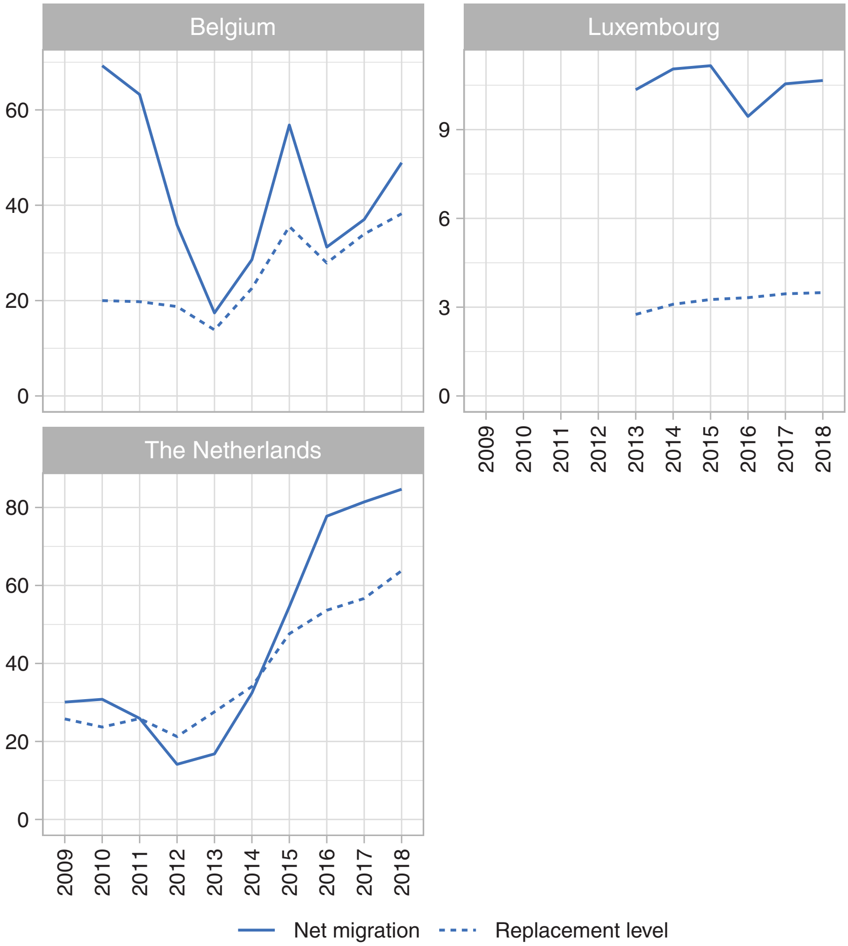
5.3 Central Europe

In 2009, the TFR in Germany was very low, at just 1.35 births per woman (Table 1). The country's economy was weak and its unemployment rate was high (Green, 2013). Like fertility, net migration in Germany was low, and was far below (just 18% of) its replacement level (Figure 3). After 2009, as the country's economy recovered, its net migration increased. After 2011, increases in the TFR and older ages at birth[14]

[13] The much higher net migration replacement level for 2018 is linked to the unusual age-sex distribution of the very small net migration total in this year. Specifically, the proportion of net migration formed by females of reproductive age was much lower. Unlike males and older females, females of reproductive age affect the calculations of births. With such an age-sex distribution, a higher total net migration level is needed to equate the stationary population size with the real population size.

[14] Substitution of the ratios of ASFR to TFR for 2011 in place of the observed values of these ratios for 2018 increases the net migration replacement level for 2018 to 332,593, i.e. by 2.0%. The increase to the net migration replacement level is due to the numbers of 'first-generation migrants' in the older reproductive age groups generally being larger than the numbers in the younger reproductive age groups. Thus, for any specified TFR, the size of stationary population (P_A) will be greater when the ages at birth are older than when they are younger, because of the greater weight of influence of the older reproductive ages on the calculation of the 'second generation' population size (P_2) and the flow-on effects of the increased size of the 'second generation' on the 'third and higher generation' sizes (Equations (1)–(5)). Thus, when the ages at birth are older, the net migration replacement level will be lower (Equation (6)).

Figure 2:
Net migration and net migration replacement level (000s) for Denmark 2009–18, Luxembourg 2013–18, Belgium 2010–18 and the Netherlands 2009–18

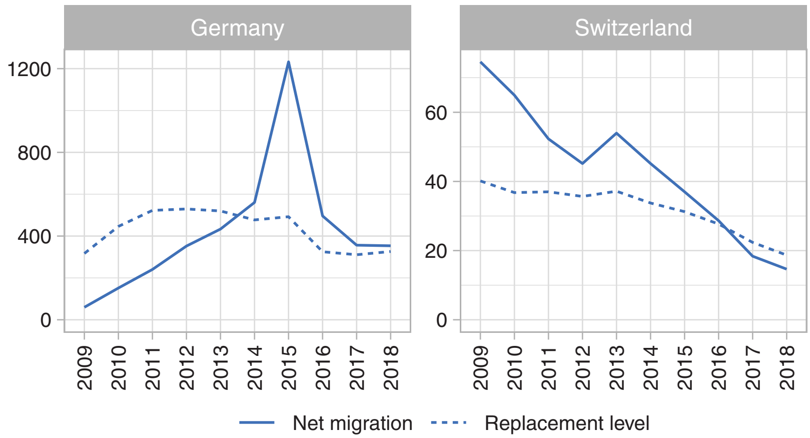


Source: Author's calculations based on Eurostat (2021).

contributed to increases in Germany's net migration replacement level.[15] In 2015, a huge spike in immigration linked to the large inflow of asylum seekers caused

15 The decrease in the net migration replacement level between 2009 and 2011 is due to females forming an increased proportion of the (increased) net migration. Unlike males, females affect the calculations of births. Accordingly, when a higher proportion of net migration is formed by females, a smaller total net migration equates the stationary population size with the real population size.

Figure 3:
Net migration and net migration replacement level (000s) for Germany 2009–18 and Switzerland 2009–18



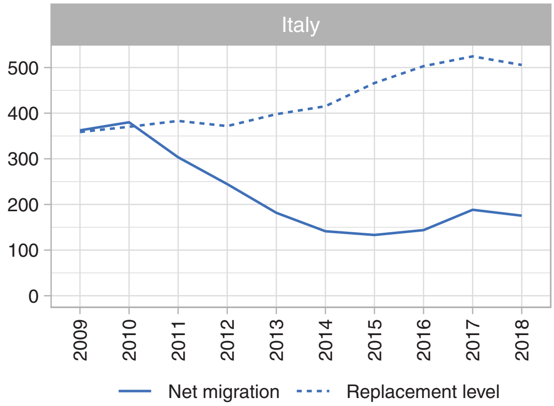
Source: Author's calculations based on Eurostat (2021).

net migration in Germany to jump to 2.5 times its replacement level (OECD, 2017; Pew Research Centre, 2016). Although net migration declined following this peak, it remained marginally above its replacement level. Not only have increases in the TFR, net migration and life expectancies between 2009 and 2018 shifted Germany's actual population growth from negative to positive, but also assuming the 2018 patterns continue, the size of the country's population would increase further over the long run (albeit only slightly).

In Switzerland, the TFR remained low at approximately 1.5 births per woman throughout the 2009–18 period (Eurostat, 2021). Nonetheless, in 2009, the country's rate of net migration, which was then one of the highest in Europe, was considerably above (1.76 times) its replacement level (Figure 3). Between 2009 and 2018, net migration in Switzerland fell rapidly, with substantial reductions occurring both before and after 2014, when a referendum proposing limits to immigration from the European Union was narrowly passed (Randall, 2016). In 2018, net migration in Switzerland was just 20% of its 2009 level, and was considerably below the net migration replacement level.[16]

[16] The reduction in net migration between 2009 and 2018 was greater for males than for females. When the proportion of females is higher, less migration is needed to replace the population. Later ages at birth and increases in life expectancies also contributed to the reduction in the net migration replacement level.

Figure 4:
Net migration and net migration replacement level (000s) for Italy 2009–18



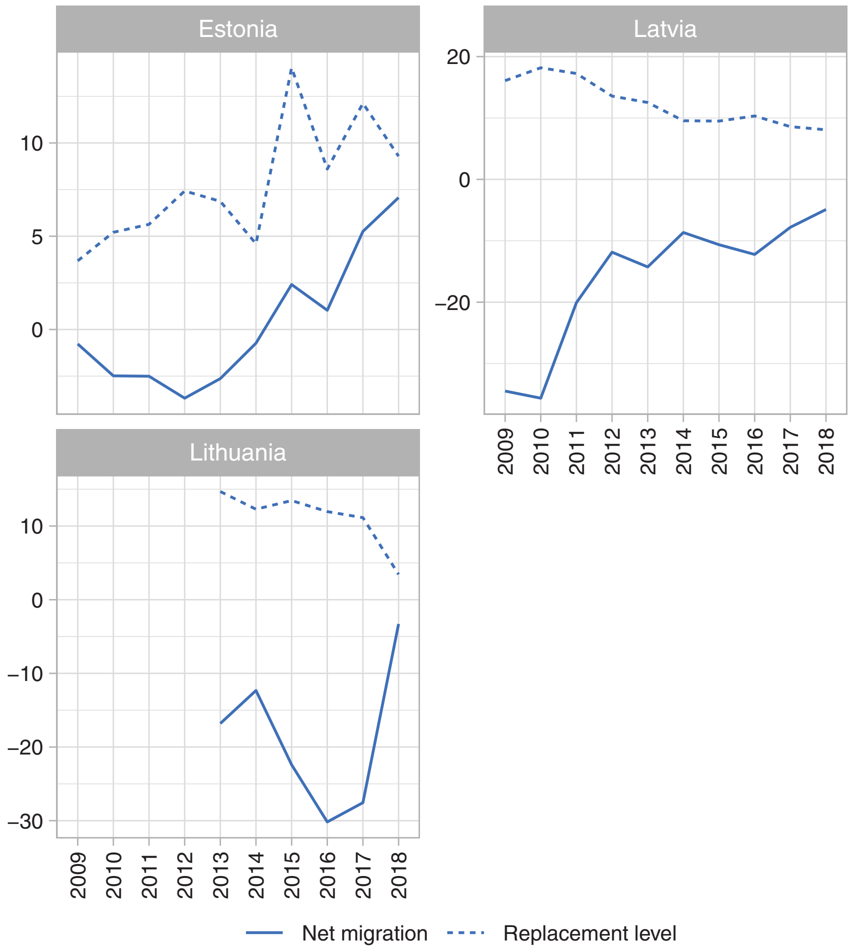
Source: Author's calculations based on Eurostat (2021).

5.4 Southern Europe: Italy

Expressed as a rate per 1000 population, the net migration replacement level in Italy in 2018 was higher than it was in the northern and western European countries previously considered, mainly because the TFR was much lower in Italy than in these countries (Table 1). Nonetheless, in 2009 and 2010, the country's net migration, swollen by large numbers of immigrants arriving by boat, roughly equalled its replacement level (Figure 4; Billari and Dalla-Zuanna, 2011; Hermanin, 2017). However, due to a significant decrease in the TFR in Italy (from 1.45 in 2009 to 1.25 in 2018), the country's net migration replacement level increased considerably, while its net migration fell sharply. Indeed, in 2018, Italy's net migration was just 35% of its replacement level. The net migration replacement level in this year exceeded any of the levels previously recorded in Italy (Eurostat, 2021).[17] Of the countries covered in Table 2, Italy had the highest values in 2018 for both the size of the net migration replacement level (Column 2) and the net migration replacement level as a percentage of the population (Column 4). The net migration replacement level in 2018 in Italy also far exceeded the value of net migration, which would have produced zero population growth in 2018 (i.e. minus the value of natural increase) (Tables 1 and 2).

17 The highest level of net migration ever recorded for Italy was 476,010 for 2007 (Eurostat, 2021).

Figure 5:
Net migration and net migration replacement level (000s) for Estonia 2009–2018, Latvia 2009–18 and Lithuania 2013–18



Source: Author's calculations based on Eurostat (2021).

5.5 Baltic states

In Estonia, net migration was negative over the 2009–14 period and was positive over the 2015–2018 period. However, even over the latter period, it remained below its replacement level (Figure 5). Thus, in the absence of substantial further increases in fertility, life expectancies and/or net migration, the positive population growth over the 2015–18 period in Estonia will give way to a decrease in the population over the long run.[18] In Latvia and Lithuania, net migration remained negative and was below its replacement level in all of the years considered. In both countries, increases in the TFR and life expectancies contributed to decreases in the net migration replacement level over the years considered (Table 1). In Lithuania, the net migration replacement level in 2018 exceeded the level of net migration, which would have resulted in zero population growth in 2018 (the value of net migration minus natural increase, i.e., 0.41% of the population). In Latvia, the net migration replacement level exceeded the (0.49% of the population) net migration level that would have resulted in zero population growth in 2018 (Tables 1 and 2).

5.6 Central-Eastern Europe

In Hungary, Czechia and Slovakia, net migration was positive but was considerably below its replacement level for all the years considered (Figure 6). Thus, a continuation of fertility, mortality and migration at the levels for any of the years considered would result in significant population declines over the long run. In Czechia and Slovakia, the prospect of long-run population decreases contrasts with recent slow population growth, while in Hungary, it represents a continuation of recent population declines (Table 1). In all three countries, recorded net immigration increased over the 2013–18 period, albeit only slightly in Slovakia.[19] In Hungary, this trend was due to a combination of an increase in returning Hungarian citizens and their foreign-born children and an increase in immigration by foreign citizens (Godri, 2020). Over the same period, the net migration replacement level generally increased in Hungary and Czechia, but it generally decreased in Slovakia.[20] In Poland, net migration was negative over the 2009–2017 period (Figure 6).[21] In 2018, due to an increase in immigration, especially from Ukraine, and a decrease in emigration, recorded net migration in Poland was positive (Eurostat, 2021; OECD, 2019). Even so, it was still far below the net migration replacement level.

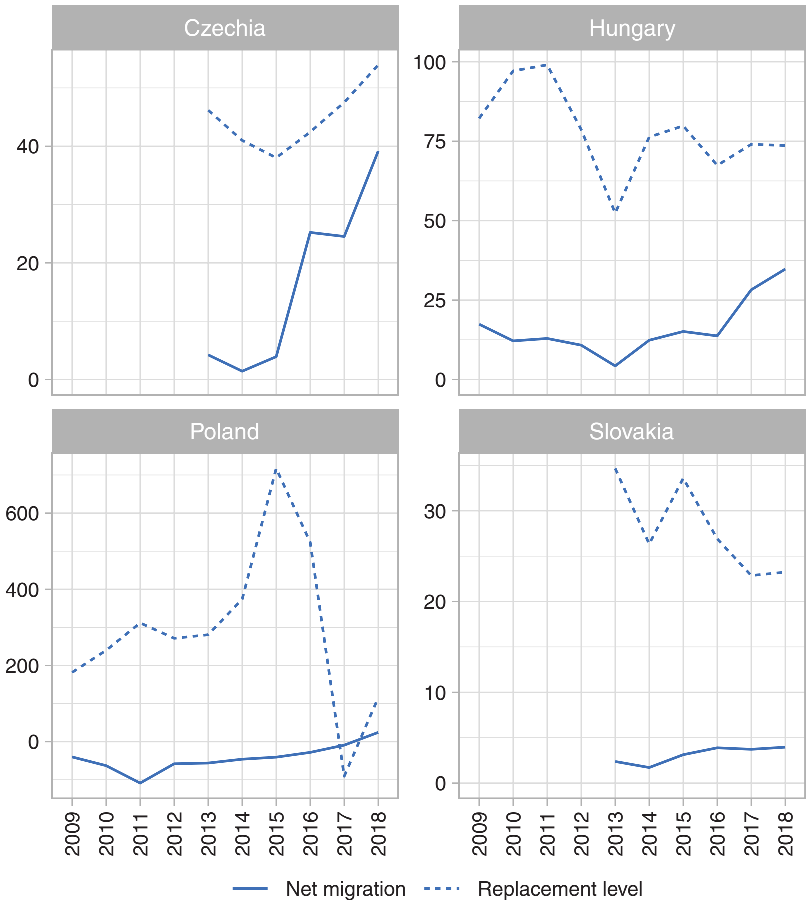
18 If fertility, mortality and net migration remains constant at 2018 levels, the population of Estonia will ultimately decrease to 76% of its 2018 size (Table 2).

19 In Hungary, recorded net migration may considerably overstate the underlying level due to the underreporting of emigration (Godri, 2020).

20 The increases occurred despite increases in the TFR and life expectancies, which, other things being equal, would have decreased the net migration replacement level.

21 In 2017, the overall negative net migration in Poland was the product of positive net migration in the young child and old age groups and negative net migration among young and middle-aged adults. The values of both P_1 and P_2 are positive because the positive net migration in the child age groups is multiplied by higher values of life expectancy and post-migration births than the negative migration in the adult age groups. Hence, scaling overall negative net migration equates the TSP with the actual population. The proportionate distribution of net migration for 2017 is, however, very different from that for other years.

Figure 6:
Net migration and net migration replacement level (000s) for Czechia 2013–18, Slovakia 2013–18, Hungary 2009–18 and Poland 2009–18

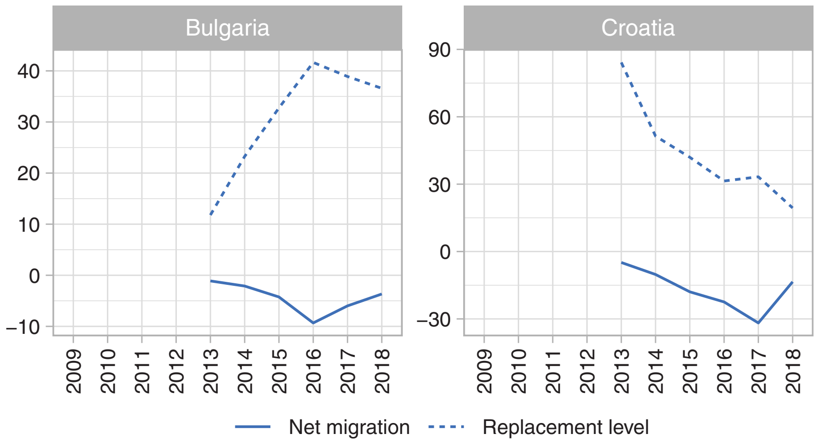


Source: Author's calculations based on Eurostat (2021).

5.7 Balkan countries

Similar to the patterns observed in Latvia and Lithuania, in Bulgaria and Croatia, net migration was negative for all of the years considered (Figure 7). In both countries, under conditions of constant fertility, mortality and migration, population size would fall to zero over the long run. In Bulgaria, the net migration replacement level in 2018 was significantly lower than the (0.66% of the population, i.e., minus natural increase) net migration level, which would have produced zero growth in that year (Tables 1 and 2). The TFR in Bulgaria fell rapidly over the 1988–1997 period to reach a very low level (1.09). While the TFR partially recovered over the 1997–2009

Figure 7:
Net migration and net migration replacement level (000s) Bulgaria 2013–18 and Croatia 2013–18



Source: Author's calculations based on Eurostat (2021).

period, it changed very little over the 2009–2018 period (Eurostat, 2020; Frejka and Gietel-Basten, 2016). The observation that the net migration replacement level in 2018 in Bulgaria was significantly lower than the level that would have immediately produced zero growth may be attributed to the latter having been affected by the impact of past very low fertility (and other factors) on the age structure, whereas the net migration replacement level was influenced by the TFR in 2018 (1.55) having been significantly higher than it was in previous years, and the value of this measure is unaffected by the population age structure. In contrast, in Croatia, the net migration replacement level in 2018 was only marginally higher than the net migration level that would have produced zero growth in that year (Tables 1 and 2).

6 Discussion

The feasibility of preventing long-run population decreases through sustained changes to immigration differs from country to country within Europe. For a considerable number of mostly northern and western European countries, the use of net migration to prevent long-run population declines would appear perfectly feasible. The recent levels of net migration in Sweden, Iceland, Belgium and Luxembourg have consistently been well above the net migration replacement levels. Assuming their fertility and mortality rates and net migration levels remain constant, the populations of these countries will grow considerably larger. In Germany and the Netherlands, a continuation of 2018 patterns would lead to population increases over the long run;

but a reversion of net migration to the lower levels observed in some of the years in the 2009–17 period would, if sustained, lead to population decreases over the long run. In Switzerland, Norway and Denmark, reverting to and sustaining net migration at certain recently observed levels would be sufficient to prevent population decreases over the long run, assuming neither fertility nor life expectancy decreases. None of these countries faces the prospect of immediate population declines.

By contrast, in all of the eastern European countries considered and in Finland and Italy, the population is projected to decrease considerably if net migration, fertility and mortality remain constant at 2018 levels. Indeed, in some of these countries,[22] extinction would occur over the long run if net migration, fertility and mortality remain constant. The populations of Estonia, Czechia and Slovakia have grown in recent years. In some of these countries that have net migration consistently below the replacement level, the influence of the age structure on natural increase means that net migration below the replacement level would suffice to temporarily prevent a population decrease in the immediate future. However, assuming fertility and mortality remain constant at 2018 levels, none of the net migration levels observed over the 2009–2018 period (if sustained) would prevent population decreases over the longer run. Nonetheless, on a per capita basis, even the highest net migration replacement level (observed in Italy) is lower than the net migration per capita recently observed in Sweden. Could any of the countries with net migration consistently below the replacement level consistently emulate the recent high net migration rates recorded in Sweden, and thereby prevent population decrease? In Italy, this would entail maintaining a level of net migration that would exceed any of the levels it recorded before the Great Recession. In most of the eastern European countries included in this study, on a per capita basis the 2018 replacement level of net migration that, if sustained, would prevent a long-run population decrease is no higher than the net migration per capita that was actually recorded in 2018 in Germany, the Netherlands and Switzerland. Whether these countries in eastern Europe, which are poorer and are often less liberal in terms of attitudes towards immigrants, would be able and willing to sustain net migration at a rate that is comparable to the rates observed in northern and western European countries, which are richer, more welcoming, and therefore more attractive to immigrants, appears doubtful (Janicki and Ledwith, 2021; Kreko and Enyedi, 2018). Moreover, given the freedom of movement within the EU, even if larger numbers of immigrants were to be admitted to these countries, many of them might not stay (Lindley and Van Hear, 2007).

The prevention of long-run population declines is not synonymous with increases in net migration: this aim could, at least in theory, be achieved by increases in either fertility or life expectancy (Parr, 2021). A resumption of the pre-Covid-19 trend of general decreases in mortality rates over time would tend to reduce net migration replacement levels. Further declines in fertility levels would increase the

22 Specifically, Bulgaria, Croatia, Latvia and Lithuania.

net migration replacement level, whereas future increases in fertility levels would have the opposite effect. This paper's results for Germany illustrate that increases in ages at birth can reduce the net migration replacement level. The recent reductions in fertility at younger reproductive ages observed in many European countries, and the related possibility that period tempo effects have distorted the TFR downwards, is one of the reasons why future increases in in the TFR in European countries should not be ruled out completely (Bongaarts and Sobotka, 2012). As was observed in Germany between 2011 and 2018, if such a 'recuperation' of cohort fertility occurred, the associated reduction in the net migration replacement level would be the product of both a 'TFR level effect' and an 'age at birth effect'. The potential contribution of the latter type of effect to preventing population decreases may not be widely recognised and warrants further investigation.

The expressed aim of a considerable number of governments of European countries to 'raise fertility' is another reason why future fertility increases should not be ruled out (UNDP, 2019b). The evidence on the effects of public policies on fertility rates appears mixed, and has been much debated in the literature (Bergsvik et al., 2021; Frejka and Zakharov, 2013; Gauthier, 2007; Parr and Guest, 2011). In the eastern European countries where net migration is positive and below the replacement level (i.e., Czechia, Estonia, Hungary and Slovakia) and in Italy, the constant TFR that, in combination with constant net migration at its current (i.e., 2018) level would produce long run zero population growth lies within the 1.78–1.99 range. In other eastern European countries, such as Bulgaria, Croatia, Latvia and Lithuania, fertility above the (NRR below1) replacement level will be needed to prevent long-run population decreases if the current negative levels of net migration continue (Parr, 2021). Given the lack of convincing evidence that public policies have achieved large and sustained increases in fertility, the prospect that fertility will increase to the required levels appears implausible in most, if not all, of these countries.

While this paper has only illustrated net migration replacement levels corresponding to certain recently observed combinations of fertility and mortality, the method may also be used to simulate what the net migration replacement level would be under other 'what if' scenarios for future fertility and mortality. For example, this paper's method may be used to simulate the stationary population sizes and net migration replacement levels corresponding to assumptions used in well-respected projections, such as those of the United Nations, or the effects of a 'recuperation' of fertility on such outcomes (Bongaarts and Sobotka, 2012; UNDP, 2019a). Such simulations have the potential to enhance our understanding of population dynamics. Indeed, the current understanding of the results of population projections may be buttressed by the comparison of assumed fertility-mortality-net migration combinations to net migration replacement levels. For example, the projected increase for the population of Sweden shown by the UNDP (2019a) medium variant could be explained by showing that it involves above replacement level combinations of net migration, fertility and mortality throughout the projection period.

This paper's method for estimating the net migration replacement level offers a number of advantages over other approaches that have been used in the literature.

First, it simply and immediately conveys the implications of the net migration level for long-run population growth; there is no need to refer to (or to run) projections to see whether net migration would generate long-run population growth. Second, this paper's estimation of 'replacement migration' is based on a flat level for net migration, as opposed to the (implausible and irregular) time-varying trajectories produced by the UNDP method (Bijak et al., 2013; Craveiro et al., 2019; UNDP, 2000). This paper's simpler trajectory for net migration may be better suited to informing public debates and deliberation on policy formulation relating to immigration levels. Third, the 'same as the current' total population scenario this paper's method considers may be more closely aligned with public perceptions of zero population growth than the zero growth of the female reproductive age population plus momentum-driven changes (more commonly increases) to the population at older ages that would occur under a cohort replacement scenario (Berelson, 1990). Fourth, unlike the cohort-based methods, this paper's method can illustrate the implications of observed year-to-year variation and simulations of plausible future changes in fertility and mortality for the net migration replacement level. Finally, this paper's method refers to the long-run sustainability of the population size, as opposed to maintaining a constant size over an (arbitrarily chosen) shorter period.

Certain properties of this paper's estimates of replacement migration are worth noting. First, in combination with constant fertility and mortality, a projection with constant replacement level net migration will ultimately approach ('asymptotically boomerang' towards) its initial size. However, the projected population size will differ somewhat from its current level in the interim. Thus, while constant net migration at the replacement level (combined with constant fertility and mortality levels) may be a recipe for little change in the population size, it is not a recipe for a perfectly flat trajectory for population size. Second, while equal in size, the stationary population generated by constant replacement level net migration has a different age structure to that of the current population. The stationary population will generally be older than the current population, because it will be shaped by current levels of fertility and mortality, which are lower than the past levels that have shaped the current population. Thus, the 'replacement' stationary population typically has fewer people in the younger age groups and more people in the older age groups than the current population. Third, this paper considers migration formulated as the difference between immigration and emigration counts (as used in population projections by, for example, the UNDP, 2019a and the ONS, 2022). This paper's method may be modified to consider the formulation of migration as a combination of the immigration counts and a rate of emigration, as used in the Eurostat (2020) projections;[23] or formulations in which immigration counts and emigration and

[23] Eurostat (2020) formulates emigration assumptions in terms of age-sex-specific rates, and further disaggregates projected emigration by destination country. While assumed immigration by age and sex is independent of the number of immigrants by age and sex in the destination country, it is dependent on the projected emigration by destination country. The net migration replacement level is a measure that is based on data for a single year: i.e. it is not a projection.

fertility rates differ between the foreign-born and the native-born (Feichtinger and Steinmann, 1992; Rogers, 1990).

While the value of the net migration replacement level is derived from real and recent data, as with other synthetic measures, such as period life expectancy at birth, the TFR and the net reproduction rate, the interpretation of its value assumes hypothetical future stability in all data input values. As is the case for any other pre-specified scenario for the long-run future, fertility and mortality are highly unlikely to remain stable at the recently observed levels. Nonetheless, for demographers to just vaguely refer to the possibility that some positive net migration level could counterbalance the effect of below replacement level fertility on population size, without providing any indication of what that level might be, would not be particularly useful to public debate or deliberation on policies relating to population decreases. Furthermore, in the absence of quantification, inappropriate or even alarmist characterisations of the migration level that would prevent population decrease in the absence of a TFR close to the replacement level may pass without due scrutiny. This paper's results offer not only a quantification, but also international contextualisation of the requisite levels. For example, rather than being characterised as 'massive', as has been done, for example, by Demeny (2016), the net migration that would prevent long-run population decrease for any of the countries covered in this paper may be seen as 'on a per capita basis no greater than the typical (pre-Covid-19) levels of net migration of Sweden, Canada and Australia' (UNDP, 2019a). When seeking to answer the question of whether the replacement migration level of Italy, for example, is 'unmanageable', it might be useful to consider the apparent success of the management of such per capita levels of net migration in these other countries (Gesano, 1994).

While it is hoped that the presentation of net migration replacement level in this paper will enhance the understanding of population dynamics for the populations it has considered, it should not be assumed that the replacement level is necessarily the most desirable level for net migration, or that the 'optimum' population size is the current population (Parr and Guest, 2014; Striessnig and Lutz, 2013). The social evaluation of migration levels should extend beyond a consideration of their implications for the trajectory of population size to also take into account their implications for a range of other population-related outcomes, including age structure, spatial distribution, human capital, labour force participation and productivity (Lutz and Gailey, 2020; Guest and Parr, 2020; Parr and Guest, 2020). In theory, such evaluations should consider a wide range of both economic and non-economic (e.g., environmental) aspects of the effects of migration on human (and, some would argue, other species') wellbeing, the impact of migration on both the origin countries and the destination countries of migrants, how the differing effects of migration on different population subgroups (particularly disadvantaged subgroups) and intergenerational equity are weighed up, and how these effects are considered across long periods of time (Parr, 2018). Such broader considerations are beyond the scope of this paper.

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