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Predicting a Migration Transition in Poland and its Implications for Population Ageing

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Poland, traditionally a country of emigration, started to record a positive migration balance in recent years. However, thus far, no forecast has indicated the possibility of Poland's transition from a net sending to a net receiving regime. This study indicates the theoretical underpinnings of such a change and provides an international migration projection. To this end, we refer to the historical experiences of other European countries, more advanced in terms of the Demographic Transition (DT), Second Demographic Transition (SDT) and Migration Transition. We develop a deterministic migration projection of four types of flow (the in- and out-migration of nationals and foreign citizens) up until 2060, combined with the United Nations' Bayesian probabilistic models of fertility and mortality projections. The results show that Poland will evolve from having a net sending to having a net receiving status around 2030–2034. The combined effect of migration flows on population ageing will not be significant but, in the long run, when considered separately, the four types of flow will have non-negligible, though opposite, effects: the outflows will contribute to population rejuvenation, while the inflows will accelerate population ageing.

Keywords: population ageing, international migration, migration projection, demographic transition, migration transition, Poland

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Introduction

In his seminal study on demographic transition (DT), Chesnais (1986, 1992) proposed the theoretical concept of the migration transition (MT) to describe how the international migration balances of Western European countries switched from negative to positive. In his view, the mass overseas emigration in the second half of the nineteenth and at the beginning of the twentieth century relieved the population pressure that had arisen as a result of the high natural increase during the DT. In the second half of the twentieth century, the low demographic dynamics and advanced population ageing during the second demographic transition (SDT) in Europe incited, according to Van de Kaa (1999, 2004), a constant inflow of foreigners. Indeed, all countries considered by the United Nations (UN) as Western[1] and Northern[2] European have registered positive migration balances since the early 1960s or the 1970s, respectively (United Nations 2019) and, alongside the low or negative natural increase rate, immigration became the main driver of population growth (Coleman 2008).

The post-communist countries of Europe, on the other hand, had been subject to severe restrictions on international mobility under the communist regime and, when these restrictions were lifted in the 1990s, this immediately prompted considerable emigration from many of them. In the post-communist countries of the European Union[3] (EU), this outflow was primarily stimulated by the opening of the labour markets of other EU member states to these countries' citizens (Bruecker *et al.* 2009; Salt and Almeida 2006). This situation is changing rapidly, though, and an increasing number of these countries – Czechia and Hungary in the early 2000s, Poland, Slovakia and Slovenia in the 2010s – have become migration destinations for substantial numbers of foreigners (Drbohlav 2012; Kaczmarczyk and Okólski 2008; OECD 2019). Since February 2022, an unprecedently massive inflow of Ukrainian war refugees to Poland, Czechia, Slovakia and the Baltic States has been taking place. At this point, little can be said on how permanent this inflow will be. Nevertheless, this development strengthens the argument that a MT may soon occur in this part of Europe. Meanwhile, the existing projections of international migration (European Commission 2019; United Nations 2022) contain no indication of reversal in the hitherto observed trends, such as a transition from the 'net sending' to a 'net receiving' status of Poland. The reason is that, with one important exception (Wiśniowski *et al*. 2012), most projections are based on net migration rates, instead of on their components: immigration and emigration.
In this study, we adopt the perspective of long-term population processes and ask:

(Q1) What are the major implications of the DT and SDT[4] for the trends in international migration?

Then, focusing on Poland, the largest post-communist EU member state in terms of population, we ask:

(Q2) What lessons for the future of migration in Poland can be learnt from the historical experiences of other European countries, in particular those more advanced in DT and SDT?

As changes in population age structure are to intensify immigration in the late phase of the MT, we investigate:

(Q3) In what way will the different migration flows affect the ageing of the population of Poland over extended timeframes, given that Poland follows other European countries in MT?

To answer these questions, we establish a population projection for Poland with a detailed international migration component consisting of four flows – i.e. the inflows and outflows of nationals and of foreign citizens – each of which is potentially determined by different factors. Furthermore, distinguishing between the different migration flows allows us to identify the separate impacts of emigration and immigration on a population's age structure; this has never been investigated before as most studies concerning historical populations are based on net migration. We conclude that, depending on the advancement of MT, inflows and outflows exert opposite impacts – favouring either population ageing or rejuvenation – and may neutralise each other, which makes the net effect marginal but does not mean that migration does not affect population ageing in the long term.

Theoretical background

Demographic transition and long-term migration trends in European countries

Without formulating a precise definition, Chesnais (1986, 1992) developed the concept of MT in reference to a historical experience of European countries undergoing the process of DT. According to Chesnais, MT depends strictly on changes in natural increase during DT and is subject to two phases: in the first, emigration exceeds immigration and the migration balance is negative (the net sending phase); in the second, immigration exceeds emigration and the migration balance is positive (the net receiving phase).

According to Chesnais, mass emigration in the first phase of the MT was a salient and neglected factor in the European demography of the nineteenth century. In the times of high demographic dynamics during DT, mobility within countries, within the continent and overseas, emerged as a phenomenon diminishing population pressure in the rural areas and contributing to economic development, notably industrialisation and urbanisation. This way of reasoning falls into a wider domain of research on the so-called hidden unemployment ('overpopulation'), prevailing in agricultural regions with high natural increase (Davis 1963; Livi-Bacci 1972; Magnussen and Siqveland 1978; Moe 1970; Quigley 1972; Wilkinson 1970). For instance, Moore (1945) analysed the relation between productive capacities and population growth in agricultural areas in Eastern and Southern Europe pre-World War II (WWII). As the tempo of industrialisation was insufficient to absorb the surplus population from rural areas, where high natural increase prevailed, he viewed emigration as a direct 'safety valve' serving to neutralise the disequilibrium between the demographic regime and the economic system. Similarly, in his theory of change and response, Davis (1963) postulated that emigration constituted one of several possible adjustments to declining infant mortality and sustained natural increase in the early phase of DT. While city dwellers adopted relatively early contraceptive methods because high fertility 'was handicapping them in their effort to take advantage of the opportunities being provided by the emerging economy' (1963: 352), farmers continued to have numerous offspring and to send their children away once they become adults.

The scale of this migration can be roughly estimated only in reference to the flows leaving the European continent: the number of emigrants leaving the countries of origin between 1816 and 1914 was approximately 44 million (Baines 2003), whereas the number of immigrants registered in the main overseas destinations amounted to 52 million (Baines 2003; King 1996). As Okólski (2012a) points out, the latter estimate constitutes a quarter of the entire natural increase observed in Europe at this epoch (based on Chesnais' estimates). The scale of this international mobility becomes even greater if we allow for mobility within the continent: as population surpluses emerged according to the onset of demographic transition, first in the North and West and later in the South and East, industrial sectors in the pioneering countries in Europe attracted labour migrants from countries that lagged behind in economic terms. For instance, between 1876 and 1920, almost half of Italian emigrants, nearly 7 million persons, migrated within Europe – mostly to France, Germany and Switzerland (Castles and Miller 1993). England became a destination for Irish migrants (MacRaild 1999), whereas Germany attracted migrants of Polish origin (Herbert 1986; O'Brien 1992).

Detailed investigations of the emigration from Europe overseas revealed the periodic character of flows (Chesnais 1986). In his seminal study, Kuznets (1930) distinguished several waves of migration from Europe to the United States, succeeding in the nineteenth century every 15 to 25 years. In his interpretation, these waves were originally brought about by the cotton production growth in the US while, later, they were enhanced by the infrastructure investment 'swings' in this country, thus enhancing the periods of economic growth. Other authors also underlined the importance of better economic opportunities in the destination – in particular, higher incomes and lower unemployment – for European emigration (Gallaway and Vedder 1971; Jerome 1926; Kelley 1965; Richardson 1972). However, Thomas (1954) reversed Kuznets' reasoning and noticed that, as investment swings occurred simultaneously in the US and other important destinations, they all resulted from structural conditions 'pushing out' migrants from their countries of origin. He claimed that the first wave of massive emigration, taking place in 1844–1854, resulted from a baby boom in the 1820s that had compensated for the low natality in the period of the Napoleonic wars and contributed, 20 years later, to a considerable increase in the number of young adults.

Several scholars found a statistical relation between the surge in natural increase and time-lagged waves of overseas emigration from Europe, which particularly applied to the flow into the US until WWI, when no severe immigration restrictions were imposed. The overseas migration from Europe appeared to be strongly related to prior population dynamics; according to studies for Norway and Sweden (Ravnholt 1937; Thomas 1954) and other European countries (Easterlin 1961), surges in natural increase in these countries were followed by emigration waves to the United States and other destinations in the 'new world' some 20–25 years later. As shown for 12 Western European countries, this statistical relation prevailed independently from economic factors, such as international wage disparities (Hatton and Williamson 1998).

In the post-WWII period, many European countries registered a positive migration balance systematically. This began in the western and the northern and, later, occurred in the southern, part of the continent (King and Okólski 2018; Okólski 2012b). However, contrary to the first 'emigration' phase of MT, which has unequivocally been interpreted by Chesnais and other authors as a response to high demographic dynamics during DT, the root causes of transition from a net sending to a net receiving status are not viewed unanimously. Chesnais (1986) emphasised its demographic determinants: low natural increase in Europe and simultaneous population growth in less-developed countries outside Europe. Other authors referred to the economic circumstances in Europe from the 1950s onwards, such as the economic boom related to the post-war reconstruction (Bonifazi 2008; Frey and Mammey 1996; Kaya 2002; Salt, Singleton and Hogarth 1994), the global flow of international capital towards more developed countries (Castles and Miller 1993) or the increased segmentation of labour markets and unsatisfied demand for low-skilled workers (Van Mol and de Valk 2016). According to Fassmann and Reeger (2012), immigration responds to growing labour deficits related to population ageing. The most frequently cited political causes are the 'return' or 'repatriation' of nationals due to decolonisation (Bonifazi 2008; Kaya 2002; Salt *et al*. 1994; Van Mol and de Valk 2016), the violation of human rights and the restriction of personal freedom in non-democratic countries (Frey and Mammey 1996; Kaya 2002; Van Mol and de Valk 2016) and the positive political climate with regard to immigration (e.g. Bonifazi 2008). However, almost all explanations tacitly admit that, in the early post-WWII decades, many European countries suffered from a relative deficit in the native labour force.

The concept of DT and its widely recognised and crucial outcome – population ageing – are very rarely associated with MT. Only occasionally is the latter considered to be an integral element of DT; the voice of Van de Kaa (1999, 2004), who incorporated the migration component into a wider European framework of DT and SDT, went almost unnoticed. In his view, international migration redresses the imbalance between natality and mortality during both the DT and the SDT – and inflow from abroad becomes an intrinsic element of demographic patterns in contemporary European countries.

In what follows, we adopt this specific interpretation of MT. We concentrate on demographic factors inciting immigration in a constant and inherent way, underlining the importance of low fertility and the increasing proportion of older individuals. In the empirical analysis that follows, we investigate whether the above-mentioned demographic phenomena will provoke Poland's turn from a net sending to a net receiving migration status, first due to a decrease in the outflow and then to an increase in the inflow, as happened in European countries which were more advanced in DT and SDT.

The impact of international migration on population ageing during MT

International migration may be viewed as both a result and a determinant of the process of population ageing. In the stylised model of DT, this process is mainly driven by fertility decline as the latter not only puts an end to the growth in the youngest population segments but also neutralises the rejuvenating effect of infant mortality decline observed in the early phase of DT (Coale 1956). However, as fertility stabilises during DT and SDT, ageing is intensified by declines in adult mortality, particularly for the oldest age groups (Bengtsson and Scott 2010; Horiuchi 1991; Preston and Stokes 2012). Murphy (2017) showed that, in Western Europe, the process of ageing evolved from being fertility-driven to being mortality-driven shortly after WWII. For a number of reasons as we have discussed elsewhere (Fihel, Janicka and Kloc-Nowak 2018), the role of international migration has been investigated less than the roles of fertility and mortality. Changes in international migration, however, do have a direct and immediate impact on the age composition of the populations of both origin and destination, mostly because mobility is a highly selective phenomenon with regard to age: young working-age people are more prone to migration than their juniors and, especially, than their seniors (Rogers and Castro 1981).

As DT progresses, changes in fertility and mortality affect the age composition of a population in a clearly patterned manner, depending on the phase of the transition. Similarly, the impact of migration seems to be strongly dependent on the advancement of DT and MT. Initially, when fertility is still high and the proportion of children increases, an growth in the emigration rates of young adults contributes to the rejuvenation of the age structure, as long as the mean age of emigrants exceeds that of the general population. Later, however, when natality declines and the mean population age rises, an outflow reduces the proportion of young adults in the population, indirectly increasing the proportions of other segments and negatively affecting the number of new births. This contributes to population ageing. When emigration and immigration reach equivalent levels, marking a turning point in the migration balance, the effect of migration becomes increasingly sensitive to differences in the age composition of emigrants and immigrants. Given that both flows are likely to consist mostly of young working-age persons, however, this effect might be close to neutral.

The increase in immigration during the MT and its age selectivity ensure 'gains' in the mobile-age population, which initially slows down population ageing. However, the long-term effect of positive net migration depends on its intensity (whether it grows, declines or stabilises) and the inclusion of the descendants of immigrants; if we allow for the first generation of a foreign-born population only, the instantaneous rejuvenation effect is replaced by the opposite effect as soon as migrants start to age. If, however, we also consider the appearance of the descendants of first-generation immigrants, the impact on the age composition also depends on the difference between the fertility levels of the foreign-origin population and the native population (and its persistence).

The stable population model and long-term projections show that, if immigrants adapt their fertility to that of natives, immigration would have to increase incessantly in order to have any effect on the population age structure (Coale 1986; Espenshade1994) and to counteract the ageing process (Bijak, Kupiszewska, Kupiszewski, Saczuk and Kicinger 2007; United Nations 2001). If immigrants originating in less-developed countries maintain the fertility levels of their home country, which is highly improbable in the long term, they may significantly contribute to natality and population rejuvenation (Feichtinger and Steinmann 1992; Jonsson and Rendall 2004). In low-fertility countries, the young native population has shrunk so much that, in line with the mechanism of inert momentum, immigrants and their descendants are becoming an increasingly important reproduction factor (Ediev, Coleman and Scherbov 2014; Lutz, O'Neill and Scherbov 2003; Wilson, Sobotka and Williamson 2013).

Although several exceptions can be distinguished, empirical studies for European countries and the US[5] have confirmed the stylised relations between migration and ageing described above. In the net sending phase, negative net migration exerted a rejuvenating, albeit minimal, impact in Western Europe: in the first quarter of the twentieth century, the mean population age in this region increased by 2.09 years but the net migration component acted in the opposite direction and accounted for -0.56 years of the mean population age change (Murphy 2017). This effect was larger and longer in two countries with particularly intensive outflows – Sweden and Norway. Several decades later, immigration quotas introduced in the US after WWI led to a significant increase in the older population in Sweden – a sending country (Murphy 2017; Preston, Himes and Eggers 1989). Similarly, in Italy, the number of persons aged 60 and older considerably increased between 1952 and 1986, because the cohorts aged 60+ in 1952 had had more political freedom to emigrate during their lifetime than those aged 60+ in 1986 (Caselli and Vallin 1990).

In the net receiving phase, if we allow for both arriving persons and their descendants, positive net migration slowed down the increase in the older segment of the population (Lanzieri 2013; Preston and Stokes 2012). In Sweden, the positive net migration was found to restrain the increase in the proportion of older persons by the year 2000 (Bengtsson and Scott 2005) whereas, in the US, immigration had a rejuvenating effect on the population's age composition until the 1950s (Notestein 1960). The same effect was observed between 1975 and 2012 in Western Europe (Murphy 2017) and between 1948 and 1988 in France, although it became weaker towards the end of the 1970s when the inflow diminished (Dittgen 1992; Murphy 2017).

All the studies discussed above are based on the net migration component and present only the combined effect of inflow and outflow. Moreover, to the best of our knowledge, there exists only one analysis of the impact of international migration on population ageing that includes countries in Central or Eastern Europe and it is also based on the net migration concept (Philipov and Schuster 2010). Historical sources on demographic events in Central and Eastern Europe are scarce, since few records of such events were kept and even fewer have been preserved to this day. Of those that did survive, many concern populations which, due to the changes in borders and statehoods following WWI and WWII, are ethnically and nationally incoherent with the contemporary societies of Europe. In the third section, we investigate how international migration affects the process of ageing in Poland and, to this end, we separate the contributions of emigration and immigration that may be driven by demographic and other factors.

Disturbed course of MT in Poland

When a large body of research on agrarian 'overpopulation' started to develop after WWI, scholars from Poland made important methodological and empirical contributions to these studies (Mincer 1944; Poniatowski 1936) and not without reason.[6] In Poland, during the period of most intensive population growth – that is, in the 1920s and 1930s – the migration potential found no outlet abroad due to the immigration restrictions gradually imposed by the main hitherto receiving countries. Although the demographic potential of Poland was reduced by 40 per cent during WWII (Okólski 2002), it was restored in the postwar decades due to relatively high fertility. In 1948, international mobility became strictly controlled and suppressed

– practically making Poland a ‘non-exit country’ – and the only emigration of a permanent nature concerned persons of German or Jewish ethnicity (Iglicka 2001, 2019).

After the introduction of martial law in 1981, Western European countries began to recognise Polish nationals as politically oppressed and to apply relatively liberal asylum procedures to those who managed to reach Austria or West Germany under the guise of tourism. Long-term emigration along this route amounted to almost 1.1 million individuals in the 1980s (Sakson 2002) and continued throughout the 1990s, though on a smaller scale. The population census conducted in 2002 revealed that 626,000 persons, still registered as permanent residents of Poland, had been living abroad for more than a year at the time of the census. A real exodus followed Poland’s accession to the EU in 2004, when Poles were granted, immediately or following transitory restrictions, full rights to settle down and work in other EU member states. Between 2004 and 2018, as many as 326,600 persons officially de-registered from the place of permanent stay in Poland,[7] whereas the stock of emigrants who had not registered their departure increased from approximately 1 to 2.5 million (Statistics Poland 2018). Nevertheless, unlike Western European countries which recorded mass emigration during a time of high natural increase, the outflow from Poland occurred under specific circumstances characteristic of SDT (Brzozowska 2021; Kotowska, Jóźwiak, Matysiak and Baranowska-Rataj 2008; Sobotka 2008): very low fertility, an increasing proportion of older persons and a natural increase fluctuating at around zero.

In the most recent years, notably in the second decade of the twenty-first century, stable economic growth and increasing labour shortages due to massive outflow abroad created perfect circumstances for labour immigration, initially in low-paid household services and seasonal work in agriculture and construction and, later, in other economic sectors as well (Górny and Kaczmarczyk 2018; Górny, Grabowska-Lusinska, Lesińska and Okólski 2010). Poland has recorded a positive net migration balance for registered migration[8] since 2016, while Eurostat assessments of long-term net migration rates have changed sign since 2019. Furthermore, Poland has lately been issuing the highest number of first residence permits to foreign nationals in the entirety of the EU (Eurostat 2019). All this suggests that it is very likely that Poland is currently undergoing a turn in its migration regime.

Methodology

Population projection

Our population projection for the period 2015–2060 is based on the Bayesian framework established by the United Nations Department of Economic and Social Affairs. We use the World Population Prospects probabilistic models for fertility and mortality (Alkema, Gerland, Raftery and Wilmoth 2015), along with the provided estimation tools (Sevcikova, Raftery and Gerland 2013). Our projection for Poland significantly differs, however, from that prepared by the UN. First, we use different historical population numbers and structures to allow for migration that has been taking place since the 1980s without being noted in the population register (see Annex 1) and adjust the values for Total Fertility Rate (TFR) and life expectancy at birth in accordance with these population numbers. Second, we introduce a more elaborate projection with regard to international migration; instead of smoothing the net migration figures to zero within the projection horizon, we develop an econometric model of different types of migration flow. The models are described in more detail below and in Annex 2; at this point, it is worth noting that the migration projection is deterministic. Despite some attempts (Azose and Raftery 2015), probabilistic models of migration were not incorporated in any official UN population forecast revision as of 2023. Finally, the horizon of the projection is shortened compared to the UN population forecast and set at 2060, for two reasons. Although we do not formally quantify the uncertainty of the migration projection with probabilistic tools, it is obvious that projections with a longer horizon are associated with a larger potential error. Also, the migration projection relies on economic predictions for the variables used in the models and these predictions are generally much more short-term than demographic forecasts.

Migration projection

Although exogeneous disturbances (Brexit, the COVID-19 pandemic, the war in Ukraine) certainly affect the course of international mobility, we expect that, in the long run, migration flows will be largely determined by general demographic and economic circumstances. A similar approach is adopted, for example, in the United Nations (2022) projection, where pre-COVID-19 migration trends were used to forecast (net) migration in the long run.

Our projection is grounded on the concept of MT: we make use of the developments that countries at more advanced stages of this transition underwent in order to forecast a reversal in the observed migration trends (from a negative migration balance to a positive one) in Poland. We apply a deterministic approach; in the first step, we estimate panel models for EU countries[9] to determine the common pattern (panels being the most suitable tool for this purpose, see Annex 2) and, in the second, we extrapolate the results into the future for Poland.[10] These models enable us to capture the general relationships observed in recent history in the entire sample of countries at different stages of the MT (for West, North, South and, eventually, East Europe), as well as to take into account the perhaps unobservable specifics of each country. Data for the 30 other European countries form an unbalanced panel for the years 1998–2014.[11] The objective was to construct empirically grounded models which would be flexible enough to show MT in response to economic and demographic variables, without the need to first explicitly specify the predicted paths.

Migration data for Poland (2004–2014), corrected to allow for actual, rather than registered flows, were presented and discussed elsewhere (Fihel *et al*. 2018). As different types of migration flow in a given country are driven by a variety of factors, we analysed four types of flow: the in- and out-migration of both country nationals and of foreigners, based on the Eurostat migration database. The choice of explanatory variables for the models was constrained by theoretical considerations and limited data availability: we were only able to use those variables for which forecasted values of explanatory variables existed or could be estimated for Poland within the time frame of the projection. The potential set of determinants was narrowed down to two basic economic variables: the Gross Domestic Product (GDP) – based on the OECD (2014) forecast – and the level of unemployment, based on the European Commission (2015) forecast, together with demographic variables (which could be computed step by step from our population forecast). The latter set initially included factors that may affect the migratory potential of individual countries, such as the percentage of the mobile-age population (20–39 years), the natural increase rate and birth rate and factors affecting the labour-market situation – i.e. the old-age dependency ratio (OADR) and the proportion of individuals of post-productive age, as well as past values of migration rates. Of these variables, in view of the MT perspective we adopted, the birth rate or the natural increase rate (when low) or the OADR, combined with migration rates, may be treated as an indication of the advancement of the MT within the DT and SDT. Therefore, an attempt to incorporate such demographic variables into the model of migration will also provide an answer to our first research question about the implications of DT and SDT for the trends in international migration.

Our approach does not differ from the general trends in migration modelling for Europe (cf. a review of models in Bijak 2011), in that we include exogenous economic predictors (push–pull factors) and account for the endogeneity of the time-varying processes[12]. Based on MT considerations, we additionally include demographic determinants of international flows. This synergic approach is in line with Bijak's (2011: 51) suggestion that 'migration forecasting should ideally be model-based, rather than follow any particular theory', since individual migration theories cannot describe migration flows in their whole complexity.

The decomposition of population ageing

To investigate the demographic determinants of the process of ageing – changes in natality, mortality and international migration – we apply the model of age-specific growth rates (Horiuchi and Preston 1988) based on earlier work by Preston and Coale (1982). In the discrete version of the framework by Preston *et al*. (1989), changes in the mean population age, A_p (captured by the derivative with respect to time), can be decomposed as follows:

$$\frac{dA_p}{dt} = \sum\nolimits_{x=0}^{\omega} r(x,t)c(x,t)\left(x - A_p(t)\right), \quad (1)$$

where $r(x, t)$ denotes the rate of growth of the population aged x at time t and $c(x, t)$ denotes the proportion of the population aged x at time t. We express the rate of growth of the population aged x between t and $t+1$ specifically (Fihel *et al.* 2018):

$$\begin{aligned} r(x,t,t+1) = \ln\frac{B(t-x+1)}{B(t-x)} + \ln\frac{p(x,t-x+1)}{p(x,t-x)} + + ln\frac{o^N(x,t-x+1)}{o^N(x,t-x)} \\ + ln\frac{o^F(x,t-x+1)}{o^F(x,t-x)} + ln\frac{i^N(x,t-x+1)}{i^N(x,t-x)} + ln\frac{i^F(x,t-x+1)}{i^F(x,t-x)}, \end{aligned} \quad (2)$$

where $B(t–x)$ denotes the number of births during the year ending at time $t-x$ and $p(x, t–x)$ denotes the fraction of the cohort born during the year ending at time $t–x$ that survived until time t; $o^N(x, t–x)$ and $o^F(x, t–x)$ denote the factor by which the cohort of nationals and foreign citizens, respectively, born during the year ending at time $t–x$, changed in size until time t due to outflow. Similarly, $i^N(x, t–x)$ and $i^F(x, t–x)$ denote the factor by which the cohort born during the year ending at time $t–x$ changed in size until time t due to inflow, after accounting for outflow. Changes in international migrants' numbers due to their mortality are embedded in the i factor, whereas births to immigrants are included in B (births). For the sake of simplicity, we assume that migrants are subject to the same mortality and fertility conditions as the non-mobile element of the population.

The model of age-specific growth rates requires longitudinal data tracking the cohorts from birth to old age. However, because reliable data about demographic events in Poland are only available from 1920 onwards (Annex 1), we were obliged to restrict our analysis to the Polish population born in 1920 or after. We chose to carry out our analysis for the period from 2010 to 2060, meaning that this research excludes people who were older than 90. While it is true that this age category significantly affects the overall process of population ageing[13], we do not believe that excluding this category jeopardises the validity of our results, as we expect the contribution of migration to the highest age groups to be negligible: the largest outflow of migrants from Poland in the present century consisted of persons born in the early 1980s and immigrants to Poland were primarily born in the 1990s or later. In short, even by the end of our projection window in 2060, the majority of immigrants and emigrants from Poland will have yet to reach the age of 90.

Results

The turnover in migration balance

The coefficients of the explanatory variables in the migration models have intuitive effects on the modelled flows (Annex 2), in particular:

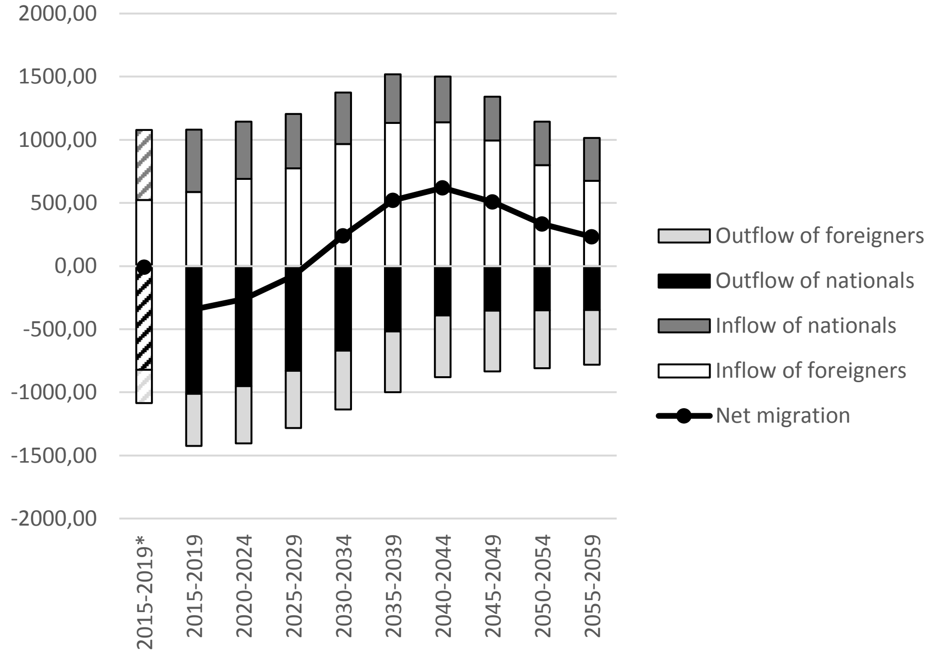
- the emigration of nationals depends positively on the unemployment level in the sending country and the GDP gap relative to the average in main destinations in the EU, and has autoregressive internal dynamics;
- the immigration of nationals (i.e., return migration) depends positively on the GDP growth rate in the receiving country, as well as on the magnitude of previous flows of nationals (in both directions);
- the immigration of foreigners depends positively on the GDP level and growth rate in the receiving country and negatively on the unemployment level. It also depends on demographic characteristics (in particular, negatively on the net increase rate in the receiving country), is higher for EU15 countries and has autoregressive internal dynamics; and
- the emigration of foreigners depends positively on the magnitude of previous flows of foreigners (in both directions).

As far as the demographic determinants were concerned, the best fit was obtained in the model for immigration of foreigners (the natural increase rate and the OADR). On the one hand, this may be attributed to the fact that historical trends in emigration outbursts from the majority of countries (in particular, Western European countries) were not accounted for in the studied period (from 1998 onwards). On the other hand, this result underlines the importance of the immigration of foreigners as a turning point in the course of the MT. Of the two demographic variables, the natural increase rate was the more important factor, with a strong negative effect: the lower the natural increase, the higher the inflow of foreigners. Combined with a positive autoregressive term of the immigration rate, this accounts for initiating inflow and sustaining it once the host country reaches a certain phase of the DT/SDT. On the other hand, a negative effect of the OADR means that, in the long run, once the share of older population groups grows significantly, immigration flows will stabilise and even decrease. This negative sign of the OADR variable may, in view of our research question, be explained by the simultaneous importance of a dummy variable describing EU15 countries, as all these countries are at a more advanced stage of the DT.

For clarity of presentation, in what follows we focus on the migration scenario corresponding to the median population forecast although the results for other plausible quartiles remain similar (see Annex 2): they indicate a transition from a net sending to a net receiving migration regime in the same period. Interestingly, the migration flows have a ‘stabilising’ effect with regard to the population forecast due to the fact that they are strongly correlated with the natural increase rate in the receiving population: lower fertility and higher mortality combinations – which lead to lower population levels – coincide with higher net migration, while higher fertility and lower mortality combinations – which lead to higher population levels – coincide with lower net migration flows.

Our estimates of Polish emigration for the period preceding the projection include 1.7 million in 2005–2009 – immediately following the country’s accession to the EU – and 1 million in 2010–2014. Within the projection horizon, the outflow of Poles is expected to gradually decrease, starting from values of approximately 1 million per 5-year period, down to one third of the value for 2055–2059 (Figure 1). Return migration is also expected to decrease, albeit at a much slower pace. Meanwhile, the flows of foreigners to Poland are expected to double until the period 2035–2044, after which inflow is expected to gradually decrease. The outflow of foreigners is expected to remain stable. Overall, the results of the modelling procedure suggest that Poland is currently undergoing a transition in its migration regime; the turning point from a net sending to a net receiving phase would be expected to occur by 2030 (had the flows not been disturbed by recent developments). In subsequent years, an increase in net migration is predicted, after which the intensity of migration is expected to diminish. The projection shows a rapid transition from the net sending to the net receiving phase: the period of the highest immigration (2035–2039) is expected to occur only 25 years after the period of highest emigration (2010–2014). Instead of emigration reaching zero, followed by gradually increasing immigration, as we have seen in Western European countries, we predict that Poland will experience an MT with high inflows and outflows throughout its course.

Figure 1. Estimated migration flows for Poland, median result of forecast, 2015–2060 (5-year totals in thousands)



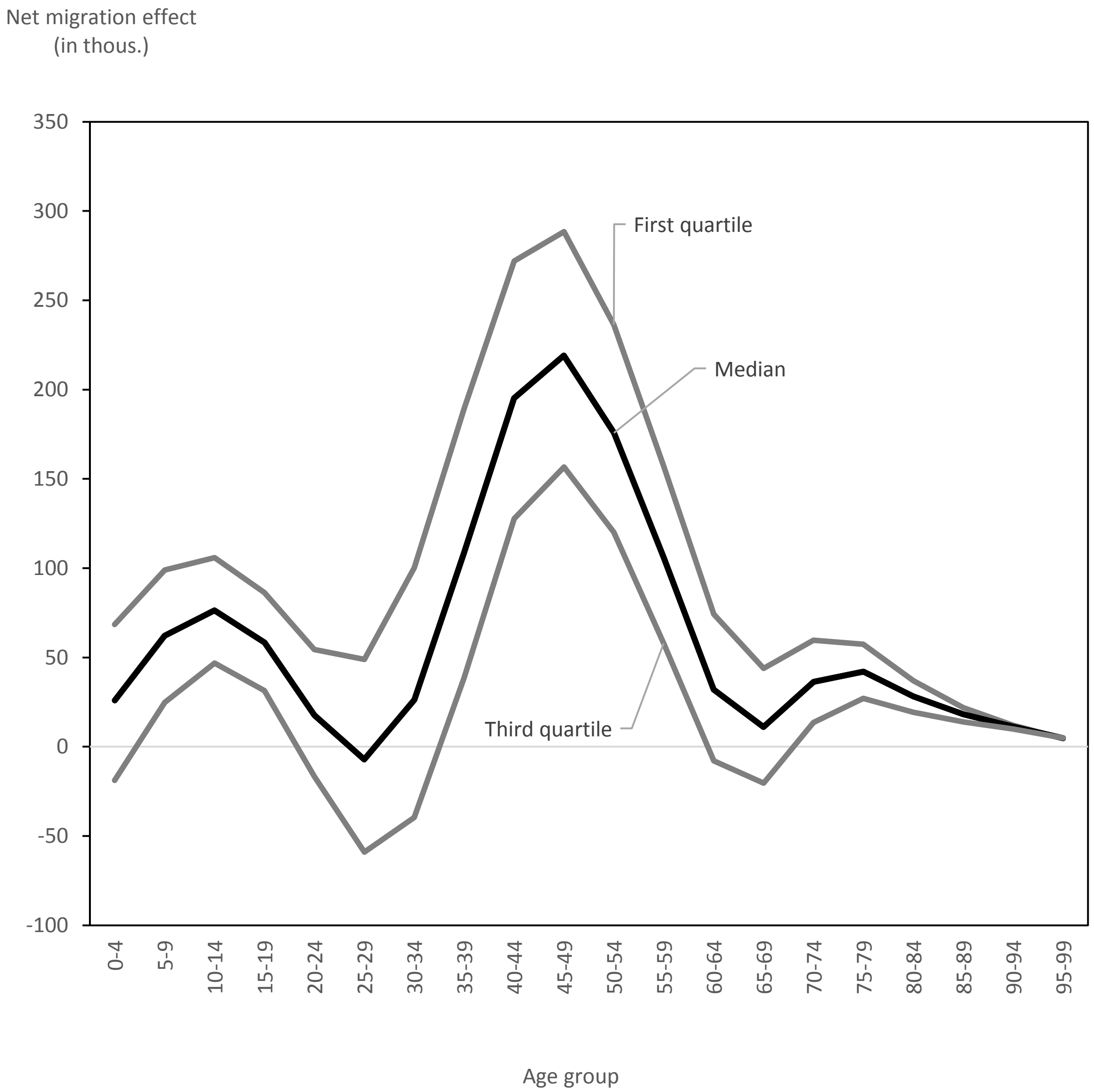
Source: Authors' own estimates.

Note: The striped bars correspond to the current assessment of actual migration flows for 2015–2019.

A comparison of the flows projected by the model for the period of 2015–2019 with actual Eurostat figures (which show a slightly negative migration balance) yields the conclusion that, in our models, the mechanisms of the inflows during this period were captured very well. Higher differences are noted for outflows; this, to some extent, may be attributed to a sharp decrease in emigration to the UK in the later years, in view of the approaching Brexit.

Obviously, expected MT will affect the population size and age structure. A comparison of the proposed projection with a zero-migration (from 2015 onwards) projection yields the conclusion that, within the horizon of 2060, expected future migration accounts for an increase of 7, 4 and 2 per cent for the first, median and third quartile projections of population size, respectively. This effect is therefore considerable, especially in the scenario corresponding to the first quartile projection, where migration compensates for low natural increase (Annex 2). The impact of migration on the population structure is not uniform across the age categories. In 2060, migration contributes most to the working-age group (20–64): depending on the projection quartile, this age category's increase as a result of migration is 15, 6 or 2 per cent relative to the no-migration scenario (Figure 2). In other age categories, the effect of migration is much less pronounced; in certain instances, there is no visible effect at all and even a slightly negative one. However, by only looking at the aggregate changes due to migration flows, we are unable to distinguish the impact of specific migration flows on the population's age composition. We therefore conduct an analysis investigating the changes occurring in age-specific categories and decompose the process of ageing into six components: natality, mortality and four types of migration flow.

Figure 2. Estimated net effect of post-2015 migration on the population size in 2060 (in thousands), by age group

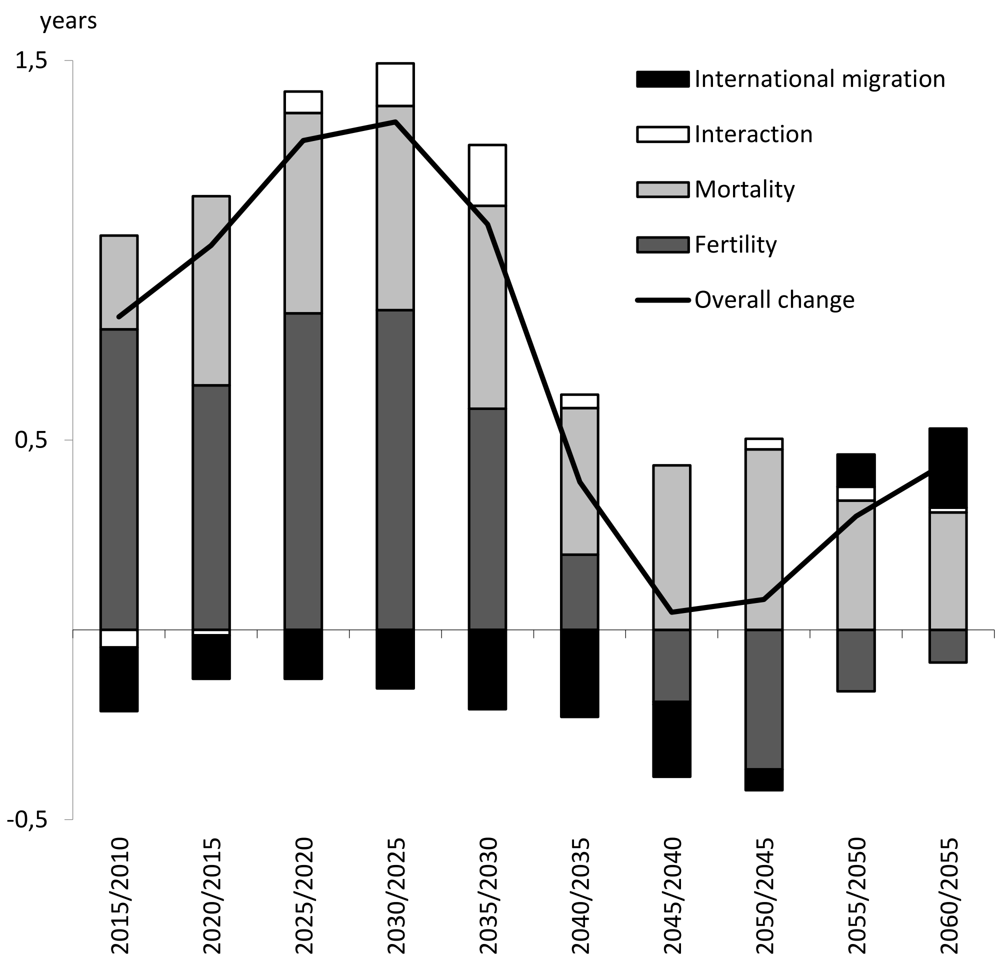


Source: Authors' own estimates.

Population ageing during the MT in Poland

All results presented in this section are based on the median scenario of the projection. Population ageing, operationalised as an increase in the mean age of the population aged 90 and younger, is expected to progress throughout the period of our analysis (Figure 3): in 2015, the mean age was 0.8 years higher than in 2010; in 2020, we predict it to be higher by one year than in 2015, etc. Between 2010 and 2060, the mean age is expected to increase from 39.6 to 46.4 years – i.e. by 6.8 years. This increase accelerates until 2030 (reaching 1.3 years during the peak 5-year period) and decelerates thereafter. Analysing the separate factors contributing to these changes – birth rate, mortality and international migration – reveals that the first contributes the most to ageing acceleration in 2010–2030. This effect has to do with the post-WWII baby boom cohorts reaching old age in this period; with the subsequent gradual diminishment of these cohorts, their contribution to the ageing process is also reduced.[14] The successive baby boom (1978–1985) was followed by a baby bust in the 1990s and 2000s; therefore, once the 1978–1985 cohorts start to vanish (a development that is expected to first reach a significant scale around 2045), the contribution of birth rate to ageing becomes negative.

Figure 3. Change in the Polish population's mean age[1] and its demographic components, 2015–2060,[2] in years

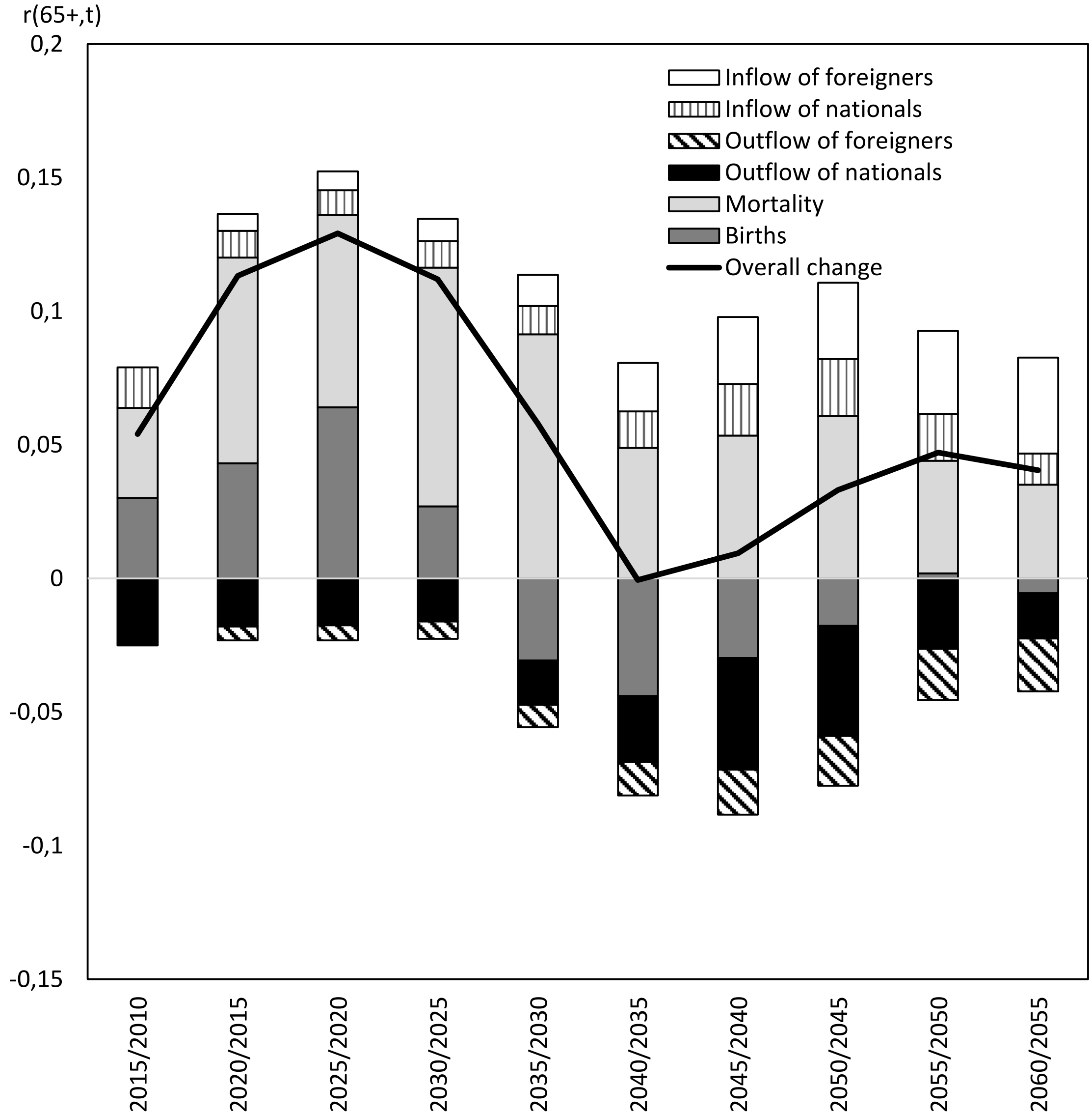


Source: Authors' own estimates.

Notes: [1] Persons aged 90 and younger; [2] As compared to each preceding 5-year period.

As in other countries with relatively stable fertility and increasing longevity, mortality in Poland will become the main driver of population ageing after 2035. Two factors contribute to this effect: first, the health crisis of 1965–1989 (Meslé 1991; Okólski 1985) had a particularly detrimental impact on cohorts born before 1965, whereas post-1989 economic and institutional changes improved the middle- and old-age survivorship of later cohorts (Fihel and Pechholdová 2017). Second, the UN forecast model assumes gradual improvements in old-age survivorship, which will eventually become the main force driving the mortality improvements. This effect is even more important when a different indicator of ageing is chosen (Figure 4): the growth rate of the older age group stems primarily from the decline in the mortality of adults.

Figure 4. Five-year growth rate of group aged 65 years and more and its demographic components, 2015–2060[1]

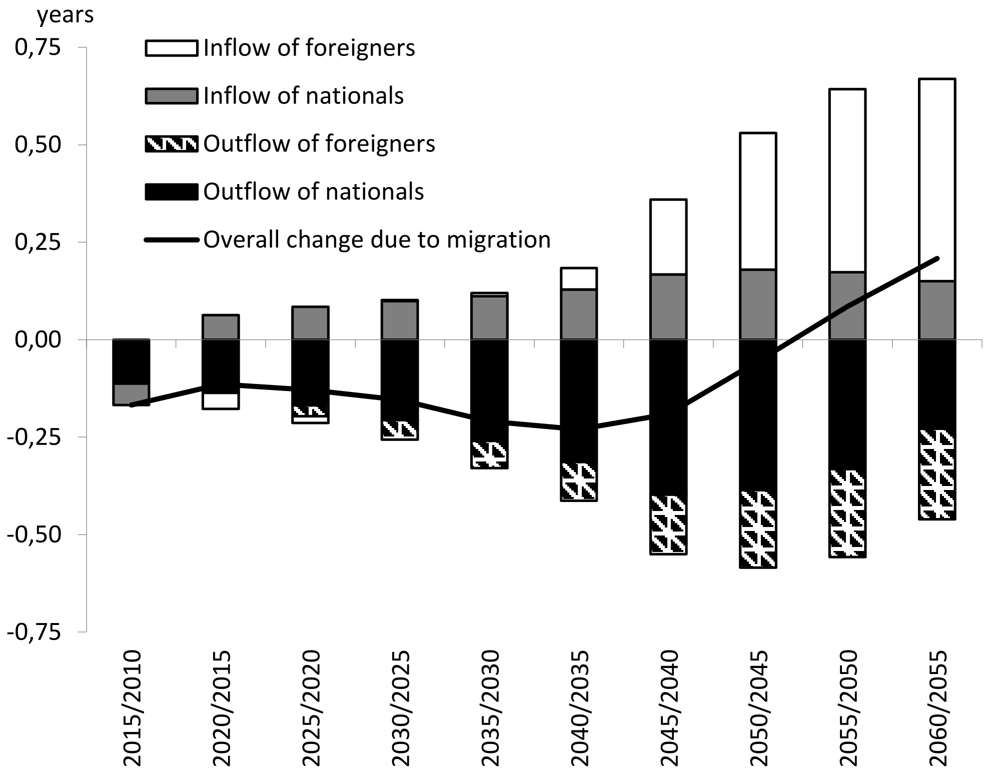


Source: Authors' own estimates.

Note: [1] Compared to each preceding 5-year period.

For the sake of simplicity, Figure 3 presents only the aggregate effect of international migration: it contributes to the population's rejuvenation until 2050, after which it contributes to population ageing; however, throughout the period of analysis, its effect remains low as compared to fertility or mortality. However, decomposing net migration into four flows (Figure 5; see also Figure 4) leads to different conclusions: the separate impacts of outflows and of inflows are relatively strong, though opposite. The outflows contribute to population rejuvenation,[15] whereas the inflows drive ageing.[16]

Figure 5. Change in the Polish population's mean age[1] due to international migration, 2015–2060,[2] in years



Source: Authors' own estimates.

Notes: [1] Persons aged 90 and younger; [2] As compared to each preceding 5-year period.

With regard to the emigration of nationals, the rejuvenating effect of this flow on the Polish population becomes considerable around 2030 and continues to increase until 2050. In this period, the most numerous cohorts of emigrants, those born in the late 1970s and in the 1980s, will reach old age.[17] The return migration of Polish nationals, on the other hand, contributes to population ageing throughout the period of our projection, particularly from 2040 on. In turn, the inflow of foreigners initially rejuvenates (2015–2025) or has no effect (2025–2040) on the population age structure in Poland. Although high, this inflow mostly consists of adults approaching the population's mean age and therefore has an instantaneous (i.e. at the moment of the immigrants' arrival) but marginal impact on the age composition of the population of Poland. However, around 2040, this effect starts to change: the inflow of foreigners that has been intense since 2015 starts to accelerate ageing – and the returns of foreigners are only able to counterbalance this to a limited extent. Around 2050, the inflow of foreigners contributes to population ageing more than any other type of flow.

To summarise, international migration contributes to the population's rejuvenation until 2050. The driving force behind this effect is the outflow of Polish nationals who had left their country of origin at the turn of the twenty-first century. However, shortly after the rejuvenating effect of the outflows reaches its peak (2040–2045), it is counterbalanced by the strong ageing effect of inflows (2055–2060). From 2055 on, international migration accelerates the process of ageing, mostly as a result of the previous inflows of foreigners. The combined impact of international migration is minimal because, under the conditions of a rapid MT, the opposite effects of outflows (rejuvenation) and inflows (ageing) coincide and neutralise each other. The impact of mobility is all the more marginal as the highest levels of outflow are followed by the highest levels of inflow, with little time between these peaks.

The results of ageing decomposition (Figure 3) also include an interaction effect that consists of the entangled impacts of the six well-defined components of demographic change. This interaction effect cannot be attributed to any particular demographic component; it is a residual that emerges when the age-specific growth rates of one well-defined component – from Formula (2) – relate demographic events to a given population at risk; however, this population is not necessarily correct due to the acting of other well-defined components. Based on our understanding, we expect that the more components one includes, the greater the interaction effect will be. In our study, the interaction effect was less than 0.05 years in all 5-year periods, except for the change in 2030 in reference to 2025 (0.11 years) and in 2035 in reference to 2030 (0.16 years).[18] This is comparable with the results obtained elsewhere for three well-defined components only (Murphy 2017).

Conclusions and discussion

This analysis is based on Chesnais' formulation of MT that captures the relation between high natural increase and emigration during the DT and Van de Kaa's postulate to consider immigration as a response to low population dynamics during the SDT. To address Q1, we provided an exhaustive review of studies illustrating the implications of population growth for the succession of the net sending and the net receiving phase in historical populations and postulated the relevance of low fertility and population ageing for immigration.

In Poland, serious mobility restrictions implemented in the inter-war period and under the communist regime deformed the relation between the population dynamics and international migration postulated by DT, SDT and MT. Unlike in most European countries, emigration became possible only towards the end of the twentieth century, during a time when fertility and natural increase became extremely low, longevity continued to rise and ageing was already set in motion. In spite of this, we were able to provide a projection of international migration for Poland, based on historical experiences of European countries well advanced in DT and MT, that addressed Q2. Our migration model captured a possible turnover in the trends that have been observed to date, with the starting point set prior to the change in migration balance. We predicted an increase and subsequent decrease in the immigration of foreigners, which will largely contribute to the change in migration balance in Poland. Our conclusions with regard to Poland may also apply to other Central European countries where immigration is currently on the increase, as well as to certain Southern European countries, such as Greece, Italy, Portugal and Spain, which were considered to be large-scale emigration countries for decades and became destinations for heavy immigration in the 1990s and the 2000s (King, Fielding and Black 1997; Peixoto, Arango, Bonifazi, Finotelli, Sabino, Strozza and Triandafyllidou 2012).

Most studies investigating ageing in historical populations show that, when the sending country's population is still relatively young, emigration contributes to rejuvenation but, later, when low fertility and declining mortality are causing the population to age, immigration accelerates this process. In this research, we proved that, while the global effect of international migration remains minor and ambiguous throughout the course of the MT, the separate migration components affect the population's age structure in a substantial and variable way (Q3). In our projection we were unable to account for the descendants of emigrants, therefore the outflow of Polish nationals unequivocally slows down the ageing process. This effect, however, will be neutralised very rapidly by the increasing inflow (and ageing) of both foreigners and nationals, which is in line with the conclusions of so-called replacement migration projections (United Nations 2001) and the short-lasting effects of inflows on the age composition of a receiving country (Bijak *et al*. 2007; Bijak, Kupiszewska and Kupiszewski 2008; Kupiszewski 2013).

Our understanding of the MT relies on its original formulation by Chesnais focusing on demographic determinants of international migration. However, a large body of research on shifts in the migration balance of countries makes reference to Zelinsky (1971) and his pioneering idea of the mobility transition, perceived as a series of space–time regularities observed within various changing and phased mobilities: circular, rural–urban, intra-urban and international. Skeldon (1977, 1992, 1997, 2010, 2012) postulated a similar idea of long-term changes in mobility patterns, becoming more complex over the course of the process of economic development. In turn, de Haas (2010) put forward a theory linking migration patterns to growing capacities and changing aspirations to migrate. Other authors, focusing on various countries and regions around the world, limit their definition of MT to the change from a net emigration to a net immigration balance as the result of a country’s economic development (Abella 1994; Clemens 2014; Fields 1994; Findlay, Jones and Davidson 1998; İçduygu 2014; İçduygu and Kirişci 2009; Încalţărău 2012; Kim 2017; King and Rybaczuk 1993; King *et al*. 1997; Skeldon 1992). These studies do not consider in any detail the demographic underpinnings of such changes and make no reference to Chesnais’ work on the relation between demographic and migration transitions.[19] Therefore, we do not consider these approaches to be compatible with analyses of population ageing, such as the present study contains.

This study has proved that, with a strong theoretical framework that identifies common regularities for different countries, one can model different types of flow without accepting simplistic assumptions, such as a constant or constantly diminishing net migration rate. Indeed, studying different types of flow (in- and outflows) and migrants (nationals/foreigners) has important analytical and interpretative advantages, whereas the concept of net migration relates to no real phenomena. By analogy, when investigating a population’s evolution, demographers do not refer only to natural increase but distinguish between the trends and intensity of natality and mortality.

As with most forecasts, the projection presented here has important limitations. First, it makes use of other economic and demographic forecasts, which increases its uncertainty. Second, it does not allow for one of the most important factors in international migration, namely migration policies in Poland and other countries. Third, it is not immune to short-term exogenous shocks, such as the mass inflow of war refugees due to the Russian aggression on Ukraine or the likely effects that the COVID-19 pandemic will have on international mobility. What needs to be underlined, however, is that historical evidence suggests that, even if mobility is halted, as was the case in postwar Poland, this may affect the timing but not the overall trend of the changes in migration patterns. Exogenous shocks will certainly affect migration in the short term – and probably the pace of the migration transition as well – but we do not expect them to significantly change the conclusions. The fact that fertility and natural increase rates observed since 2015 in Poland were lower than in the first stage of our projection, will probably lead to increased migration flows; indeed, higher (than predicted by this study) inflows were recorded even before the outburst of the war in Ukraine. Increased, even if temporarily, mortality during the COVID-19 pandemic is, in view of our model, going to have the same effect. Therefore, in all likelihood, the migration transition for Poland will be quicker than anticipated.

Notes

1. Austria, Belgium, France, Germany, Luxembourg, the Netherlands and Switzerland.
2. Denmark, Finland, Norway, Sweden and the United Kingdom. Ireland, which had a negative migration balance until the mid-1990s, constitutes an important exception here.
3. Bulgaria, Croatia, Czechia, Estonia, Hungary, Latvia, Lithuania, Poland, Romania, Slovakia and Slovenia.
4. Although these are two distinct theories, in reference to historical developments taking place in European countries, we consider the SDT as the continuation of DT.
5. Although our considerations on MT do not refer to the US, we present this instructive example of a country with a positive net migration regime.
6. The studies by Moore (1945) and Davis (1963) also made explicit references to Poland.
7. In the same period, 189,500 persons arrived (registered for a permanent stay in Poland).
8. The scale of the flows visible in the registers and reported by Statistics Poland is very different from the scale of real, long- and short-term flows. See Annex 1 for details.
9. The dataset consisted of all EU countries as of 2015, extended by Iceland, Norway and Switzerland, as per the availability in the Eurostat database. This set of countries includes, on the one hand, the major migration destinations for emigrants from Eastern European countries and, on the other, all the major destination countries, for which the MT was described in the literature.
10. This extrapolation requires a careful recursive procedure as the migration forecast makes use of population characteristics in the future, which may only be calculated if the (future) migration flows are known.
11. The countries which have fewer data available are usually also those with less-reliable migration statistics; therefore, the fact that the panel is unbalanced does not seem to be a drawback – higher weights are attached to countries with more-reliable data.
12. We acknowledge that the values of the flows depend on the historical values of flows (in both directions). This autoregressive component enables not only the tracking of the MT phase but also the capturing of the ‘hidden’ effect of migration networks.
13. For instance, in 2015 the mean age was 40.8 in the overall population and 40.4 in the population aged 90 and younger whereas, in 2060, these values will be, according to the median scenario of the forecast, 47.7 and 46.4 respectively.
14. This conclusion is based on more-detailed results on age-specific growth rates and their components: changes in natality, mortality and migration (see Formula 2). Here we only present aggregate results.
15. From 2040 on, the contribution of the joint components of outflows (of nationals and foreigners) to the mean age change is at least 0.4 years (within a 5-year period) and exceeds the separate contributions of mortality and of natality.
16. From 2050 on, the contribution of the joint components of inflows (of nationals and foreigners) is at least 0.5 years (within a 5-year period) and exceeds the separate contributions of mortality and of natality.
17. In order to investigate the ageing process in Poland’s entire net sending phase, we applied the same procedure to the period 1990–2060. Due to historical data constraints, this limited the analysis to the population aged 70 and younger (i.e. born after 1920). In this case, the outflow of Polish nationals primarily rejuvenates the population of origin between 2030 and 2050 and the general

trends are similar to those for the 2010–2060 period. These additional results are available on request.

18. Most likely – due to significant changes in the population size due to sharp increases in inflows.
19. Chesnais himself was probably not aware of Zelinsky's idea of 'vital and mobility transition'.

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Conflict of interest statement

No conflict of interest was reported by the Authors.

Data availability statement

The data that support the findings of this study are available from the corresponding author, Agnieszka Fihel, upon reasonable request.

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Annex 1. Data estimation and population forecast assumptions

Official statistics concerning the outflow from Poland include only persons who de-register from the place of permanent stay in Poland when moving to another country. As the legal obligation of deregistration has never been efficiently enforced, most migrants leave Poland without having fulfilled this formality. For instance, the most recent population census revealed that, in 2011, almost 1.6 million persons had been living abroad for at least one year without having deregistered from the place of permanent stay (Statistics Poland 2013). Therefore, we have estimated real mobility (for a thorough description see also Fihel *et al*. 2018) based on:

- estimates by Sakson (2002) of emigration in 1981–1988;
- population censuses of 2002 and 2011, regarding the numbers of persons staying abroad on a long-term basis (12 months and more), by year of departure from Poland (1988–2010) and the numbers of foreign citizens in Poland on long-term stays, by year of arrival (1989–2010); and
- Eurostat data (2017) that seem to properly account for long-term emigration and immigration without deregistering from/registering at the place of permanent stay in Poland since 2011.

As a result, our estimates of flows between 1989 and 2010 do not account for migrants who emigrated and subsequently returned to their home country within the same intercensal period. This implies some degree of underestimation of the scale of international migration to and from Poland. Nevertheless, our results remain comparable with other authors' results on flows (Wiśniowski 2017) and stocks (Statistics Poland 2013, 2018).

As our estimates of the mobility of Polish nationals allow for real but not necessarily official migration numbers, our estimates of the Polish population differ from those reported by Statistics Poland to international agencies, including the United Nations Department of Economic and Social Affairs. For instance, our estimate of the population as of 1 January 2015 is 36,263,000, instead of the 38,034,000 reported by the UN (as of 1 July 2015). The two main measures used to establish the population forecast assumptions, namely TFR and life expectancy at birth, were adjusted in accordance with our population estimates. For example, the recalculated TFR for the period of 2010–2014 amounts to 1.46, in contrast to the value of 1.33 reported by the UN. Similarly, female life expectancy at birth for the period of 2010–2014 was recalculated at 80.85, compared to the value of 81.14 used by the UN.

Annex 2. The migration forecast model

Our migration forecast is based on Eurostat data for 30 European countries for the years 1998–2014, with corrected data for Polish migration flows and population size (and the resulting demographic statistics). The panel is not balanced and the number of observations varies by country. In general, countries with more-reliable statistics (such as Sweden, Finland, the UK) have longer time series, while countries with less-reliable statistics (such as the eight new member states, NMS8) have much shorter data series available. This means that, in the modelling procedure, more weight is attached to countries with more-reliable statistics.

Prior to 2009, Eurostat data were not fully harmonised in terms of the adopted migration definitions, which leads to known biases and efforts to harmonise the data (cf. Raymer, Wiśniowski, Forster, Smith and Bijak 2013 for a review of empirical approaches). The results of these efforts were not unanimous, however. For example, the official statistics for emigration from Poland – which, in the Eurostat statistics, are by far the most biased, apart from emigration data for Slovakia to the UK for 2008 (De Beer, Raymer, van der Erf and van Wissen 2010) – stand at a value based on the register of approximately 9,000. This value has been recalculated by De Beer *et al.* (2010) to approximately 44,000 and Raymer *et al.* (2013) to approximately 82,000, while Abel (2010) estimated it at approximately 177 000. All of the recalculations involve adjusting the data for specific countries based on data from other countries but none take into consideration the specifics of the particular countries. Therefore, the results of the available harmonisation efforts do not seem reliable, either.

Having this in mind, we decided to base our model on the original statistics for all countries (apart from Poland), adding dummies to account for breaks in time-series definitions (which did not influence the forecast results). Due to the fact that we included autoregressive terms in the four equations (immigration and emigration rates for both foreigners and nationals), standard panel models could not be applied. We used the GMM Arellano Bond estimators instead. The fact that autoregressive terms were used also means that systematic multiplicative biases in data for different countries had less effect than they would otherwise have had.

The total sample consisted of 288 observations for flows of nationals and 320 for flows of foreigners, with N = 30 and T= 16. The estimated model coefficients, interpreted in the main body of the text, are presented in Table A1. For each of the four models, the Wald statistics of the null hypothesis that all the coefficients except the constant are zero was soundly rejected (p-value equal to 0) and the results of the Arellano Bond test for zero autocorrelation suggest that there is autocorrelation in first-error terms (which is expected for this type of model). Furthermore, there are no grounds to reject the null hypothesis of no autocorrelation for higher order terms (the p-values are 0.47 for the model for the immigration of foreigners, 0.41 for the emigration of foreigners, 0.3 for the emigration of nationals and 0.38 for the return of nationals), which means that there is no evidence of model misspecification.

Table A1. GMM Arellano Bond estimates for the rates of migration flows[1] (per 1,000 inhabitants)

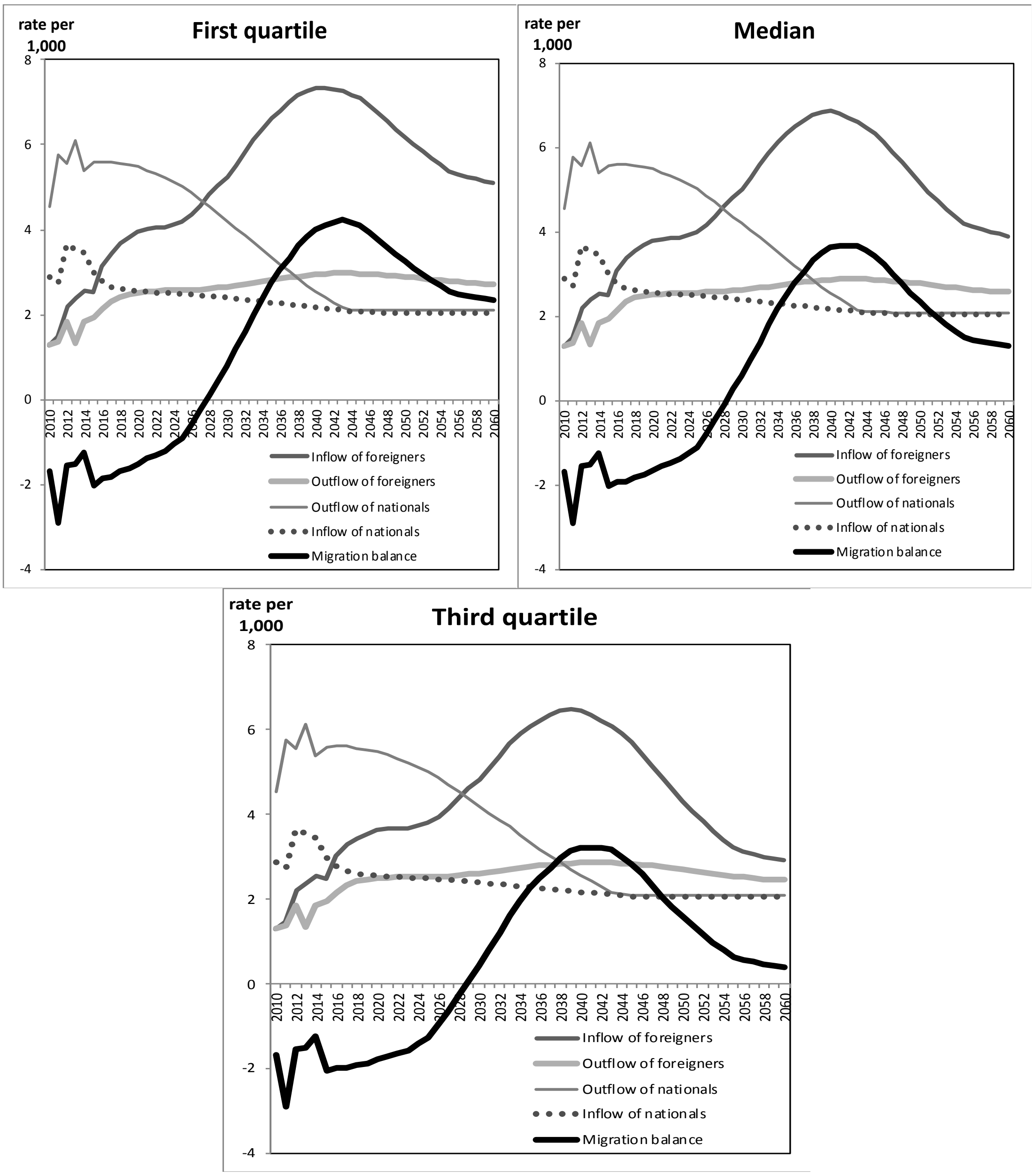
Determinants	Coefficient	Std deviation	p-value
Emigration rate of nationals (Poles)			
Lagged value	0.3489	0.1083	0.001
Unemployment level in sending country (Poland)	0.2199	0.0979	0.025
GDP gap in sending country (Poland) relative to EU15 countries[2]	2.1726	1.1179	0.052
Constant	-0.2308	0.6550	0.725
Immigration rate of nationals (Poles)			
Lagged value	0.4879	0.1424	0.001
GDP growth rate in receiving country (Poland)	0.0220	0.0117	0.06
Rate of emigration of nationals (Poles from Poland)	-0.0553	0.0291	0.057
Lagged value of the rate of emigration of nationals (Poles from Poland)	0.1169	0.0207	0
EU15 country dummy – not applicable to Poland	*-0.1858*	*0.0940*	*0.048*
Constant	0.9016	0.4220	0.033
Immigration rate of foreigners			
Lagged value	0.4577	0.0704	0
Natural increase rate in receiving country (Poland)	-1.1857	0.3969	0.003
GDP *per capita* (in PPP) in receiving country (Poland)	0.0002	0.0000	0
GDP growth rate in receiving country (Poland)	0.0678	0.0421	0.108
Unemployment level in receiving country (Poland)	-0.3272	0.1196	0.006
OADR in receiving country (Poland)	-0.2900	0.1469	0.048
EU15 country dummy – not applicable to Poland	*0.9727*	*0.5561*	*0.08*
Constant	8.8556	3.5834	0.013
Emigration rate of foreigners			
Lagged value	0.2963	0.1243	0.017
Lagged value (two years) of the rate of immigration of foreigners	0.0616	0.0230	0.007
Constant	2.2100	0.6808	0.001

Source: Authors' own estimates based on Eurostat, OECD and Statistics Poland data.

Notes: [1] The coefficients in the model are calculated based on the full sample but the results (interpretation of dummy variables, types of flow) are presented as they were used for the forecast – i.e. for Poland; [2] 'EU15 countries' refers to the 15 EU member states prior to the 2004 EU enlargement: Austria, Belgium, Denmark, Finland, France, Germany, Greece, Ireland, Italy, Luxembourg, the Netherlands, Portugal, Spain, Sweden and the United Kingdom.

In order to obtain a forecast, the rates of migration flows need to be translated to numbers of individuals in specific age categories. The sex-specific age structures of migrants are different for the four types of migration flow considered but fixed for the whole forecast period. The age structures are based on migration flows for the years 2006–2011 as registered in the 2011 Polish census. The adopted migration modelling framework is deterministic and the levels of flows depend on current demographic and economic variables, This means that, in order to provide a migration forecast, a demographic forecast is needed and *vice versa*. Therefore, in order to obtain a full population forecast, a joint computation of population and the corresponding migration forecasts were calculated in an iterative procedure, obtaining internal consistency. Due to the fact that the fertility and mortality components of the forecast were modelled in a Bayesian framework, a different migration path is to be observed for each population forecast trajectory. Below we present three migration forecasts, corresponding to the first, second (median) and third quartiles of the fertility/mortality forecasts (Figure A1). The patterns visible for the three trajectories are the same.

Figure A1. Migration rates per 1,000 inhabitants corresponding to the first, second (median) and third quartiles of the population forecast,[1] Poland



Source: Authors' own estimates based on Eurostat, OECD and Statistics Poland data.

Notes: [1] The period of 2010–2014 refers to observed migration rates, whereas the period 2015–2016 refers to the forecast.

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