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Replacement Migration Revisited: Simulations of the Effects of Selected Population and Labor Market Strategies for the Aging Europe, 2002–2052

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Abstract This paper contains the selected results of research concerning the impact of international migration on population dynamics and labor force resources in 27 European countries over the 2002–2052 period. The study presents a set of simulations prepared under various assumptions on target population size and selected proxy indicators of population and labor force structures. The concept of "replacement migration" is used to illustrate the magnitude of the expected deficit and structural imbalance of the population and labor force in the first half of the 21st century. The results are the basis for making general recommendations for future population, migration, and labor market policy strategies in Europe, taking into account the long-term plausibility of the proposed solutions. It is argued that only a combination of policies aimed at increasing fertility and labor force participation, together with reasonable-level immigration, can help meet socioeconomic challenges posed by population aging.

Keywords Europe · Population aging · Population policies · Replacement migration · Simulations

Introduction

The study presents an analysis of interrelations between international migration, population aging, and labor force dynamics in Europe, followed by recommendations for future policies in these areas. Our aim is to simulate the magnitude of immigration hypothetically needed to maintain the population size or selected

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structural indicators of population and labor force, and to discuss plausible policy options in that context.

In geographic terms, the analysis covers 27 European countries: the enlarged European Union (EU) without the smallest island states (Cyprus and Malta), as well as Norway and Switzerland. The timeframe covers 50 years, from 2002 to 2052. The mathematical model of population dynamics used in the analysis is MULTIPOLES (Kupiszewski and Kupiszewska 1998, 2005). The paper is supported by extensive background material, including a discussion of simulation assumptions and country-level results in a number of papers (Bijak et al. 2004, 2005; Bijak 2004; Saczuk 2004; all available online at http://www.cefmr.pan.pl). The study aims to present a policy-oriented follow-up to the paper of Bijak et al. (2007), which focuses on population and labor force projections.

Apart from the Introduction, the paper contains six sections. Section "Background: Population and Workforce Aging as a Policy Challenge" presents background information on population and labor force aging as an important contemporary policy challenge, with particular reference to the European context. Section "Data, Model, and Simulation Assumptions" briefly discusses the data used, the model of population dynamics, as well as the assumptions on future demographic and labor force developments. Section "'Replacement Migration' Simulations for 27 European Countries" presents simulations of "replacement migration" from the outside world that would hypothetically be needed to maintain the values of certain indicators: either population size or various support ratios. Section "Sensitivity of the Results to Fertility and Economic Activity Changes" offers an analysis of the sensitivity of the results to changes in assumptions about the future fertility and economic activity patterns. Our "replacement" simulations are compared with other similar studies in section "Comparision with similar studies." In particular, the *Replacement Migration* report of the United Nations (2000) is referred to (hereafter: "the UN report"). Finally, a brief summary of the outcome and the most important conclusions are offered in section "Conclusion."

Background: Population and Workforce Aging as a Policy Challenge

Population aging became a very important policy challenge, having widespread consequences in various areas of social, economic, and political life. Aging, a "process, by which older individuals become a proportionally larger share of the total population" (United Nations 2002, p. 1), is a direct consequence of low fertility and longer life expectancy observed especially in developed countries. As it has been noted by Coleman (2002), this process is durable and irreversible.

According to the United Nations (2002), the key policy challenges posed by aging include: increasing public expenditure on pensions, social security, and health services; shrinking of the labor force and an increase in the overall burden on the working population in terms of intergenerational transfers; increasing risk of failure of the repartition (*pay-as-you-go*, PAYG) pension systems; changing patterns of public health, and many others. Although these problems are not critical yet, relevant policy measures should be implemented as soon as possible in order to

prevent the negative consequences of aging in the future. A comprehensive study prepared recently for Australia by the Productivity Commission (2005) includes a broad analysis of potential problems and areas for policy actions with respect to aging, the demographic ones being just a tip of the iceberg.

The challenges posed by aging have already been acknowledged by the European Commission (2005) in the recently published Green Paper "*Confronting demographic change: A new solidarity between the generations*." The proposed counteractions include the promotion of "active aging" (cf. also Avramov and Mašková 2004), a gradual increase of the retirement age, reforms of social security systems, and policy measures aimed at achieving a better balance of career and family life: development of child care structures, division of parental leave, and part-time working. The presented examples belong to a broader category of life-course policies (e.g., Leisering 2003) that encompass all kinds of government intervention along the life courses of individuals, with respect to various spheres of human life and activity. Nevertheless, as regards all the above-mentioned issues, the European Commission openly admits that the EU is presently very far from achieving the set objectives.

Since Espenshade et al. (1982) showed that in a population with a below-replacement fertility constant immigration leads to a stationary population with a stable age structure, there have been many attempts to find out whether immigration can at least partially offset population aging. From the recent examples, the "replacement migration" issue has been addressed by Feld (2000), and in the United Nations (2000) report, the latter criticized by many authors (Coleman 2002; Espenshade 2001; Lesthaeghe 2000). Earlier work on this topic includes Lesthaeghe et al. (1988) for the then European Economic Community, Blanchet (1988) for France, Wattelar and Roumans (1991) for Austria, Belgium, Canada, and Spain, as well as Gesano (1994) for Italy. All these studies show that the size of "replacement" population inflows would have to highly exceed any reasonable quantities. Blanchet (1988) demonstrated visible cycles in the projected "replacement migration," offering a theoretical possibility of successive waves of immigration and emigration, which, however, would be infeasible in practice.

The authors of the mentioned studies were very careful in formulating recommendations for population policies. Lesthaeghe et al. (1988) concluded their simulations by stating that relevant demographic policy means should be sought not in "replacement migration," but rather in increasing fertility rates. The infeasibility of migration policies aimed at keeping the potential support ratios constant has also been repeated by other authors (Gesano 1994; Coleman 1992; Wattelar and Roumans 1991). Recently, Coleman (2002) stressed that policy responses to aging should focus on the economic issues instead. As the most profound and feasible—yet still partial—solutions, the increase in both labor force participation and retirement age were proposed.

As a result of the aforementioned discussion, the implausibility of "replacement migration" has been recognized by the European policymakers (European Commission 2004), who explicitly acknowledged the need for alternative policy measures aimed at dealing with population aging. Fotakis (2000) stressed the necessity for combining migration and economic policy measures, aimed at an

increase in labor force participation and productivity, e.g., through technological change. Mass "replacement migration" would then be no longer needed to sustain the economic parameters in the long run. In the short term, however, additional inflow of immigrants into Europe may be helpful in offsetting the labor market mismatches.

A recent study by Grant et al. (2004) provides a detailed overview of possible policy measures aimed at dealing with the consequences of aging, divided into three groups (Grant et al. 2004, pp. 3–4):

- Indirect preventive policies (concerning economics, gender issues, and education), aimed at creating long-term conditions for higher fertility in the post-modern society through affecting the macro-level socioeconomic variables;
- Direct preventive policies (migration, family support, reproductive health, child benefits, and family-friendly employment), aimed at influencing micro-level decisions of individuals and families with respect to fertility and migration;
- Ameliorative policies concerning social security, labor force, health care, and support for the elderly, aimed at reducing the negative impact of aging on the society and economy.

Grant et al. (2004) concluded that long-term conditions for fertility increase should be created using indirect and direct preventive policy measures, influencing the underlying causes of the recent fertility decline. As it has also been noted by Lesthaeghe (2000), although demographic policies aimed at increasing fertility are not the only remedies against the consequences of aging, in the long run they have to be introduced in order to avoid problems in the more distant future. Moreover, the process of aging in Europe is already so advanced that it causes a negative population momentum (Lutz et al. 2003). Even if total fertility rates instantly returned to the replacement level, negative population growth would still be observed for many years, due to the ever smaller generations of the newborn from the recent decades.

Recently, Lutz et al. (2004) developed a concept of "population balance" as a possible policy goal, not limited to the issue of demographic growth alone. According to the authors, population policy should be aimed at finding such population structures that would maximize the welfare of the individuals, as well as intergenerational equity. Focusing on the issues of investment in human capital, the authors found that fertility and education levels are in interplay with respect to welfare maximization and that higher education can compensate for reduced fertility. An experiment with a stable population showed that given a high percentage of educated people, welfare is maximized by TFR levels less than 1.5 (Lutz et al. 2004, p. 329).

The current study aims at contributing to the debate on "replacement migration," providing simulations for 27 European countries for the 2002–2052 period. We simulate the additional inflow of people needed to maintain the population size or selected aggregate indicators of the age structures. With respect to the latter, the current study focuses on the analysis of a commonly used proxy measure, the *Potential Support Ratio* (PSR). The PSR indicates how many people aged 15–64 in a given population correspond to (can potentially support) one person aged 65 or

over. The age limits of 15 and 65 years—dividing the population into three groups: pre-working, working and retired—have been chosen arbitrarily. The lower limit of the working age (15 years) is disputable due to increasing participation in tertiary education. Here we decided to keep it for the sake of comparability with other similar studies, as well as due to the increased elasticity of labor markets expected in the future, allowing for various forms of employment of students and youth. We also deliberately omitted the analysis of sensitivity of the results to the legal retirement age, as it has already been covered by Roseveare et al. (1996), the United Nations (2000), and Coleman (2002).

In addition to the PSR, two additional aggregate measures are proposed, the *Economic Elderly Support Ratio* (EESR) and the *Labor Market Support Ratio* (LMSR), taking into account the size and structure of the labor force. The EESR is defined as the ratio of the economically active population aged 15 or over to the inactive population at the retirement age (65+). Such a measure is a proxy of the economic burden of inactive pensioners on the working population, and is therefore an important indicator of the effects of aging from the point of view of sustainability of the pension systems. The LMSR is defined as the ratio of the whole economically active population to the whole inactive population, considering people aged 15 or over. This indicator can be interpreted as a proxy of the overall economic burden of the inactive population on the labor market. Similar measures have already been used in a number of studies. For example, a generalized reciprocal of the EESR is known as the *System Dependency Ratio* (SDR), i.e., "the ratio of those receiving pension benefits to those accruing pension rights" (OECD 2005).

A brief analysis of these measures confirms that population aging in Europe has advanced in the second half of the 20th century. According to Eurostat data, the average PSR in the 27 countries under study declined from about 6.5 in 1960 to 4.2 in 2002. The average EESR in 2002 indicated that every economically inactive person over 65 years of age corresponded to 3.1 persons in the labor force. The LMSR of 1.3 for the same year denotes a heavy burden of the whole inactive population on the labor market.

There are visible differences between the individual countries. For 2002, the values of the three indicators for all countries under study, ranked from the highest to the lowest, are presented in Table 1. It has to be noted that the exceptionally good position of Romania, especially with respect to the EESR, is primarily due to the very broad definition of the economically active population (Saczuk 2004).

Data, Model, and Simulation Assumptions

The analysis is based on data from the official statistical registration of population, births, deaths, and migratory events in the countries under study, published by Eurostat and the Council of Europe. Data on labor force participation come from the database of the ILO (2003). Five-year age groups are used, with 85+ being the highest group for population stocks and 75+ for economic activity. Migration flows have been estimated as the higher of the figures available from the origin and destination countries. Details on the sources, data quality control, and preparation

Table 1 Potential support ratio (PSR), economic elderly support ratio (EESR), and labor market support ratio (LMSR) in Europe, 2002

Rank	Country	PSR	Country	EESR	Country	LMSR
1	Slovak Republic	6.11	Romania	5.59	Switzerland	2.06
2	Ireland	6.09	Ireland	4.52	Denmark	1.99
3	Poland	5.49	Slovak Republic	4.30	Norway	1.96
4	Czech Republic	5.07	Denmark	3.92	Netherlands	1.72
5	Netherlands	4.95	Netherlands	3.88	Portugal	1.64
6	Romania	4.88	Portugal	3.87	United Kingdom	1.63
7	Slovenia	4.80	Poland	3.83	Sweden	1.63
8	Luxembourg	4.80	Switzerland	3.82	Finland	1.61
9	Lithuania	4.58	Norway	3.82	Romania	1.59
10	Denmark	4.48	Czech Republic	3.78	Lithuania	1.58
11	Hungary	4.47	Slovenia	3.66	Slovak Republic	1.50
12	Finland	4.39	Lithuania	3.61	Czech Republic	1.48
13	Norway	4.38	Estonia	3.48	Ireland	1.44
14	Austria	4.38	United Kingdom	3.41	Austria	1.41
15	Switzerland	4.35	Finland	3.41	Slovenia	1.40
16	Latvia	4.34	Latvia	3.34	Germany	1.39
17	Estonia	4.30	Austria	3.23	Estonia	1.39
18	United Kingdom	4.19	Luxembourg	3.12	Latvia	1.35
19	Greece	4.13	Sweden	3.10	France	1.23
20	Portugal	4.07	Germany	2.94	Poland	1.22
21	Spain	4.04	Greece	2.86	Spain	1.15
22	Bulgaria	4.02	France	2.78	Luxembourg	1.15
23	France	4.00	Spain	2.74	Greece	1.13
24	Germany	3.91	Hungary	2.72	Belgium	1.07
25	Belgium	3.86	Bulgaria	2.62	Bulgaria	1.03
26	Sweden	3.77	Belgium	2.55	Hungary	0.96
27	Italy	3.55	Italy	2.21	Italy	0.88
–	All 27 countries	4.19	All 27 countries	3.09	All 27 countries	1.30

Sources: Eurostat, NewCronos; ILO (2003); own calculations

can be found in the background papers on demographic, migration, and labor force scenarios (Bijak 2004; Bijak et al. 2004; Saczuk 2004).

The model of population dynamics used in this study, MULTIstate POpulation model for multiLEvel Systems (MULTIPOLES) was developed by Kupiszewski and Kupiszewska (1998). It is a cohort-component, female-dominated, multilevel and multiregional model, which operates in the methodological framework set by Rogers (1975) and Rees (1996), and is based on the movement-type population accounts. The age-specific rates in the model equations are defined as numbers of events (births, deaths, or migrations) in a projection period divided by the population at risk. The assumptions on the future developments of fertility and mortality are prepared respectively in terms of total fertility rates (TFR) and life

expectancy at birth (e_0). International migration is dealt with on two levels: (i) between the countries under study and (ii) between each of them and the remaining countries of the world. The former is modeled in terms of emigration rates, while the latter is modeled in terms of crude net migration numbers. A detailed description of MULTIPOLES is available among others in Kupiszewska and Kupiszewski (2005). The model has been developed since 1996 by D. Kupiszewska as computer software, redesigned for the purpose of the current study to allow for the "replacement migration" simulations.

Considering assumptions on future fertility, it has to be noted that the changes in social values and norms (Lesthaeghe and van de Kaa 1986), and the related increase in the alternative costs of childbearing (Becker 1991), occurring in Europe for over four decades, brought fertility far below the replacement level. The return to replacement fertility in the future cannot be feasibly assumed as there is no evidence that policy measures can counterbalance the fertility decline significantly enough. However, some recuperation of period fertility levels in Europe is expected, primarily due to the realization of the childbearing postponed in the past (Sobotka 2004). Hence, the period total fertility rates (TFR) for the 27 countries under study are expected to follow their past downward trends in the short run, but then recover and stabilize by 2052 at the levels reflecting the current diversity of childbearing patterns in Europe. The target TFR values for individual countries, ranging between 1.4 and 1.9, are shown in Table 2, and a detailed discussion of the assumptions is presented in Bijak (2004).

With respect to future mortality, it has been assumed that although one cannot exclude the emergence of new infectious diseases in the future, their impact on public health in the developed countries will likely be offset by technological, institutional, and behavioral changes. As a result, the maximum life expectancy is envisaged to continue increasing, although at a declining pace, reaching 85 years for males and 90 years for females by 2052. For Western Europe, a visible convergence of the trends to the maximum levels is expected, much slower in the case of Central and Eastern Europe. Due to institutional, economic, and social drawbacks it will undoubtedly take the post-socialist countries many more years to recover in terms of mortality improvements, although the recent trends already indicate the upturn from the post-transformation crisis (Meslé 2004). The target values of life expectancy at birth (e_0) for 2052 are presented in Table 2 and discussed more thoroughly in Bijak (2004).

Each of the two types of migration (flows between the 27 countries under study, as well as the population exchange with the rest of the world) has been assigned separate assumptions, based on the qualitative analysis of migration factors. These scenarios of future migration developments are further referred to as the "base" ones, in order to distinguish them from the "replacement migration" simulations.

With regard to the population exchange with the rest of the world (the "external" migration), the base scenario assumes a sustained improvement of the socioeconomic and political situation worldwide. This is expected to result in a moderate overall population inflow to Europe and a gradual shift in places of origin from the neighboring countries to other developing regions. Policy measures are assumed not to be very restrictive, due to a relatively good and stable socioeconomic situation in Europe.

Table 2 Assumptions about target values of demographic parameters for 2052 for all simulations

Country	Total fertility rate (TFR)	Life expectancy		Yearly net migration rate per 1,000 population of a given country*			Labor force
		Males	Females	Among 27 countries	'External'	Total	Participation**
Austria	1.5	84.8	88.9	–0.19	2.57	2.38	B
Belgium	1.8	84.5	88.4	0.29	2.30	2.58	A
Bulgaria	1.4	79.8	83.3	–2.01	1.75	–0.26	C
Czech Republic	1.5	82.6	86.3	0.16	2.85	3.01	C
Denmark	1.5	84.4	87.0	–0.44	1.85	1.41	B
Estonia	1.6	76.5	84.8	–1.15	1.96	0.81	C
Finland	1.9	84.4	88.8	–0.15	1.89	1.73	B
France	1.9	84.7	89.7	−0.41	2.12	1.71	A
Germany	1.5	84.7	88.6	−0.28	2.68	2.40	B
Greece	1.5	84.7	88.2	0.49	3.06	3.55	A
Hungary	1.5	79.4	84.4	0.47	2.91	3.38	C
Ireland	1.9	84.6	87.9	1.11	1.72	2.83	A
Italy	1.5	85.0	89.8	0.73	3.18	3.91	A
Latvia	1.5	76.1	83.7	−0.59	2.07	1.47	C
Lithuania	1.5	77.4	85.2	−1.16	2.06	0.90	C
Luxembourg	1.8	84.4	88.8	−0.49	2.00	1.52	A
Netherlands	1.9	84.8	88.1	−0.67	2.13	1.46	B
Norway	1.9	84.9	88.7	−0.80	1.72	0.92	B
Poland	1.5	81.2	86.3	−0.42	1.83	1.42	C
Portugal	1.7	83.8	87.9	−0.07	3.00	2.93	A
Romania	1.4	78.6	82.6	−3.56	1.63	−1.94	C
Slovak Republic	1.5	80.7	85.4	0.68	1.75	2.44	C
Slovenia	1.5	83.0	87.9	0.88	3.23	4.12	C
Spain	1.5	84.8	89.8	2.23	2.56	4.79	A
Sweden	1.9	85.0	89.2	0.46	1.79	2.25	B
Switzerland	1.5	85.0	89.8	1.21	2.12	3.33	A
United Kingdom	1.8	84.8	87.9	−0.62	2.26	1.65	A
All 27 countries	–	–	–	0.00	2.41	2.41	–

* Assumptions have been set in terms of emigration rates for migration between 27 countries and net migration volume for "external" migration from the remaining countries

Net migration rates for 2052 shown in the table have been computed after running the model

** Types: A, Low female participation, B, High female participation, C, Central and Eastern Europe. Male labor force participation pattern common for all the countries

Similar assumptions are envisaged for population flows among the 27 countries under study, with alterations resulting from the gradual liberalization of the labor markets of the old EU-15 for the citizens of the new member states. Hence, we assume a stable socioeconomic situation and a long-term convergence of income

levels in Europe. This is expected to result in an overall rise in mobility following the increase of job opportunities abroad, as well as in a reduction of the income-related push factors to emigrate from Central and Eastern Europe to the West. In the longer term, the positive effects of European integration are likely to occur in full, which is going to increase the returns of the former emigrants.

The gradual liberalization of the Western European labor markets is expected to result in temporary deviations from these global trends. To start with, Ireland, Sweden, and the United Kingdom already opened their labor markets in 2004. For the remaining countries we developed a simple scenario. Firstly, we assumed Denmark, Finland, the Benelux countries, and Norway (country of the European Economic Area, guaranteed the same rights to restrict the access of foreign workers as the old EU-15) to open their labor markets in 2006. Further, Italy, France, Spain, Portugal, and Greece are foreseen to follow in 2009, with Germany and Austria in 2011. The Swiss labor market is expected to be opened by 2007 for the EU-15 citizens and by 2011 for the nationals of the new member states. Bulgaria and Romania, which have joined the EU in 2007, are assumed to follow the other new EU member states with a three-year delay.

It has to be noted that the above-mentioned assumptions were prepared in 2005 and reflect a state of knowledge that has already been outdated by political decisions of particular countries in May 2006. Despite the recommendation of the European Commission (2006) to liberalize labor markets throughout Europe, as no negative impact of immigration on Ireland, Sweden, and the United Kingdom has been found, some countries postponed the opening for purely political reasons (e.g., Belgium and the Netherlands, although the latter only with respect to certain sectors of the economy). Nevertheless, at the time of writing, some decisions concerning the 2006 liberalization round were still pending.

Numerically, the scenarios of flows among the 27 countries are obtained by multiplying the initial emigration rates by factors consisting of two components: an overall trend (mobility increase by 0.5% yearly) and temporal deviations resulting from the labor market liberalization discussed above (for details, see Bijak et al. 2004). The age schedules come mainly from German data depicting migration to or from a given country. One exception is migration to the Mediterranean, where age distributions are based on the receiving countries' data, with the visible presence of the post-retirement migration. Migration within Central and Eastern Europe uses average age schedules of flows to or from Germany. "External" migration has been extrapolated exponentially from the recent (2002) values to the target ones, corresponding to the rates shown in Table 2. The age structures of net "external" migration for the countries of Western, Southern, Northern, and Central-Eastern Europe have been assumed to follow the 2002 schedules for Germany, Spain, Sweden, and the Czech Republic, respectively.

Assumptions on labor force participation, discussed in detail in Saczuk (2004), follow the argumentation of Palomba and Kotowska (2003), and include a further increase of the economic activity of women, primarily in the age group of 25–54 years, especially in the low-participation countries of Southern Europe. By 2052 all countries under study should reach an inverted U-shaped pattern of female economic activity. The European countries are grouped in three clusters according to their recent

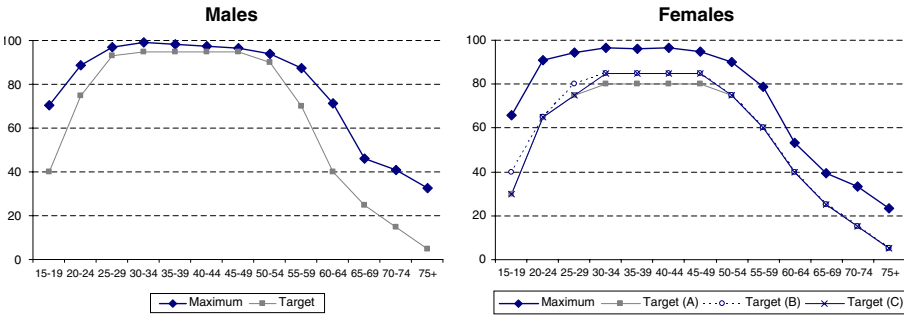

Fig 1 Assumptions about the target age-specific labor force participation rates for 2052 (percent of the population in a given age group). *Sources:* ILO (2003); own elaboration

activity patterns: low female participation countries (A), high female participation countries (B), and Central and Eastern Europe (C), as summarized in Table 2.

According to Saczuk (2004), economic activity in the older age groups in most countries is expected to be much higher in 2052 than in 2002. For the 2002–2012 decade a continuation of the country-specific trends is assumed, followed by the convergence of the rates to the assumed target values. The scenarios for all countries foresee that in the long run the economic activity of older people should stabilize on the same level for both sexes. For the youngest workers (15–24 years), it is assumed that after a decade of continuation of the recent downward economic activity trends, the development of flexible forms of employment will enable reconciling work with education. Hence, an increase of activity rates after 2012 and their stabilization on higher levels in the long run are envisaged. Stagnation or a moderate decline in the age-specific economic activity rates is expected only for the middle-aged men. The assumptions on the target age- and sex-specific labor force participation rates, together with the "maximum" patterns, showing the highest rates observed in 1985–2002 in all countries under study, are summarized in Fig. 1.

"Replacement Migration" Simulations for 27 European Countries

In order to measure the size of the population deficit and structural demographic imbalances forecasted for 2002–2052, four "replacement migration" simulations have been conducted. The first one aims at assessing how many immigrants would be needed to sustain the population size of the individual countries under study. Having adopted the base migration scenario, the number of additional immigrants coming from the other countries of the world has been calculated. If the base migration alone was enough to prevent the population decline for a given country and period, the "replacement" immigration has been set to zero.

Under these assumptions, Europe would face an inflow of 33 million immigrants more than under the base migration assumptions. The overall population of the 27 European countries under study would increase from 494 million in 2002 to 533 million in 2052. At the end of the simulation period, the post-2002 external

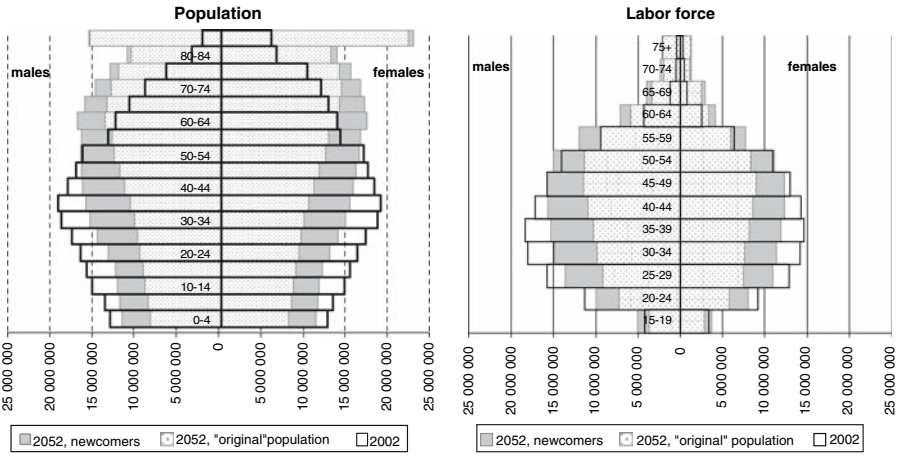

Fig 2 Population and labor force structures in the 27 European countries, 2002–2052, the non-decreasing population scenario. *Sources:* Eurostat, NewCronos; ILO (2003); own calculations

immigrants and their descendants (the "newcomers") would comprise 118 million people, about 22% of the total population. The PSR would decline to 2.0, which shows that maintaining the population size alone does not reverse, or even substantially slow down the process of aging (Fig. 2).

On the country level, the relatively highest numbers have been obtained for Bulgaria, with "replacement immigration" amounting to 45% of the 2002 population, and for Romania (over 40%). On the other hand, in 10 countries the maintenance of the population size would not require additional "external" migrants apart from the ones scheduled in the base scenario. These countries are: Belgium, Denmark, France, Ireland, Luxembourg, the Netherlands, Norway, Sweden, Switzerland, and the United Kingdom. Meeting the same goal in Finland would require only 1.7 thousand additional immigrants in the 2037–2042 period. It is worth noting that these are the countries for which the target 2052 total fertility rates of 1.8 or 1.9 are assumed.

The "non-decreasing population" simulation has been prepared for the sake of comparison of the results with the United Nations (2000) report. Although, in our view, preventing population decline can hardly be considered as the most important policy goal in itself, some authors argue that the division and specialization of labor, beneficial for productivity, is easier in larger populations (Espenshade 2001). Nevertheless, we tend to think of population decline not as a policy "problem," but rather as a characteristic of yet another phase of human history, especially concerning the developed countries (Bouvier 2001).

Despite the lack of direct policy implications, the "replacement" simulation with the non-decreasing population produces feasible numbers of potential immigrants for most of the countries. Only for Central and Eastern Europe, most notably for Bulgaria and Romania, the assumed low fertility and low net migration lead to extremely high numbers of "replacement migrants" required to maintain the population size.

Fig 3 Population and labor force structures in the 27 European countries, 2002–2052, the non-decreasing PSR scenario. *Sources:* Eurostat, NewCronos; ILO (2003); own calculations

Three further simulations have been performed in order to calculate the number of "replacement migrants" required to maintain non-decreasing support ratios: the PSR, the EESR, or the LMSR. Maintaining the support ratios reflects the aim to preserve the current status quo, rather than to achieve "optimal" population structures. Therefore, no minimum thresholds for the PSR, the EESR, and the LMSR have been set. Although this approach is purely judgmental, it has been chosen in order to show problems with maintaining the aggregate parameters of population and labor force structures.

In this group of simulations, the most extreme results have been obtained for the one assuming the non-decreasing PSR. In order not to let the country-specific PSR decrease in each of the simulation periods, the 27 European countries would have to accommodate 828 million immigrants by 2052, in addition to the ones that are expected to come under the regular conditions (base assumptions). The whole population under study would have to treble between 2002 and 2052, eventually achieving the size of 1.5 billion. By the end of the simulation horizon, the post-2002 newcomers and their descendants would amount to 1.1 billion people, thus to 72% of the total population. From the point of view of the "replacement migration" concept, that would be the price of reaching the PSR value of 4.3 half a century ahead, given the assumed patterns of demographic change. The age structures of the population and labor force of all 27 countries under study simulated for 2052 follow to a large extent the ones of the immigrant population, except for the oldest age groups (Fig. 3).

The age structure shown in Fig. 3 is very far from the stationary one that would guarantee long-term population stability. In the simulated 2052 population, the base of the age pyramid is very thin (there are relatively few children). This directly implies that in the more distant future, the inflow of "replacement migrants" would have to increase continuously in order not to allow the PSR decline. This conclusion supports the results of other research, as mentioned in section "Background: Population and Workforce Aging as a Policy Challenge" of this paper.

Both the magnitude of the "replacement migration" and the structural features of the hypothetical 2052 population render the "non-decreasing PSR" scenario nothing but a theoretical exercise. As noted by Espenshade (2001, p. 388), "the current potential support ratio in [the European] countries is substantially higher than the potential support ratio one would observe in a long-run stationary population endangered by below-replacement fertility and constant immigration. […] The only way to maintain a permanently younger population than the population implied by constant immigration stream is to let the annual migration stream increase into the indefinite future."

In order to partially address the criticism the United Nations (2000) report has been subject to (e.g., Coleman 2002; Espenshade 2001), selected labor market aspects of aging have been incorporated into the analysis. This has been done in two simulations assuming constant aggregate measures that take into account the economic activity: the EESR and the LMSR. In both cases a simplistic assumption has been made that the labor force activity patterns for the "original" population, as well as those for the immigrants ("newcomers") are identical.

The simulation with the non-decreasing EESR resulted in a similar yet slightly less drastic outcome, as compared to the previous one, due to assumed improvements in age-specific labor force participation rates. In order not to let the country-specific EESR fall in each of the simulation periods, in total 653 million people would have to immigrate into all countries under study by 2052 in addition to the number envisaged in the base scenario. The 2052 population would amount to 1.3 billion persons, over 2.5 times more than the 2002 one. Some 861 million people (67%) would be the post-2002 newcomers and their descendants.

The simulation with the non-decreasing LMSR generates less extreme results, while still remaining very far from feasible. Preventing the country-specific LMSR values from declining would require accommodating 471 million people in total by 2052, in addition to the immigrants that would come under the regular conditions. At the end of the simulation period, the population of all 27 countries under study would then amount to 1.1 billion people. Out of this figure, the contribution of the post-2002 newcomers and their descendants would be 652 million (61%). The overall age structure of all 27 European countries simulated for 2052 in the "non-decreasing LMSR" scenario is presented in Fig. 4. The "non-decreasing EESR" simulation yielded an age structure that was in-between the ones obtained with the PSR and the LMSR targets.

The age pyramid shown in Fig. 4 is also far from stationary. However, the taking into account of the economic activity improvements resulted in a decrease in the number of "replacement migrants" and in smoothened age structures of the simulated populations, as compared with the "non-decreasing PSR" scenario. Still, the simulations confirmed that setting aggregate measures (the PSR, the EESR, or the LMSR) as targets does not help to achieve population structures close to the optimal. Adversely, such an approach generates the demand for increasingly more immigrants, eventually leading to artificial age structures, not suiting the aim of counteracting the aging processes. The same also applies to the labor force resources.

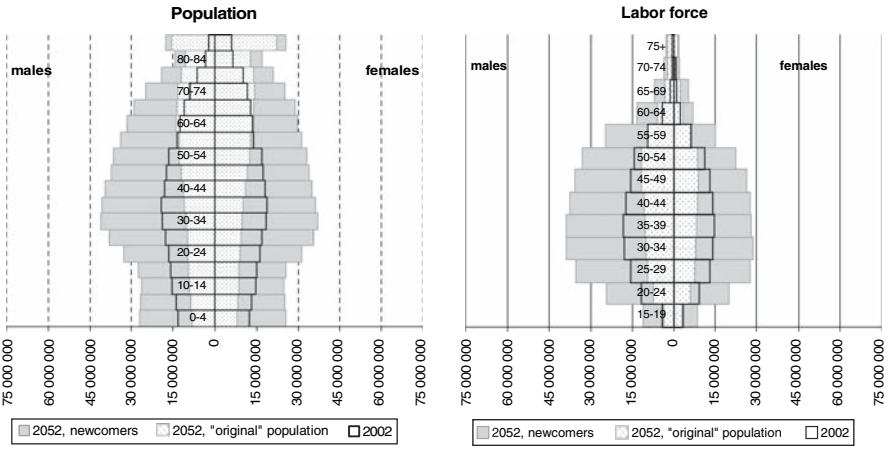

Fig 4 Population and labor force structures in the 27 European countries, 2002–2052, the non-decreasing LMSR scenario. *Sources:* Eurostat, NewCronos; ILO (2003); own calculations

On the country level, the magnitude of "replacement" inflows depends heavily on the initial values of the respective dependency ratios, as well as on the assumptions on the future demographic and labor force developments. An overview of country-specific results for all four "replacement" simulations is presented in detail in Table 3.

These results show that only the scenario aimed at preserving the current population size of particular countries generally fits within the reasonable range of international migration developments. Three scenarios aimed at sustaining the aggregate parameters depicting population and labor force structures (the PSR, the EESR, and the LMSR) result in the dominance of the post-2002 newcomers and their descendants in the overall population. In reality such a situation would lead to social and political turbulences, especially in the short term, before the eventual ethnic and cultural "melting" of the society could possibly take place, as suggested by Espenshade (2001).

Similar conclusions can be drawn with respect to the labor force resources. The forecasted improvements of the age-specific economic activity rates do not significantly reduce the economic burden on the active population. From the point of view of the labor force, it is the aging process of the overall population that is the key factor shaping the future size and structure of the labor supply.

Sensitivity of the Results to Fertility and Economic Activity Changes

In order to assess the impact of fertility assumptions on the simulation results, we performed a simple sensitivity analysis. For each country and period we assumed that the TFR values would be higher than the originally projected trajectories by 0.25 in the "moderate fertility increase" variant, and by 0.5 in the "high increase" one. This approach, although purely mechanical, aims at setting the plausible upper limits of future fertility improvements.

Table 3 "Replacement migration" volume: cumulated 2002–2052 and annual average for 2047–2052, four simulations

Country	Mid-2002 population (thousands)	Cumulated "replacement migration," 2002–2052 (thousands). Simulations with non-decreasing:				Average "replacement migration," 2047–2052 (thousands). Simulation with non-decreasing:			
		Population	PSR	EESR	LMSR	Population	PSR	EESR	LMSR
Austria	8,053	363	17,378	13,562	11,271	23	710	514	366
Belgium	10,332	0	10,073	6,278	2,533	0	387	220	58
Bulgaria	7,868	3,512	9,842	5,760	1,269	69	409	212	36
Czech Republic	10,204	1,089	27,314	22,912	15,325	29	1,348	1,037	471
Denmark	5,375	0	9,063	8,888	10,032	0	371	356	359
Estonia	1,358	296	1,623	1,288	746	5	78	58	23
Finland	5,200	1	10,386	9,060	8,012	0	515	409	220
France	59,486	0	75,731	41,501	23,717	0	3,354	1,623	463
Germany	82,488	4,663	130,243	99,655	68,208	214	5,010	3,567	2,220
Greece	11,003	335	19,866	15,915	8,633	21	823	626	298
Hungary	10,158	1,245	13,933	7,110	939	23	642	307	29
Ireland	3,931	0	13,039	10,436	5,121	0	697	529	202
Italy	57,157	3,221	87,482	64,480	38,021	161	2,859	1,951	837
Latvia	2,338	604	2,858	2,308	1,831	11	140	103	44
Lithuania	3,469	911	5,037	3,881	2,349	19	235	170	93
Luxembourg	446	0	626	467	291	0	25	17	5
Netherlands	16,148	0	35,614	29,967	25,030	0	1,610	1,256	939
Norway	4,538	0	7,393	6,221	7,666	0	315	253	288
Poland	38,425	6,640	108,390	80,825	26,324	179	5,754	3,872	782
Portugal	10,368	159	16,952	13,453	9,929	13	646	494	335
Romania	21,803	8,801	34,208	46,990	42,611	189	1,451	2,045	1,015
Slovak Republic	5,379	712	18,154	13,270	6,442	24	953	637	210
Slovenia	1,994	139	5,282	3,793	1,842	5	239	158	56
Spain	41,200	107	76,814	63,177	56,857	21	2,681	2,175	1,880
Sweden	8,925	0	9,880	9,135	14,722	0	444	387	360
Switzerland	7,289	0	12,261	12,007	15,200	0	548	525	700
United Kingdom	59,231	0	68,395	60,713	65,804	0	2,671	2,328	2,617
All 27 countries	494,178	32,806	827,849	653,065	470,739	1,013	34,925	25,841	14,917

Sources: Eurostat, NewCronos; own calculations

As expected, on the level of all 27 countries the simulated "replacement migration" volumes, cumulated over the period 2002–2052, are lower than the respective ones presented in the previous section. The values produced in the "moderate" and "high increase" variants, presented in Table 4, are on average lower for all four simulations. The drops in "replacement migration" values due to

Table 4 Cumulated "replacement migration" volume for 2002–2052 for alternative fertility trajectories, four simulations

Country	Mid-2002 population (thousands)	TFR trajectory higher by 0.25 than the baseline. "Replacement migration" (thousands), under non-decreasing:				TFR trajectory higher by 0.50 than the baseline. "Replacement migration" (thousands), under non-decreasing:			
		Population	PSR	EESR	LMSR	Population	PSR	EESR	LMSR
Austria	8,053	50	16,197	12,596	10,675	0	15,009	11,618	10,063
Belgium	10,332	0	8 793	5,242	2,101	0	7,506	4,192	1,998
Bulgaria	7,868	2,844	9,076	5,174	1,190	2,153	8,291	4,569	1,183
Czech Republic	10,204	294	25,660	21,606	15,054	0	23,992	20,279	14,760
Denmark	5,375	0	8,290	8,164	9,449	0	7,517	7,437	8,856
Estonia	1,358	172	1,460	1,160	717	50	1,296	1,030	715
Finland	5,200	0	9,604	8,391	7,621	0	8,820	7,717	7,218
France	59,486	0	67,821	35,534	23,444	0	59,887	29,776	23,480
Germany	82,488	308	119,371	90,711	62,620	0	108,461	81,671	56,813
Greece	11,003	0	18,400	14,689	7,928	0	16,929	13,449	7,199
Hungary	10,158	296	12,608	6,248	731	0	11,268	5,597	1,006
Ireland	3,931	0	12,237	9,792	4,827	0	11,437	9,145	4,525
Italy	57,157	421	80,479	58,647	33,852	0	73,470	52,763	29,560
Latvia	2,338	388	2,581	2,085	1,782	169	2,300	1,857	1,794
Lithuania	3,469	586	4,601	3,540	2,205	257	4,158	3,191	2,057
Luxembourg	446	0	564	416	254	0	502	364	223
Netherlands	16,148	0	32,933	27,544	23,015	0	30,257	25,120	20,981
Norway	4,538	0	6,727	5,656	7,371	0	6,060	5,088	7,067
Poland	38,425	3,208	101,864	75,907	24,197	364	95,280	70,908	22,776
Portugal	10,368	0	15,566	12,354	9,529	0	14,173	11,243	9,116
Romania	21,803	6,738	31,570	44,559	43,158	4,630	28,880	42,070	43,683
Slovak Republic	5,379	292	17,172	12,530	6,175	0	16,178	11,777	5,895

Table 4 continued

Country	Mid-2002 population (thousands)	TFR trajectory higher by 0.25 than the baseline. "Replacement migration" (thousands), under non-decreasing:				TFR trajectory higher by 0.50 than the baseline. "Replacement migration" (thousands), under non-decreasing:			
		Population	PSR	EESR	LMSR	Population	PSR	EESR	LMSR
Slovenia	1,994	23	4,956	3,547	1,720	0	4,629	3,298	1,595
Spain	41,200	0	70,877	58,100	53,533	0	64,946	52,987	50,082
Sweden	8,925	0	8,753	8,142	14,632	0	7,625	7,142	15,005
Switzerland	7,289	0	11,132	10,979	14,530	0	10,003	9,944	13,846
United Kingdom	59,231	0	60,734	54,061	61,782	0	53,010	47,333	57,729
All 27 countries	494,178	15,627	760,039	597,384	444,102	7,625	691,894	541,577	419,237

Sources: Eurostat, NewCronos; own calculations

improved fertility are highest in the "non-decreasing population" scenario, and lowest in the "non-declining LMSR" one.

The detailed results shown in Table 4 vary for individual countries. In the non-decreasing LMSR simulation, in three cases (Hungary, Romania, and Sweden) the TFR increase by 0.5 yields an even higher "replacement migration" volume than the regular fertility assumptions. This is likely due to the fact that the LMSR is set to relatively high values, which are thereafter difficult to prevent from declining. Apart from these extreme examples, fertility increase reduces the future demographic deficit (estimated in terms of "replacement migrants") in the European countries under study, but in all cases its impact is rather limited (Table 4). The presented simulations show that even a rapid and lasting fertility increase, as high as by 0.5 child per woman on average, would not be sufficient for offsetting the effects of aging, at least not in the first half of the 21st century. Changes in reproductive patterns alone would not prevent the aggregate support ratios from declining.

In addition to the aforementioned simulations, an experiment was performed regarding the impact of increased labor force participation. For all countries under study we assumed that the economic activity patterns would reach their historical cross-country maxima (shown in Fig. 1) in the 2002–2007 period and remain constant thereafter. In order to prevent the country-specific LMSR values from declining below their 2002 levels, no additional "replacement" immigration would then be needed in 21 out of the 27 countries in the whole projection period. In four cases (the Czech and Slovak Republics, the Netherlands, and Spain) the LMSR would become lower than its initial values in the period 2047–2052, and in one case (Portugal) between 2042 and 2047. Only for Switzerland, the country with the highest initial LMSR and labor force participation, would the LMSR be smaller than its starting value halfway through the projection horizon, between 2022 and 2027. This illustrative example shows that increasing labor force participation is an efficient way to reduce the aging-related burden on the labor market, at least in the short and middle term. Especially in the low-participation countries, there is still much potential left in that respect.

Comparison with Similar Studies

The outcome of the current study can be directly compared with the United Nations (2000) report for France, Germany, Italy, and the United Kingdom, as well as for the "old" European Union (15 countries). In both studies, the simulated yearly net "replacement migration" required under the assumption of non-decreasing total population or the PSR, converges to similar values by 2050. For the United Kingdom, our results are also not very far from those presented by Coleman (2002).

A more detailed comparison with the UN study reveals dissimilarities in the initial period of the simulations. The discrepancies, among others, may be explained by different jump-off periods. The UN study, which had 1995 as a starting year, underestimated net migration for most of the European countries for the beginning

of the 21st century. Another source of the difference is some non-zero migration assumed in the current study independently from the development of the overall population size.

The UN report additionally shows the impact of raising the retirement age. The average PSR value of 2.0 forecasted for 2050 for the EU-15 would increase to 4.1 if the upper limit of the working age was set to 75 years (United Nations 2000, p. 143). Nevertheless, the approach taken in the current study is in our view more complete: it assumes some economic activity improvement also beyond the age of 65, reflected in the EESR and LMSR proxies. An additional argument for manipulating labor force participation rather than changing the age limits in indicators like the PSR is that the real retirement age is usually lower than the legally-defined one.

A study by Feld (2000), focusing on 12 Western European countries, showed that the short-term effects of aging are not going to be as profound as they are expected to be in a longer run. Until 2010–2015, in most of the countries the high population momentum caused by the "echo" of the 1950s baby boom is going to prevent the overall population and labor force from declining. This finding is consistent with the results of the current study.

In comparison with other similar studies, the current research focuses more on the structural issues of the labor markets. To a lesser extent we are dealing with topics that have already been covered elsewhere, such as the absolute size of the labor force (Feld 2000). Our research is, however, the first one explicitly dealing with this issue for the 27 countries of Europe, including the new EU member states. The only Central European countries that have been subject to similar analysis to date are Hungary (Hablicsek and Tóth 2002) and the Czech Republic (Burcin et al. 2007). The selection of countries was aimed at treating the enlarged European Union, Norway, and Switzerland as one migratory system. Within such a system, migration flows are taken for granted, as following the increasing freedom of movement of labor it will be hardly possible to influence them with policy means. In this approach, only inflows from third countries may constitute decision parameters of the policy process.

Conclusion

There is a lot of research, including this study, showing that the population and labor force deficit and age structure imbalances caused by the aging process will become important, if not overwhelming, phenomena all over Europe. The demographic change results in a relatively declining number of workers and an increasing number of retired. In consequence, in many countries pension payments in the PAYG system will exceed the contributions. Therefore, it seems that future sustainability of social security may be achieved only through transformation to systems based on individual savings.

Given the pace of population changes, Europe has hardly more time for a relatively painless implementation of appropriate policy measures. Further delays will result in the accumulation of the negative side-effects of aging over time that would eventually require significant changes anyway, only at a higher social cost. In

order to achieve the desired aims, more efforts are needed to increase the public awareness and change attitudes with respect to the discussed policy issues.

In this study, three possibilities to reduce the forecasted imbalances were examined: two demographic (increased fertility and increased immigration) and another one consisting of labor market changes. Obviously, neither of them is exclusive. Our simulations showed that the magnitude of migration flows needed to maintain various support ratios 50 years ahead would have to be well above any reasonable absorption capacity of Europe. Instead, European policymakers should focus on developing migration policy measures aimed at balancing current shortages on the labor markets through the means of selective immigration.

A long-term increase in fertility patterns seems indispensable to reduce the pace of aging. Nevertheless, as shown by the sensitivity analysis, in the middle run the impact of increased fertility alone will not be sufficient, given the negative population momentum. The experiment with maximum labor force participation indicated that increased economic activity can postpone the negative labor market effects of aging, at least for half a century in most of the European countries, especially given large potential left in that regard. These results confirm that only a combination of all mentioned population and labor force policies may bring about significant changes.

Besides the proposed solutions, another important policy goal would be the promotion of investments in human capital according to the life-course policy paradigm. Such an approach would benefit both individuals, through lifelong learning and longer working possibilities, and societies, through an increase in productivity and maximization of social welfare. More attention should also be paid to interdisciplinary policy-oriented research on aging and its socioeconomic implications (NRC 2001), which should address the issues of interactions between policies, for example, aimed at increasing fertility and female economic activity.

Our simulations confirm the results of earlier studies and reiterate their conclusions. Policymakers should see the consequences of demographic change in a long-term perspective and address them with serious proposals of reforms, not limited to partial, marginal, or temporary solutions. An efficient policy combination should include measures aimed at fertility and labor force participation increase, combined with reasonable migration management and in-depth reforms of social security systems. Raising the awareness of aging problems in society is a precondition for the success of any action. Only combined policy means can address problems related to population aging with due attention; the sooner, the better.

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