Can Immigration Compensate for Europe's Low Fertility?

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Abstract

This paper addresses in a systematic demographic manner the widely discussed question: To what extent can immigration compensate for low fertility in Europe? We begin with a set of 28 alternative scenarios combining seven different fertility levels with four different migration assumptions at the level of the EU-15 to 2050. Next, we address the research question in the context of probabilistic population projections, and the new concept of conditional uncertainty distributions in population forecasting is introduced. Statistically this is done by sorting one thousand simulations into low, medium, and high groups for fertility and migration according to the average levels of paths over the simulation period. The results show a similar picture to that of the probability-free scenarios, but also indicate that for the old-age dependency ratio, the uncertainty about future mortality trends greatly adds to the ranges of the conditional uncertainty distributions.

European Demographic Research Papers are working papers that deal with all-European issues or with issues that are important to a large number of European countries. All contributions have received only limited review.

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The decline of European birth rates to levels well below those required for the full replacement of one generation and the associated prospects of rapid population ageing have given rise to a discussion of the question, to what degree immigration of young adults from outside Europe could fill this gap. The underlying reasoning is that the volume of immigration could be more easily determined by government policies than the level of Europe's birth rate. It also assumes that rapid population ageing will have negative implications for Europe's social and economic structure and for global competitiveness. These are all highly complex questions with many political, economic, and even cultural dimensions that shall not be discussed here. Instead, this paper will only discuss the strictly demographic dimension of this question: What are the implications for Europe's population size and structure of alternative future fertility levels combined with alternative levels of immigration? We will present the results of 28 scenarios that combine seven different fertility levels with four different migration levels for the current 15 member countries of the EU to 2050. In the second part, we discuss this question in the more complex framework of probabilistic population projections for the EU. We will introduce the concept of conditional uncertainty distributions and compare the distributions that result from the combination of different fertility and migration ranges given the full range of mortality uncertainty. This provides the reader with more information than the simple if-then scenarios in the first part.

The question used as the title of this paper has gained wide public prominence following the publication of a UN study entitled "Replacement Migration: Is it a solution to declining and ageing populations?" (UN 2000). This study presents several scenarios for a set of eight countries as well as Europe and the EU as aggregates. One scenario computes and assumes the migration required to maintain the size of total population; another keeps the working-age population constant; and finally, one maintains the support ratio, i.e., the proportion of the population aged 15-64 over the population 65 or older. For the individual countries, the results show that significant immigration can result in constant population sizes and even constant sizes of the working age population, whereas the support ratio can only be maintained with implausibly high immigration levels. The absurd number of 5.1 billion immigrants necessary to maintain a constant support ratio until 2050 in the Republic of Korea has received a lot of attention in this context. For the European Union (EU-15) these calculations show that a total of 47.5 million (or 0.95 million per year) migrants would be required to keep the population size constant; 79.4 million (or 1.6 million per year) would be needed to maintain the working-age population; and an impossible 674 million (13.5 million per year) would be needed to keep the support ratio constant. It was interesting to see that in terms of public reactions to these calculations, one could find opposing conclusions ranging from "immigration can never solve the ageing problem" to "immigration is urgently needed to solve the ageing problem."

This UN study chose an approach that works completely top down or more precisely "back from the future." A certain demographic target (such as keeping the support ratio constant) is set and then one calculates what immigration would be needed to achieve this goal, assuming invariant paths of future fertility and mortality, i.e., viewing migration as the only policy variable. From a purely computational point of view, such calculations are certainly possible and legitimate, although they may not be very meaningful. We see two main problems with the publication and broad dissemination of this kind of study. One has to do with public perception, the other with the nature of demographic evolution. The problem with the public perception of such studies is that inevitably people take the (hypothetically) set target as a real target, moving immediately to the processes that will achieve the target without questioning the meaning of the target. In the classic schools of rhetoric this is a famous trick identified by the ancient Greek in order to manipulate the listener in a certain direction. We certainly do not want to imply that the authors of this study had manipulation in mind, but only point to the mechanism through which many commentators were led to not discuss whether, e.g., a constant labour force is a meaningful political goal, but took this for granted and immediately moved to the discussion of migration policies. The second problem with this approach is that real populations do not evolve "back from the future." Demographic trends tend to be determined by past and current contexts and evolve as these contexts change. Even policy makers who should orient their current policies on anticipated future conditions do not think in terms of strictly demographic targets, but rather in terms of the sustainability of social security systems, which are based on many more parameters than the strictly demographic ones. In the context of discussing the "replacement migration" study, demographer David Coleman of Oxford once warned of the danger of what he called "demographism," i.e., reducing the complex world to simple demographic numbers (personal communication).

In this study, we try to avoid the problems described above by having a different approach: we combine a range of different possible and plausible evolutions of fertility rates over the coming decades with a range of different possible and plausible immigration levels. Calculations are performed at the level of the European Union (with its current 15 member states). In the following section, this will be done through the discussion of 28 probability-free scenarios. Later we will discuss the approach in the context of new probabilistic population projections.

SCENARIOS COMBINING ALTERNATIVE FERTILITY AND MIGRATION LEVELS

Figures 1 and 2 present selected findings from a large number of different simulations that were calculated at the level of the EU-15 with a population of 376 million in 2000. Since the discussion of this question mainly concerns the long-term impacts, the figures only show the results for 2050. They are based on alternative population projections in which fertility and net migration are kept constant over time at the level indicated, while mortality – the third component of population change – is improving slowly as assumed in the regular projections (see below). The figures group the projection results by the assumed total fertility rate (TFR) ranging from 1.0 to 2.2. For 1999 Eurostat gives a TFR of 1.45 for the EU-15, which covers a range from Spain (1.19), Italy (1.21), Greece (1.30), and Austria (1.30) at the low end, to Denmark (1.74), Finland (1.74), France (1.77), and Ireland (1.89) at the high end (European Commission 2001). The different bars under each fertility assumption refer to different assumed levels of net migration gain. For 1999 Eurostat estimates a positive net migration rate of 1.9 (per 1,000 population) for the EU-15, which in absolute terms implies a migration gain of 714,000 persons (European Commission 2001). Over the past decade, however, migration flows have shown strong annual fluctuations and great differences between the 15 member states. The figures show the results for four different levels of annual net migration, ranging from zero (no migration gains) at the low end to a constant annual gain of 1.2 million, which over the 50-year period would accumulate to a 60 million immigration surplus.

Figure 1 presents the results with respect to the total population size of today's EU-15. Not surprisingly, the lowest population size in 2050 (271 million or a 28 percent decline from today) results from the combination of a TFR of 1.0 with the assumption of zero net migration gains. At the high end, the combination of a TFR of 2.2 with a 1.2 million annual migration gain results in a population size of 431 million in 2050, which is an increase of 15 percent as compared to today. The Eurostat projections, which combine fertility and migration assumptions that are considered most plausible as of today (baseline scenarios), give a total population size of 364 million for 2050, which is a decline of about 3 percent (European Commission 2001). Of all the alternative scenarios included in the figure, the overwhelming majority points toward population decline, but the impacts and the differences among the scenarios are not too dramatic considering that it reflects the change over half a century. This shows that total population size is a rather inert variable, and even rather extreme combinations of assumptions affect it only very slowly.

Figure 1 Total population of the EU-15 in 2050, according to alternative projections assuming a wide range of fertility and annual net migration levels. The level of 2000 is marked as a black line.

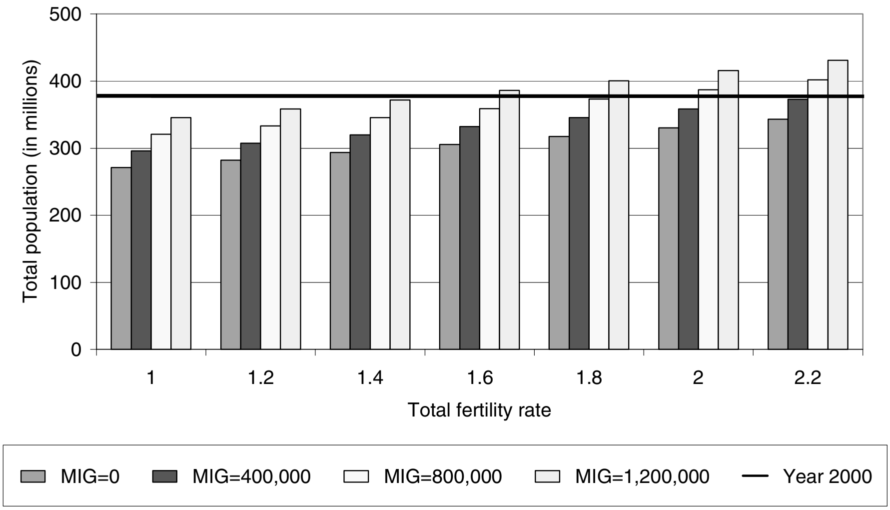
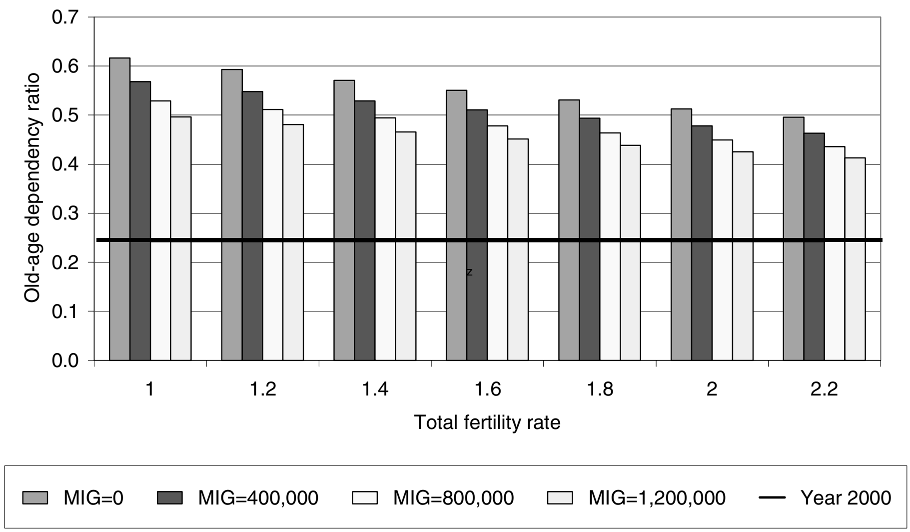


Figure 2 shows that the population age structure is expected to change more rapidly and more profoundly than population size. The graph plots the so-called old-age dependency ratio, which is defined here as the proportion of the population above age 65 divided by the population aged 15-64. At the level of the EU-15 this ratio is presently 0.24. Due to the inevitable changes that are mostly pre-programmed in the current age structure of the population, this ratio is bound to increase significantly under all scenarios. Up to 2050 this dependency ratio will increase by a factor of roughly two to three depending on the future fertility and migration levels assumed. It is interesting to see that even massive immigration to Europe makes little difference for the old-age dependency ratio. This difference is somewhat more pronounced in the case of very low assumed fertility and less pronounced for the higher fertility scenarios. Even in the extreme case of 60 million young immigrants added to the EU labour force, over the next five decades the expected increase in the old-age dependency ratio would be only slightly more moderate than under current migration rates and even not very significantly different from the other extreme case of no migration gains.

Figure 2 Old-age dependency ratio for the EU-15 in 2050, according to alternative projections assuming a wide range of fertility and annual net migration levels. The level of 2000 is marked as a black line.



PROBABILISTIC PROJECTIONS CONDITIONAL TO DIFFERENT FERTILITY AND MORTALITY LEVELS

While the above-described scenarios are based on conventional demographic projection methods, this section introduces a methodologically innovative element in the rapidly expanding field of probabilistic population projections. This field cannot be described here, but has been extensively documented elsewhere (Lutz et al. 1999, 2001). There have been essentially three major approaches for deriving probabilities, i.e., quantitative assessments of the uncertainty ranges for future demographic trends (time series models that assume structural continuity and extend past variances in vital rates into the future); assessments of the errors in past population projections, which assume that future errors will be of the same nature; and magnitude and assessments of uncertainty based on expert arguments. Since it is obvious that all three approaches cover important aspects of the question, and that all of them include elements of expert judgment, a synthesis of the three approaches has occurred. One such synthesis has recently been developed and applied to the projection of 13 world regions by Lutz et al. (2001). The projections presented here are based on this model; the methodology is described in the supplementary information to Lutz et al. (2001) and can be downloaded from www.nature.com. Since the world regions in Lutz et al. (2001) do not include the EU-15 as a distinct region, the projections presented here represent the first projections for the EU-15 based on that methodology.

Generally speaking, probabilistic projections are an attempt at providing the users of projections with more information than contained in one best guess forecast or in completely probability-free, if-then scenarios. Most users of population projections tend to be satisfied with one projected future path that tells them what experts assume to be the most likely trend in the future. Such a best guess projection will suffice for many applications. In some instances, however, users also want some information about the uncertainty involved in the projections. This is especially the case if there is some cost involved in erring. If, for instance, construction plans for new schools are based on projections about the number of children in certain areas, it can mean high costs if the projections turn out to be wrong. Hence, in rational decision processes, cost functions are usually combined with risk functions. Only fully probabilistic projections can provide such risk functions.

One common way to deal with uncertainty in population trends is to define alternative scenarios on fertility, mortality, and migration, and calculate their implications in terms of population size and structure. Such scenarios are simply exercises in population dynamics and cannot tell the users whether the described future path is more or less likely, whether it should be taken seriously as something to prepare for, or whether it can be disregarded as a low probability scenario. This is clearly the case for the above-described scenarios, in which we do not tell the user which fertility or migration paths are more likely to happen than others. The variants approach (still) used by the UN Population Division and many national statistical agencies is an attempt to move from completely probability-free scenarios to giving the user a "plausible range" defined by high, medium, and low variants. As more extensively discussed elsewhere (Lutz et al. 1999) this variants approach is inappropriate for three distinct reasons. 1) The variants can only vary one of the three demographic components, which in most cases is fertility, thus disregarding the significant uncertainties about future mortality and migration trends. 2) This approach does not tell the user what a "plausible range" means: does it cover 100 percent of all possible cases, or only 50 percent, or something in between? 3) The approach is "probabilistically inconsistent" (National Research Council 2000) when aggregating results, e.g., summing up all the high variants for different countries to obtain a regional high variant because it requires the additional very strong and implausible assumption that national trends are perfectly correlated. For these reasons, the authors are convinced that the variants approach represents a bad compromise between probability-free scenarios on the one hand, and fully probabilistic projections on the other. Hence, depending on the purpose of the exercise, either of the two, i.e., probability-free scenarios or fully probabilistic projections, should be chosen.

Probabilistic projections as published in the literature so far, however, have one important disadvantage for policy making. They only provide the user with one unconditional distribution of possible future population trends without being able to show, for example, the consequences of alternative immigration policies. For this reason, when IIASA presented its global-level probabilistic projections for the first time (Lutz 1996), it also maintained a separate chapter presenting alternative scenarios to serve the purpose of evaluating the longer-term consequences of alternative paths.

Here we suggest that this duality of presenting both scenarios and probabilistic projections is not necessary to meet the demand by users to see the consequences of alternative fertility, mortality, and migration paths. Within the framework of fully probabilistic scenarios, it is possible to satisfy this demand through the presentation of conditional distributions. This can be done simply by grouping 1,000 simulated paths that are used to generate the uncertainty distribution of output parameters into subsets of simulations defined by specific ranges of the input parameters. Table 1 presents the results of a grouping that distinguishes between three different fertility ranges and three different migration ranges with the range of the mortality paths being unrestricted.[1]

Table 1 has six parts, which give the results for such conditional probabilistic population projections for the EU in terms of different output parameters. For each of the output variables the results are given in terms of nine cells, which show the results for the simulation runs that result from three different migration ranges (given across) and three different fertility ranges (from top to bottom). All fertility and migration paths have been sorted by the average level of TFR and net migration over the projection period 2000-2050. For fertility the lowest simulation run has an average TFR of 1.08 over the entire period. The highest average TFR is 2.20. Since these values are averages and the simulated paths have quite strong annual fluctuations, the TFR range in any particular year may lie well outside this range. The assumptions underlying these projections are based on a distribution of the TFR in 2030 in which 80 percent of the range lies between 1.2 and 2.2 with the median at 1.7. For the level of annual net migration, the 80 percent range is from zero to 1 million, i.e., in any year the difference of immigrants to the EU and emigrants from the EU lies with a probability of 80 percent within the range of zero and 1 million, with the

[1] It should be stressed that the fertility and migration distribution within the lower and high thirds are not symmetric since they are derived from the overall normal distribution.

median at half a million. As the labels for the three groups of average net-migration levels show, individual average paths may well lie outside these 80 percent ranges.

The first panel gives the results for the total population. The numbers in the nine cells that are defined by the three fertility and three migration ranges give the medians of the total population distributions of the EU-15 in 2050 from all the simulations that fall into this group. The numbers in parentheses below give the 80 percent uncertainty intervals. Hence, for the upper left cell, the results show that a combination of low fertility (the lowest third) and low migration gains (the lowest third of the assumed paths that includes net migration losses) yields a median population of 323.91 million for the EU in 2050. This is well below the current population size of 376 million. The 80 percent uncertainty range in this cell goes from 299 million to 352 million. This range is due to the uncertainties in fertility and migration within the defined categories, and to the full uncertainty about future mortality trends. In this first cell, even the upper end of the 80 percent uncertainty range is well below the current population size, i.e., this combination of low fertility and low migration almost certainly leads to population decline. In the lower right corner we find the opposite picture. High fertility combined with high migration gains lead to a median population size of 418 million in 2050, which is well above the current size. Even the lower end of the 80 percent range in this cell (389 million) implies some increase in total population. The other seven cells lie in between these two extremes, with the 80 percent ranges often overlapping. It is worth noting that of the given ranges, the combination of high fertility with low migration results in a higher total population size than the combination of low fertility with high migration gains.

Table 1 Conditional uncertainty distributions (medians and 80 percent ranges in parentheses) for the EU-15 in 2050 by high, medium, and low segments of the assumed fertility and migration paths.

TFR	Migration		
	(-175394-438533)	(438533-667560)	(667560-1244037)
Total population in millions			
(1.08-1.53)	323.91 (299.11-351.73)	344.48 (321.23-368.88)	359.12 (334.41-385.43)
(1.53-1.71)	351.19 (327.02-372.39)	372.39 (351.03-397.58)	389.71 (365.99-411.61)
(1.71-2.20)	375.34 (348.90-407.90)	402.32 (369.66-434.50)	418.06 (388.76-450.00)
Proportion above age 65			
(1.08-1.53)	0.34 (0.30-0.38)	0.33 (0.29-0.37)	0.32 (0.29-0.36)
(1.53-1.71)	0.32 (0.28-0.35)	0.31 (0.28-0.34)	0.30 (0.27-0.33)
(1.71-2.20)	0.29 (0.26-0.33)	0.29 (0.26-0.32)	0.28 (0.25-0.31)
Proportion aged 0-15			
(1.08-1.53)	0.11 (0.08-0.12)	0.11 (0.08-0.13)	0.11 (0.09-0.13)
(1.53-1.71)	0.13 (0.12-0.15)	0.13 (0.12-0.15)	0.14 (0.12-0.15)
(1.71-2.20)	0.16 (0.14-0.18)	0.16 (0.14-0.18)	0.16 (0.14-0.18)
Old-age dependency ratio			
(1.08-1.53)	0.62 (0.51-0.71)	0.60 (0.49-0.71)	0.57 (0.49-0.66)
(1.53-1.71)	0.58 (0.49-0.69)	0.56 (0.49-0.63)	0.54 (0.46-0.61)
(1.71-2.20)	0.53 (0.45-0.64)	0.52 (0.44-0.61)	0.51 (0.44-0.58)

The second panel gives the results of the conditional probabilistic projections for the proportion of the population above age 65. As discussed above, this proportion is bound to increase significantly from its current level of 0.163 mostly due to the already existing age structure. Even high fertility (almost around replacement level) combined with very high average migration gains (the upper third of the migration range) will lead to an increase, to a median of 0.28 and an associated 80 percent range of 0.25-0.31. As one would expect, the increase in the proportion elderly is greatest for the combination of low fertility and low migration gains. Comparing the lower left with the upper right cells, again the effect of a higher fertility level is clearly more significant than that of higher migration levels.

The third panel gives the results for the proportion of children aged 0-15 in the total population. This proportion is currently 17 percent and is bound to decline under practically all combinations of fertility and migration. Only in the high fertility category, the upper end of the 80 percent ranges imply a small increase to 18 percent by 2030. It is evident from this panel that the proportion of children is almost exclusively determined by the level of fertility and virtually insensitive to even greatly differing migration levels.

The last panel shows the projected trend in the old-age dependency ratio, defined as the proportion of the population aged 65 and above divided by the population aged 15-64. This ratio, which currently stands at 0.24, will increase significantly under all circumstances. This has already been demonstrated clearly for the deterministic scenarios above. An additional piece of information to be derived from these conditional probabilistic projections is that mortality uncertainty plays a major role in determining the uncertainty range of the future old-age dependency ratio. This is clearly visible from the fact that the 80 percent ranges given in parentheses are unusually broad, and that all nine ranges overlap. The lower bound in the cell combining low fertility with low migration (0.51) is the same level as the median in the cell of high fertility and high migration, and well below the upper bound in this cell.

This last point clearly demonstrates that the calculation of scenarios that only consider fertility and migration uncertainty and disregard mortality uncertainty (as given in the first section of this paper) tell only part of the story. In the presence of mortality uncertainty, the resulting uncertainty ranges for the proportions elderly and the old-age dependency ratio increase significantly. This is an important point of high policy relevance when it comes, e.g., to pension reforms; it is entirely missed by the traditional UN-type high, medium, and low variants, as well as other scenario exercises that disregard mortality uncertainty. The above-cited UN replacement migration study falls into this category as well.

In conclusion, this paper has made two distinct contributions. First, it provides a more systematic and useful consideration of the consequences of alternative migration levels, combined with alternative fertility levels, than given previously in the literature. Second, this study presents for the first time the concept of conditional uncertainty distributions for population projections, and demonstrates that this is a feasible and useful means for combining the policy makers' desire for population outcomes that are contingent to variations in the components of change with the other well-established advantages of probabilistic population forecasting.

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