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Optimal Fertility

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Contents

Abstract

In this paper we challenge the widespread notion that replacement level fertility is the most desirable level of fertility both for countries currently above and below this level. We first discuss possible alternative criteria for choosing one fertility level over another. Dismissing for the time being the two extreme criteria of ever increasing national strength (which would imply unlimited population growth) and preservation of the environment (which would see human numbers converge to zero), we focus on age dependency as the sole criterion. But we do so by relaxing the strong assumption that all individuals of a given age are equal in terms of their economic contribution to society and introduce education as probably the most relevant observable source of population heterogeneity. Our criterion variable is the education weighted support ratio and we perform thousands of alternative simulations for different constant levels of fertility starting from empirically given populations. If education is assumed to present a cost at young age and results in higher productivity during working age then for most countries the optimal long-term total fertility rate turns out to be well below replacement level.

Acknowledgments

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Optimal Fertility
Erich Striessnig and Wolfgang Lutz

1 Introduction

Assume for the moment that fertility is a policy variable and we can choose among different hypothetical future pathways. Which average number of children should we be promoting as a social norm in the best interest of society? Demographers have so far been quite reluctant to even hint at possible answers to this rather normative question, whereas the factual trends in the levels of fertility, as well as their projection into the future have received widespread attention. If at all, then normative judgments are voiced indirectly, for example, from scientists expressing their concern about high-fertility in some contexts and possible ‘low-fertility traps’ in others. Yet, what enables them to judge and describe such scenarios as possible catastrophes?

The goal of our paper is to find possible criteria to enable us to choose one fertility future over the others. How is it even possible to identify one pathway that would be preferable compared to all others? And what could valid criteria for considering one trend as being more desirable than another look like? This is in short the normative analysis that is conducted in Section 2. Section 3 introduces the model and our base-line assumptions upon which the results – presented in Section4 – are based. Section 5 consists of detailed sensitivity analysis before a final discussion revisits – and challenges – the theme developed in many previous discussions of the disastrous long-term consequences of low fertility. It delivers a potentially unexpected message to governments on what should be the goal of their policies in the context of population ageing and shrinking.

2 Criteria of Optimality

When asked what a desirable fertility level for populations in Europe might be, most politicians, journalists and even social scientists would say that demographers intimate it is around two children per woman – a level called ‘replacement level fertility’. The reasons stated in support of this level of fertility (which in most European countries is higher than the one currently reported) usually refer to maintaining the size of the labor force and stabilizing the old-age dependency ratio. But a closer look at the demographic models that underlie this reasoning reveals that this supposedly precise level of 2.1 (actually more like 2.06 under low mortality conditions) is only derived from a highly stylized theoretical model of stable population. It has little to do with maintaining the size of the labor force in contemporary *real* European societies. These have an age structure which is highly irregular due to past fluctuations in fertility and net migration.

Even in the hypothetical absence of migration, in countries with a high share of young people (positive momentum of population growth) fertility should be well below replacement level if the goal is to maintain the absolute size of the working age population. Conversely, in countries with relatively few younger people (i.e., that have already entered a phase of negative momentum) fertility should be significantly above replacement level if the goal is to maintain the working-age population.

Lutz et al. (2003) showed that Europe's population entered a phase of negative momentum around the year 2000. Hence in this context of real European populations and their empirically given age structures, a reference to replacement level fertility makes little sense in terms of the stated goal of maintaining the labor force in its current size.

Another line of argumentation in favor of two surviving children per woman refers to individual preferences and a supposedly 'natural' desire for a man and a woman to have two children together to replace themselves and hence continue living in their children. Lutz and Scherbov (2008) argued that it is worth distinguishing between population level replacement and individual level replacement. They stress that at the individual level it is sufficient to have one child (under low child mortality conditions) if the primary goal is to pass on one's genes and continue to live on in the next generation. In the absence of cloning it takes a partner of the opposite sex to produce this one offspring. As such, the child is made up of only half of each parent's genes. Yet having two or three children does not make the offspring more similar to the parent. It would of course spread his/her genes more widely, but this is a very different goal from replacement and if this were the goal then, of course, one should have as many children as possible. There would be no reason to stop at two. There may be other individual level reasons for having a second child, such as providing the first child with a sibling, but again this is not related to the question of replacement. We only mention this important distinction between societal and individual level replacement in order to make sure that the following discussion of optimal fertility at the societal level is not confounded with that of personal optimal fertility at the level of individuals and couples. Seen from the individual perspective it may be optimal to minimize the difference between desired and actual family size; however, the resulting aggregate level of fertility may not be 'optimal' for society.

When thinking about what would be the 'optimal' level of fertility in the longer run for any given population, one must first think clearly about the criteria for making such judgments. In the context of current European populations, most of the concern in the discussion of demographic trends centers on the economic and social security consequences of population ageing. In this context the criteria for optimality are to minimize the projected increases in the old-age dependency burden and, more generally, to maximize the economic well-being of the average citizen in the population studied. But in times of major concerns about global climate change, the possible impacts of different demographic trajectories on future paths of greenhouse gas emissions and on a future generation's ability to cope with the expected negative consequences of climate change must be taken into consideration, at least conceptually. With respect to this environmental dimension, there is generally little doubt that fewer people would be better. Still, the major challenge is how to quantify this effect and how to weigh it against the costs and benefits of the ageing dimension.

There still may be a third, quite powerful criterion for judging the desirability of alternative longer-term fertility trends and levels. We may label this criterion 'national identity,' reflecting a population's fears of having a smaller population in relation to its rivals. Under such a view population growth, even if not considered economically advantageous may still seem desirable. This can operate at both inter-state and intra-state levels and may explain the prevalence of high birth rates under conditions of ethnic rivalry such as between Palestinians and Jews in Israel, despite the relatively high levels of socio-economic development in both communities (Fargues 2000).

While at some point these non-economic criteria must also be taken into consideration – not so much because of their stringency but because they exert a significant influence in real world discussions –in the following we focus solely on the economic aspects associated with the changing age structure of the population while explicitly taking education into account.

3 The Model

In 2004, Lutz, Sanderson and O'Neill published their 'Population Balance' Model which directly addressed the question of optimal fertility (Lutz et al. 2004). The welfare indicator that was used to assess 'optimality' was sensitive to age- and education-specific productivity, cost of pension and cost of education. They asked whether the per capita welfare decline caused by rising dependency ratios could be counterbalanced by the improved education of the smaller young cohorts. This might increase their productivity, offsetting the costs of rising dependency ratios. At the same time, smaller young cohorts cost less at a given level of education expenditure per child.

The effects of alternative levels of education on welfare were evaluated in the context of different fertility scenarios. Each steady-state level of fertility produces a distinct age structure which becomes stable in the long run. The results are shown in Figure 1. They clearly indicate that in the case of low education, the optimum is very broad – meaning that the welfare indicator is not very responsive to changes in fertility – and peaks around two children. In the context of higher education levels, however, the optimum moves to the left (around 1.4 – 1.7 children per woman) and the overall level of welfare increases. This clearly illustrates that under hypothetical stable conditions, sub-replacement fertility can be optimal if society is willing to spend more on each child's education.

We will now further expand this analysis, conduct sensitivity studies and, most importantly, apply the model to the actual age- and education-structures of selected European countries, rather than stable populations. In order to assess the welfare impact of different long term patterns of fertility we use a simple population model that enables us to calculate education weighted support ratios based on observed initial (2010) population structures and survival probabilities as forecasted by the United Nations in its 2008 revision of the *World Population Prospects* (UN 2010). Using the IIASA/VID (Vienna Institute of Demography of the Austrian Academy of Sciences) data and projections on educational attainment (KC 2010), the population is first divided into four education categories: None, primary, secondary and tertiary (for the European countries studied, the first category is irrelevant). We then apply different weights to these categories, both with regard to the dependency burden due to getting education and to differential support that people in working-age groups can supply for those not actively taking part in the labor force. This is a somewhat more sophisticated and realistic extension of the conventional support ratio where every person of working age is assumed to make the same contribution to the support of the dependent population.

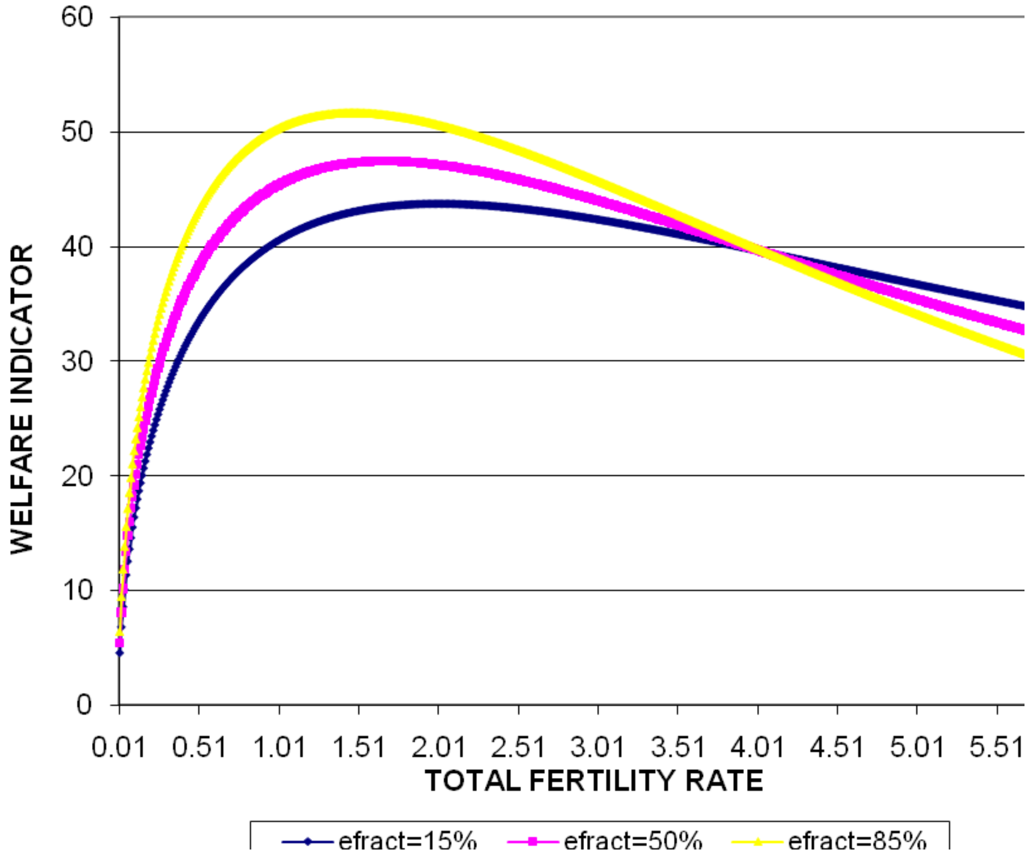

Figure 1. Welfare indictor for stable populations by fraction educated and total fertility rate, baseline parameters.

Since there is overwhelming evidence that in virtually every society the more educated, the more productive in economic terms and hence contribute more, this effect is captured here in terms of giving them higher weights when calculating the numerator of the support ratio.[1] In the following figures the specific assumptions made are listed in the box on the upper right where 'ed1_weight' refers to the weight given to working-age people with only primary education (this is usually set to 1.0), 'ed2' refers to those with at least junior secondary and 'ed3' to those who have at least a completed first-level tertiary education. In all other respects this analysis makes the same simplifying assumption as the usual support ratios (that everybody of working age who no longer goes to school is in the labor force, there is no unemployment, etc).

As far as the dependents (denominator of the education-weighted support ratio) are concerned, retirees get the same weight (here assumed to be 1) but the ages of labor market entry and exit are education specific. In other words, uneducated and primary educated people are assumed to move from the denominator of the support ratio to the numerator after age 15, secondary educated after age 18, and tertiary educated follow at the age of 25. We also assume that those getting secondary and tertiary education require a higher education input after the age of 10.

[1] The specific weights at this stage are rather arbitrarily chosen but as sensitivity analysis shows in the following, the optimum does not respond greatly to the choice of these weights. Rather they affect the level of the support ratio.

Here the assumed values are listed under 'ed_cost' where the cost is 1.0 for everybody up to age 10. It is then increased to 'ed2_cost' for those with secondary education up to age 18, and to 'ed3_cost' for those going on to study to age 25.

Education has benefits as well as costs. When retiring from the labor market and thus returning to the denominator, the primary educated are assumed to make the transition at the age of 57; secondary educated retire at 61; and tertiary educated at 65. This tries to roughly resemble the current pattern in some European countries (Heckman 2010). However, current trends across the continent strongly suggest these ages will increase over the coming decades in response to past and future increases in life expectancy. In our baseline case, we do assume therefore that every additional year of life is an additional year spent in the workforce.

Likewise, education also matters when "retiring" from the denominator of our support ratio. Following KC (2010) and KC et. al. (2010) we assume that the difference in life expectancy between people with primary education and those who have completed at least some level of tertiary education on average is of four years. The gain in life expectancy from finishing secondary education compared to just primary education is of 2 years. For simplicity mortality, as well as the retirement ages are assumed to be the same for men and women, but this could easily be changed as could all of the other assumptions on weights and transition ages.

4 Results

In the context of real populations with non-stable age distributions, the time dimension becomes extremely important in this exercise. If the time horizon for optimization is only 10 or 20 years, the optimum for increasing the support ratio is very different from that of a longer time horizon. In the following figures it was assumed that the fertility moves from its current level to the target level (listed on the TFR-axis) by 2015 and then remains constant. The standard assumption used here for all education trends is the global education trend (GET) scenario, defined as the baseline in the IIASA-VID education projections. It assumes a further improving trend following the countries that are already more advanced in their educational structure with tertiary education assumed to level off at a maximum proportion of 60 percent of a cohort. A three-dimensional representation of our baseline results for Finland is given in Figure 2.

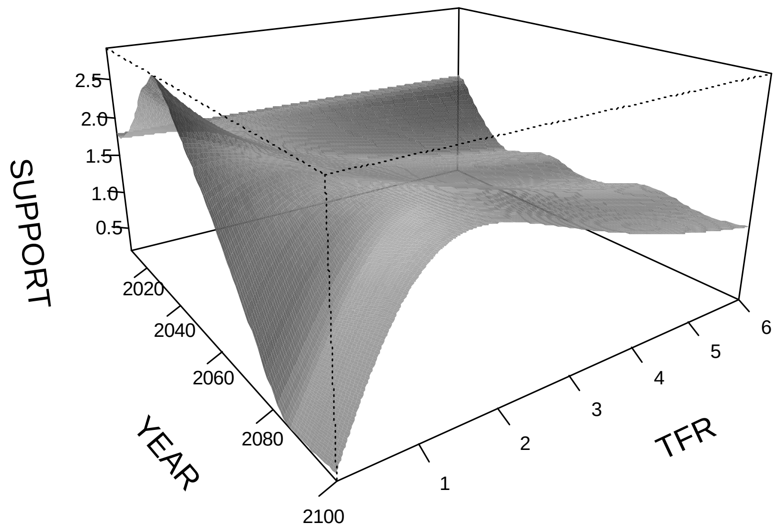

Figure 2. Support ratio for global education trend (GET) scenario.
Baseline for Finland, 2010-2100

It shows that in the first few years of our projections the rate of fertility does not matter because the picture is still dominated by its initial conditions. Up until around 2035, however, it becomes better and better in terms of overall support not to have had children over the past 25 years compared to having had at least a few children. This is because in our model it takes at least 15 and up to 25 years, in the case of tertiary education, before the babies born in 2010 enter the labor force. Until that age they are really just a burden for society. After that, having had at least a few children is already becoming less burdening since by that time those who were born shortly after 2010 and/or who have left school early are already shifting from the denominator to the numerator of our support ratio. But since the share of people with higher education is constantly rising it takes some time until the additional productivity in the numerator exceeds the additional costs in the denominator and so when looking at the question of optimal fertility in this way it really takes much longer until we reach the threshold year, when past investments in children start making economic sense.

Figure 3 cuts through the 'support-mountain' in Figure 2 and shows the support-optimizing level of fertility in selected years. Extremely low fertility is optimal for all time horizons in which these fewer children do not yet affect the size of the labor force but only bring down young age dependency. In this case, not to have children is best. Such a policy increases the support ratio, but is of course very short-sighted because it will begin to starve the economy of workers after 15 years. As can be seen in the second half of the century, the pattern of an inverted U-shape appears which characterizes all of the graphs for the longer run. This is because high rates of fertility never even start making economic sense since at any given point in time the bigger education costs from ever bigger future cohorts of children will outweigh the gains in productive potential. What is also interesting to note is that the curve declines more steeply to the left for cases of extremely low fertility and somewhat slower to the right for cases of high fertility. This arises from the fact that with very low fertility the numerator simply converges towards zero, leading to a rapid decrease in overall support. Conversely, at high levels of fertility – despite of an ever increasing number of dependents – the numerator is still fed with an increasing number of young workers as well, slowing the decline in overall support somewhat. Of course, this comparison does not say anything about i.e. the environmental sustainability of these high fertility scenarios. Note that the box in the lower right corner of Figures 3 and 4 indicates the TFR which shows the highest level of our welfare indicator, that is, the optimum level of fertility (OLF).

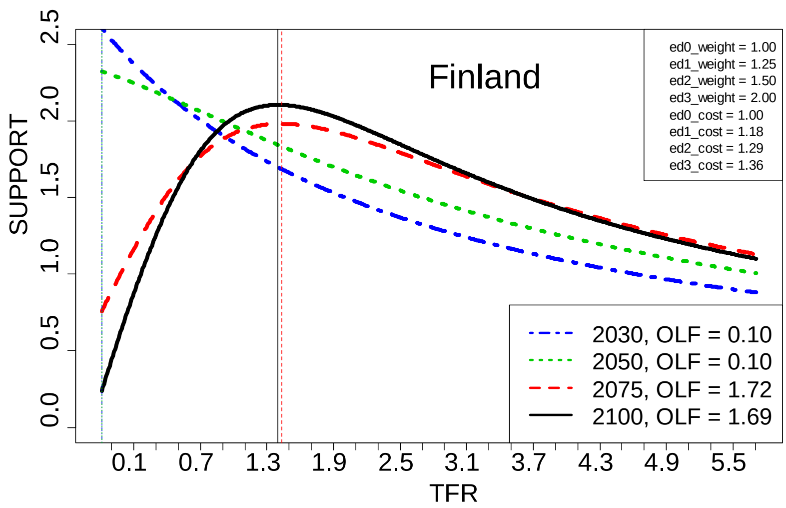

Figure 3. TFR which shows the highest level of our welfare indicator, that is, the optimum level of fertility (OLF) Baseline for Finland with lines at 2030 to 2100

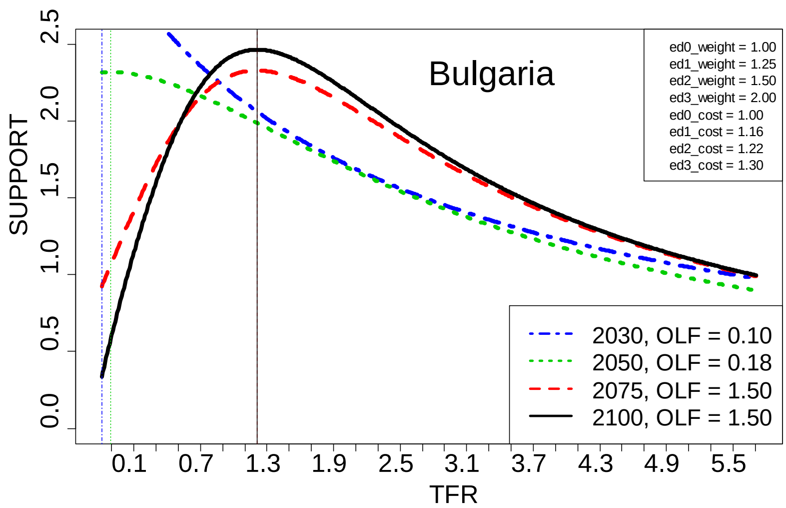

Figure 4. Support ratio for global education trend (GET) scenario. Baseline for Bulgaria with lines at 2030 to 2100.

Figure 5 goes further into detail showing the Total Fertility Rates optimizing support in every year up until 2100 for these two countries. And as we shall see, in the GET scenario for any year these levels of TFR are well below replacement level fertility. Note, however, that in our baseline scenario we are assuming gains in life expectancy to translate entirely into gains in working years. This way by 2100 the mean retirement age has increased to an astounding 72.4 years by which we are lowering the pension burden, causing the OLF to shift downward. As we shall see in the sensitivity section, these results change as we assume less or no adaptation of the pension age with regard to life expectancy.

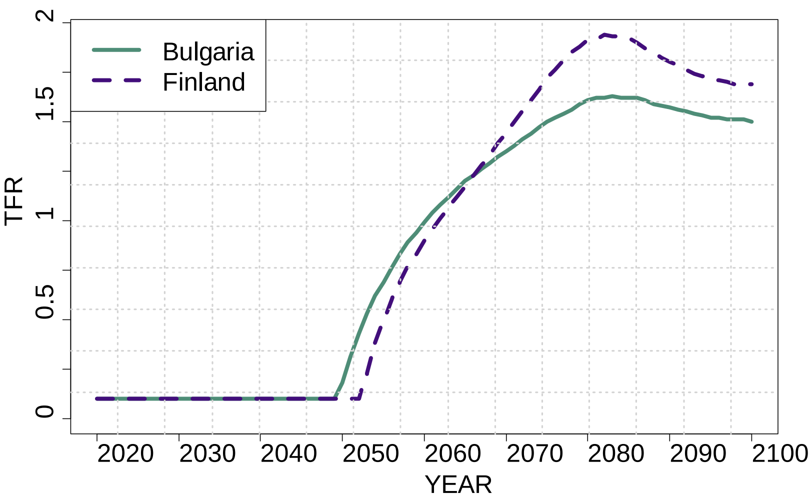

Figure 5. Optimal TFR for Finland and Bulgaria (GET), individual years 2020-2100.

5 Sensitivity

But what if the educational system does not, as assumed in the GET scenario, continue to expand over the course of the 21st century but rather shows stagnation? In our next step, therefore, we are looking at the sensitivity of the education weighted support ratio with respect to alternative educational structures of the population. This is illustrated for the case of Finland for the baseline scenario where all other weights are the same as above.

The alternative scenario depicted in Figure 5 is the constant enrolment rate (CER) scenario. It assumes constant education levels based on 2010 age-specific school enrolment rates. The picture clearly shows that more education not only brings a higher support ratio (and hence a higher level of per capita material well-being) but also that the optimal TFR is lower in an educated population than in one with lower average education. Again, this arises due to the balance of total education costs (which are lower for fewer children at any given level of per capita expenditure), increased productivity due to education, and the proportion of pensioners at any given point in time.

The time frame is important for understanding this effect. Thus, despite the fact that bigger cohorts of schoolchildren imply larger cohorts of productive adults in the future, they also beget future large cohorts whose education costs will outweigh the prospective benefits. At any point in time, the ratio of schoolchildren to productive adults remains less favorable under conditions of high fertility.

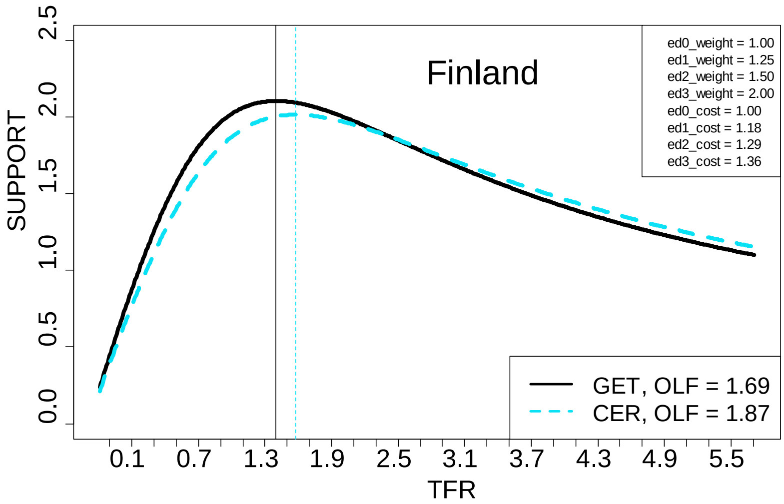

Figure 6. The effect of alternative education trajectories. Support ratio in 2100.

But the OLF does not just depend on the education scenario. Figure 6 shows its sensitivity to our assumptions about how additional life years will be used in the future. One might even question that life expectancy will go up in the future but we do not consider this possibility for the moment. Rather, we take a look at what happens to our measure of social wellbeing when we keep pension ages constant despite of allowing life expectancy to go up (scen1) or assume that only half of the gains in life expectancy will be time spent in the numerator of the support ratio, whereas the other half is additional time spent in retirement (scen2).

Again, a smaller share of additional life years spent working not just lowers the level of overall support, it also has a strong effect on the OLF. If only half the gain in life expectancy becomes a gain in working years then the mean age at retirement in 2100 reaches 67.3 years and the OLF would be 1.99. If in the extreme case pension ages are entirely inelastic with respect to life expectancy the mean retirement age stagnates at around 63 years, making a TFR of 2.32 optimal. Turning the rationale around, if fertility cannot easily be stimulated effective pension ages will have to increase to maximize welfare.

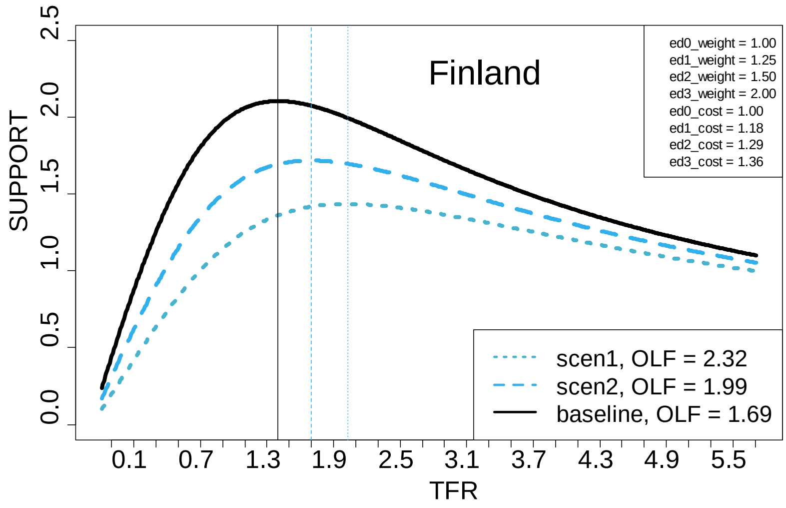

Figure 7. The effect of alternative assumptions regarding future life expectancy gains.

While we have performed large numbers of alternative model calculations, in this section we only summarize the findings with respect to the parameters to which the model is most sensitive. General changes in the education weights for the numerator (ed_weight) and denominator (ed_cost) mostly influence the level of the support ratio and have only minor influence on the shape of the curve, i.e., the resulting optimal level of fertility. But, as might be expected, the shape of the curve is rather sensitive to changes in the pension burden (pension cost) relative to the contribution of working-age people. The higher the level of pension payments relative to the education-specific carrying capacity of active people, the lower the support ratio (level of wellbeing) and the higher the OLF. In other words, under this scenario more children are required to expand the workforce in order to pay for a higher welfare level of pensioners.

In conclusion, this brief exercise in education-specific population dynamics shows that against widespread expectation it is far from self evident that replacement level fertility should be considered optimal. If education is factored in, a TFR quite clearly below replacement turns out to be optimal. Only very high pension incomes relative to earnings of people in the labor force result in higher optimal fertility, but this comes at the cost of much lower levels of overall wellbeing. Having said that, our numerical exercise only covers the quantifiable economic burden associated with population ageing. If global environmental change is factored in as a criterion, then there are likely to be additional forces that would pull optimal fertility to yet lower levels. In the next section we discuss the political implications of this finding.

6 Discussion[2]

Many governments in Europe report in international inquiries that they are dissatisfied with the current demographic trends in their countries. In Western Europe the story has been less dramatic because thanks to migration gains, only very few countries are already a decline in population and the public policy concern is mostly with respect to the implications of population ageing. Yet, the further one goes to the east of the continent, the stronger the publicly expressed concern about population size. While the prime minister of Bulgaria calls his country's 'demographic crisis' the number one policy priority, the president of Belarus speaks of a national 'demographic security crisis', implying that this may require equally drastic action as a security crisis at the military level. Less dramatic in tone but equally urgent in its message, the President of the European Commission repeatedly called Europe's demographic trends one of the three main challenges facing Europe, the other two being globalization and technological change.

What do these policy makers have in mind when they refer to demographic crises or challenges? In the eastern part of Europe, where most countries (with the notable exception of Russia, which received many Russians from other former Soviet republics) have experienced significant population declines since the political transformation around 1990, the concern seems to be very deeply rooted and associated with the fear that the country will lose its population base. Bulgaria, for example, had close to 9 million inhabitants in the late 1980s; now (2008) it has only 7.6 million and is projected by Eurostat (2008) to further shrink to around 6.5 million in 2035 and 5.5 million in 2060.

If fertility in Bulgaria were kept constant over the entire period at the level of 1.5 which corresponds to the long term optimum when considering education the total population size would decrease to 5.6 million in 2050 and to 3.3 million in 2100. This loss of significant shares of its entire population, which is also associated with very rapid population ageing, is indeed significant, particularly in the context of traditional thinking, where more population meant more soldiers and more power, but also in view of the fact that throughout human history, population shrinking has always been associated with misery and national decline. n the global-level policy debate, for decades the notion of 'population stabilization' has been the guiding principle and the explicit goal of virtually all population-related policies, both within the United Nations (UN) system and outside. The international political goal of population stabilization corresponds nicely to the UN population projections which used to assume that in the longer run, all countries of the world converge in their fertility rates to replacement level, resulting (in combination with an assumed leveling-off of life expectancy) in a long-term stabilization, i.e., constant size of the world population as well as of the population of all individual countries. Such a perceived future of population stabilization is likely to please government officials who do not want to see their population as either disappearing or exploding long-term.

[2] Part of this section was published by Wolfgang Lutz as a commentary in the *Vienna Yearbook of Population Research 2008* (Lutz 2008).

Actually IIASA's most recent probabilistic population projections indicate a probability of more than 85 percent that world population will peak during this century and then start to decline (Lutz et al. 2008). This is very different from stabilization. The notion becomes even more problematic at the level of individual countries. What does the goal of population stabilization imply for Bulgaria? Does it call on the government to bring the population back up to the 9 million mark of the late 1980s, or keep it constant at the current 7.6 million, or stop it from declining below 7.0 million? None of these seem to be a realistic goal for Bulgaria. But what would be an appropriate population-related goal for a country like Bulgaria? Since this is not obvious, we see a great need for coming up with a more useful and more comprehensive policy paradigm and goal that includes education as well as the number of people by age and sex.

> Human Capital: People are the wealth of nations. But it is not only the number of people that counts; it is also the skills, abilities and health status of the people that matter. All these aspects viewed together can be called the human resources base or human capital in more economic language. This broadened view of population also implies that political goals should not be defined in terms of population size, but rather in terms of human resources available for producing the best possible quality of life for all citizens.
>
> *Wolfgang Lutz, in his role as population advisor to the Bulgarian Government* (Lutz 2008)

This shift in paradigm, from a focus on only population size to one that aims at a balanced development of the population by age and sex as well as their capabilities and skills, is not an easy one because for centuries, population size has been the primary target of national and international population policies. Throughout European history, one view has predominated: It assumed that the bigger a kingdom/republic in terms of population, the more powerful this state would be and the better it would be for all of its citizens (see Coleman 2006). The rationale behind this view has been primarily in military terms: The bigger the population, the more potential soldiers and the greater the possibilities to defend, or expand, the national territory. But there has been economic reasoning behind this view as well: More people imply greater markets with more trade, and higher population density furthers the division of labor and technological progress – all things that are considered to be conducive for economic growth. In the specific case of Bulgaria, however, the accession to the European Union brought a huge increase in the market even under conditions of population decline.

The opposite view that population growth is detrimental to human wellbeing also has a long tradition – at least since Malthus ([1798] 1967). Here the reasoning has been that the resource base is limited for any national population and that population growth which leads to higher population density may in the end surpass the carrying capacity of a given territory and hence would lead to lower quality of life and even starvation and death. With such reasoning, regions such as the Netherlands or England were labeled overpopulated in the 19th century. In reality the resource base of these countries was expanded through colonization, but also by means of greater international trade. Technological progress has resulted in a much higher quality of life combined with higher population density. A modern version of this Malthusian view is reflected in the 'Limits to Growth' study by the Club of Rome (Meadows et al. 1972) and more recently in the notion of the 'ecological footprint' that shows how the numbers of people in a country and their consumption have ecological consequences far beyond the territory of a given country. There also have been many discussions of what the 'optimal' population size of a given country would be. While this discussion has been inconclusive, the majority of researchers in the field have understood that it makes little sense to have this one-dimensional focus on absolute population size. What really matters is the change over time and most importantly the composition of the population. For this reason the section above considered the more meaningful question about optimal fertility and considers education in addition to age and sex.

Demographers tend to study the composition of the population mostly with respect to age and sex. Changes in the age structure of a population matter for society and the economy in many respects. Most importantly, it is the ratio of persons who pay into the social security system to those who withdraw from it. More generally, it is the number of people who primarily produce compared to those who primarily consume. Significant changes in this ratio can be associated with decreases in the wellbeing of the population. In terms of pension systems, the expectation is that as the population age structure is bound to become much older, with the proportion of the population above age 60 increasing rapidly, there will be growing pressure toward one of the following measures: Increasing the mean age of retirement, or decreasing the pension benefits, or increasing the individual contributions to the system, with the alternative of having a huge deficit in the pension fund. Most European countries typically show a combination of these responses. But the process of population ageing has only started. Significant future ageing is already pre-programmed in the existing population age structure, most importantly as a consequence of very low fertility over the last decade. Bulgaria has some more time to prepare for the peak of population ageing than most other European countries, where fertility already declined steeply during the 1970s, a period during which Bulgaria still had fertility rates around replacement level.

There is little doubt that population ageing will pose many serious challenges to European societies and that the more rapidly the proportion of elderly increases in a population, the greater the challenge will be. In this sense – at least at the national level – population ageing is clearly more relevant than decline in absolute population size in terms of potentially diminishing the welfare of individuals. Therefore, should it be the goal of a population policy to try to minimize the speed of population ageing? It would clearly be a more meaningful goal than trying to attain a certain absolute population size because it is more directly related to consequences for the wellbeing of the population. But – as we were trying to show – this is not yet the full story. Whether a smaller number of young workers actually translate into a decline in total production depends not only on the number of workers but also on the productivity of these workers. If productivity per worker increased at the same rate as the number of workers declined, it would not make any difference for total production (although a distributional issue still remains). There are many factors that contribute to the growth of productivity, but the most important seems to be human capital, a consequence primarily of the education of workers and to some extent of their health status and motivation. In other words, the future development in human capital formation is a crucial determinant of the question to what extent population ageing and decline have negative consequences for the wellbeing of the population. But again, it greatly depends on the skills and capabilities of the additional people whether they are to the benefit or detriment of society.

This focus on human capital is not new in the history of demographic thinking. Alfred Sauvy wrote in the context of the miracle of Germany's economic rise after total destruction in 1945 and the fact that it had to absorb five million refugees:

> Why this success, contrary to the forecasts of all doctrines…? Because these men without capital came with their knowledge, their qualifications. They worked and they recreated the capital that was lacking, because they included a sufficient number of engineers, mechanics, chemists, doctors, sociologists, etc. If five million manual workers had entered Western Germany instead there would be five million unemployed today (Sauvy 1963: 169).

Despite the demographic prominence of Sauvy, mainstream demography has not really incorporated this important line of thinking. Instead such 'quality dimensions' were considered too difficult to measure and largely left to economists. Only the more advanced demographic tools of multi-state population dynamics, pioneered at and around IIASA in the 1970s, now allow us to fully and quantitatively integrate the educational attainment dimension into formal demography. As the title of an article by Lutz, Goujon and Doblhammer 'Adding Education to Age and Sex' suggests, it seems to be time to more systematically apply the human capital approach in standard population analysis and consequently in population policy (Lutz et al. 1999).

The concept of 'human capital development' combines the concerns about population size with the concerns about the age structure and that of human capital. It goes beyond the more traditional population policy paradigm of 'population stabilization' which has a one-dimensional focus on population size. Population stabilization is not a viable policy goal for Bulgaria and for many other countries in Europe over the coming decades because further population shrinking and ageing are already pre-programmed in the given age distribution. Even in the unlikely case that fertility rates increased again up to replacement level, the small cohorts of women born over the past one and a half decades indicate fewer potential mothers in the future and therefore fewer numbers of babies born. Population balance as a policy paradigm, on the other hand, also considers human capital and its distribution by age and sex. This does not imply that the three determinants of population size and age structure – fertility, mortality and migration – do not matter.

They continue to be the key drivers of change, but they also must be seen in their interactions with education. In the case of migration, for instance, under a human capital perspective, it would not only be the numbers of migrants that count, but the numbers (by age and sex) times their skills and qualifications. There are important interactions between education and fertility (with higher educated women having their births later, but also having on average better educated children) and mortality (more educated people being in general more healthy) that need to be considered in the formulation of policies.

Further scientific research (including alternative projections and considerations of the criteria of optimal fertility as described above) as well as a dialogue among scientists, stakeholder groups, civil society and government is necessary to find out what is the best way forward. The input of scientists and, particularly, demographers into this process will be crucial. But in order to be useful in this process, demographers need to go beyond their traditional focus areas and apply their very powerful measurement concepts and tools to fields that also include the quality dimension of population (as approximated by human capital). To do this we need to stop staring at population size and age structure and start including this quality dimension in our models (wherever it is feasible) and try to address broader societal concerns such as climate change and national identity. This is both a highly demanding and highly important task for the future.

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