Eur J Population (2010) 26:141–158
DOI 10.1007/s10680-009-9182-1

The Cost of Low Fertility in Europe
Le coût de la basse fécondité en Europe

David E. Bloom · David Canning · Günther Fink · Jocelyn E. Finlay

Received: 9 July 2008 / Accepted: 1 February 2009 / Published online: 22 April 2009

Abstract We analyze the effect of fertility on income per capita with a particular focus on the experience of Europe. For European countries with below-replacement fertility, the cost of continued low fertility will only be observed in the long run. We show that in the short run, a fall in the fertility rate will lower the youth dependency ratio and increase the working-age share, thus raising income per capita. In the long run, however, the burden of old-age dependency dominates the youth dependency decline, and continued low fertility will lead to small working-age shares in the absence of large migration inflows. We show that the currently very high working-age shares generated by the recent declines in fertility and migration inflows are not sustainable, and that significant drops in the relative size of the working-age population should be expected. Without substantial adjustments in labor force participation or migration policies, the potential negative repercussions on the European economy are large.

Keywords Fertility · Population dynamics · Economic growth

Résumé Nous analysons l'effet de la fécondité sur le revenu par habitant, avec un intérêt particulier pour le contexte européen. Pour les pays européens avec une fécondité inférieure au seuil de remplacement, le coût de la baisse continue de la fécondité ne pourra être apprécié que sur le long terme. A court terme, nous

This article was prepared for the International Conference on the Economic Consequences of Low Fertility, April 11–12 2008 at the University of St. Gallen, Switzerland. We are grateful to three anonymous referees and to Rainer Münz, and other participants in the conference for their helpful comments. Support for this research was provided by grant number 5 P30 AG024409 from the National Institute on Aging, National Institutes of Health, and by a grant from the William and Flora Hewlett Foundation.

D. E. Bloom (✉) · D. Canning · G. Fink · J. E. Finlay
Harvard School of Public Health, Program on the Global Demography of Aging, Cambridge, USA
e-mail: dbloom@hsph.harvard.edu

démontrons que la baisse de la fécondité réduira le rapport de dépendance des jeunes et élèvera la part de la population d'âge actif, ce qui entraînera une hausse du revenu par habitant. A long terme, le fardeau de la dépendance des personnes âgées pèsera toutefois plus que la baisse de la dépendance des jeunes, et la poursuite de la chute de la fécondité conduira à un abaissement de la part de la population d'âge actif, en l'absence de mouvements migratoires de grande ampleur. L'étude apporte la preuve que la part très importante de la population active résultant du déclin récent de la fécondité ne pourra pas se maintenir, et que des baisses significatives de cette part sont à prévoir. Si des ajustements importants en matière de participation au marché du travail ou de politiques migratoires ne sont pas mis en œuvre, les répercussions négatives sur l'économie européenne pourraient être considérables.

Mots-clés Fécondité · Dynamique des populations · Croissance économique

1 Introduction

The impact of demographic change on economic development has long been debated. Although the Malthusian hypothesis that population growth is constrained by available resources held a central position for centuries, the simultaneous occurrence of economic growth and population growth over long periods of time has demanded new models of the interplay between these phenomena (Becker et al. 1999; Galor and Weil 1999; Galor and Weil 2000; Galor 2005). Little consensus has been reached during the last 50 years on the effect of population growth on economic growth. For example, Kelley and Schmidt (1995) find no correlation between population growth and economic development in the 1960s and 1970s, yet find evidence of a negative relationship emerging in the 1980s. This later relationship appears to be even stronger when other demographic factors such as age structure are controlled for (Kelley and Schmidt 2005).

The concept of "optimum population growth" is an old debate (Samuelson 1975; Deardorff 1976; Samuelson 1976). Further debate over the effects of population pressure on economic development remains fervent (Simon 1996; Ehrlich 2008). Ehrlich argues that population pressure on natural resources and the environment is a contemporary issue that has been ignored by policy makers. Simon takes an alternative view and stresses the benefits of the technological progress that he argues is a natural concomitant of population growth. Larger populations make innovation more likely, and moreover, increase the scope for technological adoption. These assumptions are central in the more recent endogenous growth literature focusing on research and development as main drivers of economic growth (Strulik 2005).

Early work by Bloom and Freeman and by others highlights the importance of analyzing the effect on economic growth of the individual components of population growth: fertility and mortality (Bloom and Freeman 1988; Kelley 1988; Brander and Dowrick 1994; Kelley and Schmidt 1995; Kelley and Schmidt 2005). In this article, we highlight the fertility channel and in particular draw on the experience of European countries.

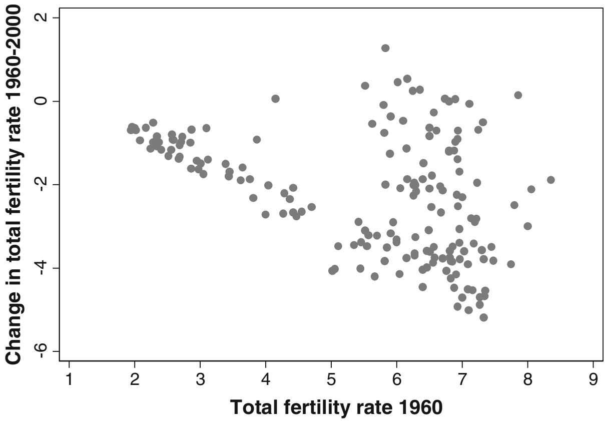

Fig. 1 Change in total fertility rate 1960-2000. *Source*: World Bank (2007)

For many, but not all, countries in the world the decline in fertility in the last 45 years has been rapid. The onset of a rapid fertility decline is a signal that a country is undergoing the demographic transition from high fertility (and high mortality) to low fertility (and low mortality). In Fig. 1, we show the change in fertility that occurred between 1960 and 2000 relative to the initial fertility rate in 1960. Virtually all countries that had a fertility rate below 5.5 in 1960 experienced a decline in fertility[1]—these countries are or have been undergoing the demographic transition.[2] Countries that had a fertility rate above 5.5 in 1960 either experienced rapid decline in fertility and thus are part of the demographic transition trajectory, or maintained high fertility levels and remain today in a high-fertility and high-mortality state.

To highlight the change in fertility in Europe between 1960–2000, Fig.2 illustrates the same relationship as in Fig. 1 for the European countries.

In 1960, Estonia was the only European country to have a total fertility rate below two, at 1.96. Today all but two countries in Europe (Albania and Iceland) have a total fertility rate below two. The reasons for the rapid decline in fertility in Europe, and its decline to "lowest of the low" rates are varied (Lesthaeghe and Willems 1999; Kohler et al. 2002; Billari and Frejka 2004; Billari and Kohler 2004; Aarssen 2005; Adsera 2006a, b; Bjorklund 2006; Coleman 2006; Kohler 2006; McDonald 2006; Feyrer 2007). Fertility decline in Europe is thought to be due to socioeconomic incentives to delay childbearing, a decline in the desired number of children and institutional factors (labor market rigidities, lack of child care, changing gender roles) (Bongaarts and Bulatao 1999; Kohler et al. 2002; Garrido and Malo 2005; Kohler 2006). Eastern European societies have also undergone major economic, political, and social changes.

[1] Gabon is an exception to this pattern.

[2] It should be noted that by 1960 most of the demographic transition had been completed in European countries.

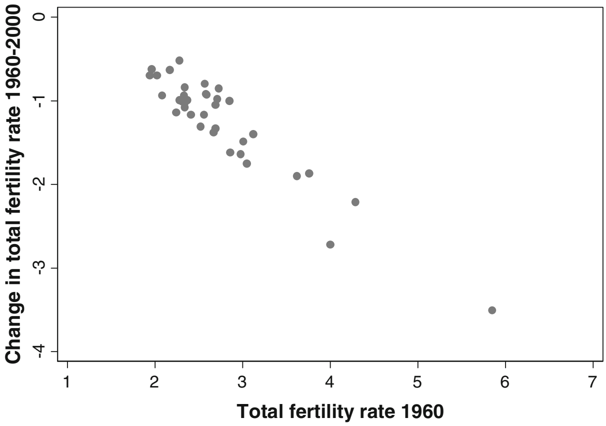

Fig. 2 Change in total fertility rate (TFR) 1960-2000 in Europe. *Source*: World Bank (2007)

Presently, Eastern and Western European countries share an important demographic feature: below-replacement fertility. The economic consequences of below-replacement fertility are not well understood. In this article, we aim to analyze this relationship. We argue that while declines in fertility generally induce positive economic outcomes in the short run, the same is not necessarily true in the long run. In the long run, below-replacement fertility is likely to lead to age structures that are sub-optimal with respect to their economic growth implications. The exact magnitude of these effects depends on a host of demographic, social, and political factors. These factors critically shape the long-term development of age structure as well as the interactions between age structure and the economy.

The analysis in this article naturally links to previous work on the "low fertility trap" (Billari and Kohler 2004; Lutz and Skirbekk 2005; McDonald 2006). McDonald (2008) argues that when fertility levels are below 1.5, it is difficult to raise fertility, due to changes in norms (through socialization) and preferences regarding the number of children. Moreover, increased opportunities for women in the workplace coupled with heightened consumerism, and the demographic, mechanical effect of fewer women entering the childbearing age-group have contributed to persistently low birth rates. Open for debate among these authors is the threshold fertility rate at which countries enter the "trap" and how countries can escape the trap. Feyrer et al. (2008) draw a more optimistic picture of general fertility trends, arguing that fertility will go up again as countries adopt new social norms and facilitate the combination of labor force participation and motherhood.

In this article, we do not model the dynamics of fertility directly, but rather explore the long-term relationship between fertility levels and the relative size of the workforce. We thus formalize and generalize the issues raised in the above literature, without making specific assumptions regarding the long-term determinants of family size.

The rest of the article is structured as follows: in Sect. 2, we discuss the basic mechanisms through which fertility affects economic growth and highlight the non-linear long-run relationship between fertility and the working-age share. In Sect. 3, we discuss recent trends in fertility, migration, and the working-age share in Western Europe and show that working-age share has not fallen yet, despite fertility levels below replacement. We summarize and discuss our results in Sect. 4.

2 Theoretical Background

2.1 Overview

There are three theoretical channels through which fertility affects economic development: population growth with fixed resources (the Malthusian theory), the Solow capital stock effect, and the age structure effect. According to the Malthusian hypothesis, larger populations imply lower resources per capita in the presence of a fixed factor (land is frequently given as an example), and thus lower income per capita. A similar yet slightly more subtle mechanism is at play in the Solow growth model (Solow 1956), where capital stock is built up through savings and declines with depreciation. With constant returns to scale, population growth works in the same way as capital depreciation and thus lowers steady-state income per capita in the traditional Solow model.

The third link between fertility and economic growth, and the main focus of this article, is age structure. The age structure of a population follows from the historical sequence of fertility, mortality, and net migration, and directly determines the relative size of the working-age population. Since output is measured in per capita terms, the fact that labor force participation rates vary by age means that the working-age share directly affects income per capita through the number of workers per capita. A decline in fertility reduces the number of children, thus unambiguously raising the working-age share and—as long as participation rates do not change—increasing labor supply per capita in the short run (Bloom and Freeman 1986).

The same argument does not hold in the long run. As we show in further detail below, persistently high fertility levels imply an age distribution strongly skewed toward the young generations in steady-state. On the other hand, sustained low fertility levels like the ones currently observed across Europe imply very large relative sizes for the old and economically inactive cohorts in steady-state.

2.2 A Simple Model of Age Structure

The intuition for the basic mechanism linking fertility levels and age structure in the long run can best be provided by a simple population model. Assume a stable population[3] with three age groups: the young, the middle age, and the old, where the size of the middle age group is normalized to one. Assuming a male–female-ratio of one and a constant fertility rate f, we must have $\frac{2}{f}$ people in the old age group,[4] and

[3] A stable population refers to a population that has constant age-specific fertility and mortality rates, which, in the absence of migration, implies a constant age structure and constant population growth.

[4] The total number of births is the age-group-specific population times $f/2$. Thus, to get a birth cohort size of 1, we need a "parent cohort" population of $2/f$.

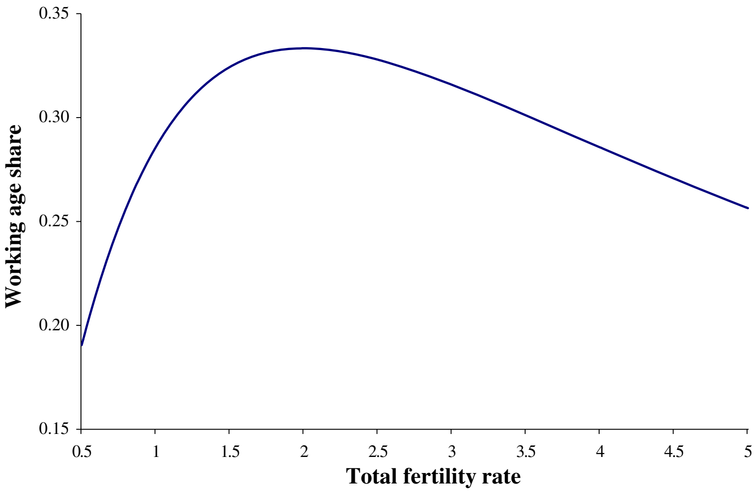

Fig. 3 Theoretical long-run relationship between stable population working-age shares and fertility

$\frac{f}{2}$people in the young group as long as we also assume that all individuals die at the end of the second period. In this setting, the age distribution of the population in equilibrium is given by

$$\left\{\frac{f}{2}, 1, \frac{2}{f}\right\}. \tag{1}$$

Assuming that only the middle age group works, the working-age share w of the population can be defined as

$$w = \frac{1}{\frac{f}{2} + 1 + \frac{2}{f}} = \frac{2f}{f^2 + 2f + 4} \tag{2}$$

This framework is similar to the models derived in Weil (1999) and Hock and Weil (2007), and has intuitive properties. First, at replacement fertility,[5] the working-age share is 1/3. Second, deviations from replacement rate fertility unambiguously lead to a decline in the working-age share. For high fertility levels, the first term in the denominator $\left(\frac{f}{2}\right)$ becomes large; this is the typical developing country scenario with high youth dependency and very low old-age dependency ratios. With fertility levels below replacement, the last term in the denominator $\left(\frac{2}{f}\right)$ becomes large, capturing the burden of very large old cohorts relative to the size of the working-age cohorts. Figure 3 illustrates the theoretical relationship between stable population fertility levels and working-age shares expressed in equation (2).

The basic mechanism outlined in our simple model has ignored two important influences on the age structure: mortality and migration. Incorporating mortality in the basic framework is relatively easy: high mortality rates have two principal effects: first, they lower the number of females reaching age 45 and thus giving

[5] In the case with zero mortality before old age, replacement fertility equals 2.

birth, as well as the number of children surviving early childhood. As a result, the relative size of the young cohorts associated with a given total fertility rate declines.

The second mortality effect comes through aging. Let us define σ as the fraction of people that survives to old age, i.e., does not die at the end of period two.[6] Then one can rewrite equation (2) as

$$w = \frac{1}{\frac{f}{2} + 1 + \sigma \frac{2}{f}} = \frac{2f}{f^2 + 2f + 4\sigma} \tag{3}$$

with $\sigma \leq 1$. Lower old age survival implies a lower old-age dependency ratio and thus a higher working-age share. Solving for the fertility rate that maximizes working-age share in steady-state, we get the following first-order condition

$$\frac{\partial w}{\partial f} = \frac{-2f^2 + 8\sigma}{(f^2 + 2f + 4\sigma)^2} = 0, \tag{4}$$

The working-age share maximizing steady-state fertility rate f* is thus given by

$$f^* = 2\sqrt{\sigma} \tag{5}$$

If $\sigma = 1$, a total fertility rate $f = 2$ is the unique solution.[7] The lower the old-age survival, the lower the working-age-share maximizing fertility rate.[8] This result is intuitive. If $\sigma < 1$, the relative weight of the old is strictly smaller than the relative weight generated by the young, so that the working-age-share maximizing fertility rate is strictly below 2.

To further illustrate this point, we simulate stable population outcomes for representative survival schedules for populations at different stages of development. Rather than assuming three broad age groups, we calculate the stock of each age group based on a given fertility and mortality schedule where the working age covers the ages 15–64. For each mortality/fertility schedule, we run the simulations until a stable population distribution is reached.[9] The resulting working-age shares are summarized in Fig. 4. The graph illustrates the relationship between fertility and working-age share in the long run, i.e., in a stable population framework.

Figures 3, 4 show that a decrease in fertility rate below the WAS-maximizing level leads, in the long run, to a lower working-age share. The short-run transitional

---

[6] In this stylized framework, we assume for analytical simplicity that agents die either at the end of the second or the end of the third period. One can, however, interpret σ as the average fraction of people from the previous cohort still alive over the last period of life, in which case death could occur any time during the last period of life.

[7] We restrict the domain of our analysis to the set of positive real numbers.

[8] As this fertility rate can be above or below the replacement fertility rate, the working-age-share maximizing stable population fertility rate parameter will lead to positive, zero, or negative population growth. Thus we cannot assert that the fertility rate that maximizes the working-age share is the "optimal" fertility rate—the population growth consequences may impose a negative effect on economic growth.

[9] We initiate the simulation with a flat age structure, and then impose constant age-specific fertility and mortality rates to impute the stock of each age group in each period. It takes up to 200 simulated periods for age structure to converge to a stable population distribution. In Fig. 4 we show the resulting stable population working-age share for three examples of mortality schedules and fertility rates between zero and ten.

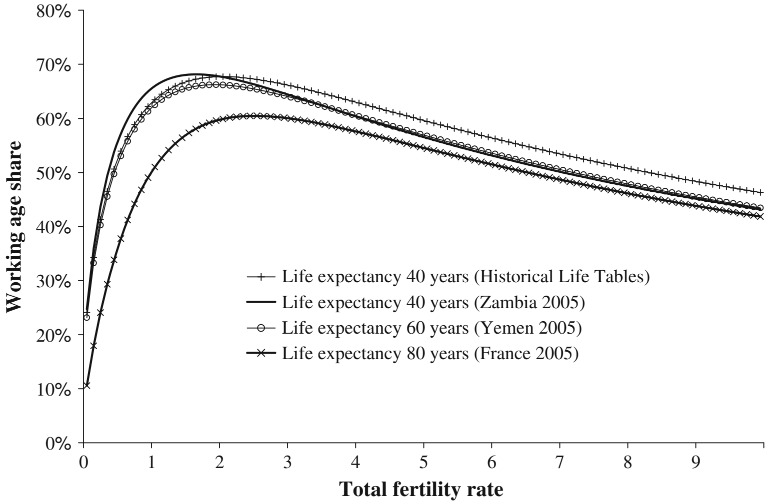

Fig. 4 Stable population distribution relationship between fertility and working-age share under different life expectancy scenarios

dynamics look quite different, since any reduction in fertility will mechanically decrease the youth dependency ratio in the near term as discussed in Weil (1999). The figures thus compare steady states, and do not illustrate short-run dynamics.

Figure 4 shows the relationship between fertility and working-age shares for different life tables (World Health Organization). The figure shows that the basic inverse U-shape relationship between fertility and working-age shares outlined in Eqs. (2) and (3) persists, independent of the mortality schedule applied.

Figure 4 also highlights the differential impact of life expectancies at different levels of fertility. Although life expectancy has very limited effects at very high fertility levels, high levels of old-age survival significantly lower the working-age share for low rates of fertility. As revealed by Eq. (5), the fertility rate that maximizes the working-age share depends on the relative size of the old cohorts. In France, with a life expectancy of 80 years, the burden from the large old generations is greater than the burden from young generations, so that the working-age-share-maximizing fertility rate in steady-state is 2.6, significantly above replacement. In Yemen, with a life expectancy of 60 in 2005, the relative burden of the young and the old is similar in magnitude, so that we get an optimal steady-state fertility rate of 1.9. In Zambia, with a life expectancy of 40 years, youth dependency is more relevant than old-age dependency, so the optimal steady-state total fertility rate is relatively low at 1.7.

The optimal fertility rate for Zambia is particularly low due to the rather peculiar mortality profile generated by the HIV epidemic. In Fig. 5 we compare today's survival curves in Zambia with a historical life table generating a Zambian life expectancy of 40 years.

The historical survival curves associated with a life expectancy of 40 years imply extremely high under-five mortality (close to 30%), and relatively low and constant

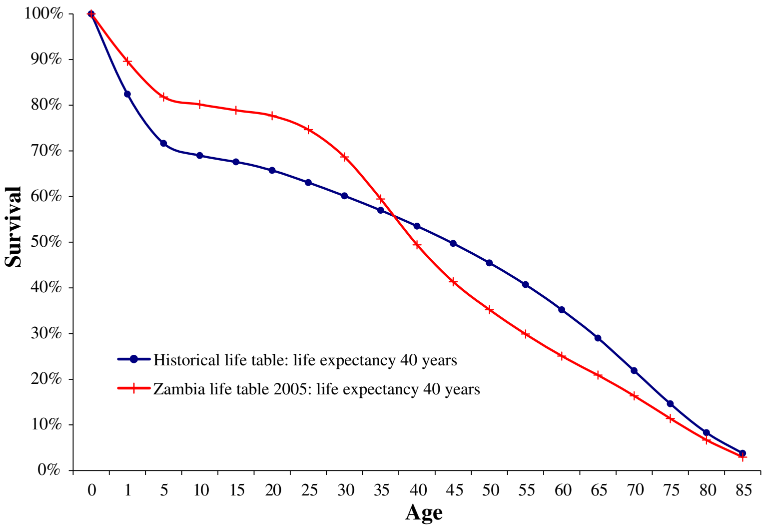

Fig. 5 Survival rates with 40 year of life expectancy: historical life tables versus Zambia 2005. *Source*: United Nations (1982), WHO (1999)

mortality afterwards. In comparison, infant and mortality rates are relatively low in Zambia today, while adult mortality (mostly generated by HIV) is significantly higher. The shift in mortality from childhood to adult life implies a very different stable population distribution. With the historical tables, the burden of high fertility levels is lower than the respective burden with modern Zambia survival rates; as a result, the working-age-share maximizing fertility rate is 2.1, significantly above the optimal rate, 1.7, for present day Zambia.

It should be stressed at this point that our analysis completely abstracts from population growth. The fertility levels maximizing the working-age shares under the different life expectancy assumptions can be associated with very different growth rates. The working-age-share maximizing rate for France (2.8) implies positive population growth of 0.8% per year; the corresponding rates for Yemen and Zambia imply population growth rates of −2% and −0.7%. As discussed in the introduction, the basic relation between population growth and income per capita remains unclear, and will not be discussed further in this article.

The focus of this article instead lies in quantifying the magnitude of the effect of demographic shifts on age structure. In the graphs and calculations made above, we have defined working age as being the age range 15–64. In the European case, a majority of workers retire around 60 (Gruber and Wise 1999; Gruber and Wise 2004), which means that the working-age shares calculated before are likely to be overly optimistic. In Fig. 6, we simulate stable population working-age-shares for a range of retirement ages using the French survival schedule. At the retirement age of 55, the burden of the old is particularly large, implying a working-age-share-maximizing fertility rate of 3.1. If, on the other hand, the working age would go all the way up to age 70, the WAS-maximizing fertility rate would fall to 2.0.

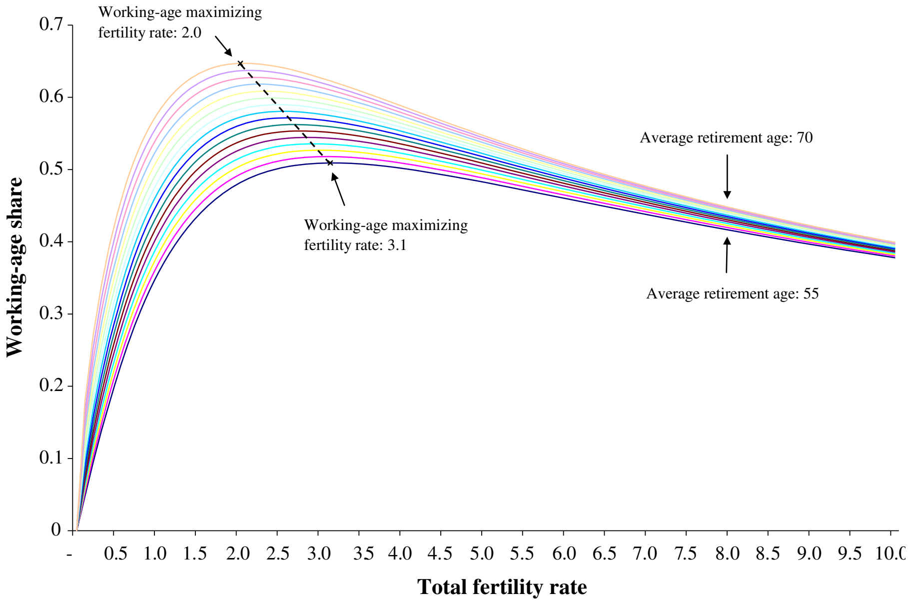

Fig. 6 Stable population distribution relationship between fertility and working-age share under different retirement age scenarios

An analogous picture emerges, when we change the assumptions regarding the lower bound of the working age to reflect differences in the years of schooling and the resulting differences in the timing of labor force entry. As Fig. 7 illustrates, later entry into the labor force mechanically lowers the working-age share. Later entry into the labor force is associated with a higher relative burden generated by the young cohorts, and thus lower working-age-share-maximizing fertility levels.

The second main channel omitted in the basic model outlined in this section is immigration. Immigrants generally display reproductive behavior different from the population in their host countries (Fernandez and Fogli 2006) and also directly affect the age distribution of countries. The exact effect of migration on age structure depends on the average age of the migrants, as well as on the duration of stay. Immigrants arriving during their working age and leaving before retirement increase the relative size of the working-age population and labor force of their host country, and lower the working-age share in their country of origin. We provide a detailed discussion of this issue in the following section, where we analyze the implications of low fertility levels for Europe.

The third main factor to be considered in the analysis of fertility trajectories is behavioral change. Changes in fertility are likely to change labor force participation rates of women (and possibly men too) (Bloom and Freeman 1987; Bloom et al. 2007a, b), but are also likely to lead to changes in the accumulation of human and physical capital (Bloom et al. 2007a, b; Lee and Mason 2008). These factors imply positive externalities generated by low fertility levels in the long run that may partially offset the negative working-age-share effects highlighted here.

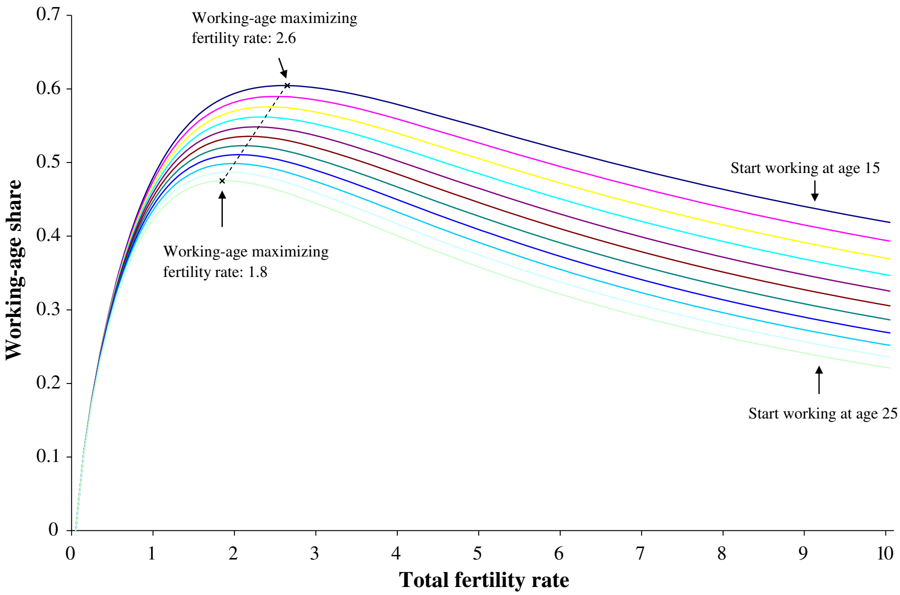

Fig. 7 Stable population distribution relationship between fertility and working-age share under different labor force entry age scenarios

3 Fertility in Western Europe

Total fertility levels have continued to decline over the last decades, falling from an average of 2.4 in 1970 to an average of 1.5 in 2005 (World Bank 2007). This decline in fertility to levels in most cases significantly below replacement, has, however, not led to falling working-age shares as predicted in the long-run stable population model presented in the last section. As Fig. 8 illustrates, the working-age share in all Western European countries (except Finland) has actually increased between 1970 and 2005. This is partially the result of the dynamics of the working-age share adjustments to lower fertility levels as highlighted by Bloom et al. (2003). An initial decline in fertility will lower the youth dependency ratio and mechanically increase the working-age share in the short run. Over a lifetime horizon, the smaller sized cohorts move through the population age groups and the new stable population distribution will be achieved if fertility, mortality, and net migration remain constant. However, as shown in Fig. 8, this dynamic has not yet materialized in Europe.

From a long-term (stable population) perspective, most of the declines in fertility are recent. In 1960, all European countries had a total fertility rate above 2; in 1970 only a small group of countries in Northern Europe had fallen below the threshold of two children per woman. Consequently, the generations currently retiring in most countries with a low total fertility rate still bore more than two children on average, which keeps old-age dependency rates moderate, while youth dependency rates have fallen dramatically. Once the generations who have fewer than two children on

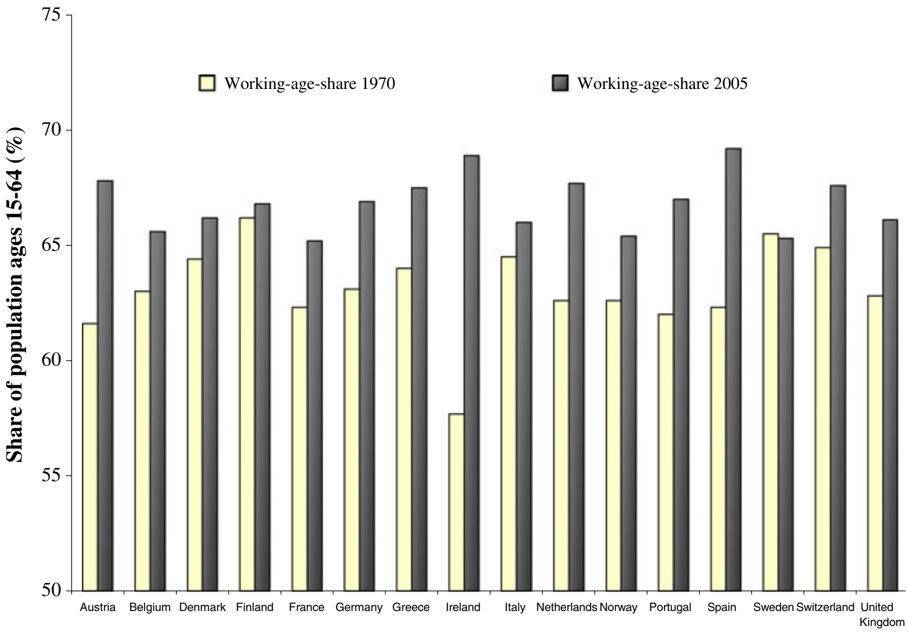

Fig. 8 Working-age shares in Western Europe: 1970 and 2005

average begin to retire, working-age-shares will fall if fertility levels stay below replacement and all other factors remain unchanged.

Positive short-term effects are, however, not the only reason why working-age shares have remained high in Europe. The second main factor contributing to the currently high levels of working-age-shares is migration. Since most immigrants are young (Malmberg 2008), migration has a direct and positive effect on working-age-shares. Most Western European countries have experienced significant migration inflows over the last decades. As summarized in Table 1 below, immigrants (defined as current residents with foreign citizenships) constitute between 2.1 (Finland) and 20% (Switzerland) of the current population. More importantly, net migration remains positive for most countries. While an average current inflow of 4 immigrants per 1,000 population, the effect of migration on population levels and working-age shares can be shown to be quite small.

One way to illustrate the mixed medium- to long-run effects of migration is to simulate counterfactual historical population under the assumption that migration flows over the last decades were zero. The thought experiment we conduct is the following: how different would European working-age shares look today under the assumption that no migration had happened in Europe over the last 45 years? Given that we know the historical age structure and subsequent fertility and mortality rates, this simulation is relatively simple to implement under the simplifying assumption that mortality and fertility levels would have been the same in the absence of migration, i.e., that immigrants have the same fertility and mortality rates as the domestic population.

Table 1 Immigrant stock in Western Europe

	Total population 2005 ('000)	Foreign nationals 2005 ('000)	Population share of foreign nationals (%)	Estimated annual net migration per 1,000 population
Austria	8,230	789	9.58	4.39
Belgium	10,500	871	8.29	3.50
Denmark	5,420	268	4.94	1.70
Finland	5,250	108	2.06	1.28
France	60,900	3,623	5.95	2.40
Germany	82,500	7,288	8.83	2.43
Ireland	4,160	255	6.14	9.47
Italy	58,600	2,402	4.10	3.87
Netherlands	16,300	699	4.29	1.37
Norway	4,620	213	4.62	3.70
Spain	43,400	3,371	7.77	13.61
Sweden	9,020	481	5.33	3.40
Switzerland	7,440	1,525	20.49	2.72
United Kingdom	60,200	3,066	5.09	3.20
Population-weighted average			6.63	4.18

Source: Eurostat (2008), United Nations (2007)

Figure 9 compares the simulated to the actual age structure for Austria as a country with relatively high immigration flows over the last 40 years. While the total population is by construction lower in the simulated scenario (7.6 vs. 8.2 million in 2005), the graph highlights the highly non-linear effect of migration on the age distribution. Immigration has led to slightly larger population shares in the age groups 35–39 and 40–44; however, the opposite is true for some of the old-age groups.

Overall, the effect of historical migration on the current size of the working-age share is very small: while the actual working age share was 67.8% in 2005, our simulation results imply that the share would have been 68.5% in the absence of migration. In short, migration over the last 45 years has undoubtedly increased the total population in Austria, but has had very little effect on the actual size of the working-age share.

The second, and much bigger, problem with the argument that migration can solve future age structure problems lies in the political feasibility of continued immigration inflows. With increasing domestic resentment against immigration documents by the wide-spread popularity of right-wing parties across European countries, immigration policies have been tightened significantly and are likely to severely reduce migration inflows in the future.

In short, migration is highly unlikely to have a major effect on falling working-age shares in Western European countries over the next decades. The size of the economic repercussions of declining working-age shares on economic development,

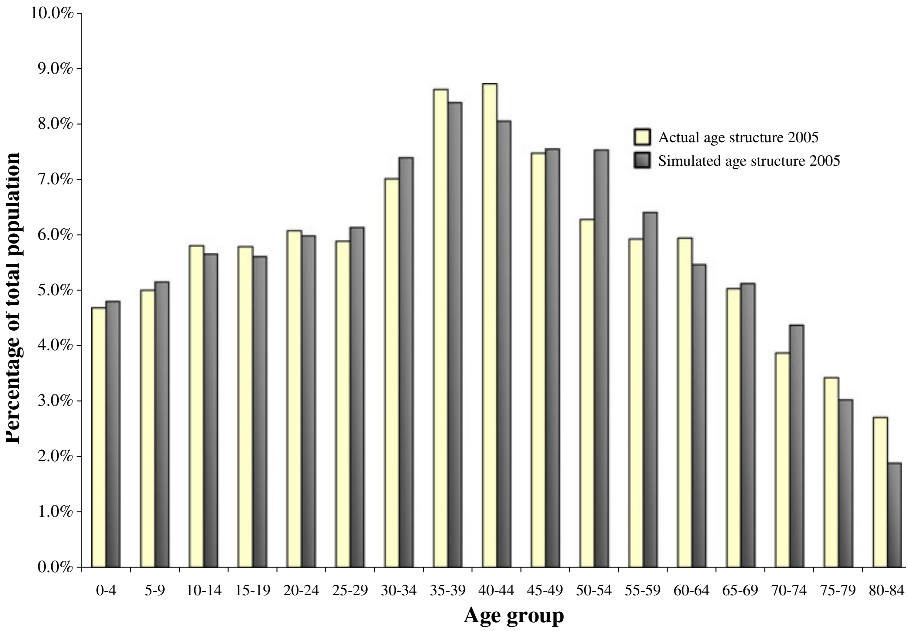

Fig. 9 Actual age structure and simulated age structure in the absence of migration: Austria 2005

however, will critically depend on individual behavior. With increasing life expectancies and smaller family sizes, many aspects of societies are bound to change.

In Bloom et al. (2007a), we show that each extra child lowers a female's labor force participation by approximately 1.9 years over an average working life. With lower fertility levels, female labor force participation increases and has important positive second-order effects on income per capita. This relationship, however, appears different in European countries, where fertility is clustered in a relatively small range as shown in Fig. 10. Engelhardt and Prskawetz (2004) argue that in fact the relationship between fertility and female labor force participation in Europe is positive when looking at the changes within countries across time. This finding, however, appears to be confounded by other country-specific trends and is reversed once country-specific factors are fully accounted for (Brewster and Rindfuss 2000; Vlasblom and Schippers 2004).

Changing fertility may also affect savings behavior. From a life-cycle perspective, children and savings can be viewed as substitutes in terms of old-age security. In the absence of formal capital markets, children may act as a more reliable form of savings for old-age support than financial savings. As capital markets develop, parents can substitute toward savings and lower the demand for children (Ehrlich and Kim 2007).

Lee and Mason (2008) argue that smaller family sizes do not necessarily lead to lower aggregate human capital. According to the Lee-Mason model, households contribute a fixed proportion of resources to fund the education of all the children.

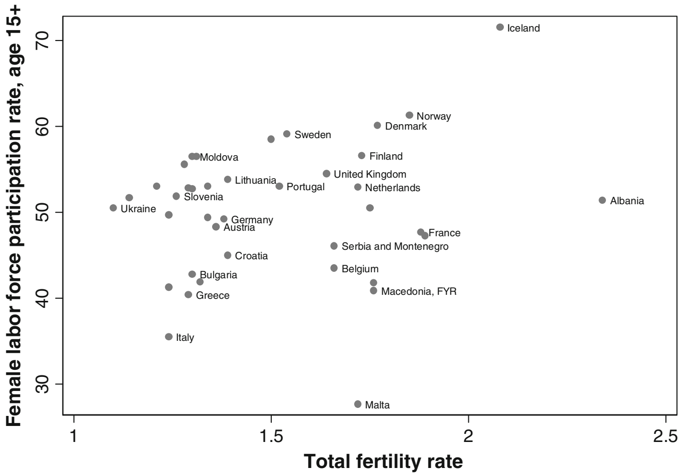

Fig. 10 Fertility and female labor force participation in Europe, 2005. *Source*: World Bank (2007), ILO (2007)

When the number of children per household declines, investment in each child's education increases proportionately. Accordingly, as these children age and enter the workforce, the aggregate amount of human capital is not compromised even though the number of people entering the workforce is now lower.

4 Discussion

In this article, we have explored the effect of fertility on income per capita in the short and long run. In the short run, a decline in the fertility rate unambiguously increases income per capita as youth dependency falls and the working-age share increases. As we have shown in the theoretical framework presented in Sect. 2 of this article, the relationship between fertility and age structure in steady-state is more complex in the long run. Although it is true that very high fertility levels have a negative effect on output per capita through low working-age shares, the positive effects of lowering fertility only exist up to the rate at which working-age share is maximized; any fertility decline below this maximizing rate lowers the working-age share in equilibrium and may induce a reduction in output per capita. In high-fertility countries such as Zambia, the message is clear: lower fertility will increase income per capita. For low-fertility European countries, the implications of fertility decline are more complex: lower fertility will increase income per capita in the short run, but decrease it in the long run. This poses a policy conundrum for European policymakers.

In most Western European countries, continued net immigration and the relatively recent decline in fertility have bolstered working-age shares to today's levels. However, given the growing aversion to further immigration exhibited in many European countries and the resulting increase in migration restrictions, the scope for large future immigration inflows seems very limited at the moment. If fertility levels stay at current levels, or fall further, declines in the working-age share of the population will occur over the next decades and depress income per capita gains. With a life expectancy of 80 years, our simulations imply that the long-run working-age shares will drop to somewhere between 50% and 55% if fertility levels stay at current levels. Comparing this with the current working-age shares close to 70% in most European countries implies a reduction in the number of workers per capita of around 25% under the assumption that average participation rates remain unchanged. Even though this adjustment is likely to happen over several decades, the resulting negative growth effects will clearly be noticed, especially by those economies with already modest economic growth.

The exact magnitude of these effects, however, critically depends on the many policies affecting labor force participation, particularly social security regulations (Gruber and Wise 1998; Blondal and Scarpetta 1999; Gruber and Wise 1999; Gruber and Wise 2004). Adjusting institutional settings such as social security, child care, and education will not only be important to ensure long-term fiscal sustainability but also to lessen and possibly avoid negative income effects generated by demographic change.

References

Aarssen, L. W. (2005). Why is fertility lower in wealthier countries? The role of relaxed fertility-selection. *Population and Development Review, 31*(1), 113–126.

Adsera, A. (2006a). An economic analysis of the gap between desired and actual fertility: The case of Spain. *Review of Economics of the Household, 4*, 75–95.

Adsera, A. (2006b). Marital fertility and religion in Spain, 1985–1999. *Population Studies, 60*(2), 205–221.

Becker, G. S., Glaeser, E. L., & Murphy, K. M. (1999). Population and economic growth. *American Economic Review, 89*(2), 145–149.

Billari, F., Frejka, T., et al. (2004). Discussion of paper 'Explanations of the fertility crisis in modern societies: A search for commonalities Population Studies 57(3): 241–263, by John Caldwell and Thomas Schindlmayr. *Population Studies 58*(1): 77–92.

Billari, F., & Kohler, H.-P. (2004). Patterns of low and lowest-low fertility in Europe. *Population Studies, 58*(2), 161–176.

Bjorklund, A. (2006). Does family policy affect fertility? Lessons from Sweden. *Journal of Population Economics, 19*, 3–24.

Blondal, S., & Scarpetta, S. (1999). The retirement decision in OECD Countries. OECD Economics Department working paper 202.

Bloom, D. E., Canning, D., Fink, G., & Finlay, J. E. (2007a). Fertility, female labor force participation, and the demographic dividend. *Journal of Economic Growth* (Forthcoming).

Bloom, D. E., Canning, D., Mansfield, R. K., & Moore, M. (2007b). Demographic change, social security systems and savings. *Journal of Monetary Economics, 54*, 92–114.

Bloom, D. E., Canning, D., & Sevilla, J. (2003). The demographic dividend: A new perspective on the economic consequences of population change. Population matters monograph MR-1274. Santa Monica: RAND.

Bloom, D. E., & Freeman, R. B. (1986). The effects of rapid population growth on labor supply and employment in developing countries. *Population and Development Review, 12*(3), 381–414.

Bloom, D. E., & Freeman, R. B. (1987). Population growth, labor supply, and employment in developing countries. In D. G. Johnson & R. D. Lee (Eds.), *Population growth and economic development: Issues and evidence.* Wisconsin: University of Wisconsin press.

Bloom, D. E., & Freeman, R. B. (1988). Economic development and the timing and components of population growth. *Journal of Policy Modeling, 10*(1), 57–81.
Bongaarts, J., & Bulatao, R. A. (1999). Completing the demographic transition. *Population and Development Review, 25*(3), 515–529.
Brander, J. A., & Dowrick, S. (1994). The role of fertility and population in economic growth. *Journal of Population Economics, 7*(1), 1–25.
Brewster, K. L., & Rindfuss, R. R. (2000). Fertility and women's employment in industrialized nations. *Annual Review of Sociology, 26*(1), 271–296.
Coleman, D. (2006). Immigration and ethnic change in low-fertility countries: A third demographic transition. *Population and Development Review, 32*(3), 401–446.
Deardorff, A. V. (1976). The optimum growth rate for population: Comment. *International Economic Review, 17*(8), 510–515.
Ehrlich, P. R. (2008). Demography and policy: A view from outside the discipline. *Population and Development Review, 34*(1), 103–113.
Ehrlich, I., & Kim, J. (2007). Has social security influenced family formation and fertility in OECD countries? An economic and econometric analysis. NBER working paper 12869.
Engelhardt, H., & Prskawetz, A. (2004). On the changing correlation between fertility and female employment over space and time. *European Journal of Population, 20*, 35–62.
Eurostat (2008). Online statistics: Population by citizenship-Foreigners. http://ec.europa.eu/eurostat. Accessed 15 March 2008.
Fernandez, R., & Fogli, A. (2006). Fertility: The role of culture and family experience. *Journal of the European Economic Association, 4*(2), 552–561.
Feyrer, J. (2007). Demographics and productivity. *Review of Economics and Statistics, 89*, 100–109.
Feyrer, J., Sacerdote, B., & Stern, A. D. (2008). Will the stork return to Europe? Understanding fertility within developed nations. *Journal of Economic Perspectives, 22*(3), 3–22.
Galor, O. (2005). The demographic transition and the emergence of sustained economic growth. *Journal of European Economic Association, 3*(2–3), 494–504.
Galor, O., & Weil, D. N. (1999). From Malthusian stagnation to modern growth. *American Economic Review, 89*(2), 150–154.
Galor, O., & Weil, D. N. (2000). Population, technology, and growth: From Malthusian stagnation to the demographic transition and beyond. *American Economic Review, 90*(4), 806–828.
Garrido, L. J., & Malo, M. A. (2005). Postponement of family formation and public budget: Another approach to very low fertility in Spain. *Public Finance and Management, 5*(1), 152–177.
Gruber, J., & Wise, D. (1998). Social security and retirement: An international comparison. *The American Economic Review, 88*(2), 158–163.
Gruber, J., & Wise, D. A. (1999). *Social security and retirement around the world*. Chicago: The University of Chicago Press.
Gruber, J., & Wise, D. A. (2004). *Social security programs and retirement around the world: Micro-estimation*. Chicago: The University of Chicago Press.
Hock, H., & Weil, D. N. (2007). Modeling the effects of population aging on consumption in the presence of intergenerational transfers. In R. Clark, N. Ogawa, & A. Mason *population aging, intergenerational transfers and the macroeconomy*. Northampton, MA: Edward Elgar.
ILO Bureau of Statistics. (2007). *ILO database on labour statistics*. Geneva, Switzerland: International Labour Organization.
Kelley, A. C. (1988). Economic consequences of population change in the third world. *Journal of Economic Literature, 26*, 1685–1728.
Kelley, A. C., & Schmidt, R. M. (1995). Aggregate population and economic growth correlations: The role of the components of demographic change. *Demography, 32*(4), 543–555.
Kelley, A. C., & Schmidt, R. M. (2005). Evolution of recent economic-demographic modeling: A synthesis. *Journal of Population Economics, 18*(2), 275–300.
Kohler, H.-P. (2006). Determinants of low fertility in Europe. *Entre Nous 63*.
Kohler, H.-P., Billari, F. C., & Ortega, J. A. (2002). The emergence of lowest-low fertility in Europe during the 1990s. *Population and Development Review, 28*(4), 641–680.
Lee, R., & Mason, A. (2008). *Fertility, human capital, and economic growth over the demographic transition*. Berkeley: Mimeo
Lesthaeghe, R., & Willems, P. (1999). Is low fertility a temporary phenomenon in the European Union? *Population and Development Review, 25*(2), 211–228.

Lutz, W., & Skirbekk, V. (2005). Policies addressing the tempo effect in low-fertility countries. *Population and Development Review, 31*(4), 699–720.

Malmberg, B. (2008). *Global population ageing, migration and European external policies*. Stockholm: Institute for Future Studies.

McDonald, P. (2006). Low fertility and the state: The efficacy of policy. *Population and Development Review, 32*(3), 485–510.

McDonald, P. (2008). Very low fertility: Consequences, causes and policy approaches. *The Japanese Journal of Population 6*(1), 19–23.

Samuelson, P. A. (1975). The optimum growth rate for population. *International Economic Review, 16*(3), 531–538.

Samuelson, P. A. (1976). The optimum growth rate for population: Agreement and evaluations. *International Economic Review, 17*(2), 516–525.

Simon, J. L. (1996). *The ultimate resource 2*. Princeton University Press: Princeton.

Solow, R. M. (1956). A contribution to the theory of economic growth. *Quarterly Journal of Economics, 70*, 65–94.

Strulik, H. (2005). The role of human capital and population growth in R&D-based models of economic growth. *Review of International Economics, 13*(1), 129–145.

United Nations (2007). World population prospects: The 2006 revision. CD ROM.

Vlasblom, J. D., & Schippers, J. J. (2004). Increases in Female Labour Force Participation in Europe: Similarities and Difference. Tjalling C. Koopmans Research Institute Discussion Paper Series. nr. 04–12.

Weil, D. N. (1999). Population growth, dependency, and consumption. *American Economic Review, 89*(2), 251–255.

World Bank. (2007). *World Bank development indicators CD-ROM*. Washington, DC: World Bank.

World Health Organization. (1999). *Life tables for WHO member states*. Geneva: World Health Organization. http://www.who.int/whosis/database/life_tables.cfm. Accessed 15 March 2008