CHAPTER III

HOW WILL DEMOGRAPHIC CHANGE AFFECT THE GLOBAL ECONOMY?

It seems possible that a society in which the proportion of young people is diminishing will become dangerously unprogressive, falling behind other communities not only in technical efficiency and economic welfare, but in intellectual and artistic achievement as well.

—Extract from the *Report of the Royal Commission on Population*, United Kingdom, 1949

The world is in the midst of a major demographic transition. Not only is population growth slowing, but the age structure of the population is changing, with the share of the young falling and that of the elderly rising. Different countries and regions, however, are at varying stages of this demographic transition. In most advanced countries, the aging process is already well under way, and a number of developing countries in east and southeast Asia and central and eastern Europe will also experience significant aging from about 2020.[1] In other developing countries, however, the demographic transition is less advanced, and working-age populations will increase in the coming decades.

The relationship between population growth and the economy has long been the subject of debate among scholars and policymakers. Thomas Malthus, in his *Essay on the Principle of Population* published in 1798, argued that the rate of population growth was held in equilibrium by the pace of economic growth. If population growth was too rapid, wages would be depressed, causing famine or disease to raise mortality, and inducing marriage, and therefore childbearing, to be postponed. Faster economic expansion and the associated increase in prosperity on the other hand would increase fertility and the population would then quickly rise to its new equilibrium. Today the theories of Malthus appear to be happening in reverse. As economic prosperity has risen around the world, fertility rates have fallen (and large gains in life expectancy have been made), resulting in slower population growth and aging.

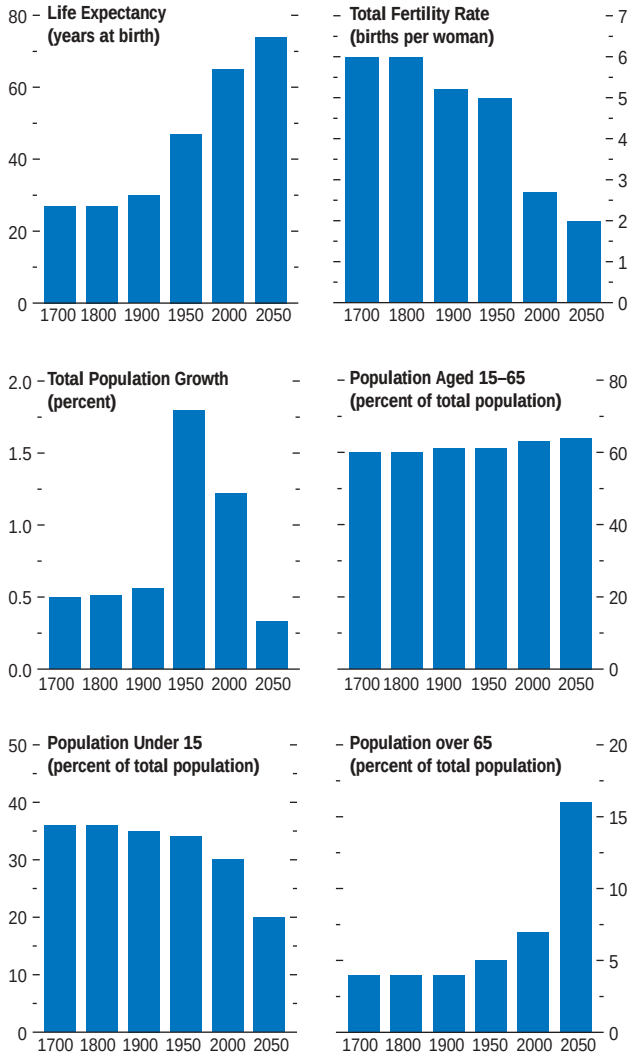
The gains in life expectancy that have been achieved in recent years are clearly very desirable and have improved individual welfare. A key question, however, is how ongoing demographic change will affect economic performance in the years ahead. Some argue that there is little reason to be concerned. Aging in the advanced countries has been under way for a considerable time, and has coincided with a period of strong income gains. Further, older people now lead healthier lives than at any time in the past, which allows them to continue to contribute to society well beyond the official age of retirement. Others see greater risks, including the possibility of slower economic growth, less innovation, financial market instability, and difficulties in funding overly generous public pension systems (see, for example, Peterson, 1999; Jackson, 2002; and Center for Strategic and International Studies (CSIS) and Watson Wyatt, 1999). Indeed, such concerns are not new. Over 50 years ago, the Royal Commission on Population in the United Kingdom worried about the consequences of declining fertility and popula-

Note: The main authors of this chapter are Tim Callen, Nicoletta Batini, and Nicola Spatafora with consultancy support from Jean Chateau, Warwick McKibbin, and Mehmet Tosun. Bennett Sutton provided research assistance.

[1]The term developing countries in this chapter refers to emerging market and other developing countries.

Figure 3.1. Global Demographic Transition, 1700–2050

Current demographic changes are unprecedented. After remaining broadly constant for centuries, the age structure of the world's population is now changing dramatically. Population growth is also slowing, following rapid growth in the second half of the twentieth century.



Source: Lee (2003).

tion aging on both the economy and Britain's influence overseas (United Kingdom, 1949). The impact of demographic change on developing countries has received less attention, but is certainly no less important, particularly given that an increasing share of the world's population will reside in these countries in the future.

Despite the uncertainty of demographic projections, the broad trends just described appear to be well established. Nonetheless, some time will elapse before their consequences for macroeconomic behavior are fully manifested. So, if the economic implications of these demographic changes are judged to be significant, policymakers do have the opportunity to respond ahead of time, although this window of opportunity is closing fast, particularly for those countries where the demographic transition is well advanced. The appropriate policy responses, however, are likely to vary between countries, will inevitably involve difficult trade-offs, and will take time to agree and implement.

In light of the changes taking place in the world's demographic structure, this chapter

- identifies more precisely the main demographic trends currently facing the world;
- assesses how these trends may affect the global and regional economies; and
- discusses policy responses to meet the challenges posed by demographic change.

The chapter is organized as follows. The first section discusses current and projected demographic trends, and how these will affect the size and structure of the world's population. The second section presents econometric and model-based evidence on the economic impact of demographic change. The last section explores possible policy options for responding to ongoing demographic developments.

Changing Structure of the World's Population

The world is in the midst of a historically unprecedented demographic transition that is having—and will continue to have—profound effects on the size and age structure of its popu-

lation (Figure 3.1). Before 1900, world population growth was slow, the age structure of the population was broadly constant, and relatively few people lived beyond age 65. This began to change during the first half of the twentieth century as rising life expectancy boosted population growth, although initially there was little change in the age structure of the population.[2] The second half of the twentieth century saw the start of another phase in this transition. Fertility rates declined dramatically—by almost one-half—causing population growth to slow, the share of the young in the population to decline, and the share of the elderly to increase. The share of the working-age population, however, also rose modestly.

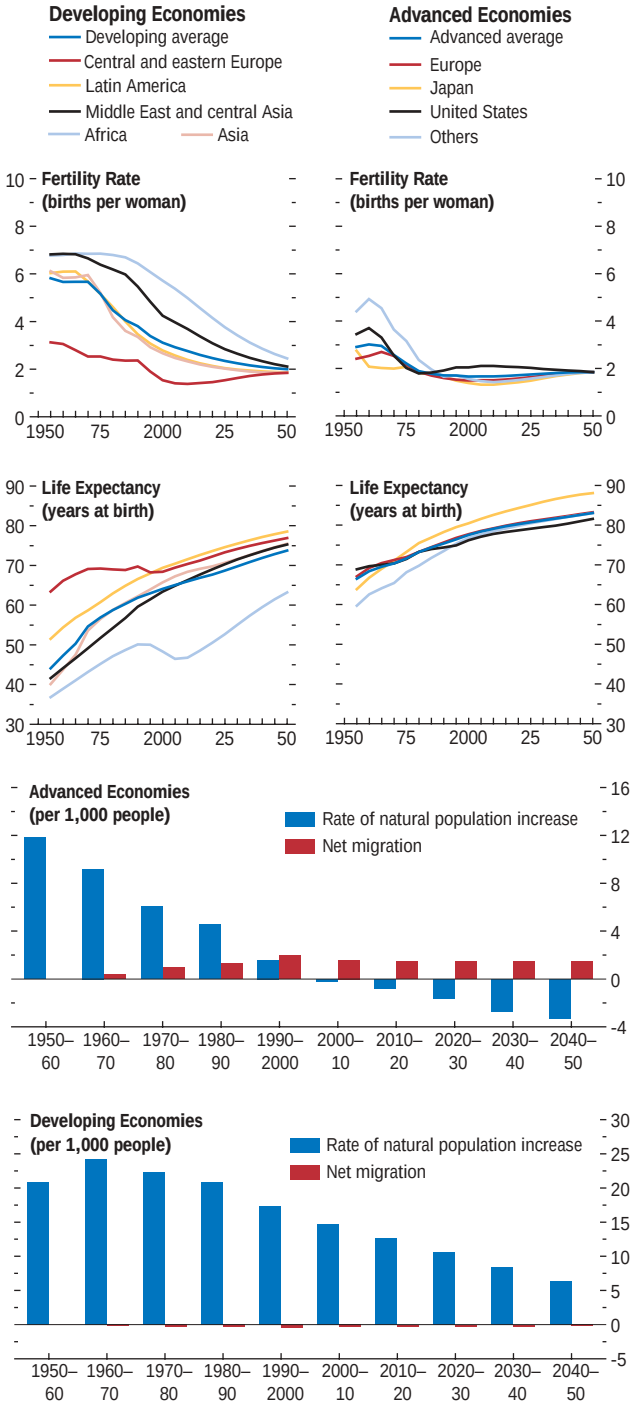
These global developments mask considerable variation between countries and regions that are the result of very different fertility, mortality, and migration trends (Figure 3.2). For example, although fertility rates have fallen almost universally in recent decades, they remain much higher in developing than in advanced countries, where they are generally below the replacement rate.[3] Even among developing countries, considerable differences exist—fertility rates are high in Africa and the Middle East, but are below replacement rates in east Asia and central and eastern Europe. Likewise, while life expectancy has risen across the globe over the past 50 years—and the largest gains have generally been made in developing countries—life expectancy still remains much higher in advanced countries. Exceptions to the generalized increase in life expectancy are Africa—where as a result of the HIV/AIDS

[2]In a number of European countries the demographic transition began much earlier. Lee (2003) dates the beginning of the decline in mortality in northwest Europe to about 1800. Population growth in the United States and Canada also decelerated in the nineteenth century.

[3]Replacement level fertility is estimated to be 2.1 births per woman in advanced countries and 2.4 births per woman in the developing countries. The level exceeds 2 in part because more boys are born than girls and in part because some children do not survive through the reproductive ages.

Figure 3.2. Key Demographic Trends, 1950–2050

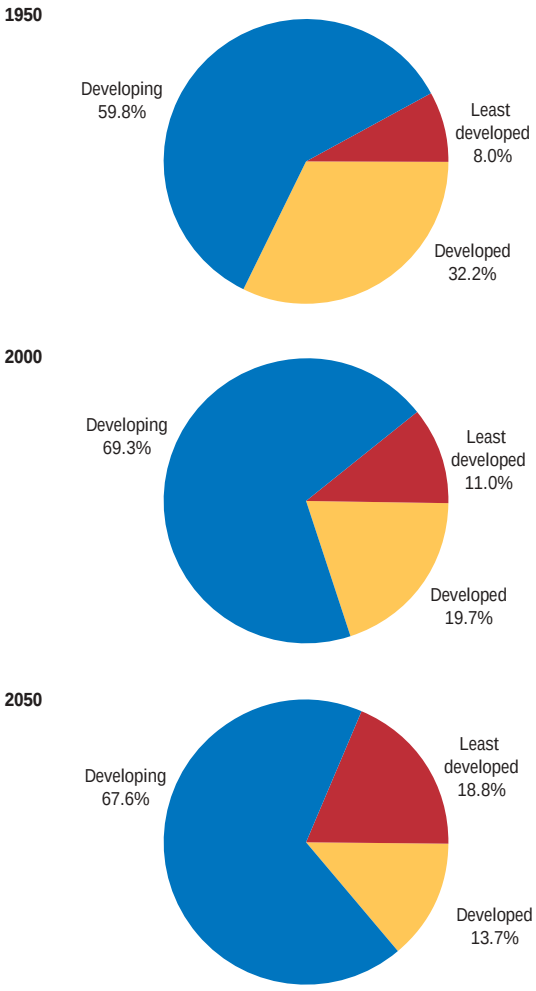
Fertility rates are declining, life expectancy is rising, and migration is becoming a more important factor in population growth in the advanced economies.



Sources: United Nations, *World Population Prospects: The 2002 Revision* (2003) and *World Population Prospects: The 2000 Revision* (2001).

Figure 3.3. Where the World's Population Lives[1]

The share of the world's population living in developed countries is declining, while that living in the least developed countries is rising.



Source: United Nations, *World Population Prospects: The 2002 Revision* (2003).
[1]United Nations definitions of developing, developed, and least developed country groups are used for this figure.

pandemic, life expectancy has declined by more than 25 percent in some countries—and the Commonwealth of Independent States (CIS) countries. Lastly, net immigration has made an important contribution to population growth in recent years in North America, while Europe and Japan have had much lower immigration rates.

As a consequence of all of these trends, population growth is much higher in developing countries—particularly in Africa and the Middle East—than in advanced countries. Indeed, in Japan and Europe, population growth is close to zero. The share of the young in the total population is also higher in developing countries, while the elderly account for a larger share of the population in advanced nations.

Looking ahead, the United Nations' current population projections (which extend to 2050) envisage that fertility rates in low-fertility countries will recover modestly, that fertility in other countries will continue to decline, that further gains in life expectancy will be made in both advanced and developing country regions, and that migration will make an increasingly important contribution to total population growth in advanced countries, but will only modestly reduce population growth in developing countries.[4] This has the following consequences.

- *Global population growth will continue to slow*. By 2050, global population growth is projected to be only ¼ percent a year, compared with 1¼ percent at present. The population in a number of countries is actually expected to decline over the next 50 years, including by over 30 percent in some central and eastern European countries, by 22 percent in Italy, and by 14 percent in Japan. In other countries—particularly in Africa and the Middle East, but also

[4]The projections discussed in this section refer to the "medium variant" of United Nations (2003). The fact that migration will become an increasingly important source of population growth in advanced countries is due to the fact that the rate of natural population increase will slow, or decline. The level of immigration into advanced economies itself is projected to be somewhat lower during 2000–50 than it has been in recent years.

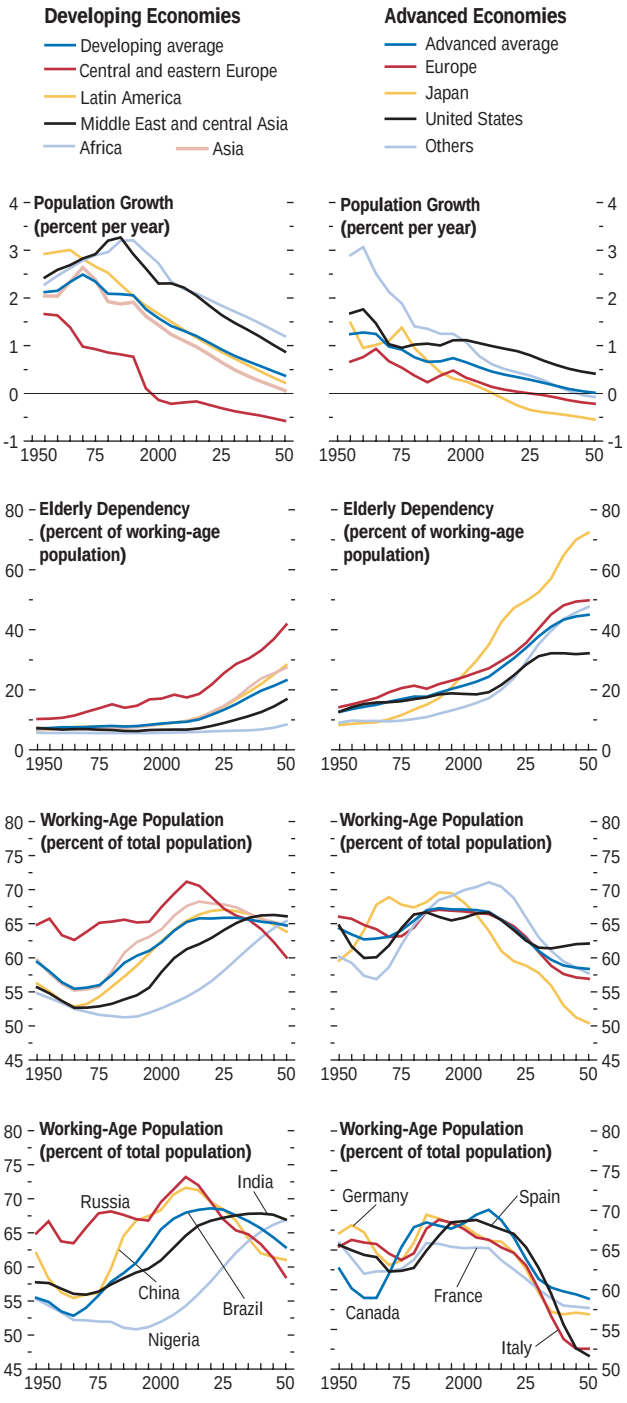
parts of Asia—population growth, although slowing, will remain robust, reflecting their higher fertility rates. These trends will lead to a continuing redistribution of the world's population away from the developed countries (Figure 3.3). Indeed, 19 percent of the world's population will be living in what are now the least developed countries by 2050, compared with 11 percent in 2000.

- *The world's population will continue to age*. The elderly will account for an increasing share of the population—although the pace and timing of aging varies widely between countries and regions—and the median age of the world is expected to increase by over 10 years during 2000–50 to 37 years. The elderly dependency ratio—which shows the population aged 65 and older as a share of the working-age (aged 15–64) population—is projected to rise dramatically in Japan and Europe, with lesser increases anticipated in the United States (Figure 3.4).[5] Further, the elderly themselves are getting older. The number of people aged 80 years and over is increasing at nearly twice the rate of that of those over 65. Among the developing country regions, aging is already under way in central and eastern Europe, a process that is expected to accelerate from about 2015. Aging will also begin to accelerate in Asia and Latin America around this time—with China experiencing particularly rapid aging—but the share of the elderly in Africa and the Middle East, while rising, will remain relatively small.
- *The share of the working-age population will fall in advanced countries, but increase in many developing countries*. In Japan and some European

[5]These elderly dependency ratios are only an approximation of the support needs of an elderly population. Some people continue to work after they have reached 65, while not everyone in the 15–64 age group is in employment—they may be still in school, unemployed, or outside the labor force. Further, in some countries, children younger than 15 are in full-time employment. It is possible to develop a measure of economic dependency that adjusts for these factors, but this alternative measure is difficult to calculate, particularly for developing countries.

Figure 3.4. Population Structure, 1950–2050

In the advanced countries, working-age populations are projected to decline and the share of the elderly to rise. In the developing countries, working-age populations are projected to first rise, before aging sets in.



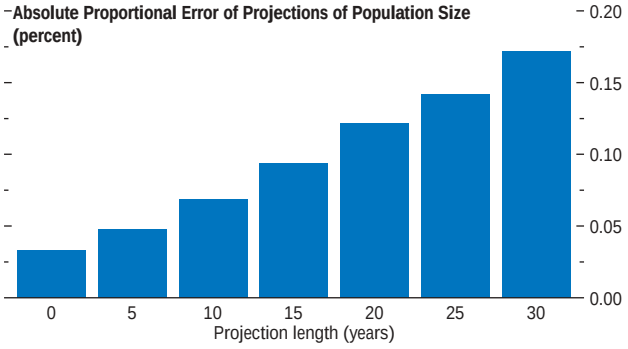
Source: United Nations, *World Population Prospects: The 2002 Revision* (2003).

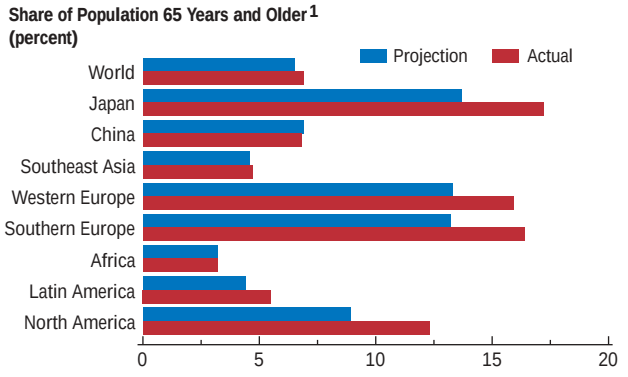
countries, this decline has already started and is projected to accelerate. In the United States, a high rate of immigration and higher fertility rates result in a more modest projected decline until 2025, after which the share of the working-age population stabilizes. In developing countries, the share of the working-age population is projected to increase until 2015, and then remain at this higher level as a declining share of the young offsets a rising share of the elderly. The working-age share will, however, start to decline in some regions before 2050, first in central and eastern Europe, and then in Asia and Latin America. In the Middle East and Africa, increases in the working-age populations are projected out to 2050. Looking at specific countries, large declines in the share of the working-age population are anticipated in Russia and China, while steady increases are expected in India and Nigeria.

The demographic changes that are projected to take place in the coming years are striking, and the important, but difficult, question is whether such projections provide a useful guide to likely future developments. Clearly, caution must be exercised when using long-term projections of any kind, and demographic projections do become much more uncertain the further into the future one goes (Figure 3.5). However, as discussed in Box 3.1, the basic trends outlined in this section—toward an increasing share of the elderly and a declining share of the young in the population—are apparent in most plausible scenarios. The main issue therefore is the extent to which the global population will age over the next 50 years (and beyond). While one cannot say on which side future errors are more likely to fall, a clear feature of past population projections has been the tendency to underestimate the share of the elderly in the total population in advanced countries, by underestimating both the decline in fertility and the increase in life expectancy. If this trend were to continue in the future, it would have important implications, particularly for public pension systems in these countries.

Figure 3.5. Uncertainty in Population Projections

Demographic projections are uncertain. Past projections have shown a clear tendency to underestimate the share of the elderly in the population.





Sources: United Nations; National Research Council; and IMF staff calculations.
[1]Projections made in 1963 of population shares in 2000.

Table 3.1. Macroeconomic Impact of Demographic Changes: Panel Instrumental Variable Regressions[1]

	Growth in Real GDP per Capita	Saving/GDP	Investment/GDP	Current Account/GDP	Budget Balance/GDP
Impact of:					
Share of working-age population[2]	**0.08**	**0.72**	**0.31**	**0.05**	0.06
Share of elderly population[2]	**–0.041**	**–0.35**	–0.14	**–0.25**	**–0.46**

[1]All regressions are panel fixed-effects regressions. The sample includes 115 countries; the data for each country are averaged over each decade. All demographic variables, as well as several other controls, are instrumented using their lagged values. See the appendix for details of the controls and instruments used in each regression. Bold-faced values are statistically significant at the 10 percent level.

[2]The working-age population is defined as the age group 15–64 inclusive. The elderly population is defined as the age group 65 and upward. Increases in the share of either are defined as coming at the expense of the age group 0–14 inclusive. These population shares appear in growth form in the regression for the growth of real GDP per capita, and in level form elsewhere except in the regression for the current account/GDP ratio, where they are expressed as deviations from the world average.

Economic Impact of Demographic Change

The demographic changes projected over the coming years are large, but are they likely to have an important effect on the economies of advanced and developing countries? This section uses two approaches—econometric analysis and simulations from a multicountry macroeconomic model—to investigate this issue.

Econometric Results

A large, 115-country, panel data set covering the period 1960–2000 was used to investigate the relationship between demographic variables and per capita GDP growth, saving, investment, the current account, and fiscal balances. The key results of the analysis—which are shown in Table 3.1 and described in more detail in Appendix 3.1—show the following, after controlling for other explanatory factors.[6]

- *Per capita GDP growth is positively correlated with changes in the relative size of the working-age population, and negatively correlated with changes in the share of the elderly* (Figure 3.6). This result, which is in line with existing studies, partly reflects the direct productive impact of a larger labor force.[7] In addition, as discussed below, lower dependency ratios tend to raise saving, which in turn helps finance more investment and boosts output.[8] Some evidence also suggests that the lower the initial level of per capita income, the larger the net positive impact of a decline in fertility (Bloom, Canning, and Sevilla, 2001). Other studies have suggested that the impact of demography on growth is linked to the strength of the institutional and policy framework in place. For example, relatively open and competitive markets, substantial investments in basic education, fiscal discipline, and a relatively deep financial sector may have helped east Asian countries benefit from the demographic dividend.[9] Per capita growth is also found to be positively associated with life expectancy—which may directly affect labor productivity and the incentives for investment in human and physical capital—although this could partly reflect the difficulty of adequately measuring and controlling for variables such as

[6]The econometric results should be interpreted with some caution as historical correlations may not reflect causality. In particular, econometric analysis of demographic issues is subject to problems of endogeneity and omitted variables. For instance, income itself is an important determinant of fertility, mortality, and hence the age structure of populations (Lee, 2003); this may introduce biases into the estimated coefficients. The analysis does try to minimize such problems through the use of instruments, as described in the appendix.

[7]See Kelley and Schmidt (2001), Bloom, Canning, and Sevilla (2001), and Gomez and Hernandez de Cos (2003). In contrast, increases in the relative size of the young or the elderly are negatively associated with growth.

[8]The association between declining fertility and increased female labor force participation also strengthens the impact of lower youth dependency—the ratio of those aged 0–14 to the working-age population—on per capita growth.

[9]Bloom and Canning (2001), Williamson (2001), and Lee, Mason, and Miller (1997) examine this issue.

Box 3.1. Demographic Projections: Methodologies and Uncertainties

The United Nations (UN) has been the leader in producing global population projections, and the analysis in this chapter is based on the "medium variant" scenario in the UN's "World Population Prospects: The 2002 Revision" (UN, 2003). Global population projections are also published by the World Bank, the United States Census Bureau, and the International Institute for Applied Systems Analysis (IIASA). At present, there is little difference in the projections of the four organizations. World population in 2050 is projected at 8.9 billion by the UN, 9 billion by the U.S. Census Bureau, and 8.8 billion by the IIASA and the World Bank (world population was 6.1 billion in 2000). Projections for individual countries, however, vary more widely. In terms of the age structure of the population, the share of the elderly—here defined as over 60 years of age—in 2050 is projected to be 21.4 percent by the UN, 21.9 percent by IIASA, and 22.2 percent by the U.S. Census Bureau.

A key issue is whether these projections provide a reasonable guide to future demographic developments. While this is clearly a very difficult question to answer because any set of projections can only be judged ex post, an assessment of past projections may provide useful information about the likely accuracy of the current projections. Past projections of world population have generally been quite accurate. The National Research Council (2000) found that while the UN was more likely to overestimate than underestimate future world population, the size of the error was small (an average of less than 3 percent in the projections made between 1957 and 1998). Indeed, the 1957 projection overestimated world population in 2000 by 3½ percent. At the country level, however, projection errors have been larger, particularly over long time horizons; these errors tend to offset when aggregated—hence the greater accuracy of the global projections. In general, population has been overprojected in most regions except the Middle East and North Africa, and projection errors have been smaller for developed than for developing countries, and for large countries compared with small countries. Another feature of past projections—as discussed in the main text—is that there has been a tendency to underestimate the share of the elderly in the total population in developed countries.

Errors in population projections occur for three main reasons. First, the estimate of the population in the base year of the projection may be inaccurate, and may subsequently be revised. Second, the underlying trends in fertility, mortality, and migration may be incorrectly projected. Third, unexpected events may occur that have demographic consequences such as war, famine, or the spread of disease. The HIV/AIDS pandemic, for example, has significantly altered the demographic profile in Africa. The National Research Council found that errors in fertility and migration projections account for most of the projection error in country forecasts over long periods. Looking at past experience, fertility rates have consistently been overestimated for most regions of the world; projections about life expectancy have generally been too pessimistic (Africa and the Commonwealth of Independent States (CIS) countries are exceptions); and net migration has been very difficult to predict.

Looking forward, uncertainties exist about future trends in fertility and life expectancy, and the assumptions made in the projections are crucial; even small projection errors—especially for fertility rates—can lead to very different outcomes in the long run. The UN's latest projections foresee a gradual recovery in fertility rates in developed countries, while fertility rates in developing countries are expected to continue to decline toward replacement levels. Those people expecting fertility to rebound in developed countries point out that the average age of childbearing is rising, leading to fewer births each year during this transition. Once this transition is over, measured fertility rates should rebound. They also note that in a number of countries—Denmark, Finland, Norway, and the United States—fertility has recovered somewhat in recent years, while in surveys conducted in Europe, women consistently say they want two children, which would boost the current fertility

Note: The main author of this box is Tim Callen.

rate if acted upon.[1] Others, however, believe that the decline in fertility will not be reversed because it represents an adjustment to changed social expectations, including the greater career orientation of women and the increased amount of time, attention, and money that are devoted to each child. Life expectancy projections are also the subject of disagreement. Some argue that there is a biological limit to life expectancy—often put at about 85 years of age—while others expect the gains in life expectancy seen in recent decades to continue into the future (see Oeppen and Vaupel, 2002, for example).

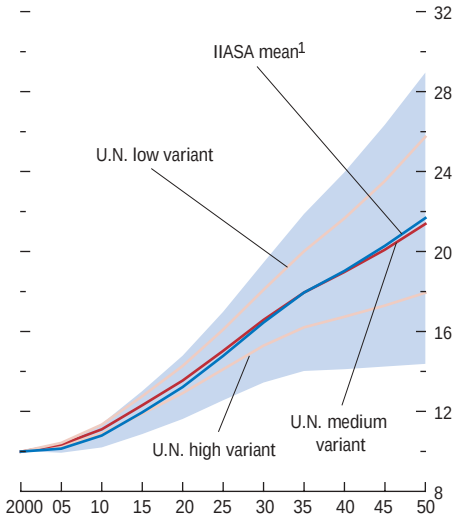
The most common way of characterizing the uncertainties with demographic projections is to consider alternate scenarios around the central projection. For example, the UN publishes different scenarios in addition to their "medium" variant projections. In the "low" and "high" variant scenarios, fertility is assumed to level off at half a birth below and half a birth above that in the "medium" variant scenario, respectively (assumptions about mortality and net migration are unchanged). These assumptions lead to very different outcomes, particularly in the long run. In the low-fertility scenario, world population increases only modestly to 7.4 billion by 2050, while in the high variant scenario it increases to 10.6 billion. The proportion of the elderly population in 2050—here defined as over 60 years of age to be consistent with the IIASA projections below—is also very different between scenarios, but in both cases is higher than in 2000 (see the figure).

A criticism of the scenario approach is that it gives no indication of the probability of any particular outcome actually occurring. Probabilistic projections—such as those by the IIASA and Lee, Anderson, and Tuljapurkar (2003)—attempt to address this problem. These projections acknowledge that there is uncertainty about future fertility, mortality, and migration trends, and use a range of possible outcomes to derive a probability distribution for the size and age structure of the future population. The IIASA's projections suggest that at the 95 percent confidence level the world's population in 2050 will be between 6.4 and 11.3 billion, and that the proportion of the population aged over 60 years will be between 15 and 29 percent.

In sum, there are clear uncertainties with projections of future demographic trends, which need to be carefully considered when using the projections for policy purposes. Under almost any scenario, however, the global population will age over the next 50 years (and beyond), and the main question is the extent to which this will happen. Policymakers need to prepare for this aging process, although the magnitude of the policy response will need to be reevaluated on an ongoing basis as more information becomes available about how demographic trends are developing.

Uncertainty in Population Projections

(Population aged 60 years and older in percent of total population)



Sources: United Nations; and International Institute for Applied Systems Analysis (IIASA).
[1]Shaded area represents the IIASA mean projection plus and minus two standard deviations.

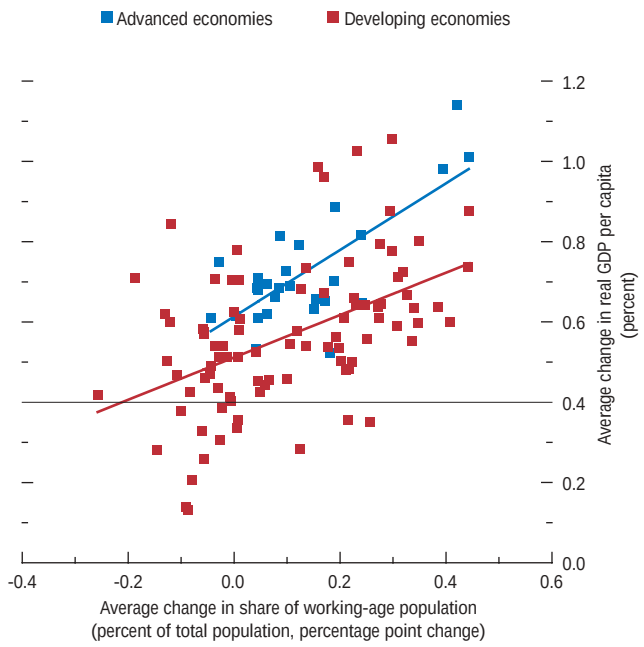
[1]The reasons for the recovery in fertility in these countries is not clear, although the emphasis in the Scandinavian countries on measures that make motherhood and women's labor force participation more compatible—such as day care services, flexible working hours, and liberal maternity and sick leave allowances—may be important (see Demeny, 2003).

institutional quality, which are likely to be correlated with both growth and life expectancy.[10]

- *There is a statistically significant association between demographic variables and saving.* According to the life-cycle hypothesis of saving, people try to maintain a smooth pattern of consumption through their lifetime. This means that when current income is low relative to lifetime average income, saving will also be low, and when current income is high relative to lifetime average income, saving will be high. Younger people tend to be net borrowers; older people at the peak of their earnings potential tend to be high net savers; and the elderly tend to dissave, or at least to save at a lower rate than during their working years. While there is some contention about the validity of the life-cycle hypothesis—particularly whether the elderly actually run down their wealth in retirement—the results in Table 3.1, as well as most other cross-country studies, find that demographic factors (together with income growth, real interest rates, and public saving) play a role in influencing saving behavior.[11] Specifically, saving rises with an increase in the share of the working-age population, and declines with an increase in the elderly share.
- *The share of the working-age population is also correlated with investment.* Demographic change influences investment through its impact on saving, and because changes in the labor supply affect the returns to investment.
- *Current account balances increase with the relative size of the working-age population, and decrease*

Figure 3.6. Per Capita Growth and Working-Age Population

There is a clear, positive relationship between growth in output per capita and the relative size of the working-age population. This holds for both advanced and developing economies.



Sources: Penn World Tables; World Bank, *World Development Indicators;* and IMF staff calculations.

[10]Meltzer (1992) started the modern literature on the links between mortality and growth. More recent contributions include Zhang and others (2003), Kalemli-Ozcan and others (2000), and Kalemli-Ozcan (2002, 2003). For a more skeptical viewpoint, see Acemoglu, Johnson, and Robinson (2003).

[11]Recent theoretical and empirical discussions of the link between demographic change and saving include Faruqee (2002), Futagami and Nakajima (2001), Deaton and Paxson (2000), Loayza, Schmidt-Hebbel, and Servén (2000), Disney (1996), Masson, Bayoumi, and Samiei (1995), Malmberg (1994), and Horioka (1991).

when the elderly dependency ratio rises.[12] Although saving and investment are both affected by the age structure of the population, so that it is not immediately obvious what impact demographic change should have on the current account, most empirical studies agree with this result.[13]

- *Demographic factors also affect the fiscal balance*. Specifically, government budgets are adversely affected by population aging due to higher spending on pensions, health care, and long-term residential care (see Heller, 2003, for an analysis of the long term fiscal challenges posed by population aging). Casey and others (2003) estimate that among OECD countries elderly-related spending will rise by an average of nearly 7 percent of GDP between 2000 and 2050 with additional expenditures on health care exceeding those on pensions in a number of countries.[14] A smaller working-age population may also result in lower tax revenues.

Demographic shifts may also have important implications for the performance of financial markets. As discussed in Box 3.2, the aging of populations may put downward pressure on real equity prices in advanced countries in the years ahead if retirees begin to liquidate their assets.[15] Chapter II of this *World Economic Outlook* also finds that demographic changes have been a factor behind the rise in housing prices in a number of countries.

The econometric results suggest that projected demographic changes could have an important impact on future economic performance. Combining the estimated coefficients reported in Table 3.1 with the UN's population projections yields a sense of the potential magnitudes, and how they may vary across regions.

- *In advanced countries, the impact of upcoming demographic changes on growth could be substantial*. The historic association between demographic and macroeconomic variables suggests that the projected increase in elderly dependency ratios and the projected decline in the share of the working-age population could result in slower per capita GDP growth, and lower saving and investment. For example, the estimates suggest that demographic change could reduce annual real GDP per capita growth in advanced countries by an average of ½ percentage point by 2050—i.e., growth would be ½ percentage point lower than if the demographic structure had remained the same as in 2000.[16] Growth would be most severely affected in Japan, while the impact in the United States would be relatively small (Figure 3.7).
- *The impact on growth in developing countries will vary by region*. In Africa and the Middle East, per capita growth could be boosted by the increase in the share of the working-age population.[17] The results suggest that per capita growth in 2050 could be 0.3 and 0.1 percent-

[12]Because separate equations are estimated for saving, investment, and the current account, the effects of the demographic variables on saving and investment do not sum to the aggregate effect on the current account.

[13]Feroli (2003) analyses the experience of the Group of Seven industrial countries (G-7); Chinn and Prasad (2003), Higgins (1998), and Luhrmann (2003) provide a wider cross-country perspective.

[14]Studies of the fiscal impact of population aging have also been carried out by the European Commission (2001), the OECD (2001), the Group of Ten (1998), and many individual countries, including for Australia (Australian Treasury, 2002), New Zealand (Janssen, 2001), and the United States (U.S. CBO, 2001). Other studies include Bohn (1999), Bryant (2004), INGENUE Team (2001), and Heller (1997).

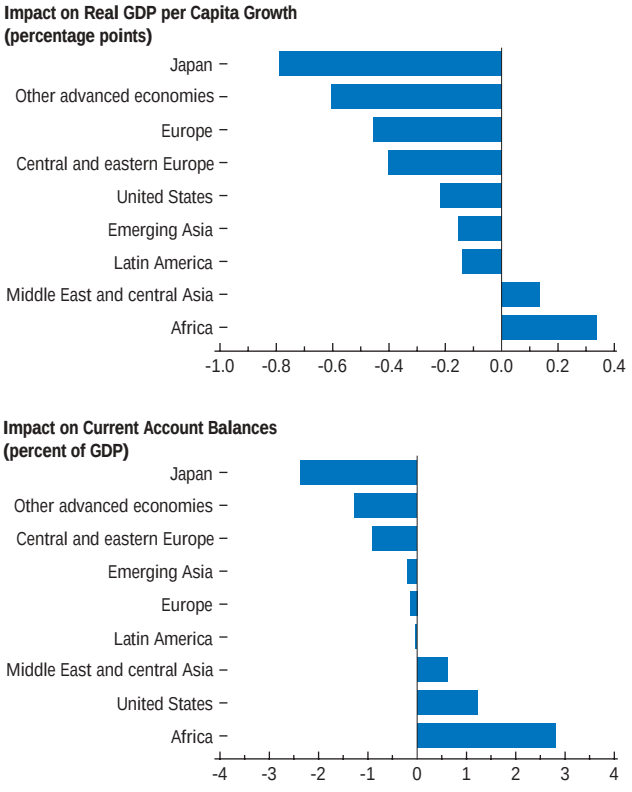
[15]The impact of demographic change on pension funds is discussed in the September 2004 *Global Financial Stability Report*.

[16]This result is not suggesting that real per capita growth *will* be ½ percentage point lower in 2050 than it was in 2000. Many of the other variables that influence growth will also change over the next 50 years, and these changes could offset the impact of demographic factors.

[17]Declining fertility rates in the developing world could also have an important impact on poverty. While causality works in both directions, high fertility increases absolute poverty both by reducing economic growth and by changing the distribution of consumption against the poor—for instance, by increasing the price of food and reducing wages (Eastwood and Lipton, 2001). Consequently, if the UN projections of a sharp decline in fertility in the least developed countries are realized, this could help reduce poverty in these countries.

Figure 3.7. Impact of Demographic Change on Growth and Current Account Balances, 2000–50

Population aging will likely depress growth rates in advanced economies, while relatively more youthful developing countries, in contrast, could enjoy a growth boost as working-age populations increase. Faster-aging countries are also likely to experience a reduction in their current account balances, as the elderly run down their assets during retirement.



Sources: Penn World Tables; United Nations, *World Population Prospects: The 2002 Revision* (2003); and IMF staff calculations.

age point higher, respectively, in these regions. These results, however, are unlikely to adequately account for the impact of the HIV/AIDS pandemic which will continue to have a significant impact on macroeconomic outcomes in countries with high prevalence rates (see Box 3.3). In contrast, demographic changes are likely to weigh on growth in central and eastern Europe and, to a lesser extent, in Asia and Latin America by 2050 (although in these latter two regions individual country experience will vary).

- *Future demographic changes could lead to large changes in current account balances.* In advanced economies, the negative impact of population aging on saving will in general result in deteriorating current account balances; indeed, for Japan, the results suggest that the deterioration could be on the order of 2½ percentage points of GDP. The major exception is the United States, where demographic developments could lead to an improvement in the current account position of over 1 percentage point of GDP. Among developing countries, demographic change could contribute to an improvement in current account balances in Africa and the Middle East, but result in a deterioration in central and eastern Europe.

Impact of Demographic Change in a Multicountry Model

The econometric analysis provides a useful guide of how demographic change could affect key economic variables, but it suffers from the drawbacks that each variable is considered separately, rather than as part of an integrated economic system, and that the historical correlations that are identified between variables may not reflect causality. To address these issues, the potential impact of demographic change was examined using a multiregion macroeconomic model—the INGENUE model (INGENUE Team, 2001)—that explicitly captures the interactions between variables and across countries within an integrated and consistent framework.

The INGENUE model disaggregates the world economy into six regions: North America and Oceania, Europe, Japan, and three developing country regions that are defined according to their particular demographic characteristics.[18] The model explicitly incorporates the age structure of the population, and adopts the life-cycle hypothesis of saving as one of its cornerstones. The model also accounts for the costs to parents of raising children, and incorporates a pension system in each country/region. Capital is allowed to move freely across regions, but labor is assumed to be immobile (since migration is an important channel through which the global economy could adjust to demographic developments, a model that allows for labor mobility is discussed in the next section).

The results from the model suggest that the demographic changes projected over the next 50 years will lower output growth in all regions although, given slowing population growth, the impact on per capita growth rates will not be as large (Figure 3.8). Per capita growth rates will slow relative to current levels in all the advanced country regions, while they will initially rise in the developing country regions as demographic changes boost the supply of labor.[19]

An important aspect of the results is that saving rates in Europe and Japan—and to a lesser extent the rapidly aging developing region—will decline sharply as the share of the elderly in the population rises and working-age populations fall. Pension systems actually contribute significantly

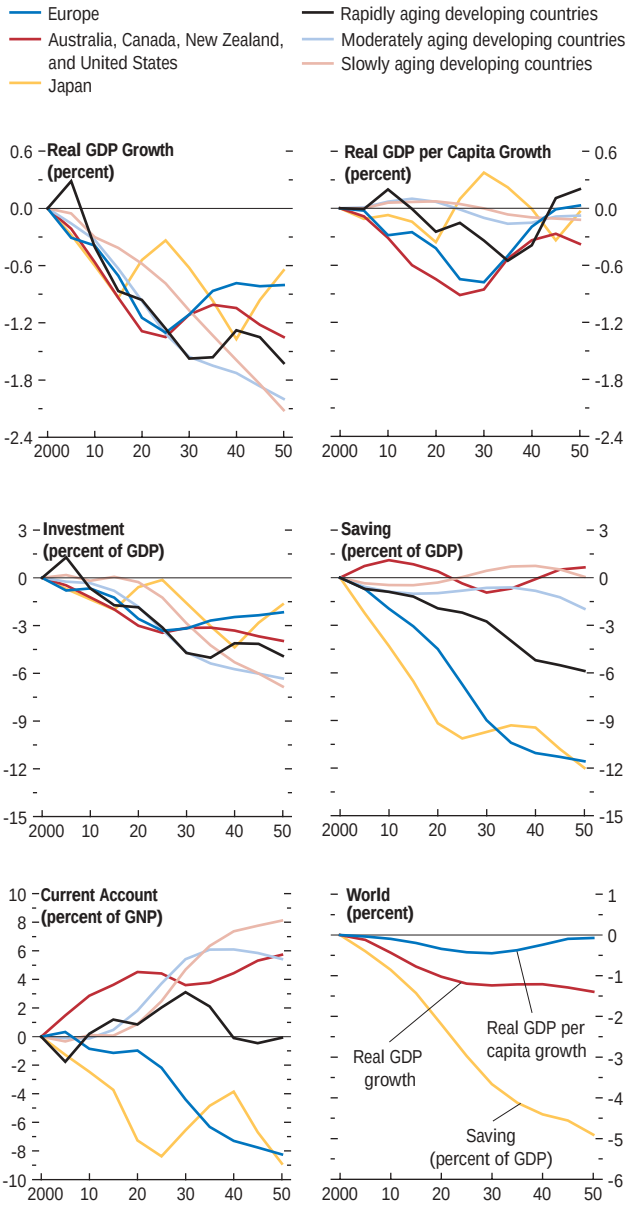
[18]The three developing country regions in the INGENUE model are those economies that are well advanced in the demographic transition, such as China, Korea, and Russia (labeled "rapidly aging developing countries"); those economies at an earlier stage of the demographic transition, such as India and many Latin American countries (labeled "moderately aging developing countries"); and, finally, those economies just starting or yet to start the demographic transition, including most African countries and Pakistan (labeled "slowly aging developing countries").

[19]The more modest decline in per capita growth in Europe and Japan relative to North America and Oceania is largely driven by the model's assumption that the former regions close their productivity gap with the United States over the projection period.

Figure 3.8. Implications of Projected Demographic Change in the INGENUE Model

(Changes relative to the model predicted outcome in 2000)

Population aging is likely to lower output growth in all regions of the world and could result in large changes in current account balances as staggered aging across the world leads to different saving-investment profiles between regions.



Sources: INGENUE Team; and IMF staff calculations.

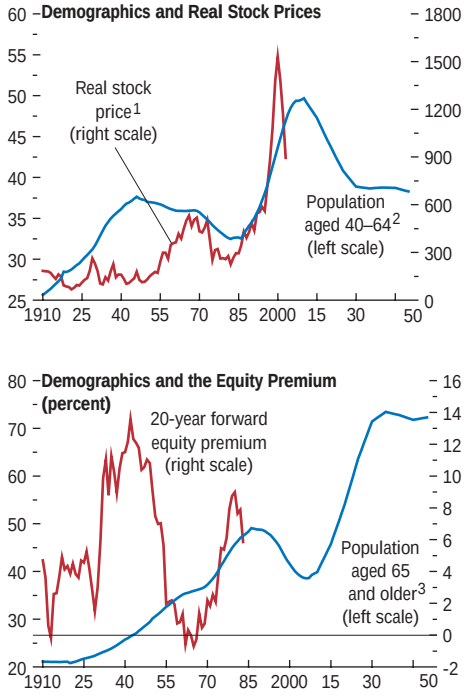
Box 3.2. How Will Population Aging Affect Financial Markets?

Even after the bursting of the technology bubble, stock prices in real terms are four times their value at the beginning of 1980. In the United States, this increase has coincided with a dramatic rise in the share of the population aged 40 to 64, as the baby boomers—those born from 1946 to 1964—have moved into their prime saving years. Popular accounts, such as Passell (1996) have linked these two phenomena, arguing that an inflow of private saving from middle-aged baby boomers has been driving up the stock market. These accounts warn that demographic forces will conspire against the stock market after 2010, when the oldest of the baby boomers begin to turn 65. They conjecture that beyond this point, the baby boomers will be selling off their stocks to a much smaller generation of buyers, causing stock prices to decline. During the postwar period, real stock prices in the United States have indeed been positively associated with the relative importance of the population in prime saving years (top panel of the figure). Given the projected path for the population of prime savers, the degree to which real stock prices will fall after 2010 then depends on understanding whether this association is empirically robust and what underlying factors could be driving it.

This box reviews recent advances in the academic literature on the link between demography and the stock market. Broadly speaking, this literature consists of two strands: one empirical and the other theoretical. The former uses a variety of techniques to test the robustness of the link between demographic factors and the stock market, while the latter uses economic models to understand how changes in the age distribution affect the stock market in a controlled environment.[1]

The empirical literature often finds a robust link between the proportion of high net savers in the population and asset prices, suggesting that the aging of the baby boomers could cause real stock prices to fall. Bergantino (1998) uses household surveys from the United States to construct age-specific demand profiles for stocks and other assets and finds that demand for stocks and other financial assets is greatest among households aged 40 to 60. Based on this exercise, he constructs an aggregate demand schedule for financial assets, which explains about three-fourths of the observed annual increase in real stock prices between 1986 and 1997. Brooks (1998) explores the link between real stock and bond prices and demography in an international setting. Using data from 14 advanced economies over the postwar period, he finds that real stock and bond prices are positively associated with the share of the population aged 40 to 64, even after controlling for other fundamentals driving

Demographic Change and Equity Markets



Sources: Shiller (2003); and United States Census Bureau.
[1]Standard and Poors 500 index, deflated by U.S. consumer price index.
[2]As a percent of population aged 0–39 and those aged 65 and older.
[3]As a percent of population aged 40–64.

Note: The main author of this box is Robin Brooks.
[1]More extensive surveys of the empirical and theoretical literature can be found in Young (2002) and Bosworth, Bryant, and Burtless (2004).

financial markets. Davis and Li (2003) report similar results for seven OECD countries—an increase in the fraction of the population aged 40 to 64 tends to boost real asset prices. Most recently, Geanakoplos, Magill, and Quinzii (2004) find that the price-earnings ratio of stock prices in the United States—a normalized measure of the level of equity prices that has the advantage of factoring out growth—is positively associated with the relative importance of middle-aged workers in the population.

This evidence, however, must be interpreted with caution. First, the effective number of observations is small. The relative importance of prime savers rises through the late 1940s, falls through the mid-1980s as the baby boomers enter the young tail of the age distribution, and subsequently rises as they enter their prime saving years. Over the same horizon, the major events in the stock market are the postwar boom in the 1950s and 1960s, the oil-shock induced bust in the 1970s and early 1980s, and the subsequent boom starting in the mid-1980s. The small effective number of observations is exacerbated by the fact that there is little systematic association between real stock prices and demography prior to the postwar period. Second, at long horizons there are common shocks, notably the Great Depression and World War II, which are driving both demography and the stock market. Because these shocks are global, data from other countries do not represent independent observations. In other words, cross-country studies do not add much explanatory power in effective terms. Indeed, Poterba (2001) argues that none of the empirical findings provide a strong and convincing measure of the amount that asset prices will change as a result of population aging.

In part because of the limitations of the empirical analysis, researchers have increasingly turned to economic models as a controlled environment in which to study the effects of demography on the stock market. Abel (2003) and Geanakoplos, Magill, and Quinzii (2004) resolve what is perhaps one of the most puzzling questions in this literature: how can there be a contemporaneous association between changes in the age distribution—a slow-moving, highly predictable process—and stock prices when financial markets are rational and forward looking? Both papers use stylized representations of the age distribution and capital markets to show that real stock prices display a contemporaneous link to the age distribution even when investors are forward looking and rational. This is because only living generations trade in financial markets at a point in time, meaning that differences in the demand and supply of financial assets—a reflection of differences in size across generations—cannot be arbitraged away ahead of time. Moreover, the latter paper shows that demographic fluctuations account for virtually all of the peak-to-trough variation in stock prices over the postwar period once the business cycle is accounted for.

Finally, theoretical approaches are increasingly being used to study the link between demography and the equity premium—the extra return that investors earn for holding equities rather than government bonds. Constantinides, Donaldson, and Mehra (2002) use an economic model to show that retirees are less willing holders of equity than workers because they can no longer count on wage income to offset the consumption effects of adverse stock market movements. Their model suggests that the equity premium should be higher the greater the fraction of old people in the population, consistent with Bakshi and Chen (1994). Indeed, in the United States, as the relative importance of the population over 65 increased after 1970, so did the 20-year forward equity premium (which measures the excess return investors could have earned on stocks under perfect foresight; see the bottom panel of the figure). However, any empirical link between the equity premium and demography is weak (see also Ang and Maddaloni, 2003).

Overall, the empirical and theoretical strands of the literature suggest that stock prices could move against the baby boomers as they retire so that past returns should not be viewed as a benchmark for returns on the retirement savings of this generation. Moreover, there is some evidence that the equity premium could rise as the boomer generation moves into retirement. This has important implications for individual accounts-based reforms to public pension systems, which often assume a constant equity premium over the reform horizon.

Box 3.3. HIV/AIDS: Demographic, Economic, and Fiscal Consequences

The HIV/AIDS epidemic has resulted in a substantial increase in mortality—and a corresponding loss of life expectancy—in many countries, particularly in sub-Saharan Africa. In addition to its devastating human costs, HIV/AIDS disrupts economic activity and erodes a government's ability to deliver public services when the demand for these services—particularly in the health sector—is actually increasing.

Demographic Impact of HIV/AIDS

HIV/AIDS is now the primary cause of death in Africa (the worst-affected region); about 20 percent of all deaths are accounted for by the disease, twice as many as are caused by malaria and 10 times as many as are caused by violence and war combined (WHO, 2004). For sub-Saharan Africa, HIV prevalence rates for the prime-age working population (ages 15–49) were 7.5 percent on average as of end-2003, but they exceeded 20 percent in 6 countries including Botswana and Swaziland where they were above 30 percent. For the worst-affected countries, mortality among the working-age population has increased substantially, and HIV/AIDS now accounts for over 90 percent of deaths in this age range for some countries (see the table). In some countries, life expectancy at birth has decreased by more than 25 percent in recent years, and in Botswana and Zimbabwe it is now lower than it was in 1950. Finally, because of HIV/AIDS, the number of orphans has increased to about 20 percent of the young in the worst-affected countries. In the broader international context, increasing attention is being paid to countries such as China or India—where the largest number of people outside of South Africa live with HIV—and where low aggregate prevalence rates mask more serious epidemics at a regional level.

Economic Impact of HIV/AIDS

The economic impact of HIV/AIDS on households is uneven, depending on whether a household member is infected or not. In households where a member is ill or dies, income falls because of the loss of the person's earnings, and because other household members have to forgo work to devote time to care for the sick. Households also have to reallocate resources to care. A survey from South Africa suggests that health spending accounts for one-third of outlays for households affected by HIV/AIDS, compared with a national average of only 4 percent (Steinberg and others, 2002). In turn, this spending on health care reduces spending on other items—including education—and saving. Orphans of AIDS victims are a particularly vulnerable group as they often live in poorer households and have lower school enrollment rates than non-orphans (which affects human capital formation).

HIV/AIDS has adverse effects on private sector businesses because it disrupts activity, raises the cost of providing benefits, reduces productivity, and increases training costs as workers who retire or die have to be replaced. While disruptions caused by illness and death are the primary cost of HIV/AIDS to small companies and the informal sector, the impact on medical and death-related benefits is more important for larger companies. Faced with rising costs and a deteriorating and uncertain economic outlook, companies may also relocate their production or, in the case of foreign investment, stop investing in countries with severe HIV/AIDS epidemics.

There are a wide range of estimates of the overall impact of HIV/AIDS on growth. For example, some studies for Botswana and Swaziland estimate that HIV/AIDS will lower GDP growth by about 1.5 percent a year. A broader empirical study—using data from 41 countries—suggests a larger decline in GDP growth of up to 4 percent a year (see Dixon, McDonald, and Roberts, 2002). HIV/AIDS in fact not only destroys existing human capital but also severely impairs its formation (see Bell, Devarajan, and Gersbach, 2004).

Income per capita, however, is far from a complete measure of the economic impact of HIV/AIDS. As Crafts and Haacker (2004) show,

Note: The main author of this box is Markus Haacker.

Demographic Impact of HIV/AIDS

	HIV Prevalence Rate Ages 15–49, End-2003 (percent) (1)	Life Expectancy at Birth (years)		Mortality, Ages 15–39, 2003 (percent)		Orphans Ages 0–17 (percent of young population)
		1990–1995 (2)	2002 (3)	Total (4)	Of which: AIDS (5)	2003 (6)
Botswana	37.3	65.0	40.4	4.3	4.1	20.0
Côte d'Ivoire	7.0	48.3	45.3	1.8	1.3	13.4
South Africa	21.5	61.8	50.7	3.1	2.9	12.9
Zambia	16.5	44.2	39.7	2.7	2.1	18.3
Zimbabwe	24.6	53.3	37.9	2.7	2.5	18.6

Sources: UNAIDS (2004) for column (1); UN (2003), for column (2); WHO (2004), for column (3); estimates provided by the International Programs Center at the U.S. Bureau of the Census, for columns (4) and (5); and UNAIDS/UNICEF/USAID (2004) for column (6).

welfare losses from HIV/AIDS are much larger than losses in per capita income because of the need for higher outlays on health services and increased poverty. More generally, the higher risk of illness and death means that living standards fall (for example, in the UNDP's Human Development Index).

Consequences of HIV/AIDS for the Public Sector

HIV/AIDS has significant implications for government budgets and service delivery. Higher mortality erodes the government's human resource base, undermines domestic revenue collection, raises costs, and causes disruptions to the delivery of public services. Many of these effects are similar to those for the private sector, although the impact on the government's personnel costs is likely to be larger because the government typically offers more comprehensive benefits, including health insurance and pensions to surviving dependants. At the same time as the government's service delivery capacities are eroded, HIV/AIDS increases the demand for a wide array of government services, most notably in the health sector. The HIV epidemic is already having a profound effect on health services in developing countries. Over (2004) estimates that an HIV prevalence rate of 5 percent could result in an increase in the demand for health services of 26 percent for the treatment of opportunistic infections alone. With HIV prevalence rates of 20–30 percent in some countries, this would mean that the demand for health services more than doubles as a result of HIV/AIDS. Available data on the share of hospital beds occupied by HIV positive patients, frequently in a range of 50–70 percent, are broadly consistent with this picture, and indicate that some crowding out of other patients is taking place.

Implementing a broad response to HIV/AIDS remains a major challenge. Substantial declines in the costs of antiretroviral drugs have resulted in a shift in the emphasis of the international response to HIV/AIDS to also include increasing access to these treatments. For example, the WHO's "3 by 5" initiative aims to provide antiretroviral treatment to three million people in developing countries by end–2005, at an estimated cost of $5–6 billion (Gutierrez and others, 2004). This means that many countries can now start to provide treatment to HIV patients. However, in countries where only basic health services are currently provided through the public sector, where the availability of health personnel is limited, or where health expenditures would increase (and sometimes more than double) from a very low base, the delivery of adequate care for patients remains a challenge (Over, 2004). The international community needs to raise the resources available for an adequate response to HIV/AIDS, help countries to mount sustainable and effective AIDS strategies, and assist countries in strengthening their capacities to deliver these strategies (UNAIDS, 2004).

to this decline because social security contribution rates have to be raised to finance the additional pension expenditures that result from the increase in retirees. This effectively transfers resources from the working-age population—which has a higher propensity to save—to older generations who have a lower propensity to save.[20] Changes in saving behavior elsewhere are much smaller. In North America, saving initially rises as the baby boomers move through their high saving years, and then begins to decline modestly after 2010. In the aggregate, world saving declines sharply. As the relative size of the working-age population (and hence the marginal product of capital) declines, investment (relative to GDP) also falls, with the most pronounced changes occurring in the fastest-aging regions.

Demographic change could result in a substantial reallocation of global capital in the long run.[21] The decline in saving causes a large current account deterioration in Japan and Europe in the model (initially, these changes result in a smaller current account surplus, which turns into a deficit around 2020 as capital is repatriated from abroad). Other countries experience offsetting current account increases, although in the moderately and slowly aging developing country regions this change does not occur immediately. An important implication of the results is that developing countries may have access to less external capital in the future, although reforms to improve the investment environment in these countries may help alleviate this problem (see below).

The results from the model and those from the econometric exercise reach broadly similar conclusions about the likely impact of the demographic changes projected over the next 50 years. Specifically, per capita growth rates are likely to decline in advanced economies, but rise in those developing countries where the share of the working-age population is increasing. Saving and investment will be affected in all countries, but the countries that are aging faster—Japan and Europe—will experience a deterioration in their current account positions, which will be offset by improvements elsewhere.

There are, however, substantial uncertainties associated with these results, and different models do project different outcomes. For example, simulations using the MSG3 model—see Batini, Callen, and McKibbin (2004)—suggest a broadly similar impact on per capita GDP to that discussed above, but different future current account paths.[22] Specifically, Europe is projected to experience an improvement in its current account position because investment declines more sharply than saving, while other regions see a corresponding deterioration. The behavior of saving is particularly critical to the results, but it is very difficult to know how households will respond to demographic change. Will the elderly dissave in retirement as expected in the INGENUE model, or will they seek to maintain their wealth in the face of uncertainty about how long they will live? Further, if people expect that incomes in the future will be lower because of demographic change, will they raise saving in the near term by more than the INGENUE model projects to smooth their future consumption? These issues are critical to the macroeconomic outcome, but they very much depend on individuals' understanding of the implications of demographic change and their expectations of the future, both of which are not easily observable.

[20]Even in the absence of a formal pension system, there would be transfers from the young to support the elderly.

[21]As populations in fast-aging regions pass through their high-saving years, they may invest part of their additional saving in regions where labor forces are larger and the rates of return on capital higher. As these populations then move into retirement, this capital should then be repatriated to finance retirement. These capital flows play an important part in the global adjustment process by allowing residents of regions that are aging at different speeds to borrow and lend to each other. These capital flows cushion the impact of demographic change relative to the case of a closed economy. See McKibbin and Nguyen (2004) for an assessment of the relative impact of demographic change in a closed versus an open economy model.

[22]MSG3 is a less regionally disaggregated model than INGENUE and does not incorporate a social security system. It does, however, have more sophisticated financial and production sectors. The model is described in Appendix 3.1.

Policies to Meet the Challenges of Global Demographic Change

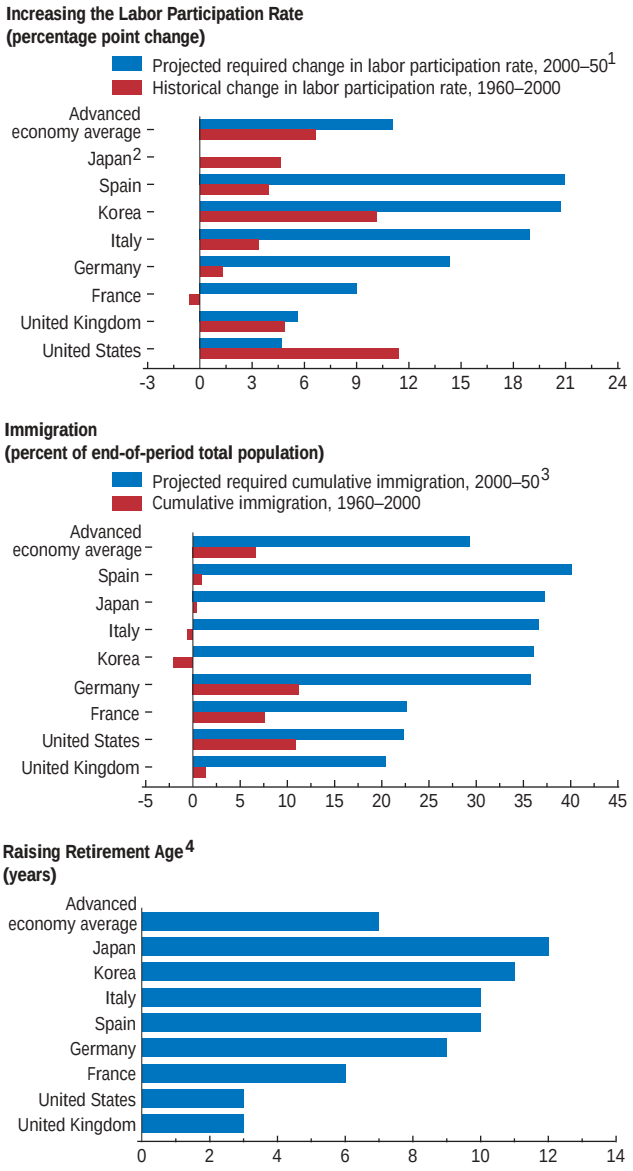
What can be done to meet the economic challenges posed by demographic change? Clearly, a wide range of possible policy responses are available—at both the national and international level—and some of these are currently under discussion, particularly in countries facing the most significant and immediate demographic pressures. While the challenges differ between advanced and developing countries, at a broad level, if a policy is to help respond to demographic change, it needs to boost labor supply, saving, or productivity.

Assuming that participation rates do not change, demographic developments will result in a decline in the supply of labor in many advanced countries over the next 50 years. Estimates by Burniaux, Duval, and Jaumotte (2003) suggest that labor supply could drop by as much as 35 percent in Japan, 30 percent in Italy, and 17 percent in Germany. Measures to boost labor force participation rates and labor supply, particularly among the women and the elderly (of both genders)—including through pension system reform and providing other work incentives—have therefore attracted considerable interest (see Casey and others, 2003; Burniaux, Duval, and Jaumotte, 2003; and McMorrow and Roeger, 2004).[23] The increase in the participation rate among the working-age population that would be necessary to keep the workforce-to-population ratio at current levels, however, is large (Figure 3.9). For advanced countries, participation rates would need to increase by an average of 11 percentage points, with the required increase much higher for European countries and Korea than for the United States; for Japan, even raising the participation rate to 100 percent would not by itself be sufficient to offset the pro-

[23]See Chapter IV of the April 2003 *World Economic Outlook* for a discussion of labor market reform in Europe. To increase the participation of the elderly, it is likely that accompanying measures would also be needed to ensure that they have the skills needed for work and that there is no employment discrimination against them.

Figure 3.9. Some Policy Responses to a Declining Labor Force in Advanced Economies

For many advanced economies, maintaining a constant ratio of work force to population over the next 50 years would require large increases in participation rates and retirement ages and/or very substantial amounts of immigration.



Sources: United Nations, *World Population Prospects: The 2002 Revision* (2003); and IMF staff calculations.

[1]Increase in the labor participation rate necessary to maintain the ratio of labor force to total population in 2050 at its 2000 level.

[2]For Japan, even if the labor participation rate increased from its 2000 value of 78.8 percent to 100 percent, the relative size of the labor force would still decline.

[3]Cumulative immigration over 2000–50 necessary to maintain the ratio of labor force to total population in 2050 at its 2000 level.

[4]Increase in the retirement age necessary to maintain the ratio of labor force to total population in 2050 at its 2000 level.

jected decline in the working-age population. The workforce could also be increased by permitting more immigration. Again, the migration flows that would be required to keep the workforce-to-population ratio constant at current levels are very large, particularly when seen against the background of the generally low levels of migration in recent years.[24] Raising the retirement age could also help offset the impact of population aging on the workforce. An increase of about seven years would be needed, on average, in the advanced countries to keep the share of the working-age population constant at its current level, although individual country requirements again vary widely.

Policies that encourage an increase in fertility rates have also been suggested as a way to counter current demographic changes, although there would be a long lag before these would increase the labor force even if they were effective in raising fertility. While there is considerable evidence that public policy has played an important role in reducing fertility rates in developing countries, there remains much more debate about whether public policies can raise fertility in low fertility countries (see Demeny, 2003). Proponents of an activist public policy to raise fertility often point to the Scandinavian countries, where measures to make motherhood and the participation in the labor force by women more compatible have been implemented, and fertility rates have also increased in recent years (although these policies are aimed at broader social objectives, rather than explicitly at raising fertility). Whether these measures have caused the increase in fertility, of course, is difficult to say, particularly as fertility rates in the United States have also risen in recent years largely in the absence of such policies. In the United States, however, the private sector has responded to the increase in demand for childcare, and this has supported female labor force participation.

In developing countries, in contrast, the key requirement for labor market policies will be to ensure that the larger working-age populations are absorbed into the workforce. This will require reforms to improve the flexibility of labor markets, as well as better education and training to provide the skills necessary for employment (see the April 2003 *World Economic Outlook* and Fasano and Goyal, 2004, for evidence on labor markets in the Middle East).

Equipping the remaining workforce with a larger and more labor-efficient capital stock could help offset the impact of a declining labor supply. To do this, saving would need to increase. One way to achieve higher saving is for the government itself to save more before the onset of its population's aging. The desirability of running primary fiscal surpluses and reducing public debt in advanced countries in this way has been discussed in the May 2001 *World Economic Outlook* and Heller (2003). As discussed in Box 3.4, however, population aging and nondemographic factors—such as the cost of new technologies and drugs—are likely to result in substantial increases in health care expenditures in the years ahead and make this fiscal task more difficult. As well as helping to contain public sector outlays, pension reforms may also contribute to higher private saving, although this will depend on the nature of the reforms themselves and the strength of the signals sent to those in the labor force to bolster their savings for retirement (see Box 3.5). In developing countries, a strong and stable macroeconomic framework—that delivers low inflation and sustainable public debt levels—together with institutional reforms are important elements of an environment conducive to domestic saving, capital inflows, and capital accumulation.[25]

[24]See United Nations (2000) for a detailed analysis of whether migration could help offset declining and aging populations in advanced countries.

[25]The importance of strong institutions for growth is discussed in Chapter III of the April 2003 *World Economic Outlook*. The sustainability of public debt in emerging market economies is considered in Chapter III of the September 2003 *World Economic Outlook*.

More efficient use of existing capital and labor could provide an important offset to the expected decline in labor (and possibly capital) availability in the advanced countries and the more rapidly aging developing countries. Therefore, structural reforms aimed at boosting productivity by reducing the impediments to competition, improving labor market and price flexibility, and spurring innovation will be important (although there is clearly little certainty about the exact impact that such reforms would have).[26] Stronger productivity growth, however, will not help to alleviate financing pressures in pension systems if benefit payments are indexed to wages (which rise with productivity), although by increasing overall income it will provide an environment in which reforms are easier to implement (see Box 3.5). Boosting productivity in other developing countries would also provide an important complement to the positive impact that demographic change may have on per capita growth in the coming years.

A broad mix of measures is likely to be needed to address the consequences of demographic change as the size of the reforms that would be needed in any single area are sufficiently large that they would be politically and economically difficult to achieve. For example, Figure 3.9 shows that for advanced economies as a whole, large increases in participation rates, immigration, or the retirement age would be needed to stabilize the labor force to population ratio at current levels if enacted on their own. These increases are outside the range of historic experience. If reforms were jointly implemented in all three areas, however, the required changes would be much smaller; an increase in the participation rate of 3¼ percentage points, immigration of 10 percent of population, and an increase in the retirement age of 2.3 years would together be sufficient to keep the labor force to population ratio at its current level in 2050. These changes—while not easy—are within the range of what has been seen in some advanced countries during the past 40 years, or, in the case of retirement age, what has been legislated in some countries in recent pension reforms. Further, policy responses are often related and complementary, and this may help maximize the impact of individual reforms—raising the retirement age would not only ease the burden on pension systems, but would also boost the potential supply of labor as the elderly stay longer in the labor force and possibly influence saving behavior.

Policies at the international level will be important for coping with demographic change. Global adjustment to differences in the pace of population aging will take place through the movement of goods, capital, and labor between countries, and these flows could be large. The reallocation of global resources will be achieved most efficiently if all of these channels are allowed to function smoothly, and the more that the adjustment is shared across the channels, the less will be the burden placed on each.[27] Policymakers, however, will need to balance economic, political, and social considerations. For example, if advanced countries allow more immigration, this would help cushion the impact of population aging on their workforces, but social implications also need to be taken into account—including the ability to integrate a large number of migrants into society and the impact that immigration would have on population density (which is already high in Europe and Japan).[28] Capital account liberalization

[26]Population aging itself could affect productivity, although there is no consensus in the economics literature about the direction of this impact. According to one strand of research, population aging is likely to be detrimental to productivity growth if an older labor force turns out to be less dynamic and innovative than a younger one (Jones, 2002; Romer, 1990). Others, however, take the view that technological change may be boosted as a premium is placed on innovation to offset the negative implications of the relative scarcity of labor (Cutler and others, 1990).

[27]In an analysis of Japan, Dekle (2003) finds that capital flows induced by population aging would be substantially reduced if the government were to allow a large increase in immigration.

[28]National security considerations may also play an increasingly important role in determining immigration policy in some countries.

Box 3.4. Implications of Demographic Change for Health Care Systems

Much of the focus of the aging policy debate has centered on the potential for rising pension outlays. Yet population aging will also have important implications for health care systems in both industrial countries and emerging market and middle-income countries. While aging itself will increase health care outlays, the principal challenge for governments in the years ahead will be to address the key nondemographic factors that have continued to increase the cost of medical care. This box discusses some of the key issues with regard to the impact of aging and other factors on health care systems.

Do the Elderly Consume More Medical Care?

In industrial countries, the elderly population—those over 65—spends more on medical care than those under 65. Thus, an increased share of the elderly in the population should imply, all other things equal, an increased average level of medical care spending. But this inference may be misleading; the higher average spending level may be simply due to a significant share of lifetime medical care costs being incurred in the last year(s) of life. If an increased share of the elderly had no effect on the death rate, then the increased share would only affect medical spending if those elderly not in their last years of life spend more, on average, than the working-age population.

Evidence that is just emerging suggests that people are living longer and healthier lives, in part because they are exercising more, smoking less, and watching their weight.[1] Access to high-quality medical care for prevention, diagnosis, and treatment and the availability of new pharmaceuticals is also contributing to additional healthy life years. But the elderly still appear to have a higher average demand for medical care in their later years (excluding the last year of life) in terms of ambulatory, inpatient, and long-term chronic care, than those under age 65. As people become very old, they seem to be subject to more disabling conditions that can require long-term care (which may require the time of those who would otherwise be fully in the labor force). Whether, additionally, the death rate will rise with an increasing elderly share (increasing the weight of those high-cost medical years) will depend on the balance between an increasing elderly population share and increasing life expectancy (which reduces the share of those elderly in their last year of life!).[2]

How Much Will Demographic Factors Contribute to Increased Medical Spending?

Recent studies have sought to estimate how demographic factors will affect medical care spending. OECD and EU studies suggest that demographic factors in isolation will lead to increased medical care spending of 2–3 percentage points of GDP between 2000 and 2050.[3] Inclusion of long-term chronic care would further increase these estimates. Yet these studies still assume that the increasing share of the elderly will spend more on health, independent of whether the elderly are indeed more healthy. More sophisticated analyses under way by the European Commission should more accurately clarify the impact of demographic factors.

Most health economists argue that nondemographic factors are primarily responsible for the surge in medical care costs since the 1960s and that these factors will equally dominate in coming decades. Many point to the United States, where medical care outlays are among the highest in the world, and where national health expenditures have risen faster—by about 2.5 percent annually—than real GDP since 1960. But the pressure for medical costs to rise faster than real GDP per capita is also evident for most other OECD countries, even with their lower medical spending levels (OECD, 2004).

Note: The main author of this box is Peter Heller.

[1]There is much ongoing work on this subject in Europe in the context of a project on Aging, Health, and Retirement sponsored by the European Union (AGIR, 2003a, 2003b). This is providing data on the biodemographic aspects of aging and the use of health care and nursing care by the elderly.

[2]See Wise (2003), Wanless (2002), and AGIR (2003a, 2003b).

[3]OECD (2001) and European Commission (2001).

Interestingly, efforts at improving health behavior by individuals (reduced obesity, curtailed smoking) would not dramatically reduce the pace of spending increases since they would lead to increased life expectancy, more demand for care, and a different composition of care than in a scenario of less behavioral change (Wanless, 2002).

Key factors underlying the strong growth in health care costs are the relatively lower productivity growth in the sector (reflecting the high share of labor costs), the expansion in health insurance coverage, the moral hazard associated with third-party coverage (as households bear only a small share of the costs of increased demand), the development of new but costly pharmaceuticals, technological innovations in diagnosis and treatment, and the increased take-up of these technologies and drugs by households and providers. These innovations have also facilitated an increase in healthy life expectancy and reduced the nonmedical costs associated with treatment and care, even if medical outcomes do not improve (Glied, 2003). Nonetheless, few analysts today expect the pressure for rising medical costs to abate in the near term (U.S. CBO, 2003).

Challenges in Containing Medical Costs in an Aging Society

There are limits as to how much of GDP can be spent on medical care, and concerns about how such spending can be financed and whether there will be equity in access to care. All industrial countries are grappling with how to contain the growth of medical care costs, particularly with the other fiscal burdens borne by governments in aging societies. Two approaches have been adopted.

- The first involves *imposing global budget constraints on health spending*, such as regulation of prices on labor and drugs; budgetary caps in the context of systems where the state is the principal health care provider; and shifting of costs to the private sector by caps on the reimbursement of purchases of goods and services (mostly pharmaceuticals).
- The second seeks to *alter the incentives facing both producers and users of health care*, including through the introduction of cost-sharing arrangements; utilization of "gatekeeper" practitioners to curb excess demand and steer demand to more efficient providers (e.g., ambulatory centers rather than more costly hospitals); an increase in competition among providers (e.g., hospitals, insurance companies); and a strengthening of efficiency through greater use of information technologies.

Emerging market and middle-income countries face similar challenges. But for many, even more complex challenges must be addressed in facilitating the modernization of their health care systems. Middle- and upper-income groups will demand the availability of modern and costly technologies of medical care. Yet for many others in society, there will be an increased prevalence of noncommunicable diseases (as a consequence of tobacco consumption) and exposure to accidents whose treatment will also require the application of modern medical technologies. And yet these countries' medical care systems will also need to treat many still subject to the communicable disease problems common to developing countries. Moreover, as their societies age as well, they will begin to experience similar problems to the industrial countries in financing the medical costs of their elderly populations.

could potentially enable developing countries to attract more external financing—and hence provide them with the opportunity to boost investment and growth—but it may also raise the risk of financial crisis, particularly if economic policies and institutions are not sufficiently robust.

Labor mobility may provide an important source of income to developing countries through remittances, but could result in a "brain drain" whereby the country's best educated people leave with a detrimental effect on output. Increased international cooperation will be

Box 3.5. Impact of Aging on Public Pension Plans

Public pension systems play a critical role in supporting the retired and elderly. In the larger countries of Europe, the public pension system provides a large share of retirement income. In the United States, social security provides a lower share of retirement income than the public pension systems of many European countries do, but nonetheless is important for millions of older Americans. In a number of emerging market countries, the public pension system can be an important source—often virtually the only source—of income for many older people. Elsewhere, the coverage of the pension system is typically very narrow.

Most public pension systems are defined-benefit pay-as-you-go plans under which the amount of the pension is determined by the number of years worked and the wage or salary received in the last years of work.[1] In a pay-as-you-go system, current period benefits are financed from current revenues—usually via a payroll tax. No reserve fund is accumulated, as is the case with an employer-provided defined-benefit plan.

Aging has a direct financial impact on a pay-as-you-go system. For pay-as-you-go revenues to equal expenditures, the payroll tax rate should equal the pension bill divided by the wage bill, which is equivalent to the ratio of pensioners to active contributors times the ratio of the average pension to the average wage. Aging increases the ratio of pensioners to employed and, absent changes to the ratio of the pension to the wage, requires an increase in the payroll tax to maintain the balance between revenue and expenditure. In many industrial countries, substantial increases in payroll tax rates have taken place over the past 40 years. In part, these increases were necessary to finance increases in average real pensions, which in turn were due in part to what is known as the maturation effect, whereby the average contributory period of new retirees increases as the plan ages. However, much of the increase is attributable to the increase in the ratio of pensioners to employed—namely, to population aging. The payroll tax increases necessary to keep pay-as-you-go plans financially balanced have contributed to labor market distortions, especially in Europe, and have compounded the aging problem by reducing labor force participation rates.

The aging phenomenon results from both declining birth rates and increasing life expectancies at all ages, but particularly among older people. Life expectancy at retirement in the advanced countries is much greater than it was even 50 years ago. When birth rates began to drop in many countries after World War II, the decline was not recorded by national accounts statisticians as a decline in investment—in human capital formation—but effectively it was. From society's, if not their parents', point of view, children are an economic investment. However, the decline in investment in future workers that declining birth rates entailed was not offset by investment in other areas.

The economic and fiscal problems that aging entails can be viewed as an intergenerational zero-sum game. There are more mouths to feed per economically active person, and the necessary decline in consumption must be shared across generations. However, an increase in saving and investment, which will equip the generation that has to support the baby boomers as they retire with more capital, will increase growth and output per head, and mitigate the generational trade-off. The increase in investment requires an initial decline in the level of consumption, which must be shared in some way across generations, but can lead to higher consumption levels later on. Similarly, any reform that raises productivity can mitigate the problem of financing the pensions of an aging populace.

Some economists have argued that the establishment of a defined contributions plan would have avoided the difficulties that the typical public pension system is now experiencing.[2] Pension pri-

Note: The main author of this box is Sandy Mackenzie.

[1]By way of illustration, a pensioner might receive 1.3 percent of the average of the last three annual salaries for each year worked. Thirty-five years of work would result in a replacement rate (ratio of pension to pensionable salary) of 45.5 percent. Caps and floors may also apply, and the accrual factor (in this example, 1.3 percent) may vary with the number of years worked.

[2]A defined contributions plan determines the contributions the participant makes—usually in terms of a fixed proportion of salary—but does not promise a specific benefit.

vatization, or an individual accounts pension reform, establishes such a scheme. However, this argument overlooks the fact that in an aging society, the working-age population has more people to support regardless of the form the pension system takes. The establishment of a defined contributions plan will not mitigate the effects of aging unless it raises the savings rate. A well-designed reform that establishes an individual accounts system may succeed in doing that, but a saving increase has to be made an explicit objective of the reform.

In considering the options for public pension system reform, it is useful to distinguish between conventional or parametric reform, under which the existing system, remains in place but its parameters are changed, and structural reform, where a new kind of arrangement, like an individual accounts system, is introduced. Conventional reform requires some combination of revenue increases and lower pensions. In many countries the payroll tax is already high, and further increases are likely to have distortive effects on the labor market. This leaves pension reductions, which can be achieved in various ways. One way is postponing the normal retirement age, an option that can be justified on the grounds that people are staying healthy longer. This option, however, requires that people near the normal retirement age be able to continue working or find alternative employment. Achieving this goal may well require both changes in employer attitudes and practices and labor market reform. A second option is to index the starting pension (the pension paid in the first year of retirement) to consumer prices rather than wages, as is done in the United Kingdom, which would require changing the benefit formula. A third is to lower the accrual factor (see footnote 1). Both political considerations and considerations of equity call for these changes to be gradually, not precipitously, introduced.

Parametric reforms reduce the implicit rate of return of the public pension system.[3] Advocates of pension privatization point to declines in the implicit rate of return over time as one of the reasons for privatization. Privatization works by establishing an individual account for each participant in the public system. Part of the participant's current payroll tax is diverted to this account—or an additional contribution may be imposed—and the funds in the account are invested in financial markets, according to the limits that the reform establishes. Upon retirement, these funds and their accumulated earnings can be used to finance the purchase of an annuity or a series of phased withdrawals. Individual accounts can replace the old state pension system in its entirety, or simply complement or supplement it.

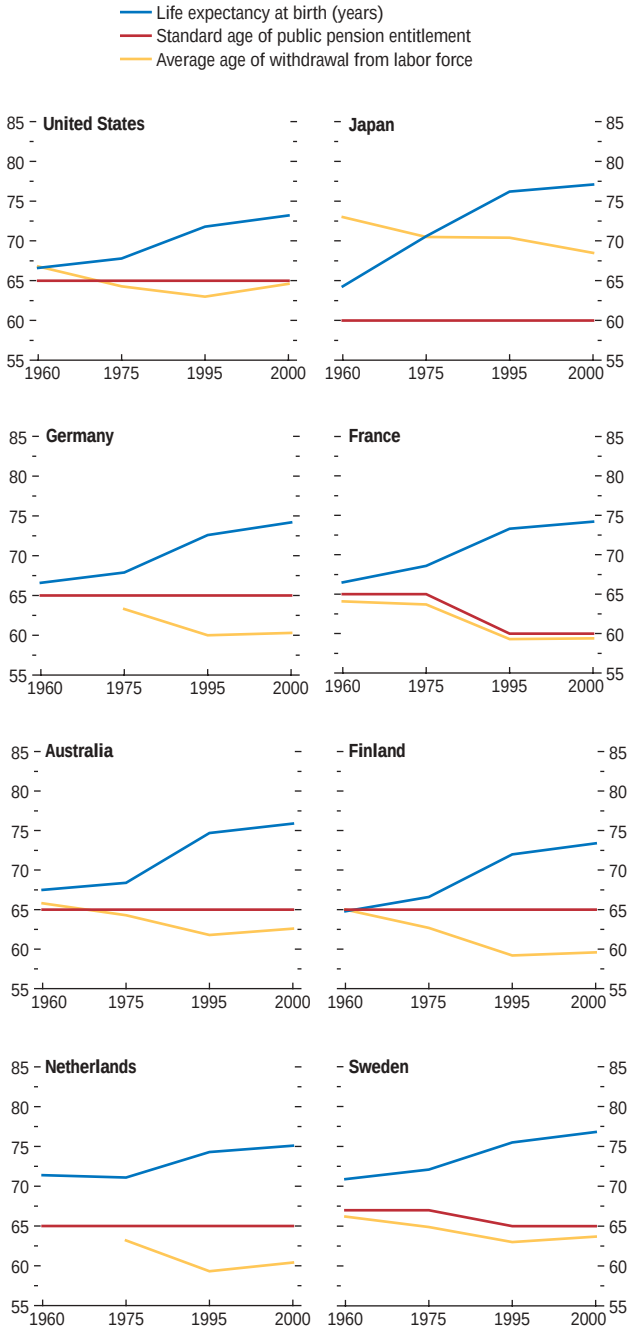
Pension reform is not simply about increasing the saving rate to boost investment and growth, but if reform is not simply to redistribute the burden across generations it has to do that at least. This increase in saving can be brought about by changes to the pension system itself, fiscal retrenchment, or both. For example, an add-on individual accounts reform can increase saving if contributors do not respond by a completely offsetting decline in other saving. A conventional reform can increase saving by increases in payroll taxation, which reduce consumption of the current working generation, or a reduction in pension benefits. The impact on saving is not the only test of pension reform: an individual accounts system differs in other important ways from the conventional public system—for example, in the risk borne by contributors. Nonetheless, both conventional and individual accounts reforms must themselves increase saving or be accompanied by measures that increase saving or boost productivity if they are to help mitigate the financial and macroeconomic consequences of aging.[4]

[3]The implicit rate of return is the discount rate that equates what the average member of a given age group can expect to receive in pension benefits with the accumulated value of his payroll tax contributions and the contributions of his employer on his behalf.

[4]For discussions of the merits of individual account systems from various points of view, see Barr (2001), Orszag and Stiglitz (2001), and Samwick (1999).

Figure 3.10. Life Expectancy and Age of Retirement for Males in Selected Advanced Economies

While life expectancy has increased, there has been little change in official retirement ages and the effective age of withdrawal from the labor force has fallen.



Sources: Scherer (2002); United Nations, *World Population Prospects: The 2002 Revision* (2003); and U.S. Department of Health and Human Services, *Social Security Programs Throughout the World* (various issues).

needed to manage these cross-country flows, and to ensure that the associated risks are minimized to the extent possible.

The remainder of this section takes up three issues related to the policy response to demographic change in greater detail, and assesses both the potential domestic and global implications of the reforms. These issues are (1) pension reforms in advanced countries; (2) the role of labor mobility (migration) in the global adjustment process; and (3) improving access to international capital markets for developing countries to maximize the opportunities presented by the demographic dividend. The choice of these three areas certainly does not suggest that they are more important than others—such as fiscal consolidation and labor market reform—in addressing the challenges of demographic change.

Reforming Pension Systems in Advanced Countries

As discussed previously, the financing of currently promised pension benefits in many advanced countries would require a substantial increase in contribution rates in the future. Given the enormous burden such an increase would place on the working-age population and the adverse effect it would have on the incentive to work, governments are actively considering a range of reforms to improve the sustainability of public pension systems. For example, retirement ages are being raised in France, Italy, and Japan, while in the United States the normal retirement age under social security has been rising gradually from 65 to 67 years of age since the implementation of the recommendations of the 1983 Greenspan Commission. The changes under way, however, are quite modest and come against the background of the substantial gains in life expectancy that have been made over the past 40 years and the general trend toward exit from the workforce before the official retirement age is reached (Figure 3.10). Announced pension reforms in Germany have taken a different approach, whereby future benefits will be reduced but the retirement age left unchanged.

The potential impact of two possible reforms to European public pension systems was assessed using the INGENUE model.[29]

- In the first scenario, the pension replacement rate is reduced to 50 percent by 2050 (from 70 percent in 2000) and the contribution rate held steady at its end-2000 level.
- In the second scenario, the retirement age is gradually raised from 60 to 65 years between 2000 and 2020, but the replacement rate is left unchanged. This requires less of an increase in contribution rates than if reforms were not implemented.

These two reform scenarios are compared with the baseline case—which underlies the results in the previous section—where contribution rates have to be raised substantially, from 22½ percent to 37½ percent, to ensure that pension systems are able to finance their obligations under existing benefit parameters. The reforms in the scenarios are assumed to be fully believed when announced, and hence individuals immediately begin to adjust their behavior.

There are important differences in the macroeconomic impact of these two types of pension reform in the model. In the case where pension benefits are reduced, private saving in Europe increases as households adjust to the realization that they will have to provide more for their own retirement (Figure 3.11).[30] Although this increase in saving lowers real interest rates and

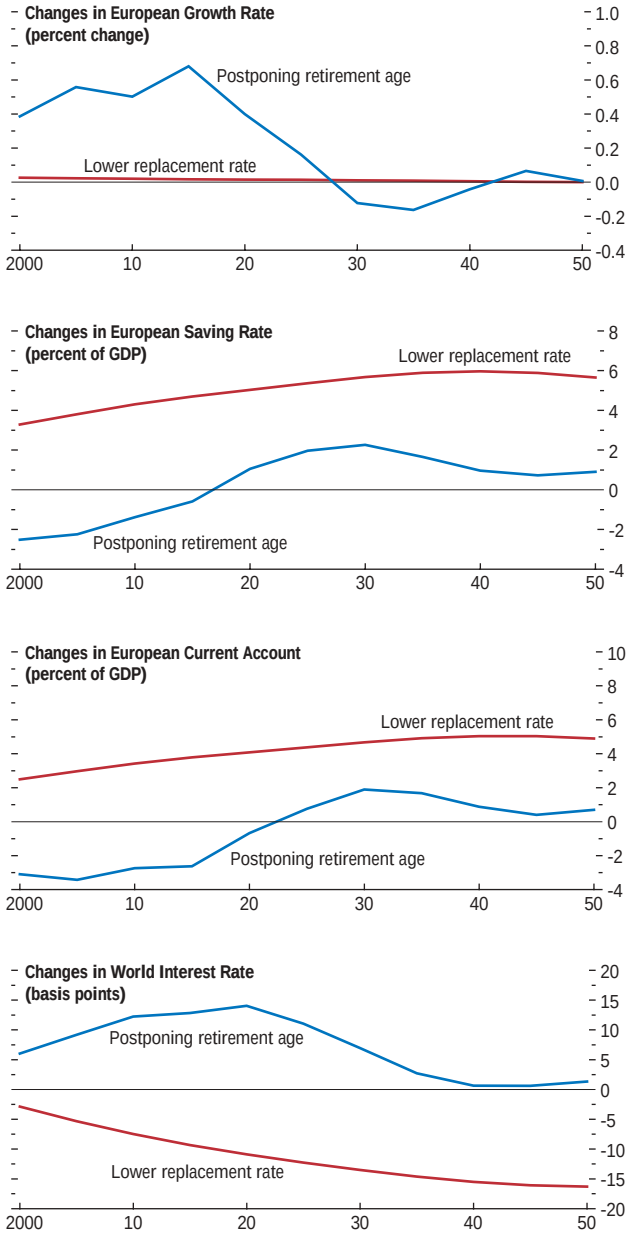
[29]The advantage of studying pension reform within a multicountry macroeconomic model such as INGENUE is that it allows an analysis of both the domestic and international aspects of the reform. A drawback, however, is that the pension systems incorporated in the model are stylized, and thus do not include all the country-specific institutional details. For a more detailed analysis of the impact of pension reforms in Europe, see Rother, Catenaro, and Schwab (2003). Pension reforms in the United States are discussed by Diamond and Orszag (2004) and Samwick (1998), and in Japan by Faruqee and Mülheisen (2001). The September 2004 *Global Financial Stability Report* discusses reforms to private sector pension arrangements in a number of advanced countries.

[30]This model-driven response is not assured. Households may not adjust their saving behavior in reaction to the pension reforms if, for example, they believe the government will ultimately be required to ensure that they attain a reasonable standard of living in retirement.

Figure 3.11. Impact of Pension Reforms in Europe in the INGENUE Model

(Percentage point difference from baseline)

Pension reforms in Europe are key for fiscal sustainability and may help support saving and growth in the face of aging.



Source: INGENUE Team.

boosts investment, it also reduces consumption, and real GDP growth rates in the model are actually little affected. The effect of raising the retirement age is less straightforward. Private saving initially falls as workers realize that they will need to finance future consumption over a shorter retirement period, and this boosts consumption and growth. In the longer run, however, the increase in real interest rates acts to modestly reduce real growth rates. The changes in saving behavior in Europe that result from the pension reforms have implications for capital flows, the world real interest rate, and external balances. The increase in saving when public pension benefits are reduced pushes down the world real interest rate—which has a small positive impact on global activity—and leads to a substantial improvement in the European current account balance. On the other hand, if the retirement age is raised, the model suggests that the current account balance in Europe would initially deteriorate owing to the decline in saving, and world interest rates would rise modestly. Then, as saving recovers, the current account balance improves, and the world real interest rate declines.

The model's results raise a number of important issues with regard to pension reform. First, alternative approaches to pension reform may affect the macroeconomy in different ways. Reforms that raise the retirement age appear to be more growth friendly than those that reduce pension benefits. Therefore, the design of pension reforms is important. Second, pension reforms in large countries will have implications for the global economy through their impact on interest rates and capital flows. While the impact in the scenarios discussed here is not that large, if advanced countries were all to implement pension reforms at the same time, the impact on the global economy would be much more significant.

An important dynamic for pension reforms is that demographic change—by increasing the political weight of older persons who may have the most to lose—is actually likely to make the implementation of such reforms increasingly difficult in the future. Older people—those over 50 years of age—will soon represent the majority of active voters in many advanced countries once the differing voter turnout between age groups is accounted for (Figure 3.12).[31]

Role of Labor Mobility in the Global Adjustment Process

The INGENUE model—along with most other large multicountry macroeconomic models—does not allow for the possibility of labor mobility between countries. Increased labor mobility, however, is a potentially important mechanism through which the global economy could respond to demographic change, and is an important alternative to the flow of capital. While migration has generally not been an important source of population growth in most advanced countries in recent years—indeed, migration has been tightly constrained by immigration policies—in the past there have been periods when substantial flows of labor have occurred, perhaps most notably during 1820–1913 when large numbers of migrants moved from Europe to the United States and other countries of the new world.

The role that labor mobility could play in helping economies respond to demographic change was investigated in a simple two-country, two-period model that extends the work of Tosun (2003). The model features an advanced and a developing country, each with a population composed of two age groups (workers and the retired). The population characteristics of each country are set to represent actual UN projections for advanced and developing countries, so that the advanced country ages more quickly than the developing country. The model incorporates a pay-as-you-go social security system, public spending on education that enhances the productivity of workers, taxes on both workers

[31]This depends on a number of assumptions, including that the over-50s vote for personal benefit rather than the benefit of society, and that voter turnout patterns remain the same in the future as in the past.

and the retired to finance these expenditures, and a simple voting system in which people vote on their preferred tax rate and in so doing determine the amount of the productivity-enhancing good provided by the government.[32] Migration of workers occurs in response to real-wage differentials between countries (retired people do not move between countries), while capital moves in reaction to real interest rate differentials (see Appendix 3.1 for more details).[33]

The implication of allowing full capital mobility (with no labor mobility) was compared with the situation where there is full labor mobility (with no capital mobility).[34] The results—in terms of per capita consumption, a proxy for household's welfare—of having full capital mobility are broadly similar to those discussed earlier. Specifically, demographic change will reduce per capita consumption growth in advanced countries and will raise it in developing countries over the next half-century (Figure 3.13).

If there is labor mobility but no capital mobility, the results change. Specifically, the advanced country benefits from labor mobility, and its per capita consumption loss is considerably less than when there is no labor mobility. This is because the advanced country already has in place the capital stock, and without inward migration the declining size of the domestic workforce—as its population ages—means this capital stock becomes less productive. Consequently, migration cushions the impact of the declining work-

[32]In the model, workers benefit directly from the impact of education on productivity so they tend to vote for higher taxes and higher spending than the retired, who receive no direct benefit from higher labor productivity and labor income. Consequently, because migration changes the share of working-age people, it also changes voting patterns, and this leads to changes in government spending on the productivity-enhancing public good and may have important growth and welfare effects.

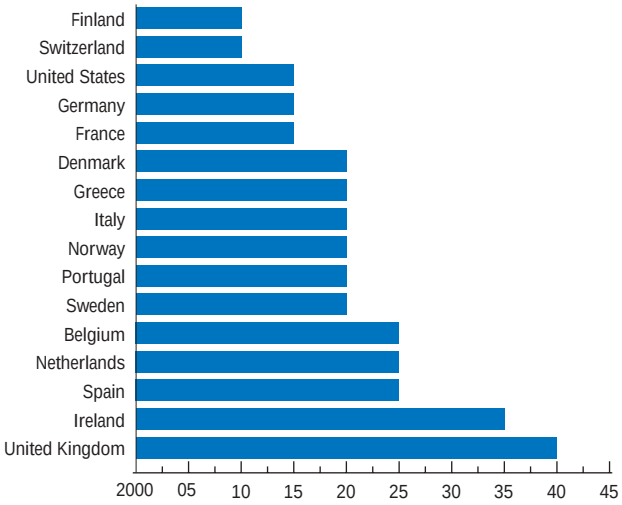
[33]Actual migration flows appear in practice to be driven by a wide range of factors, not only wage differentials; see Greenwood (1985) and Carrington, Detragiache, and Vishwanath (1996), among others.

[34]Of course, capital and labor mobility are likely to move together. Considering these polar opposites, however, not only makes it easier to establish the mechanisms at work but also considerably simplifies the modeling.

Figure 3.12. The Last Train for Pension Reform Departs in . . .[1]

(Year in which voters aged 50 and older comprise at least 50.1 percent of all voters)

In many countries the elderly may soon represent the majority of the voting public, making it harder to implement reforms that adversely affect them.



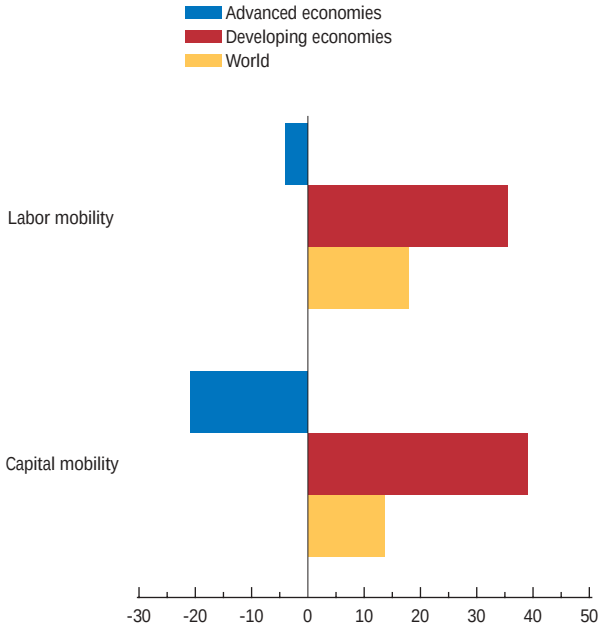
Sources: Institute for Democracy and Electoral Assistance, *Youth Voter Participation* (1999); Statistisches Bundesamt, *Voter Behavior in the Federal Elections 2002 by Gender and Age* (2003); United States Census Bureau (2003); and United Nations, *World Population Prospects: The 2002 Revision* (2003).

[1]Number of voters aged 50 years and older adjusted for voters' turnout by age.

Figure 3.13. Implications of Labor and Capital Mobility for Per Capita Consumption, 2000–60

(Total percent change in per capita consumption over 2000–60)

Capital and labor mobility have different implications for advanced and developing economies. This simple model suggests advanced economies benefit more from labor mobility, and developing economies more from capital mobility.



Source: IMF staff calculations.

force, although growth is still slightly negative over the period.

The developing country, however, is slightly better off with capital mobility, although it grows more strongly than the advanced country in both scenarios. It benefits more from capital mobility because it has a large workforce, but labor productivity is low because its capital stock is inadequate. It therefore gains from capital inflows that allow it to invest more and build up its capital stock, thus boosting labor productivity and growth. Of course, this model does not account for some of the other potential channels through which migration benefits the developing country, including increased migrant remittances or reduced domestic unemployment if there is excess labor.[35] At the global level, per capita consumption growth is slightly higher under labor mobility than under capital mobility in the model.

The results in this section suggest that inward migration has the potential to help respond to the effects of population aging in the advanced countries, although—consistent with the evidence discussed earlier—the inflow of migrants to the advanced country is large (immigrants equivalent to 13 percent of the end-period native working-age population move to the advanced country during the 60-year period in the model). While such large-scale immigration may face social and political barriers, some increase in labor flows between countries from existing levels is likely to be an important part of the global adjustment to demographic change.[36]

[35]Cardarelli and Ueda (2004) find that migration to the United States has significantly raised the well-being of a number of developing countries in recent years when account is taken of the income produced by nationals residing at home and in the United States. Further, Ratha (2003) estimates that workers' remittances back to developing countries are very large, generally exceeding official development assistance to low-income countries. Remittances support growth and are a more stable form of financing than private capital flows.

[36]See Borjas (1999, 2001) for a general discussion of the impact of immigration on advanced economies, particularly the United States, including the implications for income distribution.

The results also suggest that labor and capital mobility may benefit developing and advanced countries differently, so ultimately some balance in the adjustment that takes place through these two channels is likely to be needed.

Of course, migration is only a "temporary" remedy to the aging of populations. In the long term, population aging is a global event, and one that migration alone cannot solve, given that immigrants themselves get old and over time also tend to embrace the fertility standards of the host country. The results also emphasize that capital flows will be important for developing countries if they are to maximize the opportunities presented by their rising working-age populations.

Improving Capital Market Access for Developing Countries

An increasing share of the world's working-age population will be located in developing countries in the future. At present, however, international capital flows to these economies are relatively small, and are generally directed at only a few countries, some of which—such as China, which attracted nearly 40 percent of net foreign direct investment to developing countries in 2003—are themselves relatively advanced in the aging process. Indeed, the results of the previous section suggested that the decline in global saving could actually reduce the availability of capital for developing countries in the period ahead. A lack of access to capital would make it more difficult for these countries to maximize the economic benefits from the increase in the relative size of their working-age populations.

What can developing countries do to improve their access to international capital? Steps are certainly needed to strengthen investor confidence in policies and institutions, including through measures to improve the sustainability of public and external debt, strengthen financial sectors, and tackle governance issues. It is very difficult to model the impact that such reforms would have, although the success of Chile in maintaining low spreads on its external debt and uninterrupted access to global capital markets clearly indicates that such reforms are important.

Here, reforms to improve the investment environment are assumed to result in a reduction in the risk premium associated with investing in developing country assets (Figure 3.14 shows the impact in the MSG3 model of a one-off 1 percentage point reduction in this risk premium, which is currently about 5 percentage points as measured by the EMBI spread). The reduction in the risk premium encourages more capital to flow into developing countries, and this reduces real interest rates and has a considerable impact on real GDP. Domestic saving also increases as the rate of return on domestic capital improves as a result of the reforms, further reinforcing the positive effect on growth. The current account position of developing countries deteriorates, while the advanced country regions—the suppliers of the capital to the developing countries—experience improvements in their external balances.

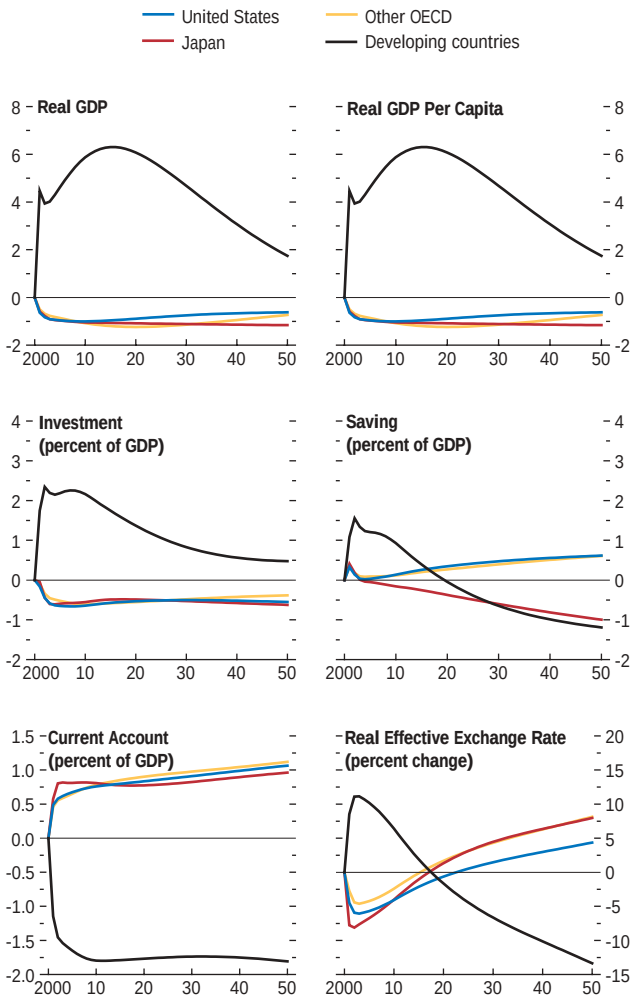
Concluding Remarks

The world is in the midst of a demographic transition that is resulting in an unprecedented aging of its population. Different countries, however, are at different stages of this transition. In most advanced countries, population aging is already well under way, and the share of the working-age population is projected to decline quite significantly over the next 50 years. In contrast, the relative size of the working-age population in many developing countries will rise in the coming years before aging then begins.

The impact of these demographic shifts will be wide ranging. In advanced countries, population aging will strain the finances of governments, especially pension and health care systems, while per capita growth rates are likely to be reduced. In developing countries, however, increases in the relative size of the working-age population could lead to stronger per capita growth provided the additional labor resources

Figure 3.14. Implications of a 1-Percentage-Point Decline in Developing Country Risk Premium in the MSG3 Model
(Deviation from baseline projection)

A reduction in the risk of investing in developing countries would boost their capital inflows, investment, and growth.



Source: IMF staff estimates.

are effectively utilized. International capital flows could also be substantially affected. The results presented in this chapter have suggested that large changes in saving, investment, and current account balances could take place over the next 50 years.

There are, however, considerable uncertainties, and our understanding of how demographic change will affect economic performance is far from complete. For example, while it is clear that population aging will put strains on pension and health care systems in advanced countries, the magnitudes of the financial impact will depend on demographic outcomes, which are difficult to project. If the pace of aging is more rapid than expected—as has been the case in the advanced countries in the past—the task of reforming pension and health care systems will be even greater than currently envisaged. Even more uncertainty surrounds the impact of demographic change on external balances and capital flows. Here, much will depend on the reaction of private saving, but it remains unclear to what extent households will adjust their behavior as the demographic transition unfolds.

In advanced countries, the key challenge in designing and implementing an effective policy package for responding to demographic change is to identify a broad mix of reforms—politically feasible changes in any single area are likely to prove insufficient—that are as resilient as possible to the uncertainties that exist. The basic aim of these reforms should be to boost labor supply, saving, and productivity. Many countries have already begun to tackle some of the critical issues, including through the modification of pension arrangements and structural reforms to boost productivity, although much more needs to be done, including to improve government budget positions and reduce public debt ahead of the onset of aging. The health care sector—where aging will add to ongoing spending pressures from other sources—is an area where much more attention is necessary.

Given the size of the task, reforms that help tackle multiple aspects of the challenges deserve

particular attention; announcing a prospective rise in the retirement age would not only ease pension burdens, but would also increase potential labor supply. Designing reforms that are resilient to uncertainties about the future is clearly a very difficult task. However, one way that uncertainties about life expectancy could be dealt with in pension systems would be to link increases in the retirement age to gains in life expectancy or to link pension benefits to life expectancy (as in Sweden). Lastly, aging may have important implications for financial markets if the elderly run down their assets in retirement, and regulators will need to ensure that financial systems are sufficiently resilient to cope with such possible changes (see the September 2004 *Global Financial Stability Report*).

The policy response to demographic change in developing countries has received less attention, but is very important, particularly as these countries will become an increasingly significant source of global growth in the period ahead. The main priorities for developing countries are to put in place a policy framework that ensures that the potential benefits from the demographic dividend are maximized, while setting the groundwork for eventual population aging. Pension and health care systems will need to be strengthened to ensure that they provide a safety net for the elderly that is both adequate and fiscally sustainable. In doing this, it will be important that governments learn from the current situation in many advanced countries, and do not commit themselves to provide benefits that will be difficult to finance.

The movement of goods, capital, and labor between countries will be an integral part of the global adjustment to the differential rates of population aging. Choices will need to be made about how these channels are allowed to operate, with policymakers having to balance the economic, political, and social implications of each. The more the adjustment is shared between the various channels, however, the less will be the burden on each, and this may help reduce the risks that could accompany large capital flows. At the international level, increased cooperation will be needed to manage these cross-country flows and to ensure that the associated risks are minimized to the extent possible. In this regard, progress toward freer trade—including through the successful completion of the ongoing Doha Round—and the strengthening of the global financial architecture will be important.

Finally, some of the policies to tackle the impact of demographic change will inevitably involve difficult tradeoffs, will take time to agree and implement, and will need to be phased in to allow people sufficient time to adjust their behavior. This is most clearly true of pension reforms—which affect the welfare of the elderly and threaten benefits that people believe they are entitled to—but also of health care. Therefore, while the full impact of demographic change will not be felt in most countries for a number of years, the process of planning a response should not be delayed. This is particularly true for advanced countries, where reforms to pension and health care systems will become increasingly difficult to implement as populations age. Policymakers therefore need to take advantage of the current strong global economic rebound to advance the reform agenda before the window of opportunity begins to close.

Appendix 3.1. Demographic Change and the Global Economy: Data and Modeling Strategy

The main authors of this appendix are Nicoletta Batini, the INGENUE Team, Warwick McKibbin, Nicola Spatafora, and Mehmet Tosun.

This appendix provides further details on the data and the modeling strategy used in the chapter to analyze the global economic impact of demographic change.

Econometric Analysis

The econometric work analyzes a broad panel of 115 advanced and developing countries, representing all major geographic regions, over the

Table 3.2. Selected Summary Statistics, 1960–2000[1]
(Percent unless otherwise noted)

Variable	All Sample Countries
Economic variables	
Output growth per capita	1.7 (6.3)
Saving/GDP	16.9 (15.0)
Investment/GDP	21.8 (8.4)
Current account/GDP	–4.1 (10.4)
Budget balance/GDP	–3.4 (7.0)
Demographic variables	
Working-age population/total population	57.4 (6.3)
Elderly population/total population	5.7 (3.8)
Change in (working-age population/total population)[2]	0.11 (0.32)
Change in (elderly population/total population)[2]	0.05 (0.11)

Sources: World Bank, *World Development Indicators*; United Nations, *World Population Prospects*: *2002 Revision*; and IMF staff calculations.
[1]Values are means at an annual frequency, with panel standard deviations provided in parentheses next to each value.
[2]Percentage points.

period 1960–2000.[37] For all variables, and for each country, the data are averaged over each decade. The analysis focuses on the impact of demographic change on each of the following measures of macroeconomic performance: growth of GDP per capita; saving/GDP; investment/GDP; current account balance/GDP; and central government budget balance/GDP.

Demographic change is measured using the following variables:

- ratio of working-age population to total population, and ratio of elderly population to total population, when analyzing any measure of macroeconomic performance except growth of GDP per capita;[38] and
- change in the ratio of working-age population to total population, and change in the ratio of elderly population to total population, when analyzing growth of GDP per capita.

Summary statistics for the key variables used in the analysis are shown in Table 3.2. To examine the importance of demographic change as a determinant of economic performance, the following equation was estimated:

$$Y_{it} = \alpha_i + \beta \cdot Demo_{it} + \gamma \cdot Z_{it} + \varepsilon_{it}, \qquad (1)$$

where Y is the specific macroeconomic variable of interest; *Demo* are the relevant measures of demographic change; Z is a set of control variables; and the subscripts i and t denote the country and the time period, respectively. This equation is estimated using the panel fixed-effects estimator. More specifically:

- in the *growth* regression, the controls include initial income; secondary school enrollment ratios; investment/GDP; budget balance/GDP; inflation rate; external trade/GDP; and country risk (as measured by the ICRG);
- in the regressions for s*aving/GDP, investment/GDP*, and *current account/GDP*, the controls include initial income; budget balance/GDP; net foreign assets/GDP; M2/GDP; the standard deviation of a terms of trade index; external trade/GDP; and an oil-producer dummy; and
- in the *budget balance* regression, the controls include initial income; the standard deviation of the terms of trade; and external trade/GDP.

To control for possible endogeneity problems, all demographic variables, as well as several other controls, are instrumented using their lagged values (for all decades except the first, the lagged

[37]These countries are Albania, Algeria, Argentina, Armenia, Australia, Austria, Azerbaijan, Bangladesh, Barbados, Belarus, Belgium, Benin, Bolivia, Botswana, Brazil, Bulgaria, Burkina Faso, Burundi, Cameroon, Canada, Central African Republic, Chad, Chile, China, Colombia, Congo, Dem. Rep. of, Congo, Rep. of, Costa Rica, Côte d'Ivoire, Croatia, Cyprus, Czech Republic, Denmark, Dominican Republic, Ecuador, Egypt, El Salvador, Ethiopia, Finland, France, Gabon, The Gambia, Georgia, Germany, Ghana, Greece, Guatemala, Guinea-Bissau, Guyana, Haiti, Honduras, Hungary, India, Indonesia, Iran, I.R. of, Ireland, Israel, Italy, Jamaica, Japan, Jordan, Kenya, Korea, Kyrgyz Republic, Madagascar, Malawi, Malaysia, Mali, Mauritania, Mauritius, Mexico, Moldova, Morocco, Nepal, Netherlands, New Zealand, Nicaragua, Niger, Nigeria, Norway, Pakistan, Papua New Guinea, Paraguay, Peru, Philippines, Poland, Portugal, Romania, Russia, Rwanda, Senegal, Sierra Leone, Singapore, Slovenia, South Africa, Spain, Sri Lanka, Sweden, Switzerland, Syrian Arab Rep., Thailand, Togo, Trinidad and Tobago, Tunisia, Turkey, Uganda, Ukraine, United Kingdom, United States, Uruguay, Venezuela, Vietnam, Yemen, Zambia, and Zimbabwe.

[38]The working-age population is defined as the age group 15–64 inclusive; the elderly population is defined as the age group 65 years of age and older. When analyzing the determinants of the current account, demographic variables for each country are expressed as deviations from the world average.

Table 3.3. Main Characteristics of the Multiple-Generations Models

Characteristic	INGENUE	Tosun	MSG3
Number of countries/blocks[1]	6	2	4
Intertemporal optimization/ overlapping generations	Yes	Yes	Yes
Expectations	Rational	Rational	Rational and rule of thumb
Sectors	1	1	3
Age cohorts	4 young, 15 adult (including elderly)	0 young, 1 adult, 1 elderly	1 young,1 adult (including elderly)
Period lengths (years)	5	30	1
Life ends at	Fixed at 60–94 years	Fixed at 60 years	Fixed with probability "*p*"
Rigidities	No	No	Yes
Capital mobility	Yes	Yes	Yes
Labor mobility	No	Yes	No
Intergenerational transfers	Adults to young Adults to elderly	Adults to elderly	Adults to young
Public sector	Yes (simple public pension scheme)	Yes (articulated with public pension scheme)	Yes (articulated without public pension scheme)

[1]INGENUE regions include (1) Western Europe; (2) North America: Australia, Canada, New Zealand, and the United States; (3) Japan; (4) developing rapidly aging countries; (5) developing moderately aging countries; and (6) developing slowly aging countries. Tosun's model's regions include an advanced and a developing country bloc. MSG3 regions include (1) the United States; (2) Japan; (3) other OECD economies; and (4) rest of the world.

value is defined as the value in the preceding decade; for the first decade, the lagged value is defined as the value in the first year).[39]

Macroeconomic Models

This section describes in more detail the three multiple generations models (MGM) used in this chapter.[40] Table 3.3 summarizes and contrasts the key features of each model.

The INGENUE Model

The INGENUE model (INGENUE Team, 2001) is a multiregion world model in the spirit of those developed by Obstfeld and Rogoff (1996) in which the structure of each regional economy is similar to that of other applied OLG general equilibrium models such as Auerbach and Kotlikoff (1987) or Cazes and others (1992, 1994), except that labor supply is exogenous.[41]

The world is divided into six regions, including three advanced areas (Europe, North America, and Japan) and three developing country zones ranked according to their stage in the demographic transition (a "rapidly aging," a "moderately aging," and a "slowly aging" zone) (Table 3.4). Each region of the world comprises three categories of economic agents: households, firms, and the public sector. These are described below.

[39]Specifically, secondary school enrollment ratios; investment/GDP; budget balance/GDP; inflation rate; external trade/GDP; and country risk.

[40]Multiple generations models were first proposed by Samuelson (1958) and Diamond (1965). In their purest overlapping-generations (OLG) form, these innovate upon the Ramsey infinitely-lived representative-consumer hypothesis by introducing at each point in time individuals of different generations. Work by Blanchard (1985), Buiter (1988), Weil (1989), and more recently Faruqee (2000a, 2000b, 2003) suggested simplified alternatives to pure OLG models. Multicountry extensions in the OLG tradition include Buiter (1981), Cutler and others (1990), Attanasio and Violante (2000), INGENUE Team (2001), Börsch-Supan, Ludwig, and Winter (2003), and Fehr, Jokisch, and Kotlikoff (2003), among others. Faruqee, Laxton, and Symanski (1997), and Bryant and McKibbin (2004) all proposed multicountry extensions in the Blanchard-Buiter-Weil multiple-generations-model tradition.

[41]A new, more sophisticated version of the INGENUE model with 10 regions, imperfect financial markets, 2 sectors, autonomous population projections based upon UN coefficient methods, stochastic life expectancy, and bequest motives is currently under construction.

Table 3.4. INGENUE Model: Countries Composing Each Demographic Zone

Name of Region	Countries in Region
Western Europe	European Union, Switzerland, Norway, and Iceland
North America and Oceania	United States, Canada, Australia, and New Zealand
Japan	Japan
Developing: rapidly aging	Armenia, Bahrain, Belarus, Bosnia-Herzegovina, Bulgaria, China, Czech Republic, Cyprus, Estonia, Georgia, Hong Kong SAR, Hungary, Korea, Dem. People's Rep., Korea, Rep. of., Latvia, Lithuania, Macao, Moldova, Poland, Qatar, Romania, Russian Federation, Singapore, Slovak Republic, Thailand, Ukraine, United Arab Emirates, and Uruguay.
Developing: moderately aging	Albania, Argentina, Azerbaijan, Bahamas, Brazil, Brunei, Caribbean zone, Chile, Colombia, Dominica, Guyana, India, Indonesia, Israel, Jamaica, Kuwait, Lebanon, Malaysia, Mexico, Panama, Peru, Sri Lanka, Suriname, Trinidad and Tobago, Turkey, and Vietnam.
Developing: slowly aging	Afghanistan, Africa, Bangladesh, Bhutan, Bolivia, Cambodia, Costa Rica, Ecuador, El Salvador, Fiji, Guatemala, Haiti, Honduras, Iran, Islamic Rep. of., Iraq, Jordan, Kazakhstan, Kyrgyz Republic, Lao PDR, Melanesia, Micronesia, Mongolia, Myanmar, Nepal, Nicaragua, Oman, Pakistan, Papua New Guinea, Paraguay, Philippines, Polynesia, Samoa, Saudi Arabia, Syrian Arab Republic, Tajikistan, Turkmenistan, Eastern Timor, Uzbekistan, Vanuatu, Venezuela, West Bank and Gaza, and Yemen, Rep. of.

Households

In each region the household sector consists of 15 overlapping five-year-long cohorts of adults aged 20–94, and four cohorts of "young" who are dependent on their parents: individuals become adults when they turn 20, and remain in the labor force until legal, mandatory retirement age, which differs according to the region. Death occurs with certainty between ages 60 and 94, but is modeled in a way that mimics realistic probabilistic assumptions for the various world regions.

Households are assumed to supply labor, inelastically and locally, during the first periods of their adult life (youth and maturity) and then to retire. In addition, young adults bear the costs of educating children, modeled as a "tax" on the parent's consumption, proportional to the number of births. Households maximize life-cycle utility, with perfect foresight: when working, they save and invest in shares of the capital stock of production firms that are sold on a unified world capital market to finance their consumption during retirement—when they dissave. There is no bequest motive so at the end of each household's life each household's cumulated saving is zero.

Firms

The model assumes that identical firms located in various regions of the world are perfectly competitive, are equipped with a Cobb-Douglas constant-return technology using two factors (capital and labor), and produce a single good that may be used for consumption and investment. In the model this good is used as a numeraire and is freely traded at no cost on a world market. The assumption of a single good traded at no cost in world markets implies that regional real exchange rates are constant and always equal to one. In the model, capital is also perfectly mobile and the world financial market is perfect so that, in the long run, regional interest rates are equalized. Although the production technology is assumed to be identical across regions, the model is simulated assuming a wide initial gap in the level of total factor productivity between regions, which in turn is driven by an exogenous growth and convergence process. A mechanism of exogenous international diffusion of technological progress is specified, whereby the various regions of the world slowly converge to the level of total factor productivity in the North American economy—the world's technological leader—so that in the very long run all regions grow at the same rate.

Public Sector

The public sector is reduced to a pay-as-you-go public pension scheme. It is financed by a pay-

roll tax on all labor incomes and pays pensions to retired households. The replacement rate on the after tax wage is fixed, and the payroll tax is endogenous in order to enforce a balanced-budget rule. The adopted calibration allows the model to reproduce realistic regional intergenerational transfers.

Equilibrium

The general equilibrium of the world economy is solved by equating, in each region, the optimal labor demand emanating from domestic firms to the exogenous local labor supply, and the sum of regional supplies of saving with the sum of regional demand for investment. These equilibrium conditions respectively yield the six regional real wage rates and the world real interest rate, which in turn determine regional GDP, aggregate consumption, and saving, as well as their distribution over living cohorts in the various regions. In any given period, the difference between the flows of domestic saving and domestic investment in any of the six regions gives the inflow or outflow of the capital for the region, while the ratio of the stock of accumulated wealth of resident households to the stock of accumulated productive capital in a particular region, defined as the ownership ratio, measures its net external position—that is, net foreign assets or net external debt.

Calibration

Fertility rates and households' life expectancy in the model are set to mimic demographic projections from the UN's medium-fertility scenario up to 2050. The evolution of regional populations beyond that date is obtained by setting reproduction rates so that populations become stationary after 2100. Parameter values governing households' and firms' behavior together with assumptions on exogenous growth rates, the degree of international technological convergence, and contribution and replacement rates for pension schemes in the various regions of the world are based on historical data in order to match as closely as possible the observed dynamic of key economic variables, notably current account balances and interest rates.

MSG3 Model

The MSG3 model is a three-sector—energy, nonenergy, and capital-producing—version of the G-Cubed model developed by McKibbin and Wilcoxen (1998) building on the earlier MSG2 model developed by McKibbin and Sachs (1989) and the Jorgenson and Wilcoxen (1990) model. The model divides the world into four regions: the United States, Japan, the rest of the OECD, and the rest of the world (in essence, the world's developing bloc). It combines the modern intertemporal optimization approach to modeling economic behavior (as found in Blanchard and Fischer, 1989; and Obstfeld and Rogoff, 1996) with short-run rule-of-thumb behavior. In doing this it brings together features of real business cycle models—with a fully articulated analysis of forward-looking producers and consumers—and modern macroeconometric models—describing the effects of demand downturns in the face of wage (and price) stickiness. The main features of the model are as follows.

- *Demographics*. The model includes demographic considerations, such that economic agents in the model possess finite life spans and their income varies as they age. Specifically, drawing heavily on Faruqee (2000a, 2000b), who extended the Blanchard (1985) model of finitely lived agents to include aging considerations, in the MSG3 economic agents progress from being financially dependent children to being adults who are financially responsible for their own children. Death occurs with a fixed probability.
- *Explicit optimization*. The model is based on explicit intertemporal optimization by agents (consumers and firms) in each economy. Thus, time and dynamics are of fundamental importance in the MSG3 model, making its core theoretical structure like that of real business cycle models.
- *Rule-of-thumb agents.* To track the inertial dynamics of some key macroeconomic vari-

ables, the behavior of agents is modified to allow for short-run deviations from optimal behavior, owing either to myopia or to restrictions on the ability of households and firms to borrow at the risk-free bond rate on government debt.

- *Cash-in-advance constraints.* Holdings of financial assets including money are explicitly modeled. In particular, money is introduced into the model through a restriction that households require money to purchase goods.
- *Nominal rigidities.* The model allows for short-run nominal wage rigidity (by different degrees in different countries) and therefore allows for protracted periods of unemployment depending on the labor market institutions in each country.
- *Two types of capital.* The model distinguishes between the stickiness of physical capital within sectors and within countries and the flexibility of financial capital that can flow immediately where expected returns are highest. This distinction leads to a difference between the quantity of physical capital that is available at any time to produce goods and services and the valuation of that capital as a result of decisions about the geographical allocation of financial capital.
- *Estimation/calibration.* Key parameters in the model—such as the elasticities of substitution in production and consumption decisions—are estimated, enhancing the model's ability to reproduce the dynamics of historical data.

As a result, the model exhibits a rich dynamic behavior, driven on the one hand by asset accumulation and, on the other hand, by wage adjustment to a neoclassical steady state. Details of the model can be found on the Internet at www.gcubed.com.

Tosun's Two-Region OLG Model with International Labor Mobility

This two-period two-country model builds on the standard closed-economy overlapping generations framework developed by Diamond (1965). The model features either capital or labor mobility in line with work by Galor (1986, 1992) and Crettez, Michel, and Vidal (1996, 1998). In the version used here the two countries represent the advanced and developing regions of the world, each with a population that is composed of two age groups (workers and the retired). The population characteristics of each country are calibrated to actual UN projections for advanced and developing blocs of the world so that the advanced countries age more quickly than the developing countries. The model incorporates the interaction of household behavior, firm behavior, political process, and international labor flows. These are described in more detail below.

Households

Individuals live for two (30-year-long) periods and seek to maximize the utility that they derive from consumption over their lifetime. To pay for consumption, households supply labor according to a distribution of abilities that is replicated in each new generation. Effective labor is the product of human capital that is accumulated from the interaction of the ability level of the individual and government spending per young on a productivity-enhancing public good such as education. Both labor and capital income are taxed to finance the provision of public goods.

Firms

Each country produces a single good using a Cobb-Douglas technology. Competitive factor markets require that the real wage and the real interest rate are equalized to the marginal product of labor and capital, respectively.

Political process

The government provides two public goods: a productivity-enhancing good (education) and social security. It is assumed that there is a predetermined "earmarked" level of social security spending. Thus the social security tax is simply determined by the government budget constraint where social security spending per worker is fixed. However, spending on the productivity-enhancing public good is determined through a political process for which a median-voter frame-

work with voter heterogeneity is used. Voter heterogeneity is introduced by assuming a distribution of genetic ability levels for the working generation. The ability level of the individual will, in turn, determine the value that the individual receives from the public good.

The preferred tax rate is increasing with the ability level of the individual and with income per worker and it is decreasing with the social security tax rate. Since retirees do not derive any benefit from this public good, they incur a cost without enjoying any benefits. Therefore, their preferred tax rate will always be zero, regardless of their ability. With an increase in the dependency ratio, retired people will need fewer working voters to form a majority. Since these working voters are at the lower end of the ability distribution, they prefer lower taxes than higher-ability people because their return from the productivity-enhancing public good is lower. Therefore, the median voter becomes a person with lower ability and the preferred tax rate of the median voter falls. The migration of workers increases the number of working voters, the upshot of which is a higher preferred tax rate of the median voter, and thus a larger provision of productivity-enhancing good. In turn, this supports labor income and growth relative to a scenario of aging where no migration takes place.

Equilibrium

In the absence of international capital mobility, capital market equilibrium requires that saving in each period equals accumulated capital in the following period. Two alternatives are also contemplated to close the dynamic model. Either capital is fully mobile internationally (so that rates of return are equalized between the two countries) or labor is perfectly mobile between the two countries (so that net-of-tax real wages are equalized across countries, given that the model uses source-based income taxation for both countries).

In the case of perfect labor mobility, it is assumed that only people of working age move between regions. Additionally, migration is assumed to have no effect on the ability distribution in both regions. This means that migration of labor affects the size rather than the composition of the working-age generation in the two regions.

References

Abel, Andrew, 2003, "The Effects of a Baby Boom on Stock Prices and Capital Accumulation in the Presence of Social Security," *Econometrica*, Vol. 71 (March), pp. 551–78.

Acemoglu, Daron, Simon Johnson, and James Robinson, 2003, "Disease & Development in Historical Perspective," *Journal of the European Economic Association*, Vol. 1 (April), pp. 397–405.

AGIR Project, 2003a, "Bio-Demographic Aspects of Aging, Data for Belgium," Working Paper No. 10–03 (Brussels).

———, 2003b, "Use of Health Care and Nursing Care by the Elderly: Data for Belgium," Working Paper No. 11–03 (Brussels).

Ang, Andrew, and Angela Maddaloni, 2003, "Do Demographic Changes Affect Risk Premiums? Evidence from International Data," NBER Working Paper No. 9677 (Cambridge, Massachusetts: National Bureau of Economic Research); forthcoming in the *Journal of Business*.

Attanasio, Orazio P., and Giovanni L. Violante, 2000, "The Demographic Transition in Closed and Open Economies: A Tale of Two Regions," IADB Working Paper No. 412 (Washington: Inter-American Development Bank).

Auerbach, Alan J., and Laurence J. Kotlikoff, 1987, *Dynamic Fiscal Policy* (Cambridge: Cambridge University Press).

Australia, Commonwealth of, The Treasury, 2002, "Intergenerational Report 2002–2003," 2002–2003 Budget Paper No. 5 (Canberra).

Bakshi, Gurdip, and Zhiwu Chen, 1994, "Baby Boom, Population Aging and Capital Markets," *Journal of Business*, Vol. 67 (April), pp. 165–202.

Barr, Nicholas, 2001, *The Welfare State as Piggy Bank—Information Risk, Uncertainty, and the Role of the State* (Oxford, United Kingdom: Oxford University Press).

Batini, Nicoletta, Timothy Callen, and Warwick McKibbin, 2004, "The Global Impact of Demographic Change," IMF Working Paper (Washington: International Monetary Fund, forthcoming).

Bell, Clive, Shantajanan Devarajan, and Hans Gersbach, 2004, "Thinking About the Long-Run

Consequences of HIV/AIDS," in *The Macroeconomics of HIV/AIDS*, ed. by Markus Haacker (Washington: International Monetary Fund, forthcoming).

Bergantino, Steven, 1998, "Lifecycle Investment Behavior, Demographics, and Asset Prices" (Ph.D. dissertation; Cambridge, Massachusetts: MIT, Department of Economics).

Blanchard, Olivier, 1985, "Debt, Deficits, and Finite Horizons," *Journal of Political Economy*, Vol. 93 (April), pp. 223–47.

———, and Stanley Fischer, 1989, *Lectures on Macroeconomics* (Cambridge, Massachusetts: MIT Press).

Bloom, David, and David Canning, 2001, "Cumulative Causality, Economic Growth, and the Demographic Transition," Chapter 7 in *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, ed. by Nancy Birdsall, Allen Kelley, and Steven Sinding (New York: Oxford University Press).

———, and Jaypee Sevilla, 2001, "Economic Growth and the Demographic Transition," NBER Working Paper No. 8685 (Cambridge, Massachusetts: National Bureau of Economic Research).

Bohn, Henning, 1999, "Social Security and Demographic Uncertainty: The Risk Sharing Properties of Alternative Policies," NBER Working Paper No. 7030 (Cambridge, Massachusetts: National Bureau of Economic Research).

Borjas, George, 1999, "The Economic Analysis of Immigration," in *Handbook of Labor Economics 3A*, ed. by O. Ashenfelter and D. Card (Amsterdam: North-Holland).

———, 2001, "Does Immigration Grease the Wheels of the Labor Market?" *Brookings Papers on Economic Activity: 1*, Brookings Institution, pp. 69–133.

Börsch-Supan, Axel, Alexander Ludwig, and Joachim Winter, 2003, "Aging, Pension Reform, and Capital Flows: A Multi-Country Simulation Model," MEA Discussion Paper No. 28–30 (Mannheim, Germany: Mannheim Research Institute for the Economics of Aging).

Bosworth, Barry, Ralph Bryant, and Gary Burtless, 2004, "The Impact of Aging on Financial Markets and the Economy: A Survey," Brookings Institution Working Paper (Washington: Brookings Institution).

Brooks, Robin, 1998, "Asset Market and Saving Effects of Demographic Transitions" (Ph.D. dissertation; New Haven, Connecticut: Yale University, Department of Economics).

Bryant, Ralph C., 2004, "Demographic Pressures on Public Pension Systems and Government Budgets in Open Economies," ESRI Discussion Paper No. 109 (Tokyo: Economic and Social Research Institute).

———, and Warwick J. McKibbin, 2004, "Incorporating Demographic Change in Multi-Country Macroeconomic Models: Some Preliminary Results" (unpublished; Brookings Institution and Australian National University).

Buiter, Willem H., 1981, "Time Preference and International Lending and Borrowing in an Overlapping-Generations Model," *Journal of Political Economy*, Vol. 89 (August), pp. 769–97.

———, 1988, "Death, Birth, Productivity Growth and Debt Neutrality," *Economic Journal*, Vol. 98, pp. 279–93.

Burniaux, Jean-Marc, Romian Duval, and Florence Jaumotte, 2003, "Coping with Aging: A Dynamic Approach to Quantify the Impact of Alternative Policy Options on Future Labor Supply in OECD Countries," OECD Economics Department Working Paper No. 371 (Paris: Organization for Economic Cooperation and Development).

Cardarelli, Roberto, and Kenichi Ueda, 2004, "Domestic and Global Perspectives of Migration to the United States," in IMF Country Report No. 04/228 (Washington: International Monetary Fund, July).

Carrington, William J., Enrica Detragiache, and Tara Vishwanath, 1996, "Migration with Endogenous Moving Costs," *American Economic Review*, Vol. 86 (September), pp. 909–30.

Casey, Bernard, Howard Oxley, Edward Whitehouse, Pablo Antolin, Romain Duval, and Willi Leibfritz, 2003, "Policies for an Aging Society: Recent Measures and Areas for Further Reform," OECD Economics Department Working Paper No. 369 (Paris: Organization for Economic Cooperation and Development).

Cazes, Sandrine, Thierry Chauveau, Jacques Le Cacheux, and Rahim Loufir, 1992, "An OG Model of the French Economy: Application to the Long-Run Prospects of the Public Pension Scheme," OFCE Working Paper No. 92–5 (Paris: Observatoire Français des Conjonctures Économiques).

———, 1994, "Public Pensions in an Overlapping-Generations Model of the French Economy," *Keio Economic Studies*, Vol. 31, No. 1, pp. 1–19.

Center for Strategic and International Studies, and Watson Wyatt, 1999, *Global Aging: The Challenge of the New Millennium* (Washington).

Chinn, Menzie D., and Eswar S. Prasad, 2003, "Medium-Term Determinants of Current Accounts

in Industrial and Developing Countries: An Empirical Exploration," *Journal of International Economics*, Vol. 59 (January), pp. 47–76.

Constantinides, George, John Donaldson, and Rajnish Mehra, 2002, "Junior Can't Borrow: A New Perspective on the Equity Premium Puzzle," *Quarterly Journal of Economics*, Vol. 117 (February), pp. 269–96.

Crafts, Nicholas, and Markus Haacker, 2004, "Welfare Implications of HIV/AIDS," in *The Macroeconomics of HIV/AIDS*, ed. by Markus Haacker (Washington: International Monetary Fund, forthcoming).

Crettez, Bertrand, Philippe Michel, and Jean-Pierre Vidal, 1996, "Time Preference and Labor Migration in an OLG Model with Land and Capital," *Journal of Population Economics*, Vol. 9, No. 4, pp. 387–403.

———, 1998, "Time Preference and Capital Mobility in an OLG Model with Land," *Journal of Population Economics*, Vol. 11, No. 1, pp. 149–58.

Cutler, David, James M. Poterba, Louise Sheiner, and Laurence Summers, 1990, "An Aging Society: Opportunity or Challenge?" *Brookings Papers on Economic Activity: 1*, Brookings Institution, pp. 1–56.

Davis, E. Philip, and Christine Li, 2003, "Demographics and Financial Asset Prices in the Major Industrial Economies," Department of Economics and Finance Discussion Paper No. 03–07 (Middlesex, England: Brunel University).

Deaton, Angus, and Christina Paxson, 2000, "Growth and Saving Among Individuals and Households," *Review of Economics and Statistics*, Vol. 82 (May), pp. 212–25.

Dekle, Robert, 2003, "Financing Consumption in an Aging Japan: The Role of Foreign Capital Inflows and Immigration" (unpublished; Los Angeles: University of Southern California).

Demeny, Paul, 2003, "Population Policy: A Concise Summary," Policy Research Division Working Paper No. 173 (New York: Population Council).

Diamond, Peter A., 1965, "National Debt in a Neoclassical Growth Model," *American Economic Review*, Vol. 55 (December), pp. 1126–50.

———, and Peter R. Orszag, 2004, *Saving Social Security: A Balanced Approach* (Washington: Brookings Institution Press).

Disney, Richard, 1996, *Can We Afford to Grow Older? A Perspective on the Economics of Aging* (Cambridge, Massachusetts: MIT Press).

Dixon, Simon, Scott McDonald, and Jennifer Roberts, 2002, "The Impact of HIV and AIDS on Africa's Economic Development," *British Medical Journal*, Vol. 324, pp. 232–4.

Eastwood, Robert, and Michael Lipton, 2001, "Demographic Transition and Poverty: Effects via Economic Growth, Distribution, and Conversion," Chapter 9 in *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, ed. by Nancy Birdsall, Allen Kelley, and Steven Sinding (New York: Oxford University Press).

European Commission, Economic Policy Committee, 2001, *Budgetary Challenges Posed by Ageing Populations: The Impact on Public Spending on Pensions, Health and Long-Term Care for the Elderly and Possible Indicators of the Long-Term Sustainability of Public Finances* (Brussels).

Faruqee, Hamid, 2000a, "Population Aging and Its Macroeconomic Implications," in Japan: Selected Issues, IMF Staff Country Report No. 00/144 (Washington: International Monetary Fund).

———, 2000b, "Population Aging and Its Macroeconomic Implications: A Framework for Analysis" (unpublished; Washington: International Monetary Fund).

———, 2002, "Population Aging and Its Macroeconomic Implication: A Framework for Analysis," IMF Working Paper 02/16 (Washington: International Monetary Fund).

———, 2003, "Debt, Deficits, and Age-Specific Mortality," *Review of Economic Dynamics*, Vol. 6, No. 2, pp. 300–12.

———, Douglas Laxton, and Stephen Symansky, 1997, "Government Debt, Life-Cycle Income and Liquidity Constraints: Beyond Approximate Ricardian Equivalence," *IMF Staff Papers*, Vol. 44, No. 3, pp. 374–82.

Faruqee, Hamid, and Martin Mühleisen, 2001, "Population Aging in Japan: Demographic Shock and Fiscal Sustainability," IMF Working Paper 01/40 (Washington: International Monetary Fund).

Fasano, Ugo, and Rishi Goyal, 2004, "Emerging Strains in GCC Labor Markets," IMF Working Paper 04/71 (Washington: International Monetary Fund).

Fehr, Hans, Sabine Jokisch, and Laurence J. Kotlikoff, 2003,"The Developed World's Demographic Transition—The Roles of Capital Flows, Immigration, and Policy," NBER Working Paper No. 10096 (Cambridge, Massachusetts: National Bureau of Economic Research).

Feroli, Michael, 2003, "Capital Flows Among the G-7 Nations: A Demographic Perspective," Finance and Economics Discussion Series No. 2003–54 (Washington: Federal Reserve Board).

Futagami, Koichi, and Tetsuya Nakajima, 2001, "Population Aging and Economic Growth," *Journal of Macroeconomics*, Vol. 23, No. 1, pp. 31–44.

Galor, Oded, 1986, "Time Preference and International Labor Migration," *Journal of Economic Theory*, Vol. 38 (February), pp. 1–20.

———, 1992, "The Choice of Factor Mobility in a Dynamic World," *Journal of Population Economics*, Vol. 5 (May), pp. 135–44.

Geanakoplos, John, Michael Magill, and Martine Quinzii, 2004, "Demography and the Long-Run Predictability of the Stock Market," *Brookings Papers on Economic Activity: 1*, Brookings Institution, pp. 241–307.

Glied, Sherry, 2003, "Health Care Costs: On the Rise Again," *Journal of Economic Perspectives*, Vol. 17 (Spring), pp. 125–48.

Gómez, Rafael, and Pablo Hernández de Cos, 2003, "Demographic Maturity and Economic Performance: The Effect of Demographic Transitions on per Capita GDP Growth," Bank of Spain Working Paper No. 318 (Madrid: Bank of Spain).

Greenwood, Michael J., 1985, "Human Migration: Theory, Models, Empirical Studies," *Journal of Regional Science*, Vol. 25 (November), pp. 521–44.

Group of Ten, 1998, *The Macroeconomic and Financial Implications of Ageing Populations* (Paris, Washington, Basel: OECD, IMF, and Bank for International Settlements).

Gutierrez, Juan Pablo, and others, 2004, "Achieving the WHO/UNAIDS Antiretroviral Treatment 3 by 5 Goal: What Will It Cost?," *The Lancet*, Vol. 364, pp. 63–4.

Heller, Peter, 1997, "Aging in the Asian 'Tigers': Challenges for Fiscal Policy," IMF Working Paper 97/143 (Washington: International Monetary Fund).

———, 2003, *Who Will Pay? Coping with Aging Societies, Climate Change, and Other Long-Term Fiscal Challenges* (Washington: International Monetary Fund).

Higgins, Matthew, 1998, "Demography, National Savings, and International Capital Flows," *International Economic Review*, Vol. 39, No. 2, pp. 343–69.

Horioka, Charles, 1991, "The Determinants of Japan's Savings Rate," *Economic Studies Quarterly*, Vol. 42, No. 3, pp. 237–53.

INGENUE Team, 2001, "INGENUE: Une Modélisation Intergénérationnelle et Universelle" (Paris: Banque de France).

Jackson, Richard, 2002, *The Global Retirement Crisis: The Threat to World Stability and What to Do About It* (Washington: Center for Strategic and International Studies).

Jannsen, John, 2001, "New Zealand's Fiscal Policy Framework: Evolution and Experience," New Zealand Treasury Working Paper 01/25 (Wellington: The Treasury).

Jones, Charles, 2002, "Sources of U.S. Economic Growth in a World of Ideas," *American Economic Review*, Vol. 92 (March), pp. 220–39.

Jorgenson, Dale W., and Peter J. Wilcoxen, 1990, "Environmental Regulation and U.S. Economic Growth," *RAND Journal of Economics*, Vol. 21, No. 2, pp. 314–40.

Kalemli-Ozcan, Sebnem, 2002, "Does Mortality Decline Promote Economic Growth?" *Journal of Economic Growth*, Vol. 7 (December), pp. 411–39.

———, 2003, "A Stochastic Model of Mortality, Fertility, and Human Capital Investment," *Journal of Development Economics*, Vol. 70, No. 1, pp. 103–18.

———, Harl Ryder, and David Weil, 2000, "Mortality Decline, Human Capital Investment, and Economic Growth," *Journal of Development Economics*, Vol. 62, No. 1, pp. 1–23.

Kelley, Allen, and Robert Schmidt, 2001, "Economic and Demographic Change: A Synthesis of Models, Findings, and Perspectives," Chapter 4 in *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, ed. by Nancy Birdsall, Allen Kelley, and Steven Sinding (New York: Oxford University Press).

Lee, Ronald, 2003, "The Demographic Transition: Three Centuries of Fundamental Change," *Journal of Economic Perspectives*, Vol. 17, No. 4, pp. 167–90.

———, Andrew Mason, and Timothy Miller, 1997, "Saving, Wealth, and the Demographic Transition in East Asia," East-West Center Working Paper No. 88–24 (Honolulu, Hawaii: East-West Center).

Lee, Ronald, Michael Anderson, and Shripad Tuljapurkar, 2003, "Stochastic Forecasts of the Social Security Trust Fund," CEDA Paper No. 2003-0005CL (Berkeley, California: University of California, Center for the Economics and Demography of Aging).

Loayza, Norman, Klaus Schmidt-Hebbel, and Luis Servén, 2000, "Saving in Developing Countries: An Overview," *World Bank Economic Review*, Vol. 14, No. 3, pp. 393–41.

Luhrmann, Melanie, 2003, "Demographic Change, Foresight, and International Capital Flows" (unpublished; Mannheim, Germany: Mannheim University).

Malmberg, Bo, 1994, "Age Structure Effects on - Economic Growth—Swedish Evidence," *Scandinavian Economic History Reviews*, Vol. 42, No. 3, pp. 279–95.

Malthus, Thomas, 1798, *An Essay on the Principle of Population* (London: Macmillan, 1926).

Masson, Paul, Tamim Bayoumi, and Hossein Samiei, 1995, "International Evidence on the Determinants of Private Saving," IMF Working Paper 95/51 (Washington: International Monetary Fund).

McKibbin, Warwick J., and Jeremy Nguyen, 2004, "Modelling Global Demographic Change: Results for Japan," paper presented at the conference on the International Collaborations Projects for the Economic and Social Research Institute, Cabinet Office, Government of Japan, Tokyo, February 18.

McKibbin, Warwick J., and Jeffrey D. Sachs, 1989, "The McKibbin-Sachs Global Model: Theory and Specifications," NBER Working Paper No. 3100 (Cambridge, Massachusetts: National Bureau of Economic Research).

McKibbin, Warwick J., and Peter J. Wilcoxen, 1998, "The Theoretical and Empirical Structure of the G-Cubed Model," *Economic Modelling*, Vol. 16, No. 1, pp. 123–48.

McMorrow, Kieran, and Werner Roeger, 2004, *The Economic and Financial Market Consequences of Global Ageing* (New York: Springer-Verlag Press).

Meltzer, David, 1992, *Mortality Decline, the Demographic Transition, and Economic Growth* (Ph.D. dissertation; Chicago, Illinois: University of Chicago, Department of Economics).

National Research Council, 2000, *Beyond Six Billion: Forecasting the World's Population* (Washington: National Academy Press).

Obstfeld, Maurice, and Kenneth Rogoff, 1996, *Foundations of International Macroeconomics*" (Cambridge, Massachusetts: MIT Press).

Oeppen, Jim, and James Vaupel, 2002, "Broken Limits to Life Expectancy," *Science Magazine*, Vol. 296 (May), pp. 1029–31.

Organization for Economic Cooperation and Development (OECD), 2001, "Fiscal Implications of Aging: Projections of Age-Related Spending," *Economic Outlook*, Vol. 69 (September), pp. 145–67.

———, 2004, *Ensuring the Financial Sustainability of Health Systems* (Paris).

Orszag, Peter R., and Joseph E. Stiglitz, 2001, "Rethinking Pension Reform: Ten Myths About Social Security Systems," in *New Ideas About Old Age Security: Toward Sustainable Pension Systems in the 21st Century*, ed. by Robert Holzmann and Joseph Stiglitz (Washington: World Bank).

Over, Mead, 2004, "The Impact of the HIV/AIDS Epidemic on the Health Sectors of Developing Countries," in *The Macroeconomics of HIV/AIDS*, ed. by Markus Haacker (Washington: International Monetary Fund, forthcoming).

Passell, Peter, 1996, "The Year Is 2010. Do You Know Where Your Bull Is?" *New York Times*, March 10, Section 3, pp. 1–16.

Peterson, Peter, 1999, "Gray Dawn: How the Coming Age Wave Will Transform America—and the World" (New York: Times Books).

Poterba, James, 2001, "Demographic Structure and Asset Returns," *Review of Economics and Statistics*, Vol. 83, pp. 565–84.

Ratha, Dilip, 2003, "Workers' Remittances: An Important and Stable Source of External Development Finance," Chapter 7 in *Global Development Finance 2003* (Washington: World Bank), pp. 157–75.

Romer, Paul M., 1990, "Endogenous Technological Change," *Journal of Political Economy*, Vol. 98 (October), pp. 71–102.

Rother, P., M. Catenaro, and G. Schwab, 2003, "Ageing and Pensions in the Euro Area: Survey and Projection Results," Social Protection Discussion Paper No. 0307 (Washington: World Bank).

Samuelson, Paul A., 1958, "An Exact Consumption-Loan Model of Interest With or Without the Social Contrivance of Money," *Journal of Political Economy*, Vol. 66 (December), pp. 467–82.

Samwick, Andrew A., 1998, "New Evidence on Pensions, Social Security, and the Timing of Retirement," NBER Working Paper No. W6534 (Cambridge, Massachusetts: National Bureau of Economic Research).

———, 1999, "Social Security Reform in the United States," *National Tax Journal*, Vol. 52 (December), pp. 819–42.

Steinberg, Malcolm, and others, 2002, "Hitting Home: How Households Cope with the Impact of the HIV/AIDS Epidemic" (Washington: Kaiser Family Foundation).

Tosun, Mehmet S., 2003, "Population Aging and Economic Growth: Political Economy and Open Economy Effects," *Economics Letters*, Vol. 81, No. 3, pp. 291–96.

UNAIDS (Joint United Nations Program on HIV/AIDS), 2004, *Report on the Global AIDS Epidemic* (Geneva, Switzerland).

UNAIDS/UNICEF/USAID, 2004, "Children on the Brink 2004: A Joint Report of New Orphan

Estimates and a Framework for Action" (Geneva, New York, Washington).

United Kingdom, Royal Commission on Population, 1949, *Report to Parliament* (June) (London).

United Nations, 2000, "Replacement Migration: Is It a Solution to Declining and Ageing Populations?" Population Division, Department of Economic and Social Affairs, United Nations (New York).

———, 2003, "World Population Prospects: The 2002 Revision," Population Division, Department of Economic and Social Affairs, United Nations (New York).

United States, Congressional Budget Office, 2001, *Uncertainty in Social Security's Long-Term Finances: A Stochastic Analysis* (Washington).

———, 2003, *The Long-Term Budget Outlook* (December) (Washington).

Wanless, Derek, 2002, *Securing Our Future Health: Taking a Long-Term View* (April) (London: Public Enquiry Unit, HM Treasury).

Weil, Philippe, 1989, "Overlapping Families of Infinitely-Lived Agents," *Journal of Public Economics*, Vol. 38 (March), pp. 183–98.

Williamson, Jeffrey, 2001, "Demographic Change, Economic Growth, and Inequality," Chapter 5 in *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, ed. by Nancy Birdsall, Allen Kelley, and Steven Sinding (New York: Oxford University Press).

Wise, David, 2003, "Program Report on Economics of Aging," *NBER Reporter*, June 22.

World Health Organization, 2004, *World Health Report* (Geneva: WHO).

Young, Gary, 2002, "The Implications of an Aging Population for the UK Economy," Working Paper No. 159 (London: Bank of England).

Zhang, Jie, Junsen Zhang, and Ronald Lee, 2003, "Rising Longevity, Education, Savings, and Growth," *Journal of Development Economics*, Vol. 70, No. 1, pp. 83–101.