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A Series on Immigration

Global Population Aging
in the 21st Century and
Its Economic Implications

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Preface

The world is in the midst of a great demographic transition. The world population nearly quadrupled during the 20th century and is projected to grow by roughly 50 percent before stabilizing during the late 21st century. That transition is expected to leave the population much larger and, on average, older than it was previously—developments that have far-reaching implications for societies and governments throughout the world and for how they are likely to interact.

This paper, requested by the Chairman and Ranking Member of the Senate Finance Committee, is part of a series of reports by the Congressional Budget Office (CBO) that presents facts and research on immigration. It describes historical and projected population trends in different regions of the world and discusses current research on the international economic implications of those trends. Such information will help inform CBO's projections of the domestic and international economies and of the federal budget. In keeping with CBO's mandate to provide objective, nonpartisan analysis, this paper makes no recommendations.

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Summary

Over the past two centuries, improvements in nutrition, sanitation, and health care have dramatically reduced infant mortality and extended the life expectancy of children and adults throughout the world. With more women reaching childbearing age, the world has experienced a period of rapid and sustained population growth, with the global population nearly quadrupling during the 20th century. As populations grow and incomes rise, however, succeeding generations are gradually reducing the number of children they have. The global population is therefore expected to increase only by another 50 percent or so before stabilizing over the next century. Thus, the world is moving from a pattern of high birth rates, high mortality, and relatively short life expectancy to one of low birth rates, low mortality, and long life expectancy—and from high rates of population growth to much lower rates and even, ultimately, to a stable or even declining population. That demographic transition has far-reaching economic implications for societies throughout the world.

Each country's demographic transition typically involves several major phases whose duration depends on the timing and pace of changes in mortality and fertility.

■ Initially, as infant mortality declines and population growth takes off, the country's population tends to grow younger, and the youth share of the population expands. The burden of raising large numbers of children tends to restrain other types of saving and investment and thus tends to restrain economic growth.

■ Later, as birth rates decline, the youth share of the population contracts and the working-age share expands. With fewer children to care for, the adult population can work, save, and invest more, all of which tend to enhance economic growth. When the workforce is relatively young, the country is likely to have relatively low saving and relatively high demand for investment—and therefore relatively high rates of return. However, as a large portion of the labor force reaches middle age, saving may rise and the demand for investment may fall, a phenomenon that tends to reduce rates of return.

■ Still later, however, as birth rates remain low and adults continue to live longer, the elderly share of the country's population rises. As a result, working-age adults may not have as many children to raise, but they have many more old (and increasingly older) people to support and care for. In addition, the rate of saving may decline as retirees run down their savings—although that effect does not appear to be as strong as one might expect on the basis of economic reasoning alone.

Other developments—for example, political, economic, or environmental disruptions and post-war "baby booms"—can change the age structure of a country's population in similar ways as well.

A further complication is that the transition is occurring at different times and at different paces in different parts of the world. Only the industrialized countries—which currently account for roughly 20 percent of the global population but about 80 percent of gross world product—and a few developing ones have reached the advanced stages. Over the next 50 years, those countries will generally see their population growth rates fall (and in some cases turn negative) and their elderly populations expand. With the growth of their working-age populations declining sharply, developed countries will find it increasingly expensive to support growing numbers of retirees, who will place increasing stress on those countries' largely "pay-as-you-go" pension systems and health care systems.

In contrast, many developing countries—which already account for roughly 80 percent of the world's population but only about 20 percent of its output—have only recently entered the transition. Their birth rates and population growth rates are expected to remain relatively high over the next half-century; their populations will remain relatively young—and in some of the least-developed countries, very young—and their working-age populations will expand. The difference in patterns between developed and developing countries is shifting the global distribution of the population, as developing regions with the youngest populations account for a growing share of

the world's population. Only in the second half of this century and beyond are many of the developing countries—and thus the world as a whole—likely to experience the full transition.

No country is likely to be immune from the effects of the transition in other countries and regions. Demographic differences probably will influence the kinds of products different countries produce, how they produce them—for instance, with more or less labor or capital—and which products they import or export. International differences in the timing and pace of the transition also are likely to make it attractive for workers to move from countries with relatively large supplies of labor to countries with relatively high demand for it. Moreover, differences in timing are likely to raise saving more than investment in some countries while raising investment more than saving in others. Investors are likely to respond by moving financial capital from countries with high saving relative to investment to countries with high investment relative to saving.

Researchers find it very difficult, however, to distinguish the influence of demographic trends from the many other influences that can drive international flows. Nevertheless, experts believe that developing regions are very likely to be an ongoing source of potential immigration to developed countries. And although capital has tended to flow from developed countries to developing ones in the past, it may well be the case that the direction of flows will reverse after the developed countries have entered a period of rapid aging and developing countries have begun to reap the benefits of declining fertility and rapid growth in their working-age shares.

Policy developments in developed and developing countries alike could greatly influence the effects of the demographic transition. For example, the effect of a rapidly expanding workforce on economic growth may be enhanced in developing countries by deliberate investment in education, by the development of flexible financial markets to channel savings to productive uses, and by openness to trade. Policies that encourage adequate retirement preparation could help rapidly aging developed countries prepare for a growing elderly population, whereas the effects of aging could be exacerbated by pension programs that discourage private saving or continued part-time work in retirement or that encourage relatively early retirement.

The United States' transition is somewhat unusual because the nation has a higher birth rate than most other developed countries and also is more open to immigrants, who tend to have more children than do natives. Immigration and relatively high overall birth rates will probably prolong the nation's transition and render it less disruptive than that of many other countries. In addition, the United States has highly developed and open financial markets that should allow capital to move across borders to its most profitable uses, wherever they may be. However, immigration is unlikely to greatly offset the stresses of aging in the United States and other developed countries or the stresses of population growth in the developing ones.

Any specific projection of global, regional, and national population trends must be based on uncertain assumptions about birth rates, life expectancy, and population movements among countries and is therefore subject to a good deal of uncertainty. For example, in its "medium variant" projection, the United Nations assumes that the low current birth rates in developed countries will gradually rebound, thus preventing their populations from dwindling away (United Nations, 2005). The United Nations also assumes that, taking the developed countries as a whole, average life expectancy will not rise above 85 years during the next half-century, an assumption that limits the extent to which longer life spans can contribute to population growth and to burgeoning elderly populations. However, demographers have tended to underestimate declines in fertility and improvements in life expectancy. Analysis and experience provide little guidance about the level at which birth rates will ultimately stabilize, leading some to question the likelihood of any such rebound. Similarly, technological breakthroughs and new applications of existing technologies could push life expectancy well above the United Nations' currently projected trend. At the same time, however, unexpected developments—disease, war, or environmental problems—could lead to higher mortality rates than projected in the medium variant.

Probabilistic projections of future population growth that explicitly incorporate a range of assumptions about birth rates and life expectancy suggest that the official population projections could substantially understate or overstate the extent of population aging over the next 50 years. Nevertheless, there is little doubt about the general trends described above and the general economic effects that are likely to result from them.

Global Population Aging in the 21st Century and Its Economic Implications

Introduction

The world is undergoing a centuries-long demographic transition that, when complete, will leave the global population larger and much older, on average, than it is today. The transition was triggered mainly by improvements in nutrition, sanitation, health practices, and medical care that have dramatically reduced infant mortality and extended the life expectancy of children and adults. With more children living to adulthood and having children themselves, the world is going through an unparalleled period of rapid and sustained growth in population. As population and incomes have grown, however, people have begun to reduce the number of children they have. The resulting decline in fertility rates is gradually reducing the rate of population growth, and the world population is gradually becoming older.

The timing and pace of the transition vary considerably across regions and countries of the world. Fertility rates have fallen nearly everywhere, but while they have generally fallen to lower levels in developed countries than in most developing countries, they are falling more rapidly in the developing countries. Similarly, life expectancies have risen to higher levels in developed countries than in developing ones and will remain higher for many years to come, but life expectancies have risen nearly everywhere and are currently rising more rapidly in most developing countries. (In a few regions, however, life expectancy has actually declined—as a result of HIV/AIDS in parts of Sub-Saharan Africa and of disruptions associated with political and economic transitions in parts of the former Soviet bloc.) In addition, immigration from developing countries has contributed to population growth in some developed countries—including the United States— although most other developed countries have allowed relatively little immigration.

The net result of those trends is that population growth rates are currently much higher in most developing countries than in developed ones, but growth rates are gradually declining nearly everywhere. Many developed coun-tries that are already well into the transition have nearly stable or even declining populations that are rapidly aging. In contrast, many developing countries will continue to have much younger and rapidly growing populations for several decades to come. The differences across regions are likely to have significant effects on international economic trends.

Significant uncertainties exist in the timing and magnitude of the demographic transition and the shifts in population structure—and how those developments will affect national economies throughout the world and the international economic flows among them. Some experts see little reason for concern, noting that the process has generally been associated with gains in health, income, and welfare; others worry about slowing rates of economic growth, stress on national pension systems, and imbalances in international financial markets.

This review describes the main trends that have produced the current global and regional population distribution and discusses the most prominent projections of future population in the literature. In addition, the paper presents an overview of the current state of knowledge about how those population trends are likely to affect international economic developments over the long term.

Sources of the Demographic Transition

Population aging is a global phenomenon in the sense that nearly all countries are undergoing a demographic transition that is likely to leave them, in time, with larger and much older populations than they started with.[1] That transition has followed the same general pattern everywhere, with relatively distinct phases involving changes in fertility (the number of children women have) and mortality (the rate at which people die). Those pat-

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1. For a general introduction to population history, see Livi-Bacci (2001).

terns of change also produce a degree of momentum: a generation that has a lot of children will also tend to have a lot of grandchildren, so that a surge in population generally continues over a few generations even if mortality rates stabilize and fertility falls dramatically.

However, the transition is not uniform: different countries and regions entered it at different times, are currently in different phases of the process, and are going through those phases at different rates.[2] The timing and pace of changes in rates of mortality and fertility can be expected to vary from region to region in the future as well. Moreover, migration from one region to another reduces population growth in the source region and increases it at the destination.

Mortality and Life Expectancy

Before the demographic transition began, fertility and mortality were both high throughout the world: many children died in infancy, and people who reached adulthood tended to have many children and die relatively young. Famines and epidemics could quickly and unpredictably kill many people, causing large fluctuations in rates of mortality. As a consequence, most people were young, and very few lived to old age.

That pattern first began to change in Europe in the 1700s as improvements in living standards led to a decline in the death toll from plagues and famines and to less dramatic fluctuations in mortality (National Research Council, 2000). A second stage, during the 1800s, involved continued improvements in living standards and sanitation, leading to a gradual decline in mortality rates and a rise in average life expectancy, mainly in Europe and in regions (such as America) settled by Europeans. A third stage began around 1900, after which medical advances contributed to a rapid decline in mortality rates, especially in infant mortality. As a result, life expectancy at birth rose by roughly one-third of a year per year for much of the 20th century.[3] Finally, in a fourth stage that began around 1960, further medical advances have reduced mortality among the elderly, leading to improvements in life expectancy for those who have already reached advanced ages.[4] At present, people born today in most of the developed countries can expect to live well into their mid-70s or longer if current mortality rates prevail and even longer if those rates continue to fall. Life ex-

pectancy at birth in those countries is therefore projected to continuously rise well into the future (see Figure 1).[5]

The rest of the world has generally followed the same phases as the developed countries, but the timing has varied considerably, and as developing countries have adopted new technologies and habits, the phases have typically occurred increasingly rapidly. Much of Latin America and a number of other countries in other parts of the world began the transition in the first half of the 20th century and are now in the fourth stage of mortality reduction. For most of the developing world, though, the transition began around World War II and is now in its third stage. However, China and a few other developing countries have experienced very rapid improvements in life expectancy and are not far behind the developed countries. In contrast, the transition began later and has progressed more slowly in the countries designated by the United Nations as "least developed"—much of Sub-Saharan Africa, a few countries in southern and southeastern Asia, and a handful of other countries. For some countries, progress has even been significantly reversed by the HIV/AIDS epidemic.[6] (Life expectancy has also declined in some developed countries of the former Soviet bloc since its collapse in the early 1990s.)

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3. Life expectancy at birth is the number of years newborn infants will live, on average, if prevailing patterns of mortality at the time of their births stay the same throughout their lives. That measure is also referred to as "period" life expectancy because it depends on mortality rates in a particular period. A different measure, "cohort" life expectancy, calculates the number of years that newborn infants will live, on average, if mortality rates continue to improve as projected. See Social Security Administration (2005), pp. 78-79, for additional details.

4. The stages of improvement in mortality are discussed in National Research Council (2000), pp. 117-127.

5. The developed countries include those of Europe and North America, as well as Australia, New Zealand, and Japan. (Life expectancy in the United States is higher than the average for other developed countries but is lower than that of many.) The developing countries include those classified by the United Nations as "less developed" and "least developed." See Appendix B for a complete listing.

6. Of the 60 countries with the largest numbers of people living with HIV, 34 are in Africa, where more than two-thirds of the people infected reside. The remaining countries are in Latin America and the Caribbean (10), Asia (nine), Europe (five), and North America (two). Data available at www.un.org/esa/population/publications/POP_HIVAIDS2005/POP_HIVAIDS.htm.

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2. See Cohen (1995) and O'Neill and Balk (2001).

Figure 1.

Life Expectancy at Birth, 1950 to 2050

(Years of life expected)
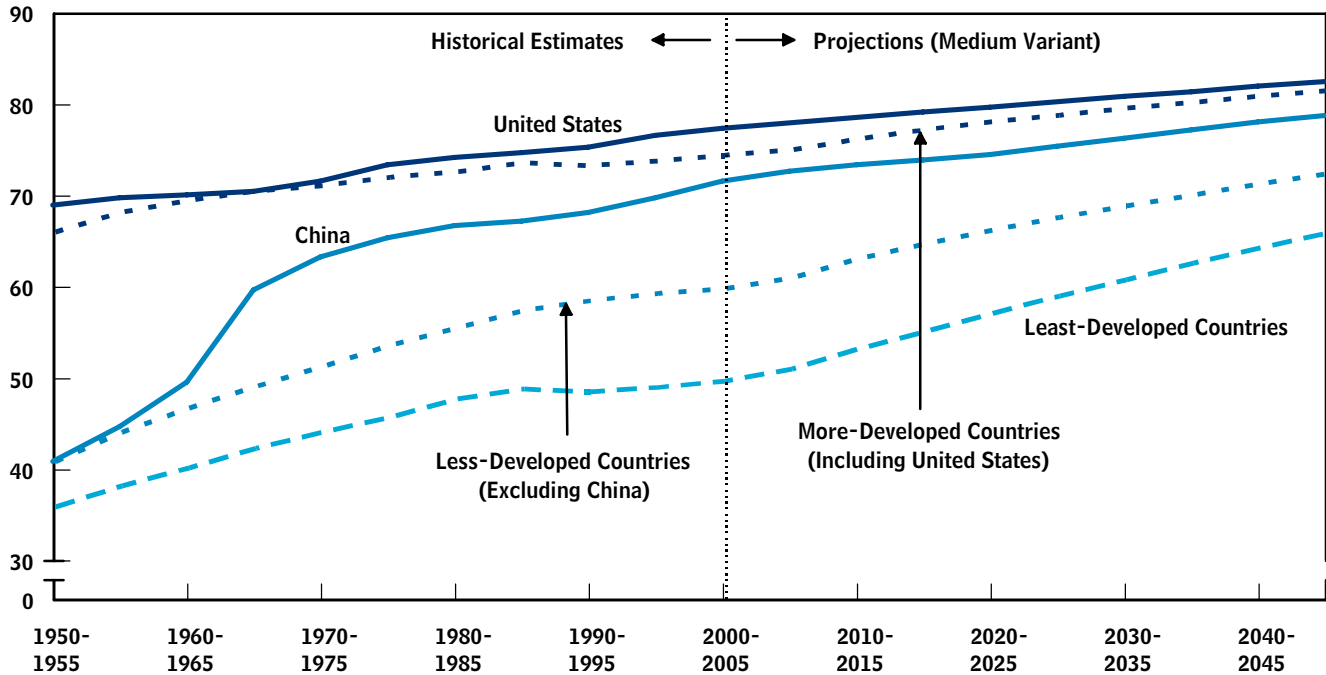
Source: United Nations, *World Population Prospects, 2004 Revision.*

Declining mortality and rising life expectancy represent an extraordinary improvement in human welfare. For the world as a whole, life expectancy at birth rose from under 30 years in 1900 to about 65 years in 2000 and, according to one fairly typical projection, may rise to 81 years by 2100 (Lee, 2003). Life expectancy for women in the record-holding country (which has changed over time) has risen steadily at about three months per year for 160 years—from 45 years in Sweden in 1840 to 85 years in Japan in 2000 (Oeppen and Vaupel, 2002). One expert estimates that over the course of the 20th century, increasing life expectancy contributed as much to human welfare as did rising levels of consumption (Nordhaus, 2003). Moreover, the medical advances and other improvements in living conditions that have helped extend people's lives have also made those additional years of life healthier (Mathers and others, 2001).

In developed countries, improvements in public health have reduced mortality among children and young people to such an extent that future improvements in life expectancy in those countries will come largely from advances that reduce mortality among old people. As a

result, life expectancy at older ages is likely to grow more rapidly than life expectancy at birth. In developing countries where infant mortality is still significant, life expectancies at birth and at advanced ages are projected to continue rising, gradually converging with expectancies in developed countries. However, according to standard projections by the United Nations, life expectancy will still be lower in the least-developed countries in 2050 than it was in the United States in 1950.

Fertility

Fertility rates began to decline in many advanced countries during the 1800s, typically—but not invariably—after mortality rates had already begun to fall.[7] In many of those countries, fertility rates fell to replacement levels— that is, levels that would keep the population roughly

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7. Fertility rates are typically measured by the total fertility rate, which measures the average number of children each woman would have if the age-specific fertility rates in her region or country in a given year remained unchanged over her expected lifetime (Census Bureau, 2004, Appendix E). For additional details, see www.census.gov/ipc/prod/wp02/appE.pdf.

Figure 2.

Total Fertility Rates, 1950 to 2050

(Births per woman)
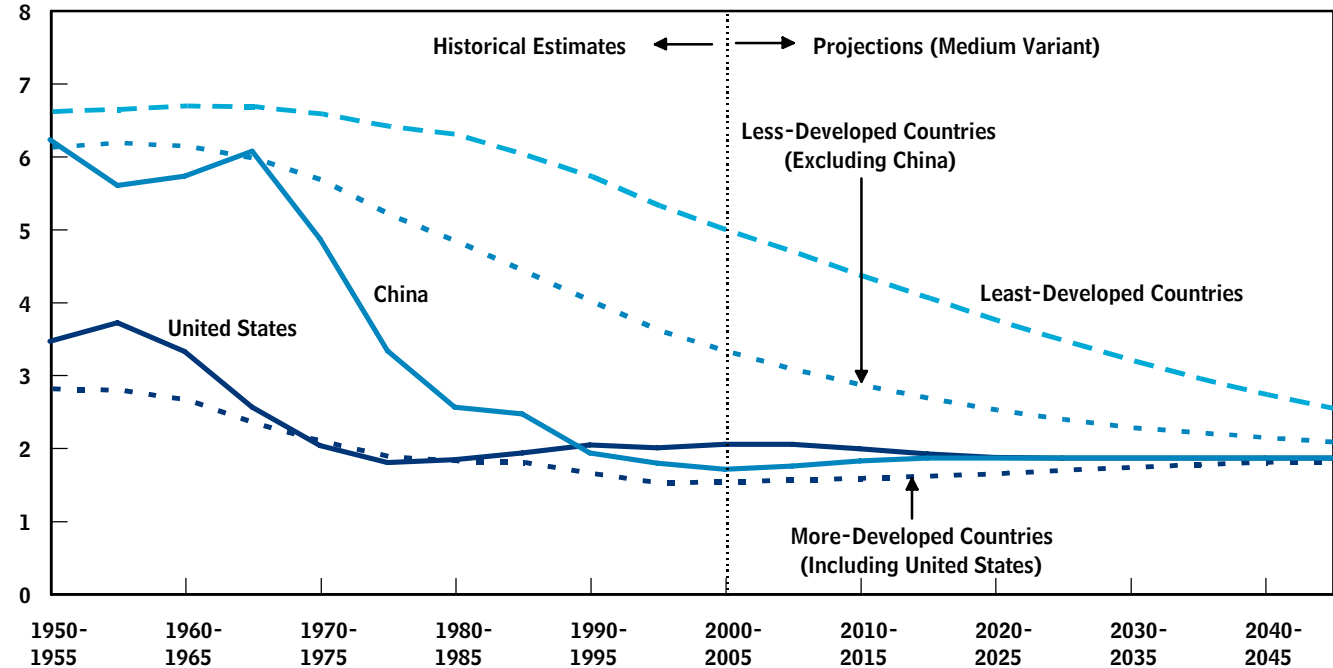
Source: United Nations, *World Population Prospects, 2004 Revision.*

constant over time—before World War II.[8] (Prior to the transition, fertility rates appear to have been typically on the order of five or more children per woman.)

Many developed countries experienced a burst of fertility following World War II—the United States' baby boom is a notable example—but have seen fertility levels fall to replacement levels or lower since then. Part of the decline in fertility rates is probably temporary, caused by women delaying having children until they are older. (That temporary fall in the fertility rate is referred to as the "tempo effect.") As the average childbearing age stabilizes, fertility should rise slightly—on the order of 0.2 children per woman—but in many countries, it is not clear whether fertility will rise back to replacement levels, stabilize at some other level, or stabilize at different levels in different countries (Bongaarts, 2001; and Demeny, 1997).

Fertility has remained higher in the United States than in most developed countries. Among the developed countries, only the United States currently has a fertility rate that is very near replacement levels, but many projections call for it to fall below replacement over the next decade (see Figure 2).[9]

In developing countries, the fertility transition started later but often proceeded much more rapidly than demographers expected on the basis of developed countries' experience at similar levels of development. Trends in total fertility also are considerably more varied among developing countries. In Latin American and Asian countries, fertility rates have fallen from around six births per woman in 1960 to fewer than three and are still declining (National Research Council, 2000, p. 56). Fertility has

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8.   See Demeny (1997). A country's replacement level of fertility depends in part on its mortality rates and on the ratio of men to women in the population. In developed countries today, the replacement level is generally about 2.1 children per woman.

9.   For its intermediate case, the Social Security Administration projects a long-term fertility rate in the United States of 1.95 children per woman. (It also projects a high-fertility case of 2.2 children per woman and a low-fertility case of 1.7.) See Social Security Administration (2005), p. 6. The Census Bureau, however, projects a rate of 2.2 children per woman (Hollman, Mulder, and Kallan, 2000, p. 25).

fallen especially sharply in China, where the government long attempted to control the number of children per couple; in the most rapidly industrializing countries of East Asia; and in a few other countries as well.[10] In the Middle East, in contrast, fertility rates have declined somewhat more slowly, and in Sub-Saharan Africa, they began to decline only in the 1980s and remain quite high. Nevertheless, fertility rates are projected to fall below 3.0 children per woman everywhere before 2040 and to gradually converge to something approximating replacement levels (see Figure 2). For the world as a whole, the total fertility rate dropped from five children per woman in 1950 to 2.7 in 2000 and is projected to fall to about 2.1 by 2050.

In nearly all regions, the bulk of the fertility transition has occurred or is expected to occur over a few generations at most. The decline in fertility rates largely results from people consciously choosing to have fewer children, but the motivations for that shift are not well understood. The conventional explanation is that parents may find it more beneficial to invest more resources in each child, raising a few well-educated children rather than raising a greater number of children with less education. According to that explanation, declining mortality makes each child more likely to survive to adulthood; economic growth allows children to be more productive over longer lives (and thus better able to care for elderly parents); and the time required to raise children becomes more costly in terms of forgone income. The evidence is somewhat mixed, however, in that the experiences of different countries are quite variable. In some cases, very poor countries have experienced much more rapid declines in fertility than the conventional explanation or historical trends would imply (Bloom and Canning, 2004a; and National Research Council, 2000, pp. 58-59). That evidence suggests that social traditions and norms, as well as the availability of contraception, also play a role in determining fertility. Other evidence suggests that increasing education, especially for women, tends to contribute to declines in fertility rates (Bongaarts, 2003).

Momentum
Once declines in mortality yield a large population of young people who can be expected to live into adulthood

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10. For further discussions, see Census Bureau (2004); Bongaarts (2001); Freedman and others (1994); Jackson (2002); and Jackson and Howe (2004).

and have children, a country almost certainly will experience further population growth (National Research Council, 2000, p. 27). If a decline in infant mortality leads to a substantial increase in the number of children who live to adulthood—and hence an increase in the population—that second generation is likely to produce another generation of children that is at least as large as the second and that is much larger than the first. Thus, even if mortality rates stabilize and fertility falls dramatically, the age structure of the population—that is, the distribution of the population according to age—will ensure that growth continues for a period of time as large, young cohorts replace smaller, older ones. Conversely, if a country's fertility levels decline below replacement levels and the population becomes sufficiently old, the same phenomenon can contribute to declines in population rather than to growth. Although that phenomenon—referred to as "momentum"—is not a fundamental cause of the demographic transition in the same sense that changes in mortality and fertility are, it is an important element in understanding how those changes translate into population growth and changes in the age structure.

Roughly two-thirds of the projected growth in global population over the next 50 years is expected to be the result of momentum. In the developed countries as a whole, however, momentum will actually lead to lower population as smaller generations with low fertility rates fail to fully replace themselves (National Research Council, 2000).

Migration
Migration between countries can significantly affect the growth rates of the source and destination countries. During the 19th century, migration tended to moderate population growth in European countries and augment it in others—the United States being a notable example. Migrants, moreover, tend to be relatively young and, at least in the United States over the past three decades, have tended to have more children than do natives (Kahn, 1994). Migration can thus play a significant role in the timing and pace of a country's demographic transition.

The Phases of the Transition
Despite variations in their timing and pace, the demographic forces discussed above have generated a similar pattern of demographic change in every region of the world.

■ Initially, prior to the transition, rates of mortality and fertility are both high, and the population is relatively young.

■ As the transition begins, mortality rates decline—particularly infant mortality—and life expectancies begin to rise. Because fertility rates remain high, the population begins to expand. The population typically becomes younger on average, and youth dependency— the number of children supported by the average working-age adult—increases.

■ As time passes, people begin to reduce the number of children they have; fertility rates begin to decline, and the rate of population growth slows—although momentum may cause the absolute increase in the number of people to continue to rise for a time. With proportionately fewer children being born and the continuing improvements in life expectancy, the population begins to get older. Youth dependency begins to fall, and the share of the population that is of working and saving age expands—a development referred to as the "demographic dividend" because it allows for greater economic output per capita.

■ As more time passes and an increasing portion of the population enters retirement, the old-age dependency ratio—the number of old people supported by the average working-age adult—tends to rise.

■ Ultimately, rates of mortality and fertility both reach low levels. Fertility may even decline below its long-run level as women postpone childbearing. The population may become considerably older, and population growth stabilizes or may even turn negative. Old-age dependency may continue to grow for many years, especially if life expectancy continues to rise.

Appendix A provides an illustrative example of the phases of the transition.

Past and Projected Population Trends

The best available estimates indicate that global population rose from about 1 billion in 1800 to 1.6 billion in 1900, 2.5 billion in 1950, and just under 6.1 billion people in 2000.[11] The population growth rate peaked at just over 2 percent per year in the early 1960s and is now growing at just over 1 percent per year. The single largest annual increase—about 88 million people—occurred around 1989; the current annual increment is about 74 million per year—the difference between 130 million births and 56 million deaths and the equivalent of about one-quarter of the U.S. population (see Figure 3).[12]

Projections

Projections typically call for fertility rates to continue to fall in all regions, for life expectancies to continue to rise, and for the global population to continue to grow but at a declining rate (see Box 1). If those trends continue as expected in the most widely cited standard projection, the United Nations' "medium variant," the global population will rise to about 9.1 billion people in 2050 and will stabilize near that value over the following 50 years (see Figures 1 and 2 on pages 3 and 4 and Figure 4 for details from that projection).[13] Nearly all of the growth is projected to occur in countries currently classified as "less developed," whose share of the global population will rise from roughly 81 percent to 86 percent. Although the U.S. population is expected to grow to about 395 million by 2050—about one-third larger than at present—the rest of the developed countries, taken together, are likely to experience a population decline.

Assumptions about future migration, which is more uncertain than many other elements of the population projections, generally project future levels of migration to be similar to current levels. Under such assumptions, migration alone will account for about half of U.S. growth between now and 2050, while migration to other developed countries will offset about 45 percent of the decline in their populations that would occur in its absence.[14] The projected levels of migration, however, would have relatively little effect on future population levels in the source countries in developing regions.

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11. The U.S. Census Bureau provides estimates of historical population through 1950 at www.census.gov/ipc/www/worldhis.html and estimates for 1950 and later at www.census.gov/ipc/www/worldpop.html.

12. Data from the Census Bureau's *International Data Base*, available at www.census.gov/cgi-bin/ipc/pcwe. The decline in population growth in 1958-1962 is due to the famine caused by the Great Leap Forward policy in China. See Yao (1999).

13. United Nations (2005 and 2004b).

14. The United Nations' medium-variant projections of migration to the United States are quite similar to those of the Census Bureau. The Social Security Administration's projections are somewhat lower.

Figure 3.

World Population Growth, 1950 to 2005

(Millions)   (Growth rate)
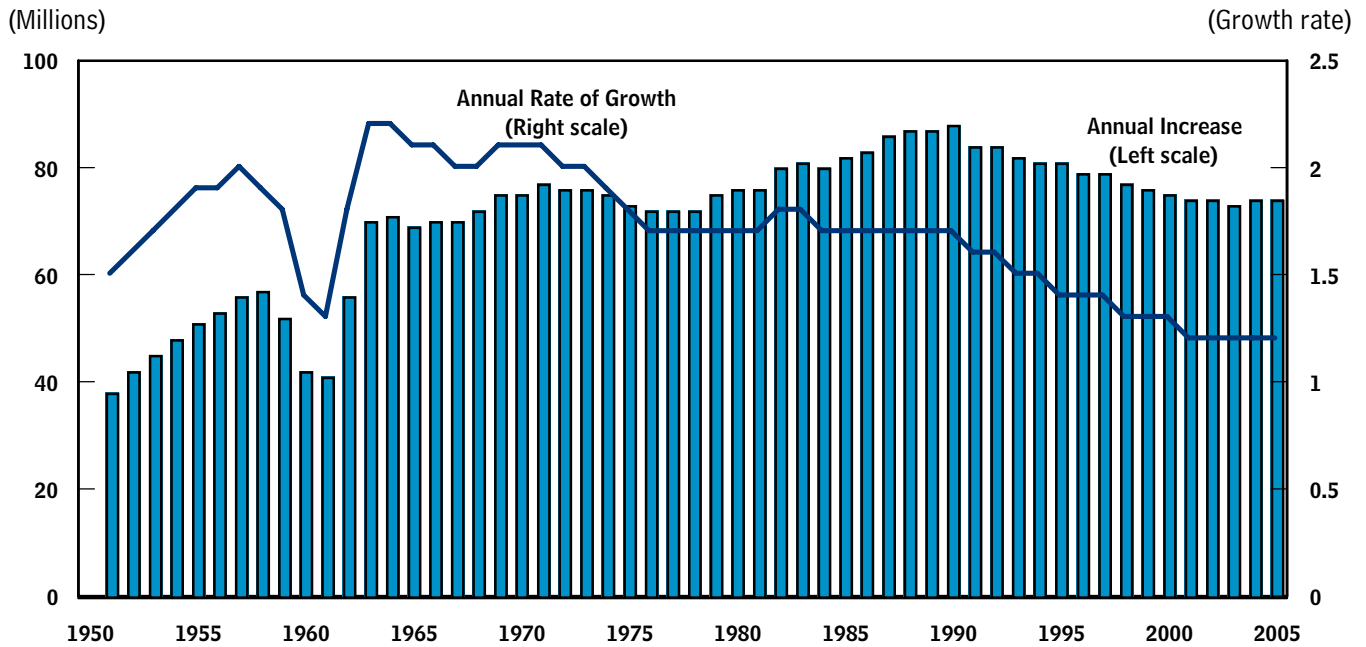
Source: Census Bureau, *International Data Base.*

Note: For both series, values show change from July 1 of the previous year to July 1 of the indicated year.

Figure 4.

Population, 1950 to 2050

(Billions)

Source: United Nations, *World Population Prospects, 2004 Revision.*

Box 1.

Sources of Population Projections

A number of official statistical agencies and private organizations publish projections of future population trends, using data from country-specific population censuses combined with assumptions about future trends in total fertilit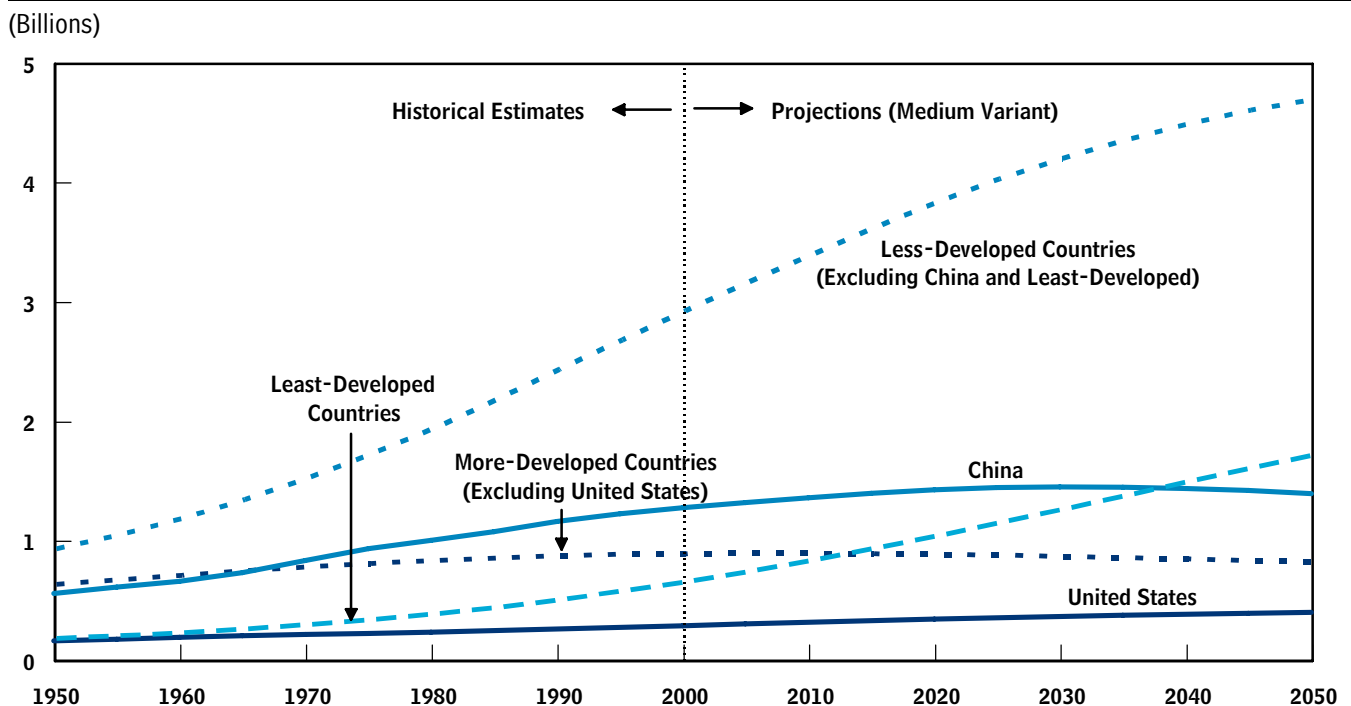y, life expectancy, and net migration (National Research Council, 2000, Chapter 1). Two organizations regularly issue detailed population projections for all countries: the International Programs Center (IPC) of the United States Census Bureau (Census Bureau, 2005) and the United Nations (United Nations, 2005). Both the IPC and the United Nations have recently released updated population projections through 2050.[1] Of the two organizations, the United Nations' projections are the most widely cited. Several other organizations also produce useful projections that provide additional perspective on population trends.[2]

Even though the IPC's and the United Nations' projections incorporate somewhat different base population estimates, as well as different fertility, mortality,

and migration assumptions, they are quite similar at the global level—differing by less than 2 percent in 2050—and broadly so at the regional level. Both organizations' estimates project rising life expectancies, declining fertility rates, slowing population growth, and significant population aging. However, the two projections' estimates of country-specific population can differ rather substantially: for instance, their projections for U.S. population in 2050 differ by more than 6 percent, or about 25 million people. (For purposes of illustration, this paper relies largely on the United Nations' population estimates and projections, mainly because the organization publishes several variations that illustrate some of the uncertainty surrounding its central projection. However, that choice should not be considered as reflecting greater accuracy or reliability of either set of projections over the other.)

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1. The United Nations also periodically releases longer-term projections, the most recent providing estimates to 2300 (United Nations, 2004b).

2. The World Bank publishes global population projections extending through 2050 (World Bank, 2004). The International Institute for Applied Systems Analysis (IIASA; Lutz, Sanderson, and Scherbov, 2004) produces probabilistic population projections extending through 2100. World Bank projections are used mainly for planning and project management, whereas IIASA's projections are used primarily to assess projection assumptions and methods (Ashford, 2001).

The global population is also projected to grow noticeably older. Under the assumptions of the medium-variant projection, for example, the share of the global population that is generally considered of working age (ages 18 to 64) will remain fairly steady over the next 50 years, whereas the share that is under age 18 will fall from about 34 percent to about 24 percent, and the share that is 65 and older will rise from about 7 percent to more than 16 percent.

Those global averages, however, mask significant differences among regional projections. In general, developed countries—as well as China and a handful of other developing countries—are likely to become much older, experiencing declines in their youth and working-age shares and significant increases in their elderly shares. In the United States, for example, the youth and working-age

shares are projected to decline by about 4 percentage points each, whereas the elderly share will rise by about 8 percentage points. Those trends will raise the old-age dependency ratio from about 20 percent today—that is, about five people of working age to each old person—to more than 35 percent by 2050—that is, about 3 to 1 (see Figures 5 and 6.[15]

In the rest of the developed countries as a whole, the youth share—which is already quite low—is projected to decline by only about 2 percentage points, but the working-age share falls by more than 10 points, and the elderly

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15. The notion of old-age dependency described here is somewhat arbitrary in that improvements in health care and living standards have generally increased the capacity of older people both to work and to enjoy leisure.

Figure 5.

Youth Dependency Ratios, 1950 to 2050

(Population ages 17 and younger as a percentage of population ages 18 to 64)
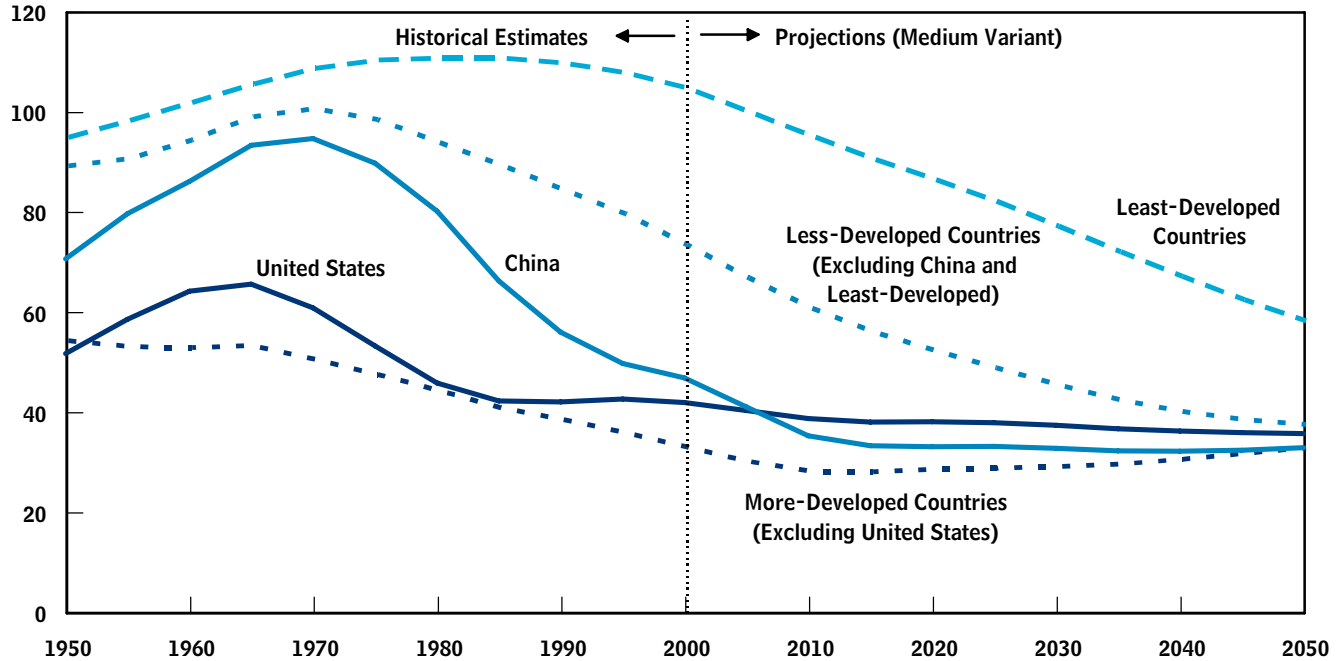
Source: United Nations, *World Population Prospects, 2004 Revision.*

Figure 6.

Old-Age Dependency Ratios, 1950 to 2050

(Ratio of population ages 65 and older to population ages 18 to 64)

Source: United Nations, *World Population Prospects, 2004 Revision*.

Box 2.

Fertility Rates in China and India

The contrasting experiences of China and India vividly illustrate how differences in fertility rates result in dramatic differences in countries' population structures. During the 1960s, China had about 50 percent more people than India and had already achieved a considerably higher life expectancy—about 55 years versus 47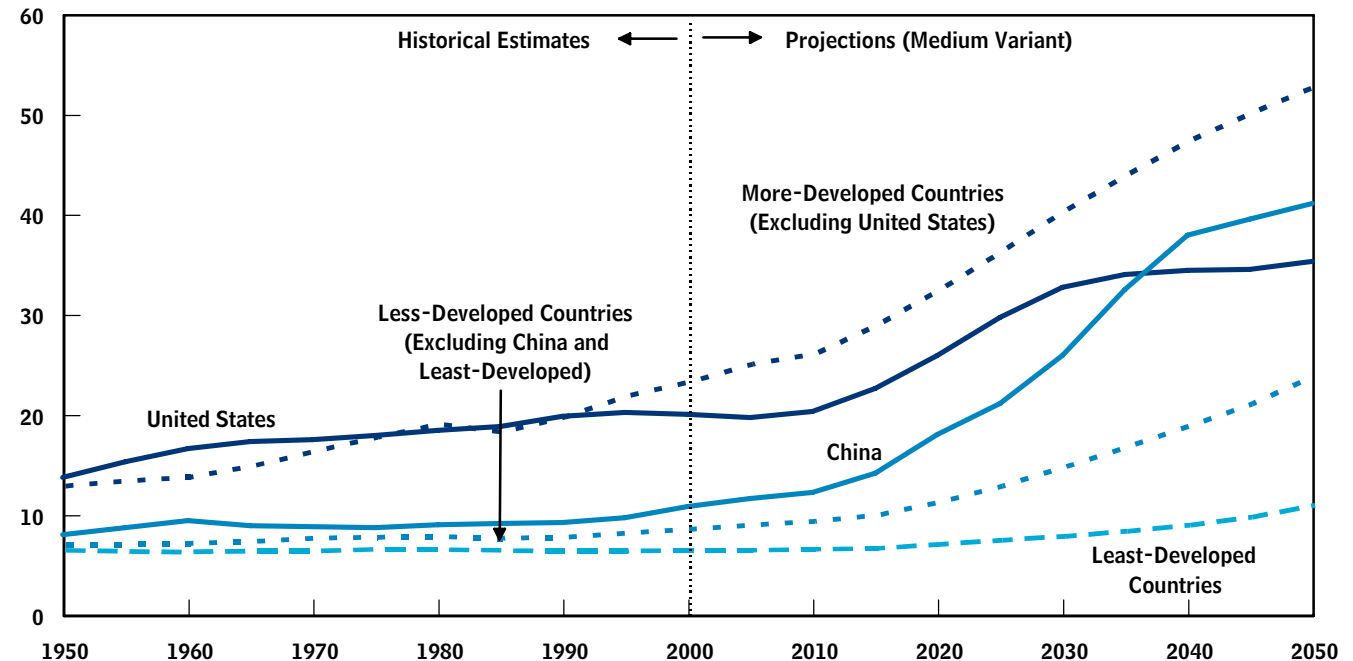 years. However, they were very similar in a number of important ways: both countries' fertility rates were extremely high (5.9 and 5.8 children per woman, respectively); their populations were growing at nearly the same annual rate—2.4 percent versus 2.3 percent; and with children ages 17 and younger making up about 45 percent of each's population, both countries faced an extended period of rapid population growth. (See the figure to the right.)

Deeply concerned with the prospect of rapid population growth, the Chinese government instituted a policy during the late 1970s largely limiting couples to only one child. That policy contributed to a dramatic reduction in fertility rates: by the late 1990s, China's rate had fallen to under 1.8 children per woman, only about half as large as India's rate of 3.4. As a consequence, China's annual rate of population growth fell to under 1 percent during the 1990s while India's remained near 2 percent; and by 2000,

Fertility Rates, 1950 to 2050

(Children per woman)
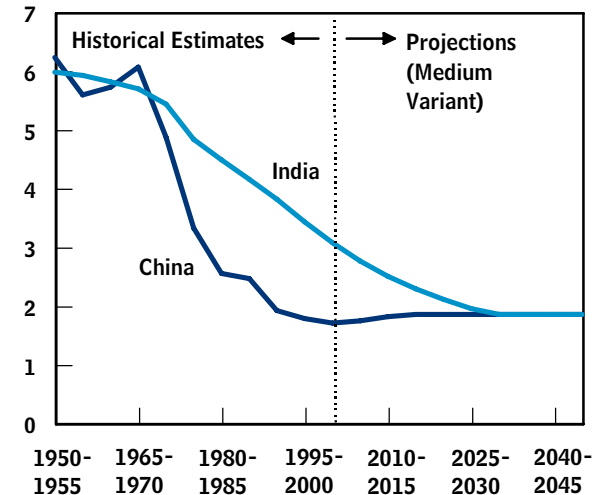
Source: United Nations, *World Population Prospects, 2004 Revision.*

Note: Values apply to five-year increments beginning in 1950.

share rises by 12 points. Those changes will raise the region's old-age dependency ratio from about 25 percent today (four working-age people to each old person) to about 53 percent (less than 2 to 1). And China faces an even more dramatic change: its youth and working-age shares decline by about 8 percentage points each, whereas the elderly share rises by about 16 points. By 2050, according to those projections, China will have an even older population than will the United States. Although there are about nine people of working age for every old person in China today, by 2050, the ratio will be 2.5 to 1 (see Box 2 for a comparison of China's and India's population prospects).

Other developing countries, in contrast, will typically experience dramatic declines in their youth shares coupled with increases in their working-age and elderly shares, according to the medium-variant projection. For the "less-

developed" countries, a nearly 15 percentage-point decline in the youth share is projected to be offset by a 5 percentage-point increase in the working-age share and a 10 percentage-point increase in the elderly share. For the "least-developed" countries, most of the decline in the youth share will be offset by an increase in the working-age share. Those countries, therefore, face the prospect of a significant "demographic dividend"—an increase in potentially productive labor that is not needed to support children and old people—before their populations begin to experience the dramatic aging that is already beginning to affect the developed countries.

Historical and projected population pyramids for the world as a whole and for specific countries and regions illustrate the aging of the populations of the United States, other developed countries, and China, as well as the very

Box 2.

Continued

children ages 17 and younger made up less than 30 percent of China's population while comprising more than 40 percent of India's. At the same time, working-age people made up a much larger share of China's population than India's—nearly 9 percentage points larger. The country's fertility decline was paying off in a demographic dividend as more people with fewer children to raise had more time to work.

The consequences for China of that rapid drop in fertility rates, combined with rising life expectancies, are very likely to unfold over several generations. According to the United Nations' projections, India's burgeoning population will overtake China's by about 2030, when each country will have nearly 1.5 billion people and when the working-age share in each will be about 63 percent. However, children will make up a much smaller share (and old people a much larger share) of China's population than India's, and it will be India that experiences enhanced growth in per capita output because of demographic factors. By 2050, the elderly will comprise nearly 24 percent of China's shrinking population but less than 15 percent of India's still-growing one. (See the figure below.)

Population Ages 65 and Older, 1950 to 2050

(Percent of total population)
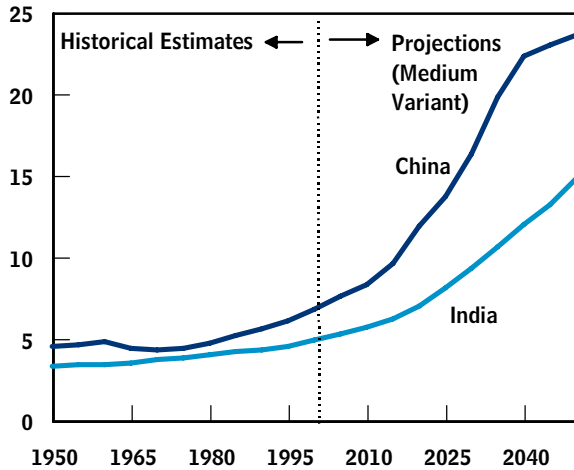
Source: United Nations, *World Population Prospects, 2004 Revision.*

rapid growth and large youth and working-age shares of other developing countries (see Figure 7 on page 12).

Uncertainty in Projections

The projections discussed above are generally point estimates based on sets of specific assumptions about trends in fertility, mortality, and migration. Because those trends can be forecast only with a significant degree of uncertainty—uncertainty that increases dramatically the longer into the future the forecast goes—the projected estimates of population and age structure are necessarily uncertain as well.

Past Errors. Past population projections may help provide a sense of the range of uncertainty. Almost all of the various projections of world population in 2000 that were carried out after 1950 turned out to be off by less than 4 percent. However, projections for specific coun-

tries were off by much more—by about 5 percent on average for five-year projections and 17 percent for 30-year projections. (Researchers made significant advances in developing projection techniques in the 1950s and 1960s but have made relatively few technical improvements since then.)

Two sets of assumptions have contributed most significantly to past forecast errors. First, researchers have consistently underestimated how rapidly fertility and birth rates would decline—particularly in developing countries. Second, they have consistently overestimated mortality rates and thus failed to anticipate how rapidly life expectancies would improve, particularly for the elderly. Those errors have resulted in overestimates in the projected number of young people and underestimates in the number of old people.

Figure 7.

Population Structure During the Demographic Transition
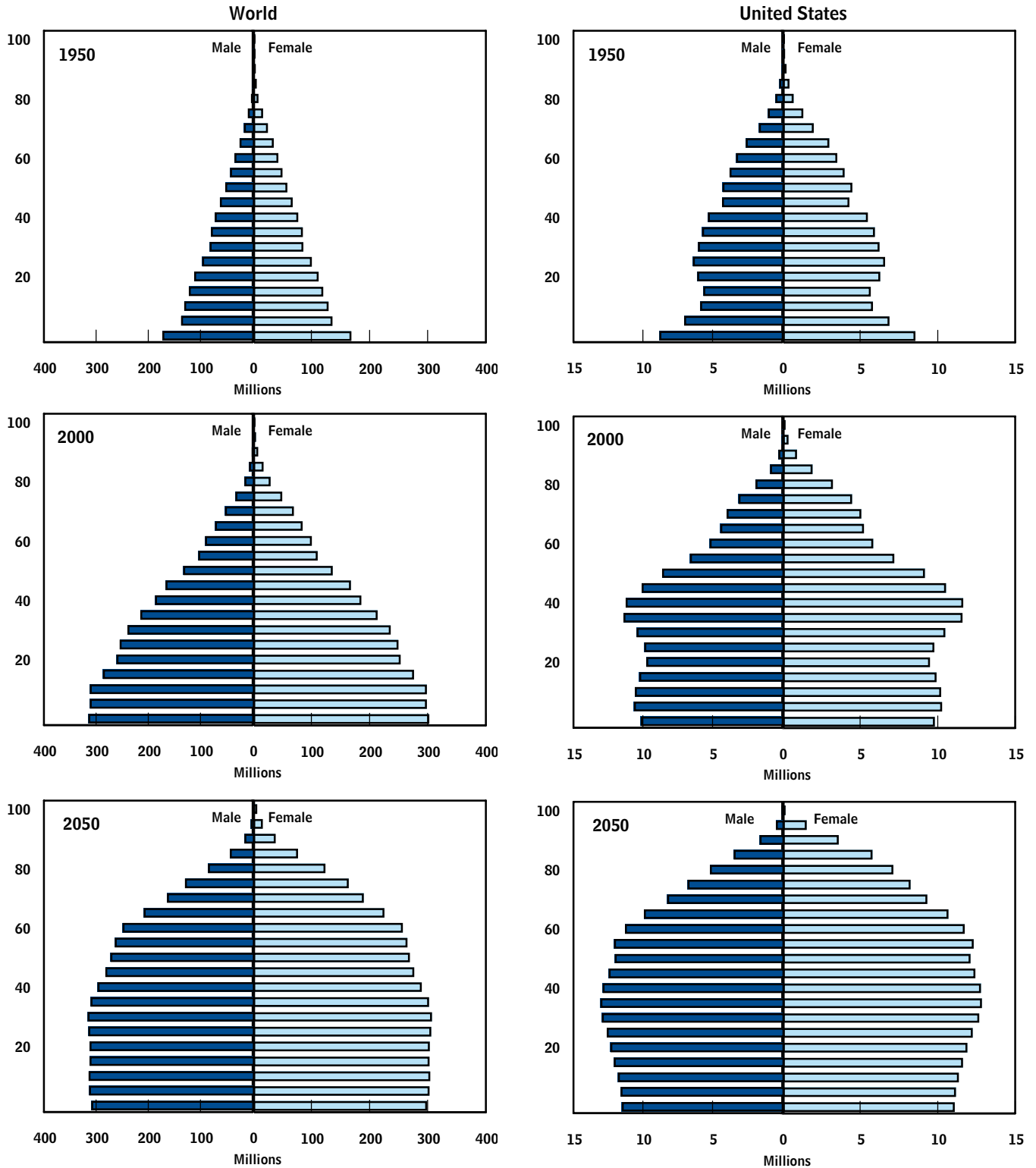
(Age)

Source: United Nations, *World Population Prospects, 2004 Revision*.

Note: Projections for 2050 are taken from the United Nations' Medium Variant.

Figure 7.

Population Structure During the Demographic Transition (Continued)

(Age)

Source: United Nations, *World Population Prospects, 2004 Revision*.

Note: Projections for 2050 are taken from the United Nations' Medium Variant.

Figure 7.

Population Structure During the Demographic Transition (Continued)

(Age)

Source: United Nations, *World Population Prospects, 2004 Revision*.

Note: Projections for 2050 are taken from the United Nations' Medium Variant.

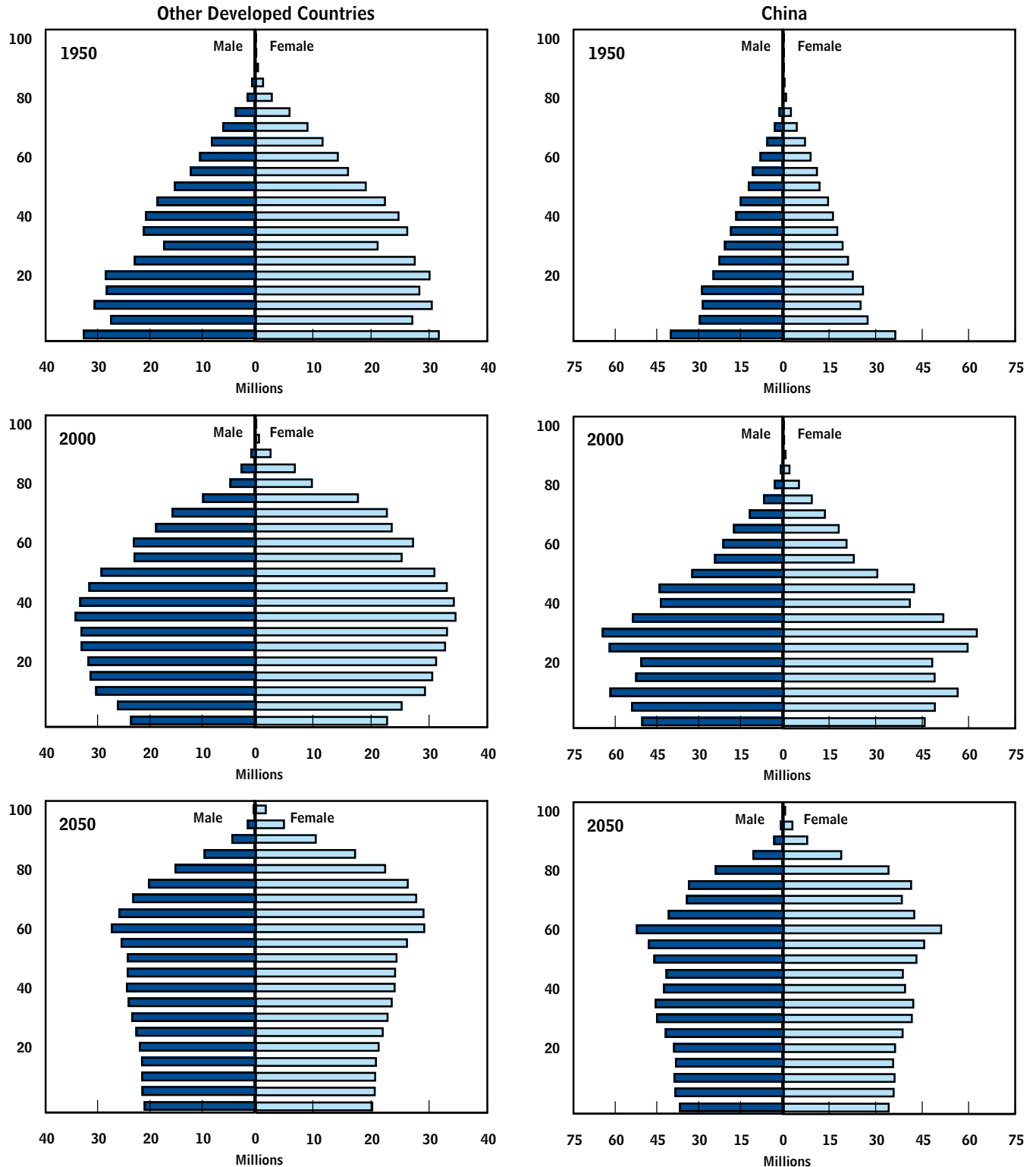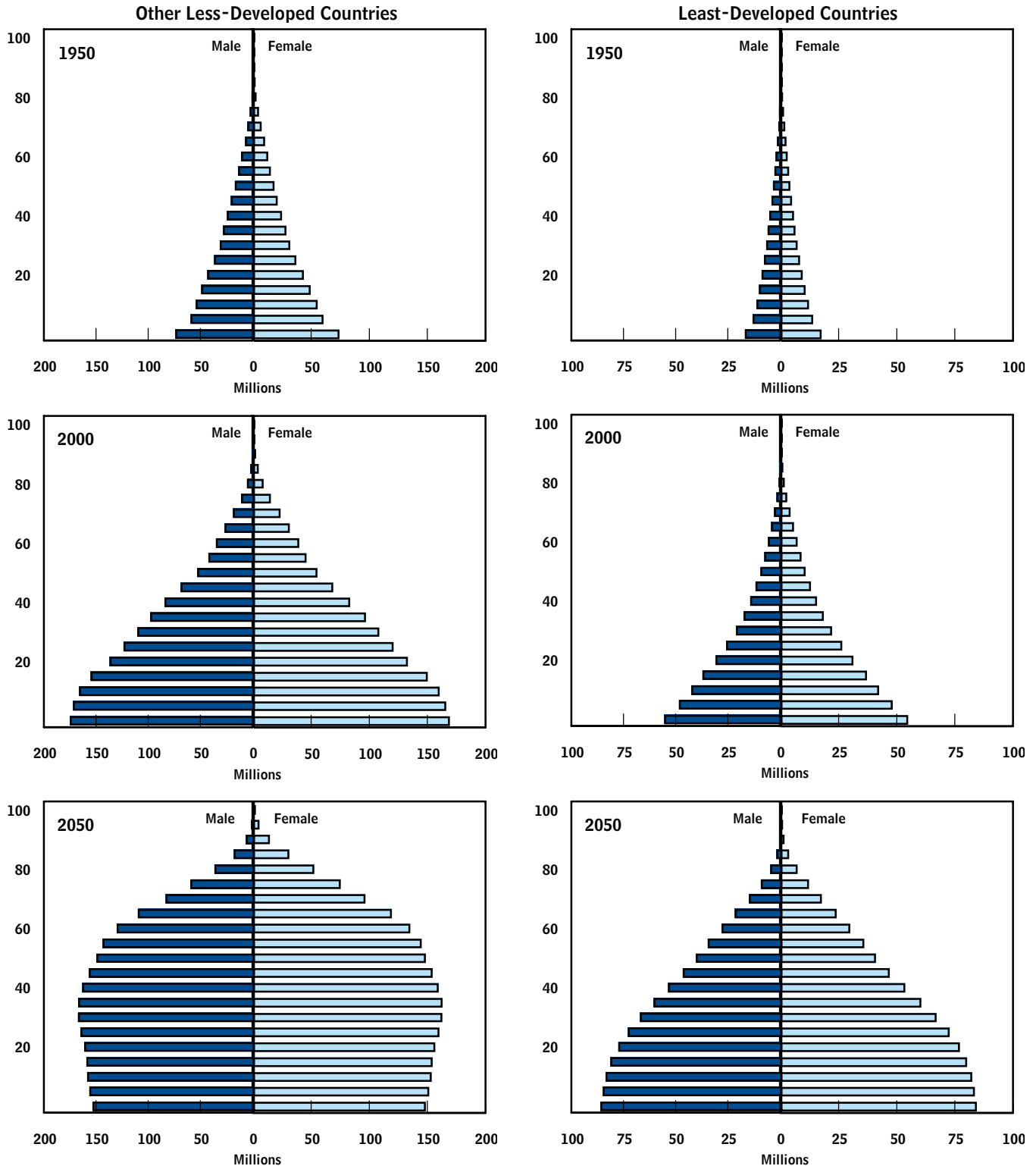The first mistake tends to lead to overestimates of population levels, whereas the second tends to lead to underestimates. However, the errors resulting from the first have been larger than the errors resulting from the second, yielding population growth projections that consistently have been too high. Both types of mistakes, however, have yielded projections of population aging that have been consistently too low.[16]

Mortality. In the past, initial decreases in mortality mainly involved improvements in sanitation and nutrition that provided the greatest benefit to young people, whereas later decreases involved medical improvements—such as the treatment of heart disease and cancer—that benefited the elderly to a greater degree. Many developing countries are still in the process of providing the basic improvements in sanitation and nutrition and are likely to see significant reductions in mortality at all ages and gradual convergence to levels found in developed countries. Most developed countries, in contrast, have reduced mortality at young ages to such an extent that future improvements in life expectancy will largely reflect gains in the average years of life enjoyed by the elderly (National Research Council, 2000, Chapter 5).

Experts generally conclude that technological improvements, new applications of existing technologies, and changes in lifestyles are likely to continue improving life expectancies in developed countries, but views differ substantially on how much or how rapidly those improvements might occur.[17] For example, in its "intermediate" case, the Social Security Administration projects average life expectancy at birth in the United States to rise from about 77 years in 2000 to 81 years in 2050, whereas the United Nations projects it to rise to 83 years and the Census Bureau to 84.[18] Moreover, the Social Security Administration allows for uncertainty by including a low projection of 79 years in 2050 and a high projection of 84 years, whereas the Census Bureau's range is from 82 years to 86 years. Thus, official projections in the United States allow for the possibility that life expectancies will improve by as little as two years or as much as nine years

over the first half of the 21st century. At the extreme optimistic end of the range, some experts argue that life expectancies could rise to 100 years or more in at least some developed countries over the next century or so (Oeppen and Vaupel, 2002).

Whatever may be the potential for improvements in life expectancy through reductions in mortality, the potential also exists for unexpected shocks—emerging epidemics, wars, environmental or social problems, or economic setbacks, for example—to increase mortality and reduce life expectancies in one or more countries or regions (Lutz, Sanderson, and Scherbov, 2004).[19] Demographers never expected that life expectancy would decline substantially in the former Soviet bloc after its collapse, nor did they anticipate the drop induced by HIV/AIDS in Sub-Saharan Africa. Similar developments could offset increases in life expectancy resulting from technological improvements and behavioral changes, but their unpredictability makes them difficult to incorporate into projections.

Fertility. Although researchers can draw on past trends to revise their assumptions about how rapidly fertility rates will decline—with current emphasis on the rapidity of the decline in developing countries—they have little basis for projecting whether different countries' fertility rates will stabilize or not, or at what level or levels they may stabilize (Kirk, 1996; Demeny, 1997; Bongaarts, 2002; and Lee, 2003). In most developed countries and even in some developing ones, total fertility has been well below the replacement rate of 2.1 children per woman for some time. Such low rates are at least partly the result of women delaying childbearing (the tempo effect mentioned earlier), and the completion of the transition

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16. National Research Council (2000). The two notable exceptions have been the failure to anticipate the drop in life expectancy in countries seriously affected by the HIV/AIDS epidemic and in the former Soviet bloc.

17. See, for instance, Oeppen and Vaupel (2002); Olshansky, Carnes, and Desesquelles (2001); and Tuljapurkar, Li, and Boe (2000).

18. See Social Security Administration (2005), p. 80; Hollmann, Mulder, and Kallan (2000), p. 26; and United Nations (2005). The projections presented in this paragraph are for period life expectancy, which is based on mortality rates in the specified year. Cohort life expectancies, which involve mortality rates projected over succeeding years, are several years higher because they reflect ongoing projected reductions in mortality rates.

19. See Table 5-2 in National Research Council (2000, p. 142) for a comprehensive list of post-World War II declines in life expectancy associated with social, political, economic, and epidemiological crises. The bulk of those episodes have taken place in countries where life expectancy was less than 55 years. One notable exception is the slow decline in life expectancy in the former Soviet Union and in the former Soviet bloc countries preceding the collapse of communism.

Figure 8.

Uncertainty in Population Projections

(Billions)
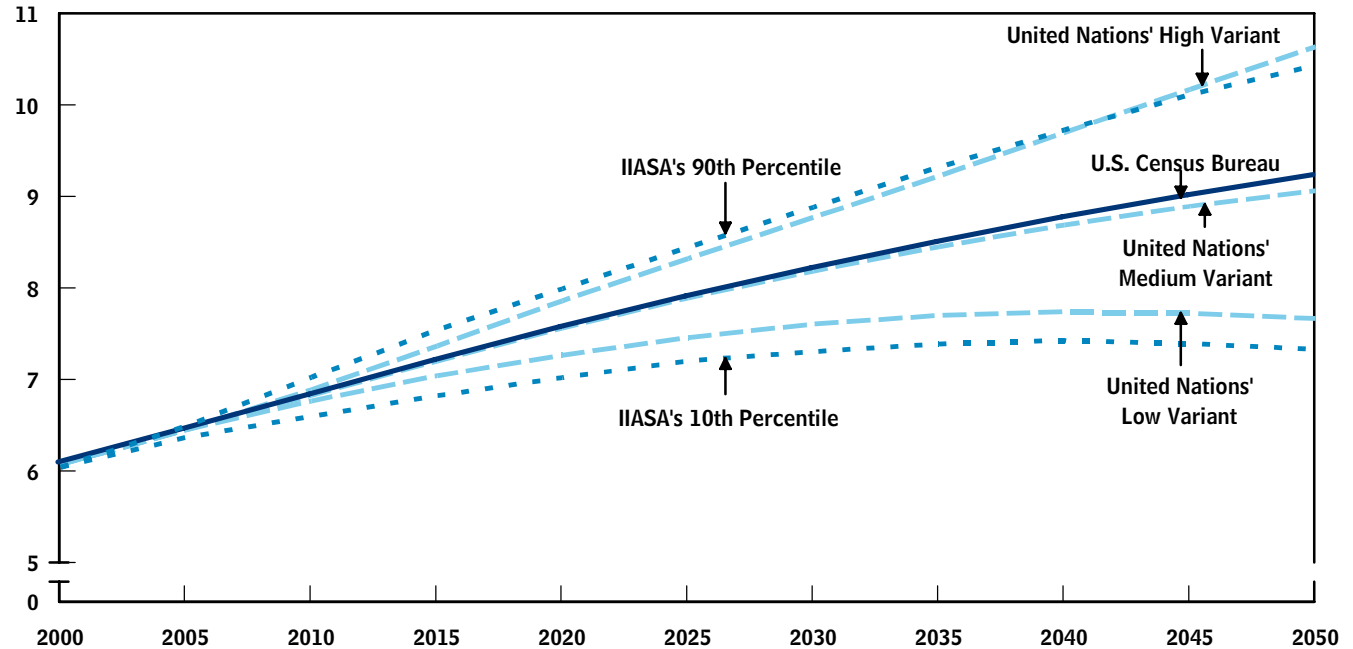
Source: United Nations, *World Population Prospects, 2004 Revision;* Census Bureau, *International Data Base;* and Lutz, Sanderson, and Scherbov, eds. (2004).

Note: IIASA = International Institute for Applied Systems Analysis.

to later childbearing, should it occur, should result in somewhat higher total fertility levels. Moreover, surveys in developed countries indicate that families want more children than they are having (Bongaarts, 2001). Those facts raise the possibility of a rebound in fertility rates.

Other considerations, however, suggest that fertility rates may not rebound a great deal: contraceptive technologies have improved and have fallen in cost; marriage rates have declined in many countries while divorce rates have risen; women have devoted increasing resources to education and careers, raising the opportunity costs of having children; and the relative costs of child care and education have also risen (Lutz, Sanderson, and Scherbov, 2004; and United Nations, 2004). Such considerations suggest that fertility rates may remain below replacement levels indefinitely in many countries (Frejka and Calot, 2001).

Uncertainty about fertility levels also affects projections for developing regions: although levels are declining throughout developing regions, demographers do not

have much information about how many children families in those regions desire or how (or why) those preferences are changing over time. Fertility may not necessarily decline with rising income in all regions: for instance, wealthy, oil-producing Saudi Arabia and Oman are experiencing long-term declines in total fertility, but such declines began earlier and progressed more rapidly in poorer, non-oil-producing countries such as Egypt and Jordan.

Given all of those considerations, the United Nations' standard or "medium" assumption that total fertility will generally trend to about 1.85 children per woman—with all developed countries and many developing countries reaching that rate by 2050—appears to be reasonable, but actual outcomes may deviate substantially.

Ranges of Uncertainty. Several research groups have produced sets of projections to characterize some of the uncertainty surrounding their central estimates. The United Nations' most recent published projections include a set involving alternate assumptions about trends in fertility,

life expectancy, and net migration (see Figure 8.) Variations in fertility assumptions of about half a child per woman less or more than the middle assumption result in global population levels of 7.7 billion to 10.6 billion in 2050. Similarly, the National Research Council, assessing an earlier projection by the United Nations, concluded that there was a 95 percent probability that the global population would be between 7.9 billion and 10.9 billion in 2050, with a median estimate of 8.9 billion.[20] Another group, the International Institute for Applied Systems Analysis (IIASA), has arrived at very similar results using a more detailed probabilistic approach. IIASA's median projection for global population in 2050 is 8.8 billion, with a roughly 80 percent chance that the population will be between 7.3 billion and 10.4 billion (Lutz, Sanderson, and Scherbov, 2004).

All of those groups project greater uncertainty for individual countries' populations than for the world as a whole. Projections of migration are particularly speculative: migration data are often unreliable; migration is often caused by unpredictable events such as wars and famines; and public policy plays a predominant and unpredictable role in determining migration levels.[21]

The uncertainties in fertility and mortality trends also contribute to uncertainties in projections of dependency ratios for youth and the elderly. For example, under the United Nations' alternative projections with lower and higher fertility ratios, youth dependency in the United States varies from 25 percent to 46 percent in 2050, whereas old-age dependency varies from 40 percent to 32 percent.

The similarity of those groups' ranges of projections suggests that they may provide a realistic bracketing of the range of likely population levels in 2050. Moreover, past global projections have turned out to be fairly accurate, suggesting that outcomes near the extremes of the uncertainty range are unlikely, barring unexpected shocks. Nevertheless, neither past errors nor the uncertainty ranges encompass the full range of possible outcomes: unpredictable events such as technological advances, natural disasters, and war could yield population levels higher or lower than the ranges presented here.

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20. National Research Council (2000, p. 10).

21. Lutz, Sanderson, and Scherbov (2004); Census Bureau (2004); and Hollman, Mulder, and Kallan (2000).

The Economic Effects of the Demographic Transition

By causing large shifts in the age structure of the population, a country's demographic transition can contribute to significant changes in its economy. Those changes occur because people's economic behavior—particularly their saving—tends to vary in predictable ways over their lifetimes (see Box 3). As the relative sizes of different age groups change over periods of decades, then, aggregate economic behavior should also shift in predictable ways:

■ Children and young adults tend to consume more than they produce as they grow up and acquire an education. Rapid growth in the number of children in the early stages of the transition can therefore reduce the accumulation of physical capital and slow the rate of economic growth. That effect may be partly responsible for the relatively low rates of growth of many African countries in the past few decades (Bloom and Canning, 2004a).

■ Working-age adults tend to produce more than they consume; they also save more than do other groups—especially in the later stages of their careers. Therefore, as a country's boom generations enter the workforce, the rate of economic growth may rise. The economy also may experience increases in saving and investment per capita and thus may grow even more rapidly—especially if families begin to reduce the number of children they have, freeing people to participate in the workforce for longer than they would otherwise. (Such a demographic dividend is believed to have contributed to the relatively rapid growth of some East Asian countries, as well as that of Ireland in recent years.) When the workforce is relatively young, investment may exceed saving, but as the workforce ages, saving is more likely to exceed investment (Williamson, 2001).

■ By contrast, old people tend to consume more than they produce and to spend more on health care than do other groups. Moreover, as a country's boom generations begin to retire and relatively few young people replace those generations in the labor force, the rate of economic growth may begin to slow. Although such effects are not widely evident yet, they are expected to appear in many developed countries over the next generation. (For instance, CBO's projections show slower

Box 3.

How People's Saving Changes over Their Lifetimes

The standard framework that economists use to understand how people behave over their lifetimes is called the "life-cycle theory" or "life-cycle model." That model is based on the idea that people try to maintain a relatively stable level of well-being throughout their lives. According to the model, one important way that they do so is to save during periods when they believe their income is relatively high—generally by developing skills in their early years and saving income during their prime earning years—and to draw down their savings when they believe their income is relatively low—for instance, by spending down their accumulated savings in retirement.[1] As a result, the model predicts that people's saving rates will tend to be hump-shaped over time: young people save relatively little, middle-aged ones save significantly more, and old people save less or even consume some of their savings. Similarly, the model predicts that in the face of considerable uncertainty about whether they may become unemployed and about how much income they may have, people will accumulate precautionary savings to tide them over during possible periods of low employment or income.

State-of-the-art versions of the life-cycle model appear to match certain aspects of the behavior of many (but not all) households, suggesting that they do aim to maintain a relatively stable level of well-being in the face of both anticipated changes and shocks.[2] However, even the most advanced versions of the model do not match all aspects of actual behavior, suggesting that people have diverse motives that the model does not account for.

Several researchers have used sophisticated versions of the life-cycle model to study the implications of population aging in a single country.[3] To date, however, only relatively simple versions of the model (such as those discussed in this paper) have been used to analyze the effects of the full demographic transition in one or more countries. Those studies provide some general insights into the economic implications of demographic transitions, but their results are best thought of as possible scenarios rather than forecasts of likely future outcomes.

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1. For an introduction to life-cycle modeling and related empirical literature, see Browning and Crossley (2001). An older but more detailed reference is Deaton (1992).

2. See, for example, Scholtz, Seshadri, and Khitatrakun (2004).

3. See, for example, Nishiyama (2004).

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growth in potential gross domestic product in the future as the growth in the labor force slows and investment's share of GDP declines.)

■ The gradual improvements in health and life expectancy that underlie all of those cohort effects may have an independent macroeconomic effect. Knowing they are likely to live longer than previous generations did, people may decide to work longer, or save more for a longer retirement, or both. In the United States, that phenomenon was long overshadowed by the impact of rising incomes, which, by making workers wealthier, have allowed them to retire earlier and enjoy more leisure. However, the gradual but sustained rise since the mid-1990s in the participation of older men in the labor force may indicate that some people are adjusting their expectations to the likelihood that they will live longer, healthier lives (Bloom and Canning, 2004b).

Although such macroeconomic effects of the demographic transition may seem straightforward, they tend to be outweighed and obscured by the effects of business cycles, productivity growth, public policies, and other influences. Researchers have therefore found it difficult to distinguish such effects empirically from the myriad of other factors that contribute to or inhibit economic growth—so much so that, until recently, most experts tended to subscribe to a "neutralist" view that population shifts do not tend systematically to promote or impede the growth of per capita income.[22] Nevertheless, recent studies sug-

gest that the demographic transition may have the sorts of macroeconomic consequences that standard economic theory would predict (Williamson, 2001; and Bloom and Canning, 2004a). An increase in the share of a country's population that is of working age tends to be associated with higher rates of saving and investment and higher output and wealth per capita, whereas an increase in the youth or elderly shares has the opposite effect (Callen, Batini, and Spatafora, 2004).

The effect of the demographic transition on aggregate output may be the opposite of its effect on individuals (Bryant, 2004). For instance, a growing labor force may increase aggregate output and consumption but may also increase competition among workers, which tends to reduce individual wages and even per capita output. An aging population may experience declining total output, but the declining workforce may experience rising wages and per capita output.

Different Effects of Changes in Mortality and Fertility

The effects of an aging population on a country's economy depend on the relative importance of changes in mortality and fertility as well as the timing of those changes (Bryant, 2004). Rising life expectancy and falling fertility contribute to population aging in different ways.

All else being equal, an increase in life expectancy causes a gradual increase in a country's population, labor force, and output and tends to increase the old-age dependency ratio.[23] In contrast, declining fertility tends to reduce population, labor force, and output and to decrease youth dependency over the long run. (As mentioned previously, however, that decrease in youth dependency may allow the workforce to save and invest more for a few decades, thus yielding an increase in economic growth.)

If fertility declines several generations after life expectancies start to rise, instead of within a generation, the population will expand much more and the labor force will

tend to grow for a longer period of time. If fertility falls very rapidly instead of gradually, dependency ratios of youth and the elderly will change more rapidly. Similarly, effects will vary depending on whether life expectancies increase relatively slowly or very rapidly.

An aging population can trigger divergent effects on a country's supply of domestic savings and its demand for investment (Bosworth, Bryant, and Burtless, 2004). For example, a country with a young, rapidly growing labor force may not save a great deal but may have a high demand for investment. In contrast, a country with falling fertility and a rapidly aging labor force may have higher saving but lower demand for investment. Depending on the relative strength and timing of fertility and mortality trends, aging may affect saving more than investment or vice versa.

In a relatively closed economy—a country that restricts the international movement of goods and financial capital—such variations would lead to changes in rates of return. (For instance, low saving relative to investment demand will tend to raise rates of return, inducing greater saving and lower investment until the two come into balance.) In an open economy, however, those variations may also lead to international flows of capital from countries with high saving relative to investment to those with high investment demand relative to saving. Those flows, in turn, will tend to affect rates of return and levels of output in both sets of countries—as will the relative size of the countries' economies. The next two sections discuss domestic effects of a transition and the cross-border implications of differences in the timing and pace of transitions in different countries.

Saving, Retirement, and Returns

The available evidence indicates that demographic changes have measurable but relatively limited effects on saving and retirement, on the demand for different types of financial and real assets, and on asset prices and rates of return (Poterba, 2004; and Bosworth, Bryant, and Burtless, 2004). That evidence suggests that other influences—such as business cycles, technological changes, and unexpected shocks—tend to have impacts on saving decisions and asset markets that are large enough to obscure the influence of population shifts. In some important cases, the historical evidence is quite puzzling: for instance, during the past two decades, as the baby-boom generation has reached its prime working and saving years in the United States and the country has enjoyed

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22. For instance, the United States experienced a relatively constant saving rate from the late 1940s to the mid-1980s despite the birth of the baby-boom generation and its entry into the labor market. Then, as the baby boomers reached their peak earning years, the saving rate began to trend downward.

23. The economic effects of rising life expectancy also depend on whether the rise results mainly from reductions in infant mortality or from reductions in adult mortality.

Box 4.

International Flows of Goods, Services, and Capital

As an extended period of relative peace, institutional developments, and rapid technological advances has helped sustain the expansion of international economic activity since the end of World War II, countries around the world have become increasingly economically interdependent. Households and firms have increasingly substituted foreign goods for domestically produced ones and foreign investments for domestic ones.[1] That interdependence can be seen in the growing importance of international trade and foreign investment in most countries' economies and in the decreasing correlation between national rates of saving and investment.[2]

Interdependence increasingly exposes many countries to the effects of economic developments and policies in other countries. If demand falls in one country, for instance, other countries' exports to that country also will tend to fall. Conversely, if changes in a country's tax code lead to greater opportunities for profitable investment, investors from other countries may channel more funds there, thus reducing the funds available elsewhere.

As those examples illustrate, the effects can be transmitted through trade flows or through investment flows. In a closed economy, domestic demand must be met through domestic production, and investment must be funded by domestic saving. An open economy, in contrast, can have more (or less) consumption than output and more (or less) investment than saving. The difference between output and consumption will be made up by net exports, and the difference between investment and saving will be made up by net inflows of financial capital from other countries.

In fact, trade imbalances must be offset by investment flows. A net inflow of capital—in effect, an international loan—will allow the citizens of a country to consume more than they produce in the aggregate. Such an inflow will be accompanied by a trade deficit—an excess of imports over exports. A net outflow of capital, conversely, will be accompanied by a trade surplus: in effect, a country cannot lend the world money unless it also sells more to the rest of the world than it buys from it.

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1. Bosworth, Bryant, and Burtless (2004).

2. For example, trade has become much more important to the U.S. economy: U.S. exports rose from about 5 percent of gross domestic product (GDP) during the 1960s to more than 10 percent during the 1990s, while imports rose from about 5 percent of GDP to nearly 12 percent. Similarly, the stock of U.S. investments overseas was the equivalent of about 25 percent of GDP in 1976 but rose to about 65 percent in 2003, while foreigners' investments in the United States rose from the equivalent of 16 percent of GDP in 1976 to nearly 88 percent in 2003. Helliwell (2004) discusses the decreasing correlation between national rates of saving and investment.

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relatively low levels of both youth and elderly dependency, the private saving rate has consistently trended downward.

Despite the lack of strong empirical evidence for demographic impacts on saving, investment, and asset markets, some experts contend that the theoretical arguments in favor of such effects are too strong to discount. For instance, studies that use simulation models to analyze the economic effects of a stylized demographic shift—a baby boom followed by a bust, similar to that experienced by the United States—generally conclude that the shift may generate modest changes in levels of saving and investment and may thus modestly affect rates of return (Poterba, 2004; and Geanakoplos, Magill, and Quinzii, 2004). Typically, such studies find that both investment demand and rates of return rise as the baby boomers enter the workforce, that rates of return tend to fall as that generation reaches its peak saving years, and that investment demand falls as the generation retires. The relative demand for risky and riskless assets also may shift, affecting the risk premium—the higher rate of return earned by stocks compared with bonds (Brooks, 2003).

Other theoretical studies, which focus on the effect of rising life expectancy, conclude that longer life spans are likely to lead people to invest more in their education, work longer, and save more—but less than proportionately to the increase in life expectancy. Thus, every year of increased life expectancy is likely to increase the amount of time spent working by proportionately less than it increases the time spent in retirement (Bloom, Canning, and Moore, 2004).

International Effects

One important reason why the economic effects of demographic shifts may be difficult to observe is that most countries' economies are increasingly interconnected to others through international flows of goods, services, and financial capital. (Migration between countries adds an additional complication.) Because changes in the age structure of a country's population—such as those brought about by the demographic transition—can affect its levels of output, consumption, saving, and investment, they can also influence other countries' economies through such international flows (see Box 4). Moreover, those international flows can work to offset or enhance the domestic effects of the shifts in population. With countries going through different phases of the transition at different rates, the effects of each country's transition on the others are very difficult to untangle.

Thus, the growing degree of interdependence greatly complicates efforts to understand the economic effects of the demographic transition in any given country. Researchers are only beginning to develop a rigorous understanding of those interactions at a theoretical level and to empirically distinguish such effects from the many other economic variables that influence trade and capital flows (Bryant, 2004).

As with empirical research on the domestic economic effects of demographic shifts, research on the cross-border effects is complicated by the fact that changes in fertility and mortality vary among countries and are occurring simultaneously. That variation and simultaneity, combined with the myriad of other influences that affect international flows, make it difficult to distinguish specific effects from demographic developments. Nevertheless, current research indicates that countries with relatively large shares of their population of working age—such as most developed countries, as well as China—tend to have more saving than investment and therefore tend to have capital outflows. (In this respect, the United States is unusual in

having more investment than saving.) In contrast, countries with relatively large shares of very young or old dependents—such as the developing countries—tend to have capital inflows (Helliwell, 2004).

Those research findings accord well with the results of recent theoretical studies. Such studies generally conclude that, all else being equal, countries that experience rising life expectancy and declining fertility sooner than others do—or that have more rapid or dramatic changes relative to others—will tend to have greater saving than domestic investment opportunities as their boom generations reach their peak saving years (Brooks, 2003; Bryant, 2004; and Bosworth, Bryant, and Burtless, 2004). That excess capital will tend to flow to the countries whose transitions are occurring later or less rapidly or dramatically, reducing the real exchange rate of the capital-exporting country's currency and raising those of the importing countries' currencies.[24]
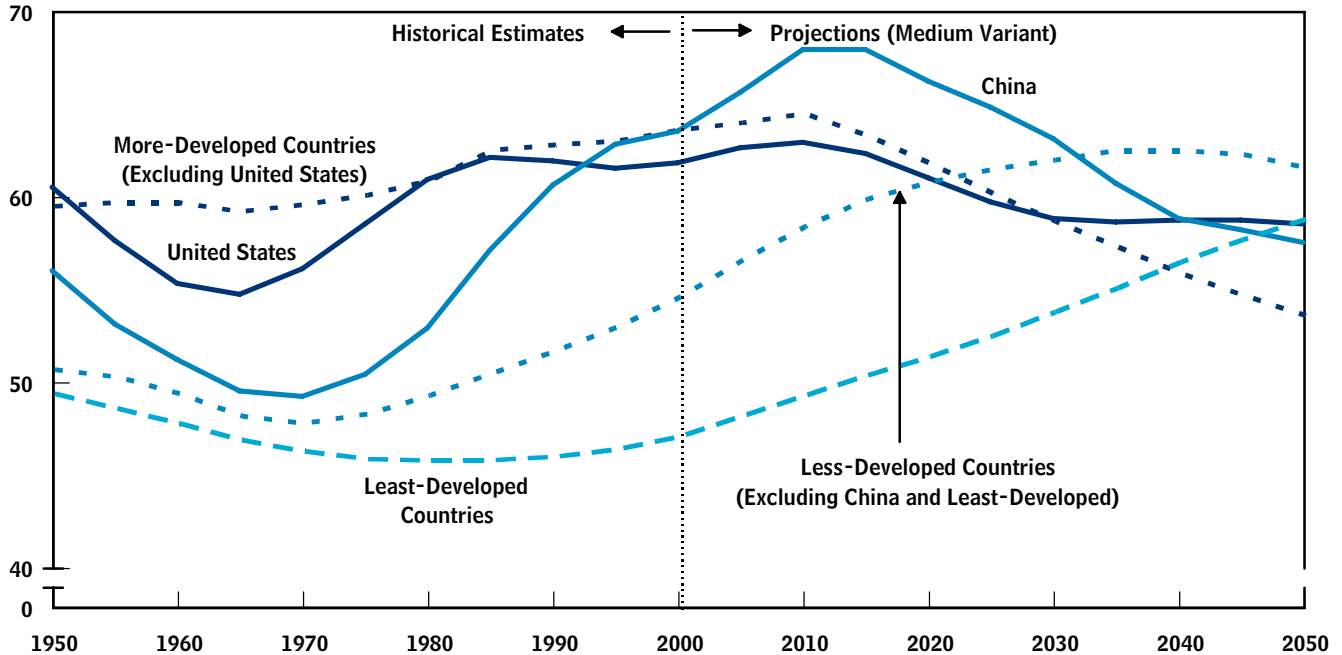
The capital flows that result from international differences in fertility or mortality trends also tend to transmit some of the economic effects of the sending country's demographic transition to the countries that receive the flows. For example, current research suggests that the capital outflows that result from a decline in fertility may tend to moderate the decline in rates of return that would occur in the sending country if all of the capital were invested domestically (Bryant, 2004). The outflows may also reduce rates of return in the receiving country. Simi-

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24. Matters become more complex, however, if some countries have begun their transitions sooner, but other countries, which began their transitions later, are going through their transitions more rapidly. In such cases—which may be the most realistic ones—the direction of flow is less clear-cut, and further research is needed to clarify understanding.

Theoretical studies find that the effects of demographic shifts on a country's exchange rate may also depend on how they affect the relative size of the country's population and economy compared with those of other countries. Rising life expectancy alone will tend to increase a country's long-run population and output, increasing the supply of its products on international markets and thus, perhaps, reducing their relative price (the exchange rate). In contrast, declining fertility alone will tend to reduce the country's population and output, making its products relatively scarce and possibly increasing their price. (That price effect will depend on consumers' relative preferences for products from different countries.) Which effect dominates at any given point will depend on the comparative strength of the country's mortality and fertility trends—and the strength of its trends relative to those of other countries.

Figure 9.

Working-Age Population Shares, 1950 to 2050

(Population ages 18 to 64 as a percentage of total)

Source: United Nations, *World Population Prospects, 2004 Revision.*

larly, capital outflows that result from an increase in life expectancy may also tend to moderate the decline in rates of return for a period of time. Over the longer run, however, as elderly populations spend down their savings, capital flows back into the country may tend to reduce domestic rates of return.

The current tendency should be for capital to flow from countries with large working-age shares to those with smaller shares—that is, from the developed countries and China to the other developing countries. However, that trend could gradually reverse over the next few decades as the working-age share of the population begins to decline in the developed countries and China and the working-age share continues to rise in the other developing countries (see Figure 9). With developing countries reaping the benefits of declining fertility and rapid growth in their working-age populations, it may well be the case that capital—and workers—will tend to flow from developing countries to developed ones. In fact, the United States has experienced unexpectedly large capital inflows (as well as immigration) from developing countries in recent years.

The Influence of Public Policy

The macroeconomic effects of the demographic transition also may be enhanced or offset by a country's economic policies and institutions. For example, a country's demographic dividend may be enhanced by deliberate investment in the education of its growing workforce, by the development of flexible financial markets to channel savings to productive uses, and by openness to trade—as appears to have been the case in several East Asian countries that experienced significant economic growth in the past few decades. In contrast, policies that tend to discourage investment and trade could offset the benefits of a growing workforce, as is believed to have occurred in many developing countries in Latin America and Africa. In such cases, a rapidly expanding, young, working-age population may become a source of social and political stress rather than of economic growth.

Similarly, the extent to which a country can support an expanding elderly population is likely to depend on its success in taking advantage of its demographic dividend. Countries that grow old before they grow rich may face enormous challenges in providing for an increasing number of elderly citizens. Policies that encourage adequate

retirement preparations could help a country prepare for a growing elderly population, whereas the effects of aging could be exacerbated by pension programs that discourage private saving or continued part-time work in retirement or that encourage relatively early retirement.[25] The existence of a public pension system—particularly an unbalanced system that places increasing stress on a government's fiscal position—may tend to discourage some private saving for retirement and thus may greatly reduce the cushioning effects of open-economy interactions on demographic stresses (Bryant, 2004). Developed countries

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25. Some studies even suggest a feedback effect between retirement policies and fertility. The results of those studies imply that policies that make it easier to accumulate retirement savings—or that guarantee retirement benefits—may reduce the incentive to have children and may thus contribute to a more rapid decline in fertility than would have been the case without them (Ehrlich and Kim, 2005; and Boldrin, De Nardi, and Jones, 2005).

appear to face varying degrees of vulnerability to pension-induced stresses. For example, France, Italy, and Spain face a high degree of vulnerability, whereas the United States, United Kingdom, and Australia face considerably less (Jackson and Howe, 2003).

Some observers have proposed an increase in immigration from relatively youthful developing countries to aging ones as a means of mitigating some of the economic stress caused by aging populations in developed countries. Those observers argue that more immigration would increase the workforce available to support the elderly population (without the additional cost of raising the workers), thus reducing the cost of support per individual worker. Recent research on that issue, however, suggests that increased immigration may do little to offset the stresses of aging on developed countries' pension systems (Fehr, Jokisch, and Kotlikoff, 2003).

A

The Phases of the Demographic Transition: An Illustrative Example

The phases of the demographic transition discussed on page 6 are illustrated in the accompanying figures, which present a generic, hypothetical demographic transition based largely on historical and population trends in developed and developing regions of the world.[1] On the basis of assumed trends in fertility and mortality rates, death rates decline and birth rates rise after 20 years, and birth rates stabilize and then decline after 90 years (see

Figure A-1). The population growth rate rises for nearly a century, peaking at around 2.6 percent per year after about 100 years, but gradually declines thereafter and falls below zero within 220 years. The population itself quadruples during the first century and quadruples again in the second century but begins to gradually decline thereafter. The expansion and decline are also accompanied by substantial shifts in the population structure, with a long-term decline in the youth share of the population and an increase in the elderly share. Population pyramids—showing the distribution of the population by 10-year age groups—for years 20, 90, 190, and 250 illustrate the increase in population as well as the growing size of the elderly population over time (see Figure A-2).
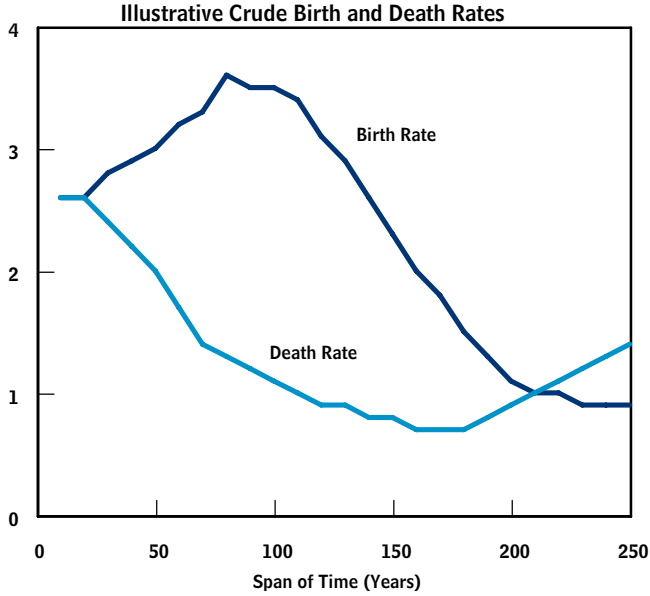
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1. The hypothetical transition is calculated in 10-year increments so that rates are average annual rates over 10-year increments. Birth rates are calculated as the ratio of 0- to 9-year-olds at the end of a decade to the total population at the beginning. Death rates are calculated as one minus the ratio of people 10 years of age or older at the end of a decade to the total population at the beginning.
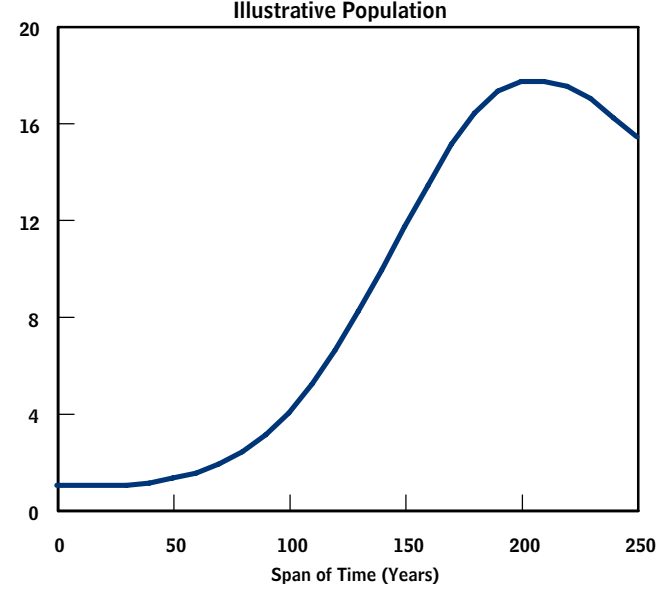
Figure A-1.

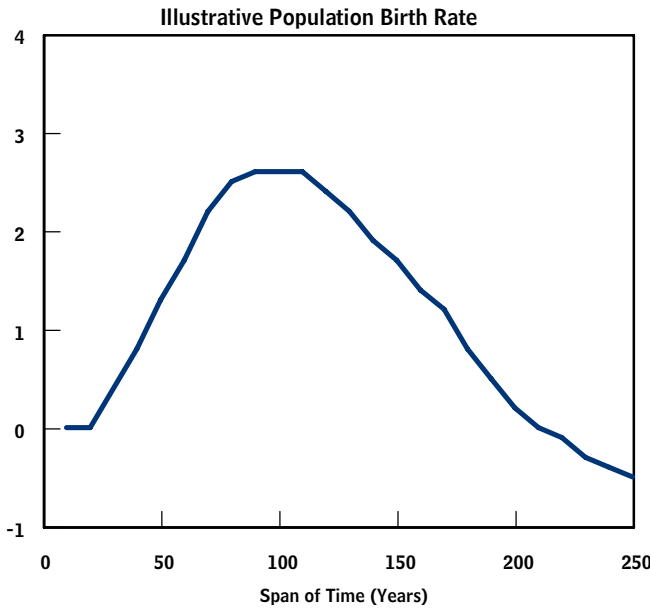# Illustrative Crude Birth and Death Rates
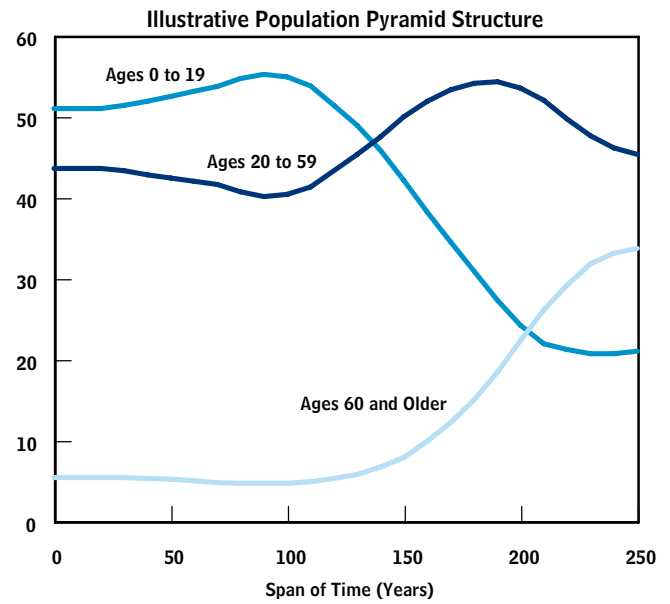
(Percent per year)

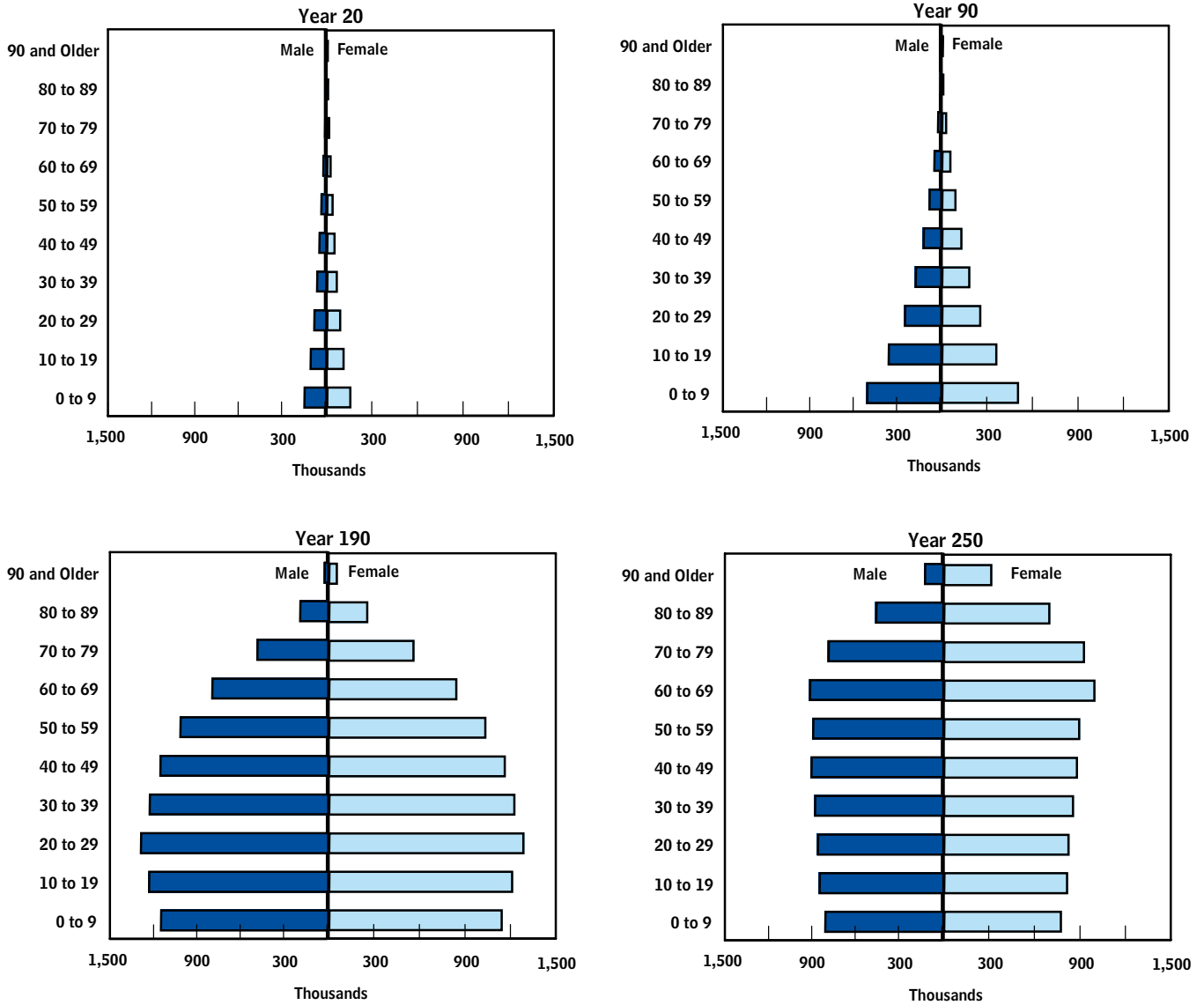(Millions)

(Percent per year)

(Percent)

Source: Congressional Budget Office.

Figure A-2.

Population Pyramid for the Illustrative Demographic Transition

(Age)

Source: Congressional Budget Office.

B

Definition of Regions

This paper classifies the world's countries into five regions that are defined largely on the basis of a United Nations classification, according to which the developed countries include all of the European and North American countries, as well as Japan, Australia, and New Zealand. All other countries are classified as less developed, with a subclass of countries defined as least developed. Apart from the United States and China, which are classified as distinct regions, this paper follows the United Nations classification.

The classification is relatively straightforward and simple to use, but it obscures some important differences among countries. Most importantly, several countries in the south and east of Europe are classified as developed, even though they have much lower average incomes than some industrialized Asian countries classified as less developed. However, those sets of countries are not very populous, and the distinction between developed and less-developed countries is largely valid.

Developed Countries (Excluding the United States)	Less-Developed Countries (Excluding China)		Least-Developed Countries
North America	**Africa (Eastern)**	**Asia (Eastern)**	**Africa (Eastern)**
Canada	Kenya	China, Hong Kong SAR	Burundi
Bermuda	Mauritius	China, Macao SAR	Comoros
Greenland	Réunion	Democratic People's	Djibouti
Saint-Pierre-et-Miquelon	Seychelles	Republic of Korea	Eritrea
Asia	Zimbabwe	Mongolia	Ethiopia
Japan	**Africa (Middle)**	Republic of Korea	Madagascar
Oceania	Cameroon	**Asia (South-central)**	Malawi
Australia	Congo	India	Mozambique
New Zealand	Gabon	Iran (Islamic Republic of)	Rwanda
Europe (Western)	**Africa (Northern)**	Kazakhstan	Somalia
Austria	Algeria	Kyrgyzstan	Uganda
Belgium	Egypt	Pakistan	United Republic of Tanzania
France	Libyan Arab Jamahiriya	Sri Lanka	Zambia
Germany	Morocco	Tajikistan	**Africa (Middle)**
Liechtenstein	Tunisia	Turkmenistan	Angola
Luxembourg	Western Sahara	Uzbekistan	Central African Republic
Monaco	**Africa (Southern)**	**Asia (Southeastern)**	Chad
Netherlands	Botswana	Brunei Darussalam	Democratic Republic of the
Switzerland	Namibia	Indonesia	Congo
Europe (Northern)	South Africa	Malaysia	Equatorial Guinea
Channel Islands	Swaziland	Philippines	Sao Tome and Principe
Denmark	**Africa (Western)**	Singapore	**Africa (Northern)**
Estonia	Côte d'Ivoire	Thailand	Sudan
Faeroe Islands	Ghana	Viet Nam	**Africa (Southern)**
Finland	Nigeria		Lesotho
Iceland	St. Helena		
Ireland			
Isle of Man			

Developed Countries (Excluding the United States)	Less-Developed Countries (Excluding China)		Least-Developed Countries

Europe (Northern), Continued
  Latvia
  Lithuania
  Norway
  Sweden
  United Kingdom
Europe (Eastern)
  Belarus
  Bulgaria
  Czech Republic
  Hungary
  Poland
  Republic of Moldova
  Romania
  Russian Federation
  Slovakia
  Ukraine
Europe (Southern)
  Albania
  Andorra
  Bosnia and Herzegovina
  Croatia
  Former Yugoslav Republic of
    Macedonia
  Gibraltar
  Greece
  Holy See
  Italy
  Malta
  Portugal
  San Marino
  Serbia and Montenegro
  Slovenia
  Spain
	Asia (Western)
	  Armenia
	  Azerbaijan
	  Bahrain
	  Cyprus
	  Georgia
	  Iraq
	  Israel
	  Jordan
	  Kuwait
	  Lebanon
	  Occupied Palestinian Territory
	  Oman
	  Qatar
	  Saudi Arabia
	  Syrian Arab Republic
	  Turkey
	  United Arab Emirates
	Latin America and the Caribbean (Caribbean)
	  Anguilla
	  Antigua and Barbuda
	  Aruba
	  Bahamas
	  Barbados
	  British Virgin Islands
	  Cayman Islands
	  Cuba
	  Dominica
	  Dominican Republic
	  Grenada
	  Guadeloupe
	  Jamaica
	  Martinique
	  Montserrat
	  Netherlands Antilles
	  Puerto Rico
	  Saint Kitts and Nevis
	  Saint Lucia
	  Saint Vincent and the
	    Grenadines
	  Trinidad and Tobago
	  Turks and Caicos Islands
	  United States Virgin Islands
		Latin America and the Caribbean (Central America)
		  Belize
		  Costa Rica
		  El Salvador
		  Guatemala
		  Honduras
		  Mexico
		  Nicaragua
		  Panama
		Latin America and the Caribbean (South America)
		  Argentina
		  Bolivia
		  Brazil
		  Chile
		  Colombia
		  Ecuador
		  Falkland Islands (Malvinas)
		  French Guiana
		  Guyana
		  Paraguay
		  Peru
		  Suriname
		  Uruguay
		  Venezuela
		Oceania (Melanesia)
		  Fiji
		  New Caledonia
		  Papua New Guinea
		Oceania (Micronesia)
		  Guam
		  Marshall Islands
		  Micronesia (Federated
		    States of)
		  Nauru
		  Northern Mariana Islands
		  Palau
		Oceania (Polynesia)
		  American Samoa
		  Cook Islands
		  French Polynesia
		  Niue
		  Pitcairn
		  Tokelau
		  Tonga
		  Wallis and Futuna Islands
			Africa (Western)
			  Benin
			  Burkina Faso
			  Cape Verde
			  Gambia
			  Guinea
			  Guinea-Bissau
			  Liberia
			  Mali
			  Mauritania
			  Niger
			  Senegal
			  Sierra Leone
			  Togo
			Asia (South-central)
			  Afghanistan
			  Bangladesh
			  Bhutan
			  Maldives
			  Nepal
			Asia (Southeastern)
			  Cambodia
			  Democratic Republic of
			    Timor-Leste
			  Lao People's Democratic
			  Republic
			  Myanmar
			Asia (Western)
			  Yemen
			Latin America and the Caribbean (Caribbean)
			  Haiti
			Oceania (Melanesia)
			  Solomon Islands
			  Vanuatu
			Oceania (Micronesia)
			  Kiribati
			Oceania (Polynesia)
			  Samoa
			  Tuvalu

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