Global Population Aging and Its Economic Consequences

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Ronald D. Lee

The AEI Press
Publisher for the American Enterprise Institute
WASHINGTON, D.C.

Distributed to the Trade by National Book Network, 15200 NBN Way, Blue Ridge Summit, PA 17214. To order call toll free 1-800-462-6420 or 1-717-794-3800. For all other inquiries please contact the AEI Press, 1150 Seventeenth Street, N.W., Washington, D.C. 20036 or call 1-800-862-5801.

Library of Congress Cataloging-in-Publication Data

Lee, Ronald Demos, 1941-
Global population aging and its economic consequences / Ronald Lee.
p. cm.
Includes bibliographical references.
ISBN-13: 978-0-8447-7197-7
ISBN-10: 0-8447-7197-X
1. Demographic transition. 2. Population aging—Economic aspects. I. Title.

HB887.L44 2007
304.6'1—dc22

2007017024

12 11 10 09 08 07 1 2 3 4 5

Printed in the United States of America

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Research for this study was funded by a grant from the National Institutes of Health, NIA R37 AG025247. The author is grateful to Nick Eberstadt for comments on an earlier draft, to Tim Miller and Gretchen Donehower for help with the calculations, and to participants in the National Transfer Account project for use of their estimates.

Global Population Aging and Its Economic Consequences

Ronald D. Lee

Population aging is a global phenomenon, already affecting all industrial and some third-world countries and soon to affect all others. It refers to an increase in the numbers of elderly, particularly relative to the numbers of working-age people. The costly aspects of this increase in the old-age dependency ratios have been widely discussed, but population aging also raises the ratio of wealth-holders to workers, a beneficial economic trend that has largely escaped attention. The net balance of gains from the second trend and costs from the first depends on each country's institutional arrangements, for these influence the relative importance of intergenerational transfers as opposed to asset accumulation as sources of old-age support.

When we focus specifically on public-sector transfers, as is often done, the costs of population aging appear large, but they become less important if we take a broader view of production and consumption by age. In this essay I will take that broader view, while occasionally looking at the public sector. I will first discuss the demography of population aging and then assess its economic consequences. Throughout the discussion, the emphasis will be on fundamentals rather than details.

The Demography of Population Aging

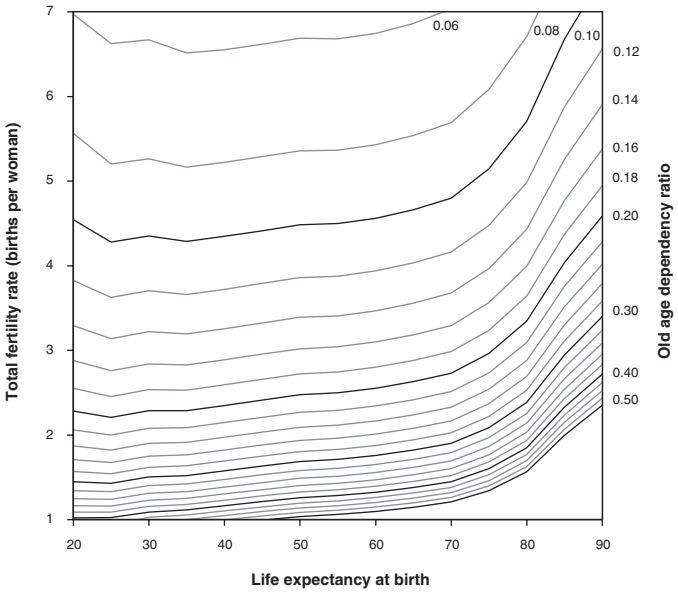
Population aging and its consequences can only be properly understood in the context of changing age distributions across the "demographic transition," the process through which countries move from initially high fertility and mortality to low fertility and mortality. The resulting changes in the population age distribution culminate in population aging. Population aging is inevitable and permanent, but its timing and extent vary from country to country and region to region around the world.

First Principles of Population Aging. Generally speaking, more rapidly growing populations are younger than slowly growing ones, because the more recently born generations are larger at birth than the older generations. This is the rate-of-growth effect. In addition, for any given rate of population growth, a population with lower mortality and longer life will be older. This is the generational-survival effect. Actual population aging results from both these effects, as well as from the particular history of past fluctuations.

Fertility decline leads to lower population and generational growth rates and is therefore a powerful force behind population aging. Mortality decline, however, has two offsetting effects. First, for a given level of fertility, it makes the population grow faster and therefore makes a population younger. Second, it tends to make a population older through the generational-survival effect. The net outcome is that when mortality is initially very high, its decline tends to make populations younger. When mortality is already quite low, as in industrial countries and many third-world countries today, its further decline makes populations older (Lee 1994).

Population aging emerges naturally from the processes of mortality and fertility decline that drive the demographic transition and in that sense is, in fact, inevitable. So long as mortality and population growth rates are both low, a population must become old. Although immigration may to some degree postpone and offset population aging, on a global scale this option is not available, and on a local scale the effects are likely to be transitory as earlier immigrants

FIGURE 1
LIFE EXPECTANCY AND TOTAL FERTILITY RATE WITH OLD-AGE DEPENDENCY ISOQUANTS



SOURCE: The contours are based on stable population variables in Coale and Demeny (1983), Model West Female. The old-age dependency ratio here is the population ages sixty-five and over, divided by the population twenty to sixty-four.

themselves age and as the fertility behavior of immigrants converges toward the low levels that prevail in most of today's receiving societies.

We can picture the demographic situation as a point in space defined by the levels of fertility (the total fertility rate [TFR] or, roughly, lifetime births per surviving woman) on one axis and mortality (life expectancy at birth) on the other, as shown in figure 1. Corresponding to each level of fertility and mortality is a unique, long-run population age distribution, known as the steady-state or stable population age distribution.

Dependency ratios provide a convenient summary of population aging. Suppose we count children from birth through age fifteen or twenty (here I will use both) as dependents, along with the elderly above age sixty-five. These age boundaries are somewhat arbitrary, as we will discuss later. The working ages are then fifteen or twenty to sixty-four. The ratio of children to the working-age population is called the child dependency ratio (CDR). The corresponding ratio for the elderly to the working-age population is called the old-age dependency ratio (OADR).

Figure 1 plots contour lines for the OADR (based on ages twenty and sixty-five), connecting all combinations of fertility and mortality that would lead to the same OADR in the long term. We can make four observations about the figure:

- The dominant fact portrayed by the contours is that lower fertility means higher OADR, since moving vertically downward on the map always means rising OADR. Going from a TFR of six births per woman to two (holding life expectancy constant at fifty years) quintuples the OADR from about 0.05 to 0.25.
- The contours slope gently up to the right, becoming steeper at higher levels of life expectancy. This tells us that longer life generally means slightly older populations—an effect that is weaker at lower life expectancies and much stronger at higher ones. Going from a life expectancy of twenty-five to seventy-five years (holding the TFR constant at three) raises the OADR only slightly, from about 0.17 to 0.20. Only after life expectancy reaches seventy or seventy-five years does further mortality decline begin to lift the steady-state OADR more substantially.
- There is much more action as we move toward very low fertility and mortality in the lower right corner, where the contour lines are more closely spaced. A fertility decline from seven to six births per woman has little effect on the OADR, whereas a decline from two births to one has a large effect.

- At very low levels of life expectancy and moderate or high levels of fertility, an increase in life expectancy is associated with a counterintuitive decrease in the OADR. Close to the vertical axis, many of the contours slope up to the left.

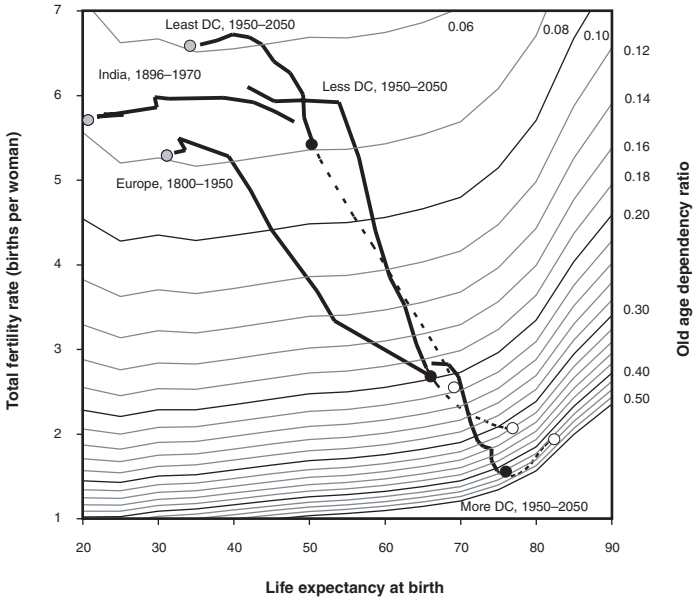
The Demographic Transition in Slow Motion. With this background, we can turn to the trajectories of actual populations across this space. The demographic transition begins in the upper left corner of figure 1 with high fertility and high mortality (low life expectancy) and proceeds to low fertility and low mortality in the lower right corner. Because mortality typically begins to decline a number of decades before fertility, the initial movement of a transition trajectory is horizontally to the right. Once fertility decline begins, the trajectory turns more sharply downward. Thus, typical transitional trajectories are bowed out to the right, rather than following a diagonal line from corner to corner.

Figure 2 shows trajectories based on United Nations data for the More, Less, and Least Developed Countries (DCs) from 1950 to 2000 and projected to 2050. The "More DCs" correspond closely to today's industrialized nations. The "Least DCs" are mainly sub-Saharan African nations, plus a few other poor countries, such as Bangladesh. The "Less DCs" comprise the majority of the world's population that lies between these two extremes, including India and China. For historical depth, I have added Europe from 1800 to 1950, which nearly connects with the More DC line in 1950. I have also added India from 1896 to 1970, which nearly overlaps the Less DC line from 1950 to 1970.

The starting points of the trajectories, at different dates, are marked by grey dots. The position in 2000 is marked by black dots, and projections to 2050 are indicated by white dots. All three trajectories move from the upper left toward the lower right, as expected, and are bowed out, as explained earlier. The starting points (grey dots) are close together, with OADRs clustered between 0.06 and 0.08, despite their rather different demographic situations. Because of different starting times and speeds of the transition, however, in 2000

FIGURE 2

LIFE EXPECTANCY AND TOTAL FERTILITY RATE WITH OLD-AGE DEPENDENCY ISOQUANTS: ACTUAL AND PROJECTED TRAJECTORIES FOR MORE, LESS, AND LEAST DEVELOPED COUNTRIES



SOURCES: Historical and middle-series forecasts for least, less, and more developed countries are taken from United Nations (2001). Data for India are taken from Bhat (1989) for the period from 1891–1901 to 1941–51, and from United Nations (2001) for the period 1950–70. Data for Europe are based on tables 6.2–6.5 in Livi-Bacci (2000) for the period 1800–1900, and Mitchell (1975) for the period 1900–1950. For the period 1800–1900, the European total fertility rate and e(0) are derived as a population-weighted average of country-specific data. Where unavailable, these data are estimated based on regression using the crude birth rate and death rate to predict total fertility rate and e(0), respectively, for other European countries in this period. For the period 1900–1950, a single series of crude birth rates and death rates for all Europe is assembled. A regression based on data from 1900–1950 is used to predict total fertility rate and e(0) based on the crude birth rate and death rate, respectively. The stable population growth isoquants are derived from Coale and Demeny (1983), using the Model West Female life table when the mean age of childbearing is twenty-nine.

the black dots are far apart. The Less DCs are more than twice as old as the Least DCs (OADR of 0.20 versus 0.08), and the More DCs are more than twice as old as the Less DCs (OADR over 0.40 versus 0.20). By 2050, all three trajectories are projected to be approaching the endpoint of the transition, so the white dots again appear close together, but this appearance masks a factor-of-two difference between the OADRs in the Most and Least DCs, because even small differences in fertility and mortality have a big effect on the OADR in the lower right-hand corner.

Note that the More DCs are not projected to get older over the next fifty years. This is because fertility is projected to rise slightly, offsetting the aging effects of declining mortality. The actual populations of Europe, Japan, and other industrial nations will grow substantially older even if their vital rates do not change much, because their age distributions will be moving toward their stable age distributions.[1] Recall that this figure only shows the stable or steady-state population age distributions, not the actual ones. Stable population age distributions are a valuable starting point for considering population aging, but they are not the whole story. Much of the action over the demographic transition lies in departures from the stable age distributions, as we shall see.

The Demographic Transition in Real Time. The changes in fertility and mortality over a classic demographic transition result in particular patterns of changes in a population's age distribution. The proportion of children in the population eventually declines, and that of the elderly eventually rises, but to focus on these long-run changes is to miss most of the drama. Indeed, starting from an initial state with high fertility and high mortality, the initial effect of mortality decline is that more babies survive to grow into children, and the population growth rate increases. These changes actually make the population younger, not older, and the proportion of children rises. Many third-world populations experienced this sequence of changes when mortality declined rapidly following World War II.

An illustration of these systematic changes in age distribution can be seen in figure 3, which shows a classic demographic transition,

FIGURE 3

A CLASSIC DEMOGRAPHIC TRANSITION: ACTUAL, PROJECTED, AND SIMULATED FOR INDIA, 1900–2100

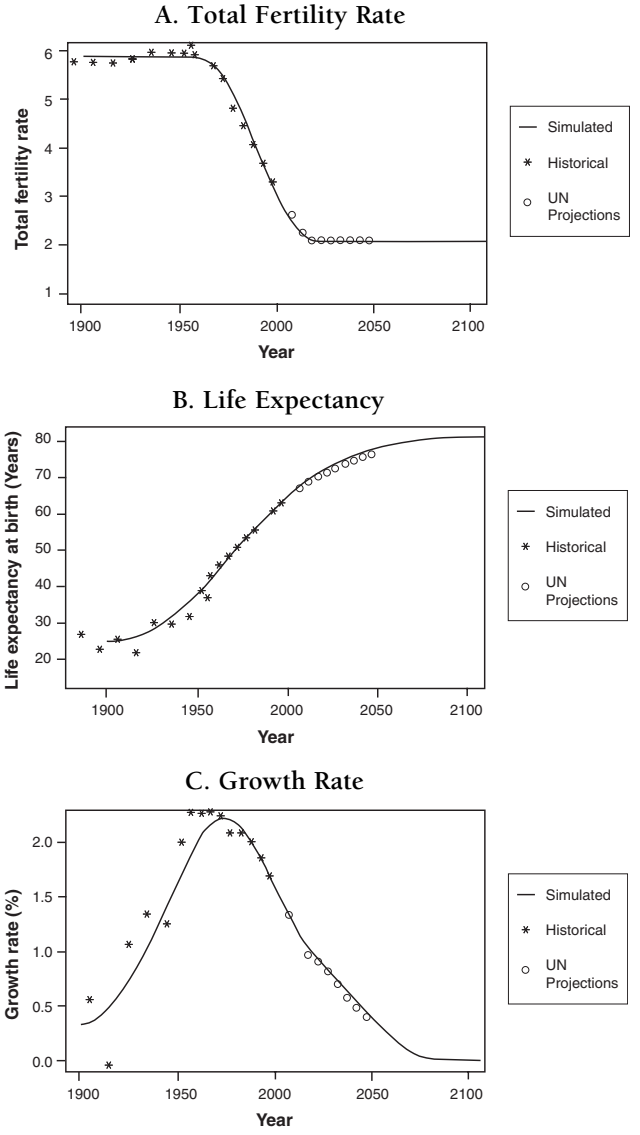


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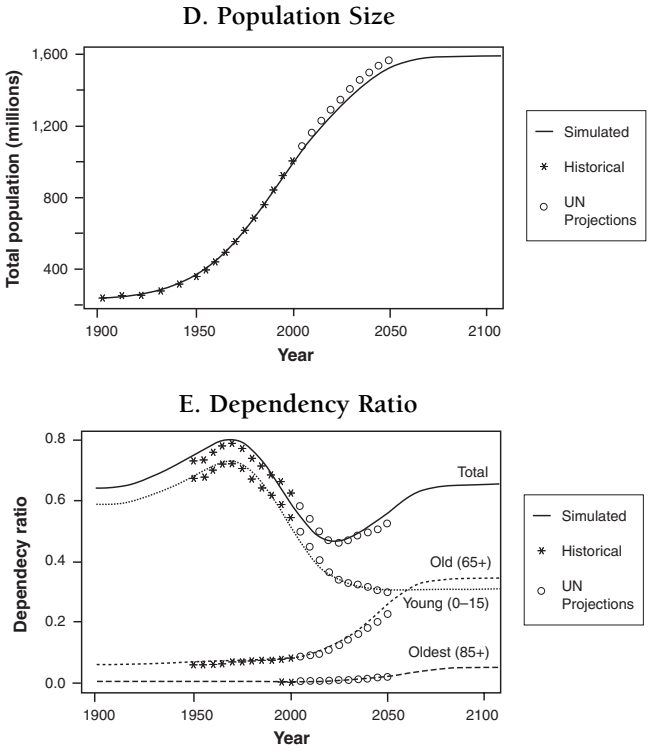
FIGURE 3 (CONTINUED)
A CLASSIC DEMOGRAPHIC TRANSITION: ACTUAL, PROJECTED, AND SIMULATED FOR INDIA, 1900–2100



SOURCES: Actual India data for the period from 1891–1901 to 1941–51 are taken from Bhat (1989). Actual and projected data are taken from United Nations (2001).
NOTE: The simulation is based on a fertility transition in which the total fertility rate follows a quintic path, declining from 5.9 in 1953 to 2.1 in 2025, and a mortality transition in which the mortality index follows a sinusoidal path as e(0) increases from 24.7 in 1900 to 80.0 in 2100.

using India as an example, with a mathematically simulated stylized transition superimposed (see Lee 2003a). The starred points in the figures represent actual data from India for 1896–2000. The hollow points show United Nations projections for India's mortality, fertility, and population from 2005 through 2050. Simple analytic functions are fit to the historic fertility and mortality data, and the lines in the

other panels are simulated based on these functions and on the initial population. In India, the pretransitional total fertility rate is about six births per woman (panel A), and life expectancy at birth is about twenty-four years (panel B). India's mortality decline begins fifty years before its fertility decline. The fertility transition is slow relative to that of East Asia, but is similar to Latin America's. These trends in fertility and mortality interact to create a population growth rate that rose from less than 0.5 percent per year in 1900 to more than 2.0 percent per year by 1950 before starting to decline (panel C).[2] India's total population size quadrupled in the twentieth century and is projected to double in the twenty-first century, with the growth rate leveling out to near zero by 2100 (panel D).

Population Aging and Dependency. The last panel of figure 3 plots the dependency ratios from the beginning to the end of India's demographic transition. We see an increase in the child dependency ratio from 1900 to 1970, extending from the pretransitional situation until just after the beginning of the fertility decline.

Once the fertility decline is well under way, it dominates the effect of increasing child survival, and the child dependency ratio begins a long period of decline, continuing through 2050. Throughout this period, however, the OADR is slowly rising, and in the early decades of the twenty-first century, its upward course accelerates. The population growth rate (panel C of figure 3) peaks around 1960, and twenty years later the growth rate of the labor force begins to slow while that of the elderly population increases due to falling mortality. Consequently, the OADR rises. After 2020, its increase outweighs the decrease in child dependency, and the total dependency ratio begins to rise.

The period during which the total dependency ratio is falling, from 1970 to 2035 for India, is sometimes called the "demographic window of opportunity." The potential boost to per-capita income from the rising proportion of workers in the population is called the "demographic dividend." The total dependency ratio declines from 0.80 to 0.45 over the course of the fifty-five years from 1970 to 2025. If output per working-age person were constant over this

TABLE 1
OLD-AGE DEPENDENCY RATIOS (POPULATION 65+/POPULATION 15–64) IN SELECTED COUNTRIES AND REGIONS IN 2000 AND AS PROJECTED BY THE UNITED NATIONS FOR 2050

COUNTRY OR REGION	2000	2050
Least DC[a]	0.058	0.098
Less DC	0.082	0.218
More DC	0.212	0.465
Japan	0.252	0.713
South Korea	0.098	0.488
China	0.100	0.372
India	0.081	0.226
Chile	0.111	0.286
Brazil	0.078	0.287
Spain	0.248	0.738
Italy	0.267	0.681
United States	0.186	0.349
Niger	0.042	0.054

SOURCE: United Nations. 2002. *World Population Ageing*, 1950–2050. New York: United Nations, Population Division.
NOTE: a. DC=Developed Countries.

period, this change in age distribution alone would boost per-capita income by 23.3 percent, contributing 0.38 percent per year to per-capita income growth. This is a modest contribution, but not negligible. Actual estimates of the association of population age distribution with per-capita income growth suggest a substantially larger demographic dividend (Bloom and Williamson 1998; Bloom, Canning, and Sevilla 2002; Bloom and Canning 2004). Later, we will discuss one possible reason for this: the influence of population age distribution on savings and capital intensity.

After the end of the first "dividend" stage, continuing population aging drives the total dependency ratio up, and in the long run it is very similar to its value before the transition started in 1900. But

there has been a big change: In 1900 there was a high proportion of children and a low share—only about 3 percent of the total—of elderly. By the end of the process, the situation has reversed, with a low proportion of children and a high proportion of elderly.

Consumption by children and the elderly is viewed as identically costly in these calculations, but is this accurate? We will return to this question later as well.

International Variation in Old-Age Dependency Ratios. The black and grey circles in figure 2 showed first dispersion and then convergence in the OADR, but the high level of regional aggregation masked a great deal of heterogeneity. Table 1 shows the OADR by development status and for selected countries. We see that the OADR is about four times as high in More DCs as in Least DCs—and the ratio will be even greater in 2050 than it is today. At one end of the spectrum is Niger, a country with exceptionally high fertility that has not yet begun the fertility transition, with an OADR of 0.042 and a projected OADR of just 0.054 in 2050. At the other end of the spectrum, Spain, Italy, and Japan have OADRs around 0.25 today, but by 2050 these are expected to be around 0.70, with each working-age person supporting 0.7 elderly people. The United States, a youthful industrial nation today, is projected to have an OADR in 2050 that is only about half that in the oldest countries, reflecting the country's relatively high fertility and immigration.

Consumption and Production over the Lifecycle

These conventional dependency ratios make stark assumptions about age patterns of economic behavior: Youths below age fifteen or twenty (for example) supposedly do not work at all, nor do the elderly after age sixty or sixty-five. In these conventional ratios, a child receives exactly the same consumption weight as an elderly person. Such assumptions are a useful first approximation, but they are clearly not realistic. It is equally clear that the appropriate age weights and boundaries vary from one country to another and may vary systematically with the level of economic development.

More Refined Measures of Production and Consumption. For these reasons, it is useful to estimate age patterns of consumption and production using real data for a variety of countries. Doing so is not straightforward or simple, however. Private consumption expenditure is generally measured in surveys only at the level of the household, so consumption by age within households must be imputed on the basis of plausible assumptions. The data reported below are based on a separate analysis of private expenditures on education and on health care, because these are often presented separately in surveys. The remainder of private expenditures is allocated to household members in proportion to equivalent adult consumer weights that start at 0.4 for an infant and rise to 1.0 at age twenty and beyond (see Lee et al., forthcoming).

A significant amount of consumption takes the form of in-kind transfers from the public sector—for example, public education or publicly funded health care or long-term care. Constructing comprehensive age profiles of these components requires careful analysis of government budgets at different levels (that is, local, state, and federal) and estimates of age patterns from administrative or survey data.

With these methods, the estimated age patterns of consumption will depend on such factors as the extent of elder coresidence with adult children, the covariation of fertility and income in the population, the variation of fertility with age, the size of the public sector, and the kinds of public transfer programs.

Estimated Consumption and Earning for Third-World Populations. The National Transfer Accounts project, directed by Andrew Mason and myself, is estimating these age profiles and other aspects of transfer behavior for a number of countries. Currently, four age profiles are available for third-world countries, three in Asia and one in Latin America. The shapes of these age profiles are quite similar across the four countries. Figure 4 plots their simple unweighted average. We see that after age twenty, consumption hardly varies at all with age. The labor income–age profile has a regular bell-like appearance; however, it is asymmetric, remaining rather positive

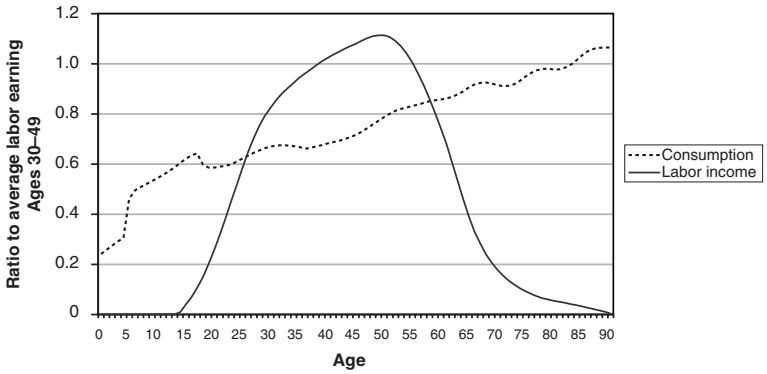
FIGURE 4
CONSUMPTION AND LABOR INCOME BY AGE, DIVIDED BY AVERAGE LABOR INCOME FOR AGES 30–49, AVERAGED ACROSS FOUR THIRD-WORLD COUNTRIES

SOURCES: Countries are Thailand (1996), Taiwan (1997), Indonesia (1996), and Costa Rica (2004). Based on estimates reported in Chawla (2006); Bixby-Rosero (2006); Maliki (2006); and Mason et al. (forthcoming). Data from four individual countries in the National Transfer Accounts project. For more information, see www.schemearts.com/proj/nta/web.

far into old age. Labor income first equals consumption at age twenty-five, and last equals consumption at age fifty-eight, after which older people begin to require other sources of income to finance their consumption. Only for the intervening period of thirty-three years do earnings exceed consumption. This is much less than the forty-five years assumed in the conventional twenty-to-sixty-four age range for the working years.

Note that there is no reason why the areas under the two lines should be equal. When aggregating, these age schedules must be weighted by the actual population age distribution, in which case the sum over ages should yield the aggregate levels of consumption and labor earnings as given in National Income and Product Accounts. In the typical case, aggregate consumption exceeds aggregate labor earnings, with the difference made up by consumption out of income from capital.

FIGURE 5
CONSUMPTION AND LABOR INCOME BY AGE IN THE UNITED STATES (2000), DIVIDED BY AVERAGE LABOR INCOME FOR AGES 30–49

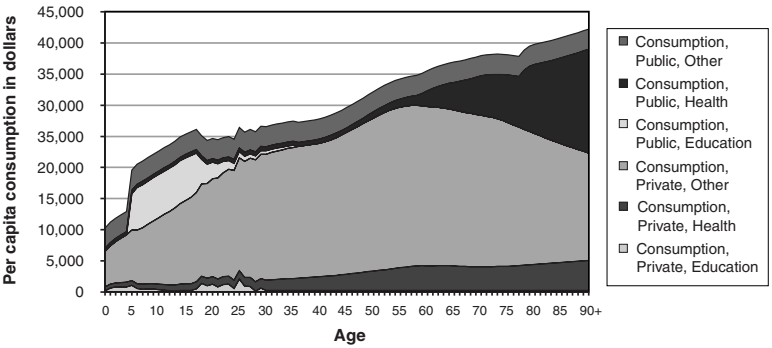


SOURCE: Based on Lee, Lee, and Mason (forthcoming).

The United States: Consumption Skewed to the Elderly. Figure 5 plots age schedules of consumption and labor earnings for the United States in the year 2002 using the same method. The difference in consumption by age is striking. Whereas in the previous figure consumption was flat above age twenty or slightly declining, here it is steeply and steadily rising with age, arriving in old age at a level about 70 percent greater than at age twenty. The crossover ages are similar: twenty-six and fifty-eight years for the United States versus twenty-five and fifty-eight years for the third-world average. The implication is clear: Population aging in the United States is a much more costly proposition than in the average third-world country because the elderly in the United States are such big consumers relative to their earnings.

We can get some insight into the reasons for the U.S. pattern by looking at the components that make up consumption in the United States, as shown in figure 6. Here we see that both private and public sources of consumption contribute to this shape. Private

FIGURE 6
PER-CAPITA CONSUMPTION, PRIVATE AND PUBLIC BY SECTOR, UNITED STATES, 2000



Source: Based on Lee, Lee, and Mason (forthcoming).

consumption expenditures rise until age fifty-five or so and then decline. However, public expenditures for health care, mainly through Medicare, continue to rise with age and make the total consumption expenditure curve do likewise. Other, unpublished analyses show that this pattern has emerged in recent decades and was not in place earlier in the twentieth century.

The Changing Balance of Earners and Consumers. The consumption and earnings profiles we have just discussed provide a more realistic picture of economic activities over the lifecycle than do the simple 0–1 assumptions of the conventional dependency ratios. We can use them in the same way we use the dependency ratios, to indicate variations in the relative numbers of consumers and workers. Here we will simply multiply the population age distribution for a country in some year by the age profile of consumption or earning at each age, and then sum over ages. The ratio of aggregate consumption to aggregate earnings is analogous to the dependency ratio. Instead of assigning each age to the status of either worker or dependent, we now recognize that people work to some degree

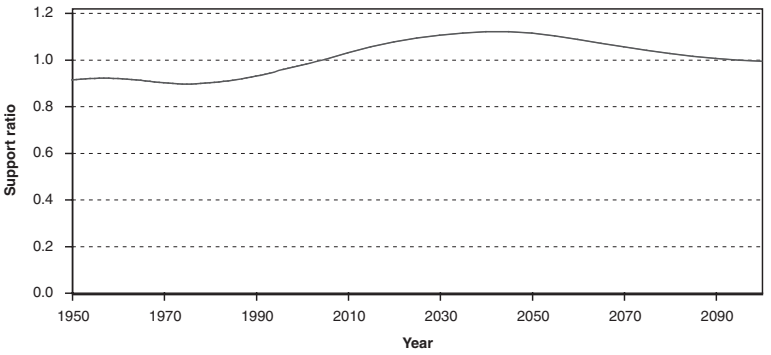
across a very broad range of ages, and that consumption likewise varies by age. Analysts typically use the ratio of effective earners to effective consumers, called the "support ratio," which is analogous to the inverse of the dependency ratio. Whereas higher values of the dependency ratio are economically disadvantageous, lower values of the support ratio are disadvantageous.

Over time, the support ratio changes both because of changing population age distribution, such as population aging, and because of changes in the age profiles of consumption and earning, such as rising health-care costs per elderly person or declining age at retirement. To isolate the pure consequences of a changing population age distribution, we can hold the age profiles constant at, say, the levels for the year 2000. Then we can apply these to changing population age distributions, both over past years and projected future populations. We can then see whether the pure demographic changes tighten or loosen the social budget constraint. The change in the support ratio between two years tells us whether the consumption profile would have to be raised or lowered in the second period in order to maintain the same ratio of aggregate labor earnings to aggregate consumption.

The Indian Support Ratio from 1950 to 2100. Here I will rely on United Nations data and projections for India and on the average age profiles of production and consumption for third-world countries, as plotted in figure 4. The support ratio for India calculated from these data are plotted in figure 7. The interpretation of the support ratio is opposite that of the total dependency ratio: High values are beneficial, meaning there are more workers to support each consumer, including both workers and dependents as consumers.

We see that initially the support ratio remains quite flat and then rises until the early 2040s, when it peaks. Its trough is in 1975, a bit later than the peak in the Total Dependency Ratio, and its peak is in 2043, again later than the trough in the Total Dependency Ratio. This difference in timing reflects the difference between net earnings starting at age fifteen, as in the Total Dependency Ratio in figure 3, and

FIGURE 7
SUPPORT RATIO FOR INDIA, 1950–2000, AND PROJECTIONS TO 2100



SOURCES: Author's calculations based on United Nations data and projections for India (United Nations [2000] long-term projections and United Nations [2005], adjusted to be consistent for period of overlap), and production and consumption age profiles averaged over four third-world countries: Thailand (1996), Taiwan (1997), Indonesia (1996), and Costa Rica (2004). The support ratio is the number of effective workers divided by the number of effective consumers based on fixed age profiles for the period 1995–2000 and changing population age distributions. The ratio has been adjusted to equal 1.0 in 2005.

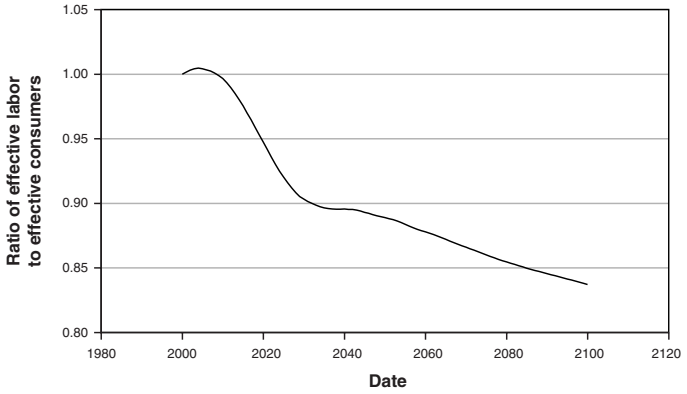
net earnings starting at age twenty-five, based on the age profiles of labor income and consumption. As for the relative magnitudes of the changes, they are very similar, with the Total Dependency Ratio implying a slightly larger first dividend. After 2045, population aging causes a drop in the support ratio by 11 percent from its peak in 2045 to its value in 2100. Although not shown in figure 7, the UN projections indicate that continuing population aging after 2100 will lead to a decline in the support ratio by an additional 10 percent, returning it to the 1950 level.

Focusing on the period 1970–2000, Mason et al. (forthcoming) estimates the first dividend for the regions of East and Southeast Asia, Latin America, and North Africa and the Middle East as falling between 0.5 and 0.6 percent per year growth in income per effective consumer. All would be larger than India's.

The U.S. Support Ratio over the Twenty-First Century. It would be convenient to be able to point to panel E of figure 3 and say that the United States is now toward the right of the figure at the point where the OADR begins to rise more rapidly. In reality, the U.S. demographic experience does not fit this classic pattern, because following the decline of fertility from 7.0 births per woman in 1800 to 2.0 births per woman in the 1930s, there was a baby boom in which fertility ascended to 3.7 births per woman in the late 1950s before returning with the baby bust to replacement levels or below. The population aging we are about to experience in the United States is the result not of the initial fertility decline up to 1930 but rather of the aging of the baby boom generations and the small size of the baby bust generations that succeeded them in the labor force. The same is true of most industrial countries (not including Japan) to a greater or lesser degree, depending on the size of their post–World War II baby booms. Nonetheless, panel E of figure 3 does provide a helpful picture of the upswing of the OADR, and we will now consider some of its economic consequences.

The U.S. support ratio from 2000 to 2100, based on the earnings and consumption age profiles shown in figure 5 and the population projections by the U.S. Bureau of the Census, is plotted in figure 8. The level of the ratio in 2000 is normalized to 1.0 for convenience of interpretation. We see that in the first few years of the twenty-first century, the support ratio rises a bit, indicating that age distribution changes are favorable to consumption. This increase reflects the low fertility and small generations born in the 1930s, resulting in smaller-than-usual numbers of people now moving into old age. Because fertility subsequently rises in the late 1930s, 1940s, and core baby boom years through the early 1960s, larger numbers of people are now growing old, while subsequent lower fertility has meant the working-age population has grown more slowly. The support ratio is projected to plunge through 2030 or so and then continue to decline, but at a slower pace. During the rapid plunge from 2005 to 2030, the support ratio drops from around 1.02 to 0.89, or by 13 percent. This tells us that the consumption age profile would have to be 13 percent lower in 2030 than in 2005

FIGURE 8
GENERAL SUPPORT RATIO FOR THE UNITED STATES, 2000–2100



NOTE: The ratio of effective labor to effective consumers is calculated from the age profiles plotted in figure 5 together with population forecasts by the U.S. Bureau of the Census (2000). The ratio has been adjusted to equal 1.0 in 2000.

relative to the age profile of labor income in order to maintain the same ratio of aggregate labor earnings to aggregate consumption (assuming no change in the shape of the age profiles shown in figure 5). By 2100 the support ratio has dropped another 5 percent, to about 18 percent below the level in 2005.

These changes in the support ratio indicate the direct costs of population aging in the United States over the twenty-first century. The 13 percent decline from 2005 to 2030 as the baby boom ages translates into an average of –0.56 percent per year for the level of age-adjusted consumption. This should be viewed relative to an expected rate of productivity growth of 1.5 percent per year (in recent projections by the Social Security Administration). In other words, population aging might offset roughly one-third of the expected increase in productivity over that period. Over the century as a whole, the impact of population aging translates into a mere –0.2 percent per year, quite small relative to anticipated productivity growth. Keep in mind, though, that these calculations are

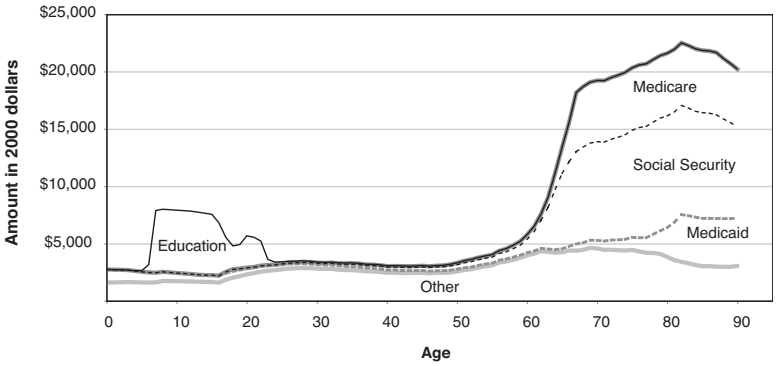
based on the age pattern of consumption in 2000, and if health-care costs continue to rise more rapidly than productivity, the age profile of consumption will tilt even more strongly toward older ages. Such a change would make population aging more costly and cause a recalculated support ratio to decline more strongly.

These calculations suggest that although the impact of population aging in the United States will be far from negligible, at this rather general level it should not be a catastrophic problem by any means. Some institutions will, however, be more severely affected than others. In particular, the federal government, which makes large transfers to the elderly in cash (through Social Security and Supplemental Security Income) and in-kind (through Medicare for health care and through institutional Medicaid for long-term care), will be more strongly affected than the general support ratio indicates. State and local governments, on the other hand, are more heavily involved in making in-kind transfers to the young, particularly for public education, and make relatively small transfers to the elderly for the state share of institutional Medicaid. At their level, population aging may actually relax the budget constraints. In California, for example, the elderly pay more in state taxes than they collect in benefits (Lee et al. 2003c). When federal, state, and local expenditures are combined, however, we find that elderly Californians receive about three times as much per capita as do children, so population aging is indeed costly on net.

These points are illustrated in figure 9, which presents the age profiles of government expenditures in the United States broken down by program. Comparable data on tax payments by age have also been calculated (see Lee and Edwards 2001 and 2002 for more detail on all this). The age profiles for overall payment of taxes and receipt of government benefits can be used to calculate a fiscal support ratio analogous to the general support ratio. Fiscal support ratios for the federal government and for the aggregate of state and local governments, based on the age profiles of taxes and benefits for 2000, are plotted in figure 10 for the twenty-first century.

The fiscal support ratio is not normalized to 1.0 in figure 10, but rather reflects the actual ratio of costs to revenues. For this reason,

FIGURE 9
COST OF GOVERNMENT BENEFITS PER INDIVIDUAL AT EACH AGE, BY PROGRAM

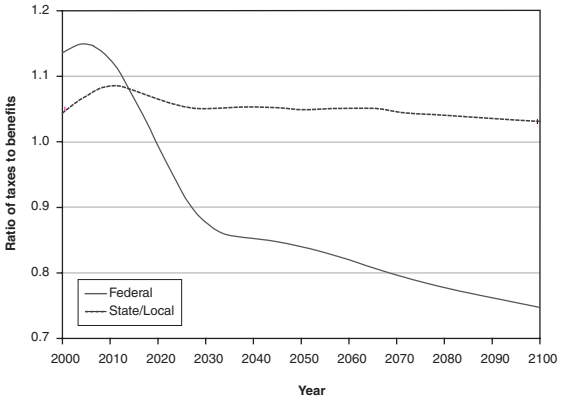


SOURCE: Based on Lee and Edwards (2002). State, local, and federal combined, for United States in 2000.

the support ratio is initially greater than 1.0, primarily reflecting the surplus in the Social Security accounts. Large federal deficits occurred following 2000, but that does not really bear on the support ratio, which abstracts from all such variations to concentrate on the effect of demographic change alone.

Whereas the general support ratio declines by 13 percent from 2005 to 2030, the federal fiscal support ratio declines by nearly 30 percent, reflecting the dominant focus of federal programs on the elderly. Over the remaining seventy years of the twenty-first century, the federal fiscal support ratio drops an additional 10 percent. The implication is that to maintain the current program and tax structures while balancing the current budget, benefit levels would have to be cut by 30 percent at each age relative to 2005, taxes would have to be raised by 38 percent relative to 2005, or there would have to be some combination of the two, given the projected age distribution for 2030. Similarly, for 2100, either benefits would have to be cut by 37 percent, or taxes would have to be raised by 60 percent. Calculations of this sort for other industrial nations

FIGURE 10
PROJECTED FISCAL SUPPORT RATIO BY LEVEL OF GOVERNMENT, 2000–2100



SOURCES: Based on Lee and Edwards (2002); population projections from U.S. Bureau of the Census (2000).

might well show even heavier fiscal costs of aging, because fertility is relatively high in the United States and the effects of aging consequently less severe. (Public pensions are also less generous in the United States than in many European countries, but growth in publicly funded health care—Medicare and Medicaid—may pose a greater concern here; Lee 2003b.)

Population Aging and the Accumulation of Wealth

So far we have considered support ratios. These tell us in a mechanical way how the level of the age profile of consumption would have to change to accommodate the changing population age distribution if saving rates remained constant. But, for several reasons, demographic change is likely to cause changes over time in the proportion of output that is saved. First, saving behavior varies across the lifecycle, so when the proportion of the population at each age changes, the aggregate saving rate would be expected to change as

well. Lifecycle savings theory, for example, suggests that workers save and accumulate assets to finance their retirement, whereas older retired people live off their assets and therefore "dissave." When population aging raises the ratio of elderly dissavers to working-age savers, the aggregate saving rate declines.

But there are also reasons to expect individuals of a given age to alter their saving behavior. Over the demographic transition, mortality falls, and life expectancy rises. Workers who recognize this change would save for a longer anticipated period of retirement. They could, of course, choose instead to work longer and retire later, maintaining a constant ratio of working years to retirement years, but in practice this has not occurred anywhere. Rather, even as life expectancy has risen, the age at retirement has fallen (Burtless and Quinn 2001). So there is good reason to expect that longer life will induce higher saving, particularly as funded pension programs become more prevalent—whether defined contribution or funded defined benefit—as is happening in the United States.

Furthermore, with lower fertility, the proportion of lifetime earnings that is allocated to children by their parents is likely to decline, even taking into account rising parental investment per child. If so, then lower fertility raises the lifetime consumption of the parents, and providing for this higher level of consumption in retirement requires more assets and higher saving rates. Thus, lower fertility may well boost saving rates.

The net effect of all these influences is not clear, because the first, population aging, tends to reduce aggregate saving rates over time, whereas the second and the third, rising longevity and falling fertility, tend to increase them. One way to assess the effects of changing population age distributions is by analyzing, as several studies have done, cross-national differences in aggregate saving rates (Kelley and Schmidt 2001; Higgins and Williamson 1997; Mason 1988). These studies uniformly reach conclusions consistent with the discussion above.

Another way to approach the problem is through simulation, as in Lee, Mason, and Miller 2000, 2001, 2002, and 2003. In these studies we posit that people are lifecycle savers, planning household consumption over time so that consumption per effective consumer

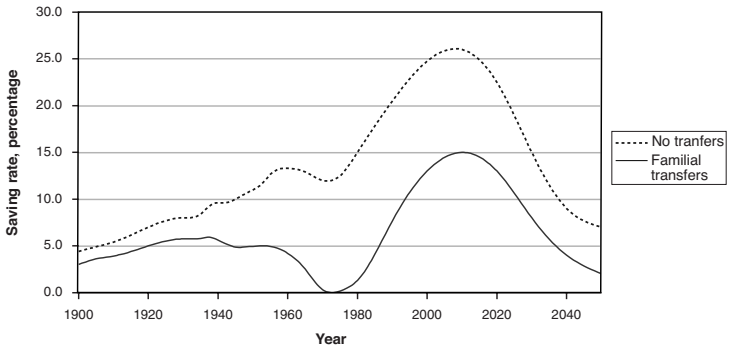
rises over the lifecycle of an adult in a way that maximizes lifetime utility, given the changing demographic composition of the household as children are born, work, contribute income to the household, or die or move out to form their own households. Individuals take into account average survival probabilities to each age, market rates of interest, age-specific wage rates, and productivity growth rates. Mortality risk is shared across all members of generations through annuities.

The simulation is run first under the assumption that each independent householder expects to be entirely self-reliant, receiving no financial help from either public pensions or adult children. This assumption is unrealistic for any country, so we do a second simulation in which householders expect to live in the household of an adult child when they grow old or simply receive the equivalent transfers from their adult children. In developing their consumption and saving plans over their lifecycles, they take into account these other sources of income in addition to their own assets, and they plan for the support of their own elderly parents at the appropriate stage of their lifecycles (Lee, Mason, and Miller 2003).

We have used this setup to simulate consumption, saving, and capital growth for Taiwan from 1900 to 2050. Elsewhere we have reported similar simulations for the United States, with public-sector transfers through Social Security (Lee, Mason, and Miller 2003). Figure 11 shows the results of the Taiwan simulations. First, consider the unrealistic case of pure lifecycle savings with no transfers, the upper line in the figure. We see that aggregate saving rates as a share of gross domestic product (GDP) rise from 1900 to 1960 or so, during the period in which life expectancy is rising but fertility has not yet begun to decline, and population growth is accelerating. This increase in aggregate saving rates reflects the fact that the more rapidly growing population will become younger, with more savers and fewer dissavers. It also reflects an increasing life expectancy that requires more savings and assets to fund a longer retirement. After 1960 the saving rate stabilizes and declines slightly before rising strongly to a peak of 25 percent around 2010 during the first dividend phase, and then declining just as strongly as the population ages.

FIGURE 11

SIMULATED SAVING RATE, ASSUMING LIFECYCLE SAVING ACROSS THE DEMOGRAPHIC TRANSITION IN TAIWAN, WITH AND WITHOUT FAMILIAL SUPPORT OF THE ELDERLY, PERCENT OF GNP, 1900–2050

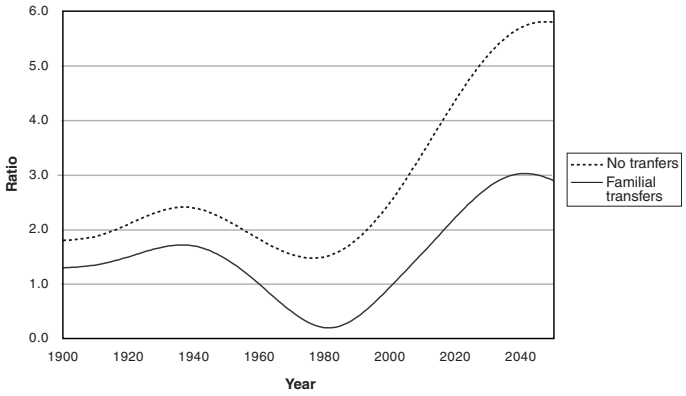


SOURCE: Based on simulations reported in Lee, Mason, and Miller (2003).

In the more realistic simulation that incorporates familial transfers to the elderly, the demographic transition does not generate as large an increase in saving rates, and there is actually a considerable decrease before fertility begins to decline. After 1970, however, the saving-rate trajectory moves in parallel to the no-transfer line, with saving rates always substantially lower. This behavior is consistent with the argument of Feldstein (1974) that Social Security benefits reduce saving rates in the United States.

It is difficult to extract from these saving-rate trajectories the implications for capital accumulation per capita or per worker, which is relevant for per-capita income growth. After all, the population and labor-force growth rates are also varying, and these also influence the growth of capital per capita. When population growth is slower, less saving is needed to achieve a given capital/labor ratio. In addition, the elderly hold more wealth on average than younger people because they have accumulated it over a lifetime. Therefore, we might well expect that population aging would raise the wealth

FIGURE 12
SIMULATED CAPITAL–INCOME RATIO, ASSUMING LIFECYCLE SAVING ACROSS THE DEMOGRAPHIC TRANSITION IN TAIWAN, WITH AND WITHOUT FAMILIAL SUPPORT OF THE ELDERLY, 1900–2050



Source: Based on simulations reported in Lee, Mason, and Miller (2003).

per capita in a society, even without changes in saving behavior over the lifecycle. By raising saving rates, the decline in mortality and fertility over the transition should reinforce this trend.

Figure 12 presents the capital/income ratio from the same set of simulations reported in figure 11. We see that for a number of decades in the middle of the century, this ratio is falling, presumably due to accelerating population growth rates. Beginning in the 1970s, however, the ratio increases rapidly, and by 2050 it has more than tripled relative to 1900 or the 1970s in the pure lifecycle saving scenario and increased substantially in the scenario with familial transfers.

In this Taiwan simulation, we have assumed an open economy in which wages and interest rates are determined by international markets, so the increased capital raises capital income but does not affect domestic wage rates. The increase in capital intensity, and the

additional income per capita it generates, we call the "second dividend." Whereas the first dividend is transitory and is reversed when population aging sets in, the second is permanent and considerably larger (see Mason et al., forthcoming, for estimates of both the first and second dividends).

The Real World: Institutions and Intergenerational Transfers

Through the second dividend, as just described, population aging can boost economic growth by raising saving rates in the middle of the demographic transition and thereby permanently boosting the capital intensity of an economy. The extent to which this may happen depends on the degree to which consumption in old age is funded from physical or financial assets rather than simply through transfers from the labor income of workers.

Suppose that postretirement consumption is funded solely by transfers, as when the elderly live with their adult children and are fully supported by them, and the children have not saved in anticipation of supporting their parents. In this case, the first demographic dividend as described by the changing support ratio tells the whole story. Then, population aging is costly and most likely slows the growth of per-capita income and consumption per effective consumer. If, however, the elderly have saved for their own retirement, either directly and purposively or indirectly through prefunded public or private pension programs, population aging will help to drive economic growth. We have seen this in the macrosimulations discussed in the previous section: When there is familial support for old age, simulated saving rates are lower, and the simulated increase in capital is less. The same principle holds true more generally.

A number of institutions channel intergenerational transfers to the elderly. These include the family support system, which is by far the most prevalent transfer system globally for support of the elderly. Also included are public-sector transfer programs for the elderly, which are very large in the industrial nations, particularly for unfunded pensions, health care, and long-term care. The tax system enforces

contributions from workers, typically via a payroll tax. Entitlement rules channel revenues from these contributions to the elderly. In some contexts, public insurance programs for long-term unemployment and disability are also important sources of transfer support for those at the transitional boundary from working age to retirement.

For the most part, public support for the elderly crowds out private familial support rather than simply augmenting it. Public-sector support is anonymous, bureaucratic, and less subject to some kinds of risks than familial support. For example, in public systems, the risks associated with numbers, sex, survival, and success of offspring are spread across the population rather than borne by each elderly couple individually. The burden on the working-age population is likewise more evenly spread through public-sector arrangements rather than being concentrated on those working-age adults who happen to have dependent parents. New costs and inefficiencies are also entailed by the movement to public support, however. Incentives may be distorted for bearing children and investing in their human capital when children are not one's sole expected source of old-age support. Motivation for labor supply at older ages is undermined by the provisions of public pension plans (Gruber and Wise 1998). Various kinds of cheating may be more prevalent when close monitoring by family members no longer occurs, and when the elderly do not believe they are shortchanging their own children if they do not work. The satisfaction of caring for loved ones may be replaced by the resentment of poorly paid strangers who provide personal care.

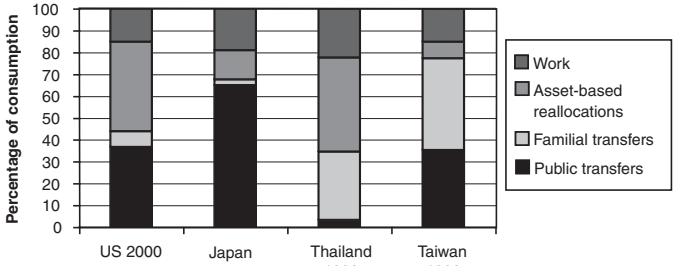
Whatever its relative merits, the familial system of support is eroding in some parts of the world. In Japan the proportion of women of reproductive age who expect to rely on their own children for old-age support declined from about 65 percent in 1950 to about 10 percent in 2004. The proportion of people over the age of sixty living in three-generation households declined by 40 percent between 1981 and 2001, with a similar trend occurring in South Korea, although even in 2001 these proportions were still about ten times higher than in various European countries and the United States (Ogawa and Matsukura, forthcoming).

In Chile and many other Latin American countries, a movement away from unfunded public pensions and toward funded individual retirement accounts is reducing the role of public-sector transfers. Brazilian policies have moved in the opposite direction, with a major expansion of pay-as-you-go pension benefits to the rural population. One of the consequences in Brazil has been that elderly pensioners are now less likely to move in with their adult children, while younger people have become more likely to move in with their elderly parents (Kamiya 2006). In Germany, the expansion of pension benefits has been accompanied by an increase in transfers from elderly parents to their adult children. These patterns in Brazil and Germany are examples of public pensions crowding out private transfers or, indeed, being neutralized by private countertransfers, as suggested by Barro's 1974 theoretical analysis.

Many elderly in China are in a difficult situation. Decades ago they were persuaded to comply with the one-child policy in part by promises that local governments would provide care for those elderly lacking children to support them. The later shift in policy toward a market system and decline in the strength of public industries undermined the ability of the local governments to provide services, including old-age support. Many rural elderly in China find themselves in a precarious situation, with neither familial nor public-sector support. Here both public and private transfer systems for the elderly have contracted (Benjamin, Brandt, and Rozelle 2000).

This account of the differing institutions governing transfers and their changes over time clearly shows that the topic is complex. The National Transfer Accounts project mentioned above seeks to estimate and describe the actual patterns of transfers and asset accumulation in a number of countries. Preliminary results for the United States, Japan, Thailand, and Taiwan are shown in figure 13, based on early research (Ogawa and Matsukura, forthcoming; Mason et al., forthcoming; Chawla 2006). The figure shows the proportional distribution of funding support for consumption by those ages sixty-five and over. There are striking differences among these countries, and many of the contrasts are unexpected. Public transfers account for a much larger share of elder consumption in Japan than in the other

FIGURE 13
FINANCING CONSUMPTION FOR THE ELDERLY (65+), SELECTED COUNTRIES



SOURCES: Based on estimates reported in Chawla (2006); Mason et al. (forthcoming); Ogawa and Matsukura (forthcoming).

three countries. Although it is not surprising that U.S. elders derive little financial support from their adult children, it certainly is surprising that in Japan there is hardly any net familial support for the elderly above age sixty-five, given general views about the strength of family ties there. Income from assets is most important in Thailand and the United States, whereas in Japan and Taiwan, both of which have had very high saving rates, the share of asset income is low. Overall, transfers fund 77 percent of old-age consumption in Taiwan and 68 percent in Japan, whereas the share is only 44 percent in the United States and 36 percent in Thailand. We must keep in mind, however, that these results pertain only to financial transfers and do not include care time and other forms of support provided by family members. If the situation portrayed in this figure were to remain the same in the coming decades, then we would expect the United States and Thailand to experience a larger boost to per-capita income growth from population aging than Japan and Taiwan.

Sometimes implicit national debt is added to explicit debt to indicate the size of the fiscal problem (Gokhale and Smetters 2003). Implicit debt is necessarily created by any unfunded transfer system

from younger to older ages and is an inherent feature of even a fiscally balanced and sustainable transfer program. If we are evaluating transfer wealth, and have already counted the transfer wealth generated through programs such as Social Security and Medicare in the United States, then we should not additionally count the implicit debt in these programs, because that would be double counting. The implicit debt is just the transfer wealth seen from the point of view of the government rather than the population. If the promises of the programs are judged to be unsustainable so that modification or collapse of the programs is inevitable, however, then neither the implicit debt nor the transfer wealth based on current program structures is more than a hypothetical construct.

Capital Saturation, Transfer Policy, National Debt, and Trade

Increases in the domestic capital stock generally raise the productivity of domestic labor and also generate increased profits, leading to higher per-capita income. Population aging tends to reduce per-capita income by reducing support ratios, but it may also tend to raise per-capita income by increasing the amount of capital. One consequence may be that population aging will lead to declining profit rates as capital intensity increases, and this in turn may lead to international capital flows as investors seek higher rates of return.

Capital Intensification in Industrial Nations. Depending on the institutional arrangements just discussed, population aging might generate a large increase in capital intensity. Most industrial nations currently have large-scale unfunded pension programs. As populations age, these will simply generate large increases in implicit debt rather than capital stock. But public pension reform is in the air, and a move to funded private accounts could change this picture. At the same time, the growth of tax incentives for defined-contribution pension plans in the private sector could also boost savings. These kinds of changes suggest that population aging might indeed lead to substantial increases in capital intensity in the next few decades.

In a closed economy, increased capital intensity would lead to lower profit rates on capital and lower interest rates. Falling rates of return on capital and other assets would be a major concern for an aging population relying on asset income to fund its consumption (Borsch-Supan 2005). Some research has explored the extent to which the industrial world might sustain high rates of return on capital by investing in the capital markets of the Third World (Borsch-Supan 2005). Macrosimulation of international capital flows as populations age suggests that, although investment in the Third World would help somewhat to prop up rates of return in the industrial world, the impact would be modest because third-world capital markets are relatively small. Furthermore, the Third World is aging as well, so any respite would be transitory. Global population aging is in our future, and eventually our institutions and lifecycle behaviors will have to adjust to it.

How Much Capital Do We Want? Capital serves two important functions in an economy. First, it is productive. More capital raises output, and it raises the productivity of labor and therefore wage rates. Second, it is a store of value that yields a rate of return and enables us to smooth consumption over our lifecycles. We can accumulate capital when we are working and use that capital as a source of income when we are retired. Population aging raises the demand for capital as a store of value, because the proportion of elderly rises and because each old person needs more capital due to longer life and fewer children to provide for, as discussed earlier. As the capital intensity in the economy rises with population aging, its rate of return falls. In principle, this rate of return could fall all the way to that yielded by a transfer system in steady state, namely, the rate of growth of the labor force plus the rate of growth of labor productivity—or, equivalently, the rate of growth of GDP. And with further capital intensification, it could fall below this level.

When the rate of return on capital equals the rate of growth of GDP in steady state, the economy is said to be on a golden-rule path. The corresponding ratio of capital to labor maximizes per-capita consumption. If capital intensity increased further, then consumption

would fall because the costs of maintaining that higher level (investment to offset depreciation and to equip the growing labor force) would exceed its incremental contribution to output. Such an economy is said to be dynamically inefficient. Because a transfer system could pay a higher rate of return in steady state, it would be more efficient to hold a portion of aggregate societal wealth in the form of transfer wealth rather than physical capital.

This is the situation contemplated by Diamond (1965), who demonstrated that in theory it could plausibly occur in a standard model. Diamond stressed the role of public debt as a policy lever for attaining an efficient economic growth path. Public debt represents a transfer from the young and unborn to the current population, and the government bonds used to finance it are an alternative to capital as a store of wealth. Creating or enlarging an unfunded public pension program would have the same effect. Similarly, if the capital stock resulting from the lifecycle saving of individuals is below the golden-rule amount, then it can be raised if the government cumulates a fiscal surplus, the opposite of government debt. This government wealth would then be a transfer from older to younger members of the population, for which a pro rata share is, in a sense, received at birth and passed on to younger generations at death, embodying negative transfer wealth. It is difficult to think of examples, other than governments that control petroleum reserves and pass these on, at least in part, from generation to generation.

These issues are highly relevant when we consider the effects of population aging. In earlier work (Lee 1994), I showed that when positive transfer wealth is necessary for an economy to attain a golden-rule path, as in the Diamond (1965) analysis, then slower population growth and, therefore, population aging will reduce consumption over the lifecycle. This makes sense, because positive transfers go from young to old, and population aging makes such transfers more costly to maintain. In my view, this case is highly unrealistic, and, in the real world, lifecycle saving is likely to generate less than the golden-rule amount of capital in virtually all nations. If that is so, then the opposite scenario of Diamond becomes relevant: Downward transfers and negative transfer wealth

would be necessary to attain a golden-rule path. In this more realistic case, population aging would be beneficial and lead to greater lifecycle consumption, because with slower growth and an older population, it is less expensive for the elderly to make transfers to the less numerous young. Put differently, in this case the second dividend would be great enough to reverse the adverse effects of the declining support ratio.

Conclusions

Global population aging is an inevitable and permanent feature of the final stages of the demographic transition. It came earlier to the industrial nations, which started the transition in the nineteenth century, but in no country has it reached full flower, and no country has attained even half of the old-age dependency ratio that looms for it in the near future.

Population aging has economic consequences because our economic behavior and capabilities vary in systematic ways with age, and, in particular, abilities tend to decline late in life. There are two dominant concerns about population aging: first, that the burden on the working-age population of supporting increasing numbers of dependent elderly will be overwhelming; and, second, that aggregate saving rates will fall as the share of elderly dissavers rises relative to working-age savers.

First consider the dependency costs of aging. Over the twentieth century the age at retirement in the industrial nations plunged by ten or more years, while life expectancy at birth increased by thirty years. Despite this great expansion in the third stage of life, the general dependency costs of population aging should not be severe, judging by projected changes in the ratio of effective workers to effective consumers—the support ratio. For the United States, the projected decline in the support ratio over the course of the twenty-first century suggests that consumption will fall by only 18 percent, other things equal. Spread over a century, a change of this magnitude will be barely perceptible. In other industrial nations with lower fertility, however, the decline will be larger.

Although it appears that the general dependency costs of population aging will be only moderate, these costs are concentrated in a few public programs for pensions, health care, and long-term care, and these concentrated costs will be substantial. Even these costs, however, are easily exaggerated. In the United States, our Social Security program currently costs about 4.5 percent of GDP. Making it sustainable in the long term while maintaining current benefits would cost roughly 2 percent more of GDP, still a modest amount. Far more serious are the projected costs of Medicare and the portion of it that pays for some long-term care. It is important that governments address these long-term problems by restructuring benefits and taxes. In some countries, such restructuring may involve converting from unfunded pay-as-you-go systems to funded systems, but such a move would require first paying back the system's implicit debt. This limits the possibilities for mature industrial economies.

Countries of the Third World are at differing stages of the demographic transition, ranging from a few where fertility has not yet begun to fall, through the majority, which are in midcourse of fertility decline and are benefiting from the rising support ratios that confer the first demographic dividend, to some that have arrived at fertility well below replacement and will experience rapid population aging in the coming decades. It is imperative that all these countries carefully consider how best to structure their old-age support systems. Most currently have familial support systems that are, in effect, unfunded pay-as-you-go systems organized at the familial rather than the national level.

Two implications are as follows: First, population aging will impose a rising transfer cost on the working-age population, just as with unfunded public-sector programs. Second, these familial systems also hold implicit debt that would have to be repaid in a transition to a funded system of private-asset accumulation to fund old-age consumption. In such a transition, some generations would have to support their own elderly parents, thus repaying implicit debt while at the same time saving for their own retirement, thus freeing their own children of the obligation of supporting them in

old age. This is the same double burden that would be involved in moving from an unfunded to a funded public pension system. Nonetheless, such a transition would be far less costly in countries that are still young than in the current industrial world, because the cost of repaying the implicit debt can be shared across more surviving children in each family.

Put differently, these younger third-world countries could spend a portion of the first demographic dividend on the transition to a funded support system. They have more appealing options for dealing with population aging than does the industrial world. The potential gain from moving to a funded system *before* population aging is that, with a funded system in place, population aging would promote capital intensification and economic growth. It may be too late for the already old industrial nations to take this step, because the time to do it is before populations have aged, not after, when the costs would be very high. With appropriate policies, third-world countries could position themselves to reap the benefits of a permanent second demographic dividend.

This brings us to the second dominant concern—that population aging will reduce aggregate saving rates. Indeed it will. Nevertheless, population aging is mainly caused by lower fertility and slower population growth, including slower growth in the labor force. With slower labor-force growth, each worker can be equipped with more capital even when the aggregate saving rate is lower (Cutler et al. 1990). Unless the elderly are supported entirely through transfers rather than assets, population aging should lead to capital intensification and therefore rising labor productivity even as saving rates fall. The extent to which this happens will depend on the structure of support for the elderly. In the industrial world, mammoth public-sector transfer programs to the elderly weaken the growth-enhancing effects of population aging. In Japan, for example, we saw that, on net, asset accumulation plays only a very small role in providing financial support for the elderly, while government transfer programs are particularly important. Prefunding of retirement in the Third World might occur through private lifecycle savings, but it could also occur through funded public or

private funded pensions. The key point is that the time to put such programs in place is now, not when population aging is already straining familial or public transfer programs.

Notes

1. In demography, the term "stable population" does not mean a population that is constant in size; it means one that has a constant growth rate and unchanging proportional age distribution, equivalent to the term "steady state." "Stationary" is used to describe a stable population that has a zero growth rate and is constant.

2. The "actual" data in figure 3 are taken from the 2000 revision of *World Population Prospects* (United Nations 2001) and exhibit an earlier peak in the population growth rate than the most recent United Nations data in the 2004 revision. In the latter, the peak is in the late 1960s, which is more consistent with the simulated data in the figure.

References

Barro, R. J. 1974. "Are Government Bonds Net Wealth?" *Journal of Political Economy* 82 (6): 1095–1117.

Benjamin, Dwayne, Loren Brandt, and Scott Rozelle. 2000. "Aging, Well-being, and Social Security in Rural Northern China." *Population and Development Review* 26. Supplement: "Population and Economic Change in East Asia," 89–116.

Bhat, P. N. Mari. 1989. "Mortality and Fertility in India, 1881–1961: A Reassessment." In *India's Historical Demography: Studies in Famine, Disease and Society*, ed. Tim Dyson, 73–118. London: Curzon Press.

Bixby-Rosero, Luis. 2006. National Transfer Accounts Project. www.schemearts.com/proj/nta (accessed March 6, 2007).

Bloom, David E., and David Canning. 2004. "Global Demographic Change: Dimensions and Economic Significance." In *Global Demographic Change: Economic Impacts and Policy Challenges*, 9–56. Kansas City, Mo.: Federal Reserve Bank of Kansas City.

Bloom, David E., D. Canning, and J. Sevilla. 2002. *The Demographic Dividend: A New Perspective on the Economic Consequences of Population Change*. Santa Monica, Calif.: Rand.

Bloom, David E., and J. G. Williamson. 1998. "Demographic Transitions and Economic Miracles in Emerging Asia." *World Bank Economic Review* 12 (3): 419–56.

Borsch-Supan, Axel. 2005. "The Impact of Global Aging on Labor, Product and Capital Markets." Unpublished manuscript, March 22. Mannheim Research Institute for the Economics of Aging (MEA), University of Mannheim, Germany.

Burtless, Gary, and Joseph F. Quinn. 2001. "Retirement Trends and Policies to Encourage Work among Older Americans." In *Ensuring Health and Income Security for an Aging Workforce*, ed. P. P. Budetti, R. V. Burkhauser, J. M. Gregory, and H. A. Hunt, 375–97, 410–15. Kalamazoo, Mich.: Upjohn.

Chawla, Amonthep,. 2005. National Transfer Account Project. www.schemearts.com/proj/nta (accessed March 6, 2007).

———. 2006. "National Transfer Accounts for Thailand." Mimeo, National Transfer Accounts Project. www.schemearts.com/proj/nta (accessed March 6, 2007).

Coale, Ansley, and Paul Demeny. 1983. *Regional Model Life Tables and Stable Populations*. New York: Academic Press.

Cutler, D. M., J. M. Poterba, L. Sheiner, and L. Summers. 1990. "An Aging Society: Opportunity or Challenge?" *Brookings Papers on Economic Activity* 1:1–56.

Diamond, Peter. 1965. "National Debt in a Neoclassical Growth Model." *American Economic Review* 55:1127–55.

Feldstein, M. 1974. "Social Security, Induced Retirement, and Aggregate Capital Accumulation." *Journal of Political Economy* 82 (5): 905–26.

Gokhale, Jagadeesh, and Kent Smetters. 2003. *Fiscal and Generational Imbalances: New Budget Measures for New Budget Priorities*. Washington, D.C.: American Enterprise Institute.

Gruber, Jonathan, and David Wise. 1998. "Social Security and Retirement: An International Comparison." *American Economic Review* 88 (May): 158–63.

Higgins, Matthew, and Jeffrey Williamson. 1997. "Age Structure Dynamics in Asia and Dependence on Foreign Capital." *Population and Development Review* 23 (June): 261–94.

Kamiya, Yumiko. 2006. "Social Security and Living Arrangements of the Elderly in Brazil." Ph.D. diss., Department of Demography, University of California, Berkeley.

Kelley, A. C., and R. M. Schmidt. 2001. "Economic and Demographic Change: A Synthesis of Models, Findings, and Perspectives." In *Population Matters: Demographic Change, Economic Growth, and Poverty in the Developing World*, ed. N. Birdsall, A. C. Kelley, and S. W. Sinding, 67–105. Oxford: Oxford University Press.

Lee, Ronald D. 1994. "The Formal Demography of Population Aging, Transfers, and the Economic Life Cycle." In *Demography of Aging*, ed. L. G. Martin and S. H. Preston, 8–49. Washington, D.C.: National Academy Press.

———. 2003a. "The Demographic Transition: Three Centuries of Fundamental Change." *Journal of Economic Perspectives* 17 (Fall): 167–90

———. 2003b. "Demographic Change, Welfare, and Intergenerational Transfers: A Global Overview." *Genus* 59 (July–December): 43–70.

Lee, Ronald, and R. Edwards. 2001. *The Fiscal Impact of Population Change. Seismic Shifts: The Economic Impact of Demographic Change*, ed. J. S. Little and R. K. Triest. Boston: Federal Reserve Bank of Boston Conference Series No. 46.

———. 2002. "The Fiscal Effects of Population Aging in the US: Assessing the Uncertainties." In *Tax Policy and Economy*, vol. 16, ed. J. M. Poterba, 141–81. Cambridge, Mass.: MIT Press, National Bureau of Economic Research.

Lee, Ronald D., Sang-Hyop Lee, and Andrew Mason. Forthcoming. "Charting the Economic Life Cycle." In *Population Aging, Human Capital Accumulation, and Productivity Growth*, ed. Alexia Prskawetz, David E. Bloom, and Wolfgang Lutz. New York: Population Council.

Lee, Ronald, Andrew Mason, and Timothy Miller. 2000. "Life Cycle Saving and the Demographic Transition: The Case of Taiwan." *Population and Development Review* 26. Supplement: "Population and Economic Change in East Asia," 194–222.

———. 2001. "Saving, Wealth, and Population." In *Population Matters: Demography, Poverty, and Economic Growth*, ed. Nancy Birdsall, Allen C. Kelley, and Steven W. Sinding, 137–64. Oxford: Oxford University Press.

———. 2002. "Saving, Wealth, and the Demographic Transition in East Asia," in Andrew Mason, ed., *Population Change and Economic Development in East Asia: Challenges Met, Opportunities Seized*, East-West Center Series on Contemporary Issues in Asia and the Pacific, Stanford: Stanford University Press, 155–84.

———. 2003. "From Transfers to Individual Responsibility: Implications for Savings and Capital Accumulation in Taiwan and the United States." *Scandinavian Journal of Economics* 105 (3): 339–57.

Lee, Ronald, Timothy Miller, and Ryan Douglas Edwards. 2003. *A Special Report: The Growth and Aging of California's Population: Demographic and Fiscal Projections, Characteristics and Service Needs.* Berkeley, Calif.: University of California, California Policy Research Center.

Livi-Bacci, Massimo. 2000. *The Population of Europe.* Oxford: Blackwell.

Maliki, nfn 2006. National Transfer Accounts Project. www.schemearts.com/proj/nta (accessed March 6, 2007).

Mason, Andrew. 1988. "Saving, Economic Growth and Demographic Change." *Population and Development Review* 14 (March): 113–44.

———. Forthcoming. "Demographic Transition and Demographic Dividends in Developed and Developing Countries." *United Nations Population Bulletin*. www.schemearts.com/proj/nta/doc/repository/M2005.pdf (accessed March 6, 2007).

Mason, Andrew, R. Lee, A. Tung, M. Lai, and T. Miller. Forthcoming. "Population Aging and Intergenerational Transfers: Introducing Age into National Accounts." In *Developments in the Economics of Aging*, ed. David Wise. Chicago: University of Chicago Press, National Bureau of Economic Research. www.schemearts.com/proj/nta/doc/repository/MLTLM2005.pdf (accessed March 6, 2007).

Mitchell, B. R. 1975. *European Historical Statistics 1750–1970*. New York: Columbia University Press.

Ogawa, Naohiro, and Rikiya Matsukura. Forthcoming. "The Role of Older Persons' Changing Health and Wealth in an Aging Society: The Case of Japan." *United Nations Population Bulletin*. www.schemearts.com/proj/nta/doc/repository/OM2005.pdf (accessed March 6, 2007).

United Nations. 2000. *Long-Range World Population Projections: Based on the 1998 Revision*. New York: United Nations, Population Division. CD-ROM.

———. 2001. *World Population Prospects: The 2000 Revision. Disk 2: Extensive Set*. New York: United Nations, Population Division, February. CD-ROM.

———. 2002. *World Population Ageing 1950-2050*. New York: United Nations, Population Division.

———. 2005. *World Population Prospects: The 2004 Revision.* New York: United Nations, Population Division.

U.S. Bureau of the Census. 2000. *Population Projections for the United States by Age, Sex, Race, Hispanic Origin, and Nativity: 1999 to 2100.* Washington, D.C.: U.S. Bureau of the Census, Population Division, Population Projections Program.

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