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Will Aging Baby Boomers Bust the Federal Budget?

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Barely ten years from now, the leading edge of the baby boom generation will turn 65, ushering in a sustained aging of the U.S. population. Many are concerned that through the first half of the 21st century, the federal government will stagger under the weight of these elderly baby boomers as they receive the medical, retirement, and disability benefits promised them. The number of people over age 65 in the population is projected to increase by a factor of 2.5 by 2040 (Lee and Tuljapurkar, 1994), with the number of nursing home residents growing even more rapidly (Schneider and Guralnick, 1990). Long-term forecasts suggest that nearly one-third of GDP will be accounted for by health care by 2030 (Burner, Waldo and McKusick, 1992; Warshawsky, 1994). The fiscal impact of this demographic change is potentially enormous (Shoven, Topper and Wise, 1994).

An alternative view is much more optimistic about retirement prospects for the baby boom generation. This view holds that disability and morbidity will continue to become more compressed, leading to healthier years later in life (Manton, Stallard and Liu, 1993b; Manton, Corder and Stallard, 1997). The average retirement age will rise. Productivity gains and increased tax revenue will offset the demands that aging baby boomers place on the federal budget. One projection suggests the percentage of those over age 65 requiring Medicaid coverage for long-term care will decline in the next century (Wiener, Illston and Hanley, 1994). Another is that long-term health care costs will decline as a fraction of median

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income (Zedlewski and McBride, 1992). As a *Business Week* cover story (Farrell, 1994, p. 68) concluded, "The elderly are more vital than before. Americans can afford to grow old. And they will grow old gracefully."

Figuring out which of these two scenarios is most likely is crucial for forming policies in preparation for the retirement of the baby boomers. If the baby boomers are likely to cause severe problems for the federal budget in the next century, then assessing costs on them now, while they are still working, clearly makes more sense than changing policies after they have already retired. Conversely, a government cure for a nonexistent problem could disrupt the saving and retirement plans of the generations it was designed to help.

But knowing which basic scenario is correct is a difficult task. First, we must know how long the baby boom generation will live. Will life expectancies continue to rise at rates observed in the past? Possible alternatives are that either we bump up against an intrinsic biomedical ceiling to longevity, or that we are on the threshold of dramatic gains in longevity as a result of breakthroughs arising from medical advances and healthier lifestyles.

A second tier of questions goes beyond years of life to consider what kind of life. Will the elderly in the next century live with the disabling after-effects of strokes and heart disease, or will the future elderly be healthier as a result of having avoided disease at younger ages? These trends in health and disability will strongly influence retirement decisions, and perhaps most importantly for government budgets, the demand for health care resources.

A third cluster of issues surrounds the evolving technology of health care, which will surely exert a strong influence on health care costs. Will technological change take the form of ever-more expensive interventions targeted not just to those who are sick, but preventive (and expensive) procedures for the enormous reservoir of those who might become sick? Or will health care evolve towards strategies that could yield cost savings, such as the use of cholesterol-reducing drugs that can attenuate future surgical expenses (Johannesson, 1997)?

The sociologist Richard Suzman (as quoted in Roush, 1996) once said about predictions of life expectancy, health, and disability, "Anyone who gives you firm prognostications about what is going to happen is either a liar or a fool . . ." We wish to avoid being lumped into either of these categories. Nevertheless, in what follows we will venture some general answers to the questions raised above. We find that the prospects for longevity are considerably brighter than currently expected by the Social Security Administration. This is good news for the baby boomers and only modestly bad news for the Social Security trust fund since more people are also expected to survive through the working ages, meaning a larger-than-expected number of taxpayers in the future. But there is considerable uncertainty about the state of the Social Security trust fund; stochastic simulations for the year 2070 show a 95 percent confidence interval with a range of $54 trillion!

The good news about longevity is not necessarily bad news for the long-term health of the Medicare trust fund. Once past the current impending crisis in Medicare—which is really the problem of the baby boomers' parents—we believe that the greater number of people dying at older ages (with the resulting lower associated costs of the terminally ill) will largely offset the direct impact on Medicare spending of more elderly people (Lubitz, Beebe and Baker, 1995; Miller, 1998). The greatest source of uncertainty about future Medicare spending is the course of medical technology. We suspect that real growth (as a fraction of GDP) will continue in the long-term, but at considerably slower rates than those projected by some government agencies.

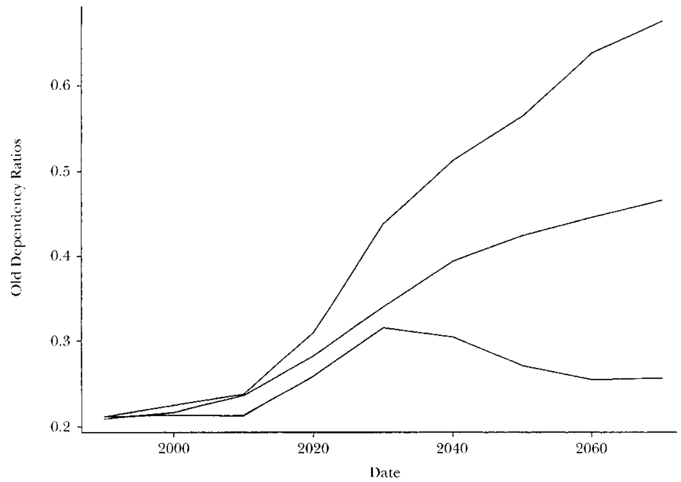
As noted above, there is a tremendous degree of uncertainty about demographic and economic projections. Thus the many proposals to ''fix'' Social Security and Medicare in expected value terms can still result in empty trust funds should the projections be wrong. For example, one proposed fix—an immediate 2 percentage point increase in the Social Security payroll tax—still leaves a 75 percent chance of the Social Security trust fund going bankrupt before 2070 (Lee and Tuljapurkar, 1998a, b). Whatever the nature of reform that takes place in this century, the government should prepare for the possibility of a major Social Security and Medicare bust (or bonanza) in the next century.

Mortality Decline: How Fast and How Far?

The total U.S. population is predicted to increase by about two-thirds between now and 2070. But in this same time, the population over 65 will triple, and the population over 85 will increase by a factor of eight (Lee and Tuljapurkar, 1994). The old age dependency ratio—that is, the population aged 65 and over divided by the working age population aged 20 to 64—is a convenient measure of population aging. In judging the fiscal viability of Social Security and Medicare, this is obviously a crucial ratio, since it approximates the ratio of people receiving benefits (the numerator) over the people paying into the system (the denominator). Figure 1 plots this ratio. The middle line is the point estimate, while the upper and lower lines show a 95 percent probability interval from a new kind of stochastic population projection by Lee and Tuljapurkar (1994, p. 1185; described in the Appendix). The old age dependency ratio rises steeply between 2010 and 2030 as the baby boom generations turn 65. By 2070, the old age dependency ratio is projected to more than double, to 0.47, but the gap around the central estimate is fairly wide, with the 95 percent confidence interval ranging from 0.26 to 0.68.

Much of the uncertainty derives from the unknown course of fertility, since sustained low fertility leads to old populations. Since the 1970s, U.S. women have averaged 1.8 to 2.0 children each. Women in Europe average 1.4 children each; Spain and Italy both have about 1.2 births per woman. If U.S. fertility were to move toward the rest of the industrialized world, aging would be much more rapid than currently projected. The fertility of immigrants and minorities contributes to higher fertility in the United States, but the fertility of non-Hispanic whites at 1.8 births per woman is itself substantially higher than European fertility. The Social Security

Figure 1
Projected Old Age Dependency Ratios with 95% Probability Intervals



Source: Based on a probabilistic population projection by Lee and Tuljapurkar (1994, Table 2).

Actuary's long-run assumption for fertility, 1.9 births per woman, is reasonable, but the assumed range of 1.6 to 2.2 births per woman seems narrow.

Many people believe that higher immigration could ease the projected problems of Social Security and Medicare, and in fact it could, if we take into account the contributions of the future descendants of immigrants as well (National Research Council, 1997, p. 107–110). However, the effect is very small, because immigrants grow old, too. In the Social Security projections, the long run effect of varying the immigration assumption is only one-fourth as great as for varying the fertility assumption, and less than a sixth of the effect of varying the mortality assumption (Office of the Chief Actuary, 1996). The role of immigrants and their descendants in helping to support the aging baby boom looms large in calculations of the net fiscal impact per immigrant (National Research Council, 1997, ch. 7), but it remains small in the context of Social Security and Medicare.

Mortality Decline in the United States During the 20th Century

As a starting point, it is useful to consider the history of mortality decline in the United States during the 20th century. The pace of mortality decline has varied, as shown by data from the Social Security Administration in Table 1. During one subperiod, 1954–68, the age-standardized male death rate actually rose. The dates in the table were presumably chosen not randomly but rather to maximize the variation, and so the marked contrasts in rates should be interpreted with caution. However, the figures in the table do not give a strong impression of either accelerating or decelerating rate of decline.

Even when age-specific mortality declines at unchanging rates, there is a built-

Table 1
Annual Percentage Rate of Decline in Age-Adjusted U.S. Death Rates
(by sex for selected periods)

Period	*Males*	*Females*
1900–1936	0.8	1.0
1936–1954	1.6	2.5
1954–1968	−0.2	0.8
1968–1982	1.8	2.1
1982–1991	0.8	0.5
1900–1991	1.0	1.38

Source: Social Security Administration (1996).
Note: This is the rate at which the crude death rate would have declined for a population with the age distribution of the 1990 U.S. population subject to the age-specific death rates of each period.

in tendency for gains in life expectancy to slow down. This happens because over time the lives saved by falling death rates are increasingly at older ages where only a few years of life are thereby added, in contrast to lives saved in childhood. In the United States, the overall age-adjusted death rate declined at virtually the same rate from 1900 to 1947 and from 1947 to 1994 (.0118 versus .0111).[1] However, life expectancy increased by 19.4 years in the first period, but only by 8.5 years in the second period (Office of the Chief Actuary, 1996, pp. 9–10, 15–16). Of course, death rates might begin to decline more rapidly in the future, particularly at older ages, which could forestall the deceleration of rising life expectancy. But if historical trends continue, then gains in life expectancy will continue to slow.

Forecasting Mortality

It is remarkable that the rate of decline of U.S. mortality, adjusted for age, has been fairly constant over broad periods in the 20th century. But what implication should be drawn about mortality declines in the future? Some analysts have argued forcefully that the pace of declines will slow, as life expectancy approaches an effective biological upper limit of about 85 years (Fries, 1980; Olshansky et al., 1990). Others believe that a life expectancy of 100 might be attained by the middle of the next century, if not sooner (Ahlburg and Vaupel, 1990; Manton, Stallard and Tolley, 1991).[2]

[1] In this case, the age standardized death rate results from applying the age-sex specific death rates of each year times the proportion of the population by age and sex in the 1980 population. See Social Security Administration (1992, pp. 3–4).
[2] For a general discussion of methods of forecasting mortality, see Lee and Skinner (1996).

As a benchmark, assume that mortality will continue to decline in the future at each age at the same rate at which it declined between 1900 and the present. This is close to the method proposed by Lee and Carter (1992), who forecast that expected length of life will rise to 86 years in 2065.

The mortality forecasts prepared and used by the Social Security Administration are done rather differently, and foresee smaller gains. Their recent forecasts give a life expectancy of 81.2 years in 2065, and 81.8 years in 2080 (Board of Trustees, 1998, p. 60). Within the range of forecasts made in recent years for the United States, some of which will be discussed below, this is definitely at the low end. The forecasts are based for initial years on extrapolation of recent age-specific trends, but these are assumed to move within 25 years to slower ultimate rates of decline. Thus, the mortality rate for those in the 0–14 age bracket declined at 3.27 percent per year from 1900–1991, but is projected to decline only 1.52 percent per year from 1995 to 2080. Similarly, the mortality rate for the 15–64 age bracket actually declined 1.39 percent per year from 1900–1991, but is projected to decline just .68 percent per year from 1995 to 2080. Only for the 85 and older group is the historical decline in mortality rates of .54 percent per year fairly close to the forecast decline of .49 percent. Of course, over periods of time approaching a century, these small annual percentages compound into large differences. The rationale for the projection of decelerating mortality decline is the expectation that progress against certain specific causes of death is less likely in the future (Office of the Chief Actuary, 1992, p. 6; 1996, pp. 8–14).

The Social Security forecasts are premised on a slowdown in mortality decline at ages below 85. Some support for this premise can be found in Table 1, which showed that in the 1980s mortality declined much more slowly than in the 1970s. More generally, might U.S. declines in mortality be slowing as life expectancy approaches an upper limit, making it increasingly difficult for medical advances to achieve gains?

If so, these arguments should apply to mortality decline in other low mortality countries. The United Kingdom, France, Sweden, the Netherlands, and Japan all have low mortality and also have excellent data on mortality in old age (Horiuchi and Wilmoth, 1995, Table 1). Life expectancy in the United Kingdom is similar to that in the United States. In Japan and Sweden, it is three or four years higher than in the United States. France and the Netherlands fall in between. The fact that citizens of other nations experience considerably higher life expectancy than Americans is some evidence that the United States will not immediately bump into some biologically-imposed upper limit on life expectancy. According to projections of the Social Security Administration, not until 2051, or 53 years from now, will the United States attain the life expectancy of 80.4 years which is observed for Japan in 1996 (Board of Trustees, 1998, p. 60).

Further evidence from the international data against the notion that life expectancies are hitting an upper limit is that the rate of mortality decline among older age groups has remained high, even in the countries that already have life expectancies as high or higher as the United States. For older males, the rates of mortality decline projected by the Social Security Administration are substantially lower than those experienced in the five countries considered by Horiuchi and Wilmoth (1995) over the period 1975–79 to 1985–89, with the single exception of 75–79 year-old males in the Netherlands. The projected declines for U.S. males are only half as rapid as the average for these five populations in the past at 60–64, and only a third as great as the average at 75–79. For females, the contrast is even greater, with projected rates of decline that are less than a third of the average at 60–64, and less than a fifth of the average at 75–79.[3]

In a notable article, Kannisto et al. (1994) present evidence on rates of mortality decline from 19 countries with reliable data on mortality among the oldest old; that is, ages 80–100. They find (p. 794): ''In most developed countries outside of Eastern Europe, average death rates at ages above 80 have declined at a rate of 1–2 percent per year for females and 0.5–1.5 percent per year for males since the 1960s.'' By contrast, the Social Security Administration projections imply a decline at only 0.5 percent, less than one-half the average pace in the Kannisto et al. sample. While U.S. death rates among the oldest old are indeed lower than those of other developed countries (Manton and Vaupel, 1995), there is little evidence that countries with higher death rates experience more rapid declines in those rates (Kannisto et al., 1994). Furthermore, rates of decline at these older ages have been accelerating throughout the 20th century, not slowing (p. 799–802).

These international comparisons provide evidence that U.S. mortality decline is not yet pushing up against biological limits, or against limits imposed by already existing medical technology. In our view, the central Social Security Administration forecasts of mortality decline are far too low.

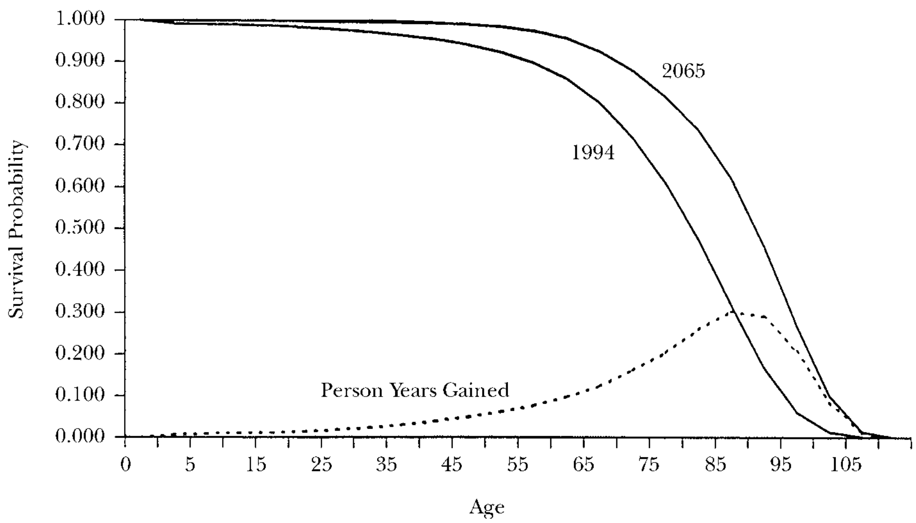
Fiscal Implications of Falling Mortality

How does mortality decline affect retirement systems? Analysts often focus on changes in life expectancy at age 65, which has risen by 50 percent, from 11.7 years in 1900 to 17.2 in 1994. But this is only part of the story. The probability at birth of reaching age 65 has increased by 60 percent, and these incremental retirees also contribute incremental years of work before retirement. The most useful single number for assessing the effect of mortality decline on retirement systems is the ratio of expected years lived during retirement to expected years lived during the working years. Between 1900 and 1997, this ratio doubled from .17 to .34, a change twice as great as the proportional change in life expectancy at 65 over the same period.

Figure 2 displays a survival function; that is, the probability at birth of surviving

[3] We should note that the average rates of decline for the same countries at the earlier dates 1955–59 to 1965–69 are similar for females age 60–64, but only 60 percent as fast for the 75–79 age bracket, leaving the qualitative conclusion unchanged; the Social Security Administration projected rate of decline is still only about a third of the average international rate. For males, however, the picture is different. The average rate of decline of mortality for males age 60–64 from 1955–59 to 1965–69 was only 0.15 percent per year in the international sample, far lower than the Social Security Administration projection, and at age 75–79 it was only 0.41 percent per year, slightly lower than the Social Security Administration projection.

Figure 2
Probabilities of Survival from Birth to Each Age in 1994 and Projected to 2065, and Their Difference



Note: Person years gained is given by the difference between the two survival curves. The area under the person years gained line equals the gain in life expectancy between 1994 and 2065, which is 10.5 years. The survival curves are from period life tables for sexes combined.
Source: Calculated from Lee and Carter (1992) and Office of the Actuary (1996).

to a given age. The two solid lines show the survival function for 1994, with a life expectancy of 75.5 years, and the survival function as forecast for 2065 by Lee and Carter (1992), with a life expectancy of 86 years. The difference between these two curves, plotted as the dotted line in the figure, gives the expected change in the person years of life lived at each age over this period. It is striking that 76 percent of the gains in person years lived are expected to occur after age 65. However, important gains will also occur during the working years, with a 22 percent increase in person years lived. These gains in the working years tend to increase earnings and the tax base, while gains at older ages tend to increase the cost of benefits provided. Gains before age 20 are very small, and can be ignored for our purposes.

The implications of these changes for Social Security have been simulated, using a dynamic model that builds on cross-sectional age schedules for payroll tax contributions and Social Security benefits (Lee and Tuljapurkar, 1997a, b). These age schedules can be suitably modified over time to reflect productivity growth and legislated changes in the normal retirement age; for example, under current law, the normal retirement age for Social Security will rise from 65 to 67, with the phase-in complete by 2025. The simulation uses the Social Security Administration "middle" assumptions as of 1996 for fertility (1.9 children per woman), immigration

(900,000 per year), real productivity growth (1 percent per year), and real interest rate for the trust fund (2.3 percent per year) (Board of Trustees, 1996). It uses the mortality model from Lee and Carter (1992) to generate different trajectories of mortality decline, attaining life expectancies in 2070 of 81, 87, 90, and 100 years.[4] The first corresponds closely in life expectancy to the Social Security Administration ''middle'' projection, the second to the Lee and Carter (1992) point forecast, and the third and fourth to hypothetical scenarios of a more rapid mortality decline.

We wish to use this simulation model to examine the fiscal implications of mortality change for the Social Security system. However, before we do, we must consider the various measures that are used to assess the long-term finances of the system. One approach is to project the trust fund balance implied by current policies. A different strategy is to specify the year when the trust fund runs out of money, which for Social Security is 2032 (Board of Trustees, 1998). Neither measure gives a good sense of what magnitude of reform would be necessary to address the problem; indeed, giving the year of projected insolvency doesn't even give much information about the size of the problem.

Another indicator is the long-term actuarial balance, as measured by the amount by which the payroll tax rate would have to be increased immediately and permanently, to leave a balance in the trust fund after 75 years equal to one year's expected costs. Under Social Security Administration's middle assumptions, the long term actuarial balance is about 2.2 percentage points, meaning that the payroll tax rate for the Old Age, Survivors and Disability Insurance Trust Fund would have to be raised from 12.4 percent to 14.6 percent.[5] This measure is a useful one, but it has a serious problem arising from the finite horizon. It conceals the fact that even after payroll taxes were raised by 2.2 percentage points, by 2070 the annual costs of the OASDI system would exceed revenue (from taxes plus interest on the trust fund) by nearly 40 percent, or by 1.8 percent of GDP (calculated from Board of Trustees, 1996, p. 187). This would leave the Social Security Administration in 2071 with some unpleasant choices.

A different picture emerges if we ask what tax rate would be necessary each year to maintain the trust fund at a level exactly equal to the following year's expenditures. This is the necessary tax rate in a pure pay-as-you-go system, with only a minimal trust fund. This tax rate can change every year. This is the measure we will calculate with the help of the dynamic simulation model described above. The results are given in Table 2, which shows tax rate trajectories of this sort, based on different mortality trajectories, but with the same assumptions about fertility, real productivity growth, and real interest rates as before.

For all mortality scenarios, tax rates are initially lower than the actual current rate of 12.4 percent, because the current level generates surplus revenues. This

[4] This is done by suitably modifying the rate of drift in the autoregressive equation for k, the mortality index, in the Lee-Carter method. We have not used the model to generate life expectancies as high as 100 years in the past, and the implied age distributions have not been verified this far out of sample.

[5] A similar calculation can be done for the necessary reduction in benefits (Burtless, 1997).

includes both the employer and employee share of the tax, and includes all Old Age, Survivors, and Disability Insurance—that is, the OASDI fund. As time passes, however, tax rates must rise to provide benefits for the aging population, reflecting the effects both of mortality decline and of trends in fertility and immigration. Even under the Social Security Administration middle projection (row one of Table 2), with slow mortality decline, the tax rate would need to increase from 12 percent in 2000 to 20 percent by 2070. Most of this big increase is due to past fertility change, including the size of the baby boom generations. The Lee-Carter (1992) point forecast (row 2 of Table 2) would require 2070 taxes to be 4 percentage points higher than the rate projected under the Social Security Administration. If life expectancy instead were to rise to 90, then taxes would need to rise to 27 percent of payroll. And if life expectancy were to rise to 100 years by 2070, then Social Security taxes alone would have to rise to 32 percent of payroll. Clearly, uncertainty about the future course of mortality entails very substantial uncertainty about the future finances of the Social Security system.[6]

The Social Security Administration provides another convenient measure of the impact of demographic change: the amount by which retirement age would have to increase to keep the ratio of those above the retirement age to those between age 20 and the age of retirement equal to its level in 1995 (Office of the Chief Actuary, 1997, p. 129–130). The current mean age of retirement is close to 63; the corresponding ratio of those 63 and over to those 20–62 is .25. To achieve that ratio of .25 in 2070 under the ''middle'' Social Security Administration forecast assumptions, the retirement age would have to be 72, fully nine years greater! Under the ''high'' cost set of assumptions of the Social Security Administration, the retirement age would have to be 76. Remember that the normal retirement age for Social Security is currently legislated to increase from 65 to 67 by 2025. If the actual retirement age also increased by two years (an unlikely event), this would comprise less than half of the five-year increase necessary to keep the dependency ratio constant by 2025, and only two-ninths of the total increase needed by 2070.

The above simulations use the Lee-Carter (1992) model to generate the age distribution of mortality corresponding to each level of life expectancy. Relative to these Lee-Carter age distributions, Social Security assumes relatively smaller gains in person years lived in working ages and greater gains in old age, due to their treatment of mortality decline at younger ages, as discussed earlier. Thus

[6] The annual reports of the Board of Trustees of the SSA indicate that an increase of 2.2 percentage points in the payroll tax rate would achieve actuarial balance of the system through 2070 (Board of Trustees, 1998, p. 3). This may appear to contradict the results of the first row of Table 2, which suggests a rise of 8.5 percentage point, for a very similar set of economic and demographic assumptions. Despite appearances, these figures are not inconsistent. The 2.2 percentage point increase is immediate, and would equalize the present value of taxes and benefit payments through 2070. As noted in the text, it would result in the accumulation and decumulation of a large reserve fund, and it would leave the system losing money rapidly in 2070. The yearly balanced budget assumption is very different.

Table 2
Balanced Budget Tax Rates for Social Security Under Different Future Mortality Trajectories

Life Expectancy in 1970 in Years	*2000*	*2030*	*2050*	*2070*
81 (SSA Middle Projection)	.12	.17	.18	.20
87 (Lee-Carter Point Projection)	.12	.19	.21	.24
90	.12	.19	.23	.27
100	.12	.22	.27	.32

Note: Tax rate is for OASDI only, and is estimated to equalize revenues and benefits yearly. SSA assumptions (Board of Trustees, 1996) are as follows: real productivity growth at 1 percent per year, real interest on the trust fund at 2.3 percent per year; TFR is 1.9; and the normal retirement age changes according to current legislation. Tax rate in 2000 is lower than current level, because the current level generates a surplus.

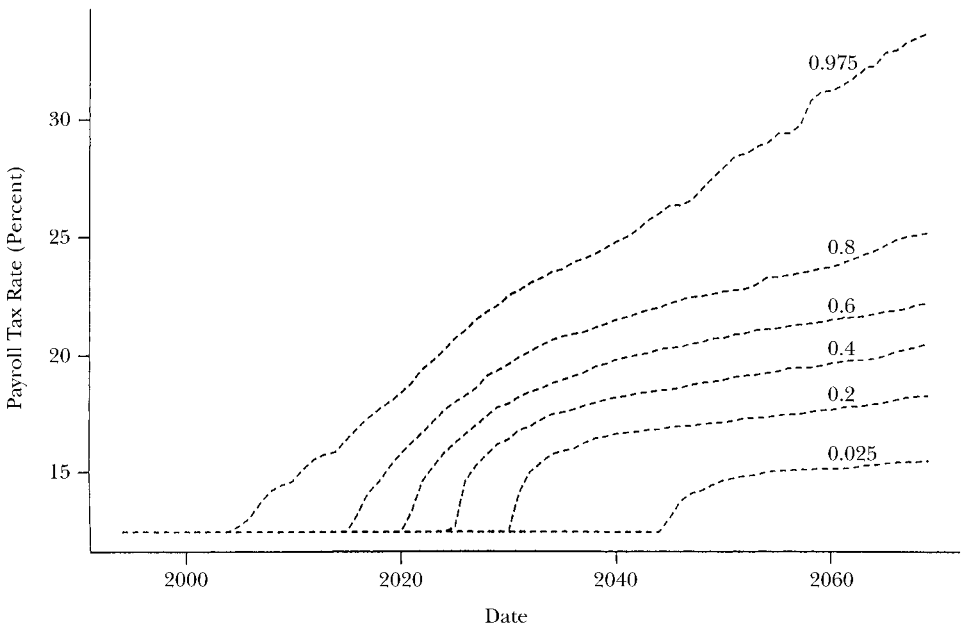
the Social Security age distribution assumptions for mortality yield *higher* old age dependency ratios for a given level of life expectancy.

There is considerable uncertainty about every one of the factors we have discussed. The most common means for representing the uncertainty of a forecast is to present alternate scenarios. This approach has severe limitations: probabilities are not given; fluctuations are ruled out; extreme and simplistic assumptions about covariances of shocks are required. For example, consider the 1995 projections by the U.S. Bureau of the Census (1996). Contrasting its ''Highest'' and ''Lowest'' projections for the year 2050, we find that the working age population (18–64) has a range of plus or minus 26 percent; the retirement age population (65+) has a range of plus or minus 27 percent, while their ratio, the old age dependency ratio, has a range of only plus or minus 1 percent! The Census report does an excellent job of providing many alternative scenarios, but problems like this are intrinsic to this method.

In Lee and Tuljapurkar (1997b), uncertainty about mortality and fertility trends, as well as productivity growth rates and interest rates, is accounted for explicitly in a stochastic forecast model. Their 95 percent confidence intervals for the Social Security Trust Fund balance show exhaustion between 2014 and 2037, and the balance in 2070 ranges from negative $6 trillion to negative $60 trillion (in 1994 dollars). One of the most striking results is that even with an immediate 2 percentage point increase in the payroll tax rate, Lee and Tuljapurkar find there would still be a 75 percent probability of trust fund exhaustion before 2070. (Recall that according to Social Security calculations, an immediate 2.2 percentage point increase in taxes should put the system in long run balance.) Including the Medicare trust fund in the stochastic simulations would increase the uncertainty about the solvency of government programs for the elderly even further.

Figure 3 shows the probability distribution for the pay-as-you-go tax rates as

Figure 3
Pay-As-You-Go Tax Rate for Social Security
(probability distribution by selected quantiles)



Source: Reproduced from Figure 14 of Lee and Tuljapurkar (1997b). Based on a stochastic projection. The payroll tax for OASDI is assumed to remain at 12.4 percent until the trust fund drops to 100 percent of the following year's expenditure level, and thereafter the tax rate is adjusted to maintain the trust fund at that level.

described earlier. By 2070, this interval extends from 15 percent to 34 percent of taxable payroll. By assumption, all trajectories remain at the currently legislated level of payroll tax until the trust fund declines to equality with the projected funds necessary for the following year's expenditures, which is why all the lines have a horizontal component at 12.4 percent. Thereafter, they rise as necessary to maintain this trust fund level.

Forecasting Disability and Health Status

The retirement experience for the baby boom retirement cohort will depend not just on their numbers, but also on their health. In this section, we consider whether people in the next century can look forward to an active, healthy retirement or to a relatively frail and inactive one, and the implications of such changes for the Medicare trust funds.

Trends in Disability

The overall level of disability faced by the elderly is determined by two counterbalancing trends. At any given age, prevalence of morbidity and disability have declined, tending to reduce the costs of providing health care and ancillary services for elderly people. However, the elderly, and in particular the oldest old, are expected to be among the fastest growing segments of the population for the foreseeable future, tending to increase the absolute numbers of frail or chronically ill elderly people requiring outpatient or institutional care (Schneider and Guralnik, 1990).

One problem with predicting how disability will evolve over the next few decades is the absence of any unique definition of disability. Objective medical measures are imperfectly correlated with functional ability, while more subjective self-reported measures of disability may depend on economic factors such as disability insurance benefits, or may evolve over time according to changing social norms. For example, Wolfe and Haveman (1990) show that predicted disability rates for a male older white widower changed from 9.3 percent in 1962 to 33.4 percent in 1973, down to 23.6 percent in 1980, and back up to 32.6 percent in 1984. It seems likely that variations of this sort reflect a changing notion of what it means to be disabled. Waidmann, Bound and Schoenbaum (1995) found an increasing prevalence in self-reported disability during the 1970s and a decline in the 1980s, which they attributed in part to better medical care resulting in higher levels of diagnosis and treatment.

Most recent studies of disability have measured functional ability in terms of ADLs, or ''activities of daily living'' such as eating, dressing or bathing, or IADLs, ''instrumental activities of daily living'' such as light housework, meal preparation or money management. But even these measures may not measure intrinsic disability (Nagi, 1991; Vebrugge and Jette, 1994). For example, Freedman and Martin (1998) point out that refurbishing an apartment or bathroom to make it handicapped-accessible could improve the resident's ADL measure without affecting the underlying medical disability; they suggest more intrinsic measures such as the ability to walk three blocks. Choosing among these measures of disability is difficult because we don't know which one best predicts the progression of frailty and health care expenditures.

Given the degree of confusion about measurement issues, it is reassuring that most studies point to a long-term decline in the prevalence of disability.[7] Manton, Stallard and Liu (1993a, b), and Manton, Corder and Stallard (1993, 1997) used a variety of statistical approaches on longitudinal data from 1984 through (most recently) 1994, and found a considerable secular decline in age-adjusted ADLs and IADLs over this period. For example, if the same age-specific disability rates had prevailed in 1994 as in 1982, then the overall disability rate would have been

[7] Crimmins, Saito and Reynolds (1997), however, find minimal and sometimes inconsistent reductions in disability.

24.9 percent, instead of the actually realized 21.9 percent (Manton, Corder and Stallard, 1997). More recently, Freedman and Martin (1998) used data from the Survey on Income and Program Participation (SIPP) to measure changes in more intrinsic functioning from 1984 to 1993. They estimated more than 10 percent declines in the fraction of people over age 50 who experience difficulty in performing tasks such as walking or reading the newspaper.

There is also evidence that these trends have been continuing for a number of years. Fogel (1994) compared pension medical records of Civil War veterans in 1910 with World War II veterans at similar ages, and found dramatic declines in the prevalence of musculoskeletal, digestive and circulatory diseases.[8] Using similar data, Costa (1996) found a dramatic increase in the ''body mass index'' or the ratio of weight to height. Her results suggested that had body mass index rates in the 1900s been similar to those in the 1980s, labor force participation rates among the men at the turn of the century would have been 6 percentage points higher.

Supposing that the trend toward reduced disability continues into the next century, how large might the reduced disability dividend be for future Medicare financial forecasts? We can provide an illustrative measure of how Medicare spending might change by matching average Medicare spending by level of disability (Manton, Stallard and Liu, 1993b) with the estimated change in the incidence of disability during 1982–94 (Manton, Corder and Stallard, 1997). The predicted 14 percent decline in the incidence of disability during 1982–94 translates to a decline of 6 percent in Medicare spending, or an annual reduction in real growth of 0.5 percent over the 12-year period.[9] The cost saving is proportionately smaller than the disability reduction because even the non-disabled account for significant Medicare spending; $2,292 per capita in 1991 (Manton, Stallard and Liu, 1993b). Were this 0.5 percent reduction in the annual growth rate of Medicare expenses to continue for 55 years, the level in 2052 would be lower by 32 percent than it would otherwise have been—certainly a significant saving to the Medicare budget.

But this potential saving could be offset by other unexpected developments. First, if actual life expectancies are substantially longer than currently predicted by the Social Security Administration, the larger number of elderly people could easily swamp the projected savings from the reduction in disability. However, we do not expect longer life expectancy to have serious adverse effects on the long-term Medicare budget. In a longitudinal study, Lubitz, Beebe and Baker (1995) found that people who live to age 90 account for $63,000 in lifetime Medicare expenditures,

[8] However, Liebson et al. (1992) suggest that reporting bias may overstate measured secular declines in disease-specific incidence rates.

[9] We used 1991 Medicare expenditures for ages 65+, the two bottom panels in Table 6 of Manton, Stallard and Liu (1993), merged with the changes in the incidence of disability from 1982 to 1994 from Table 1 in Manton, Corder and Stallard (1997). The definitions of disability were not exactly the same in the two groups; we matched the classifications as follows: a) nondisabled with nondisabled; b) IADL impaired with mild cognitive impairment; c) moderate IADLs with 1–2 ADLs; d) physical impairment with 3–4 ADLs; e) frail and highly frail with 5–6 ADLs; and f) institutional with institutional.

not much higher than the $55,000 accounted for by people living to age 79.[10] Lubitz, Beebe and Baker simulated Medicare expenditures for the year 2020, and found that the pure effect of an 8 percent increase in lifespan past age 65 (from 17.7 to 19.1 additional years) was only a 2 percent increase in Medicare spending. Although health care expenditures rise with age, this is largely because the proportion dying also rises with age, and a high proportion of costs is incurred in the last few years of life. Declining mortality only postpones these costs, and can lead to cost reductions at earlier ages.

These projections of Medicare spending, however, exclude nursing home care, which is not generally paid for by Medicare. Current estimates of the elderly nursing home population based on Social Security Administration population projections range between about 2.5 and 3.5 million people by 2020 (Manton, Stallard and Liu, 1993a; Wiener, Illston and Hanley, 1994; Schneider and Guralnick, 1990). These different point estimates, however, probably do not reflect the true uncertainty underlying future nursing home populations. Currently, only 24 percent of the disabled elderly are in institutions, with the rest cared for by family members or public programs (Soldo and Freedman, 1994). A modest increase in that proportion, because of fewer family caregivers for aging baby boomers, could have large *proportional* effects on the demand for institutional facilities or home health services. Such a development would have a greater impact on Medicaid, which pays for a substantial fraction of nursing home care, but it would also increase the demand for Medicare-financed home health care (Ettner, 1994).

Predicting Health Care and Medicare Costs

In the shorter term, the Medicare crisis is not because of increasing numbers of old people. The crisis is because of increasing real per capita health care expenditures. Specific diseases are being treated more intensively and with ever-greater levels of technology. Cutler and McClellan (1996), for example, showed that the increased cost of treating heart attacks has come from the increased use of surgical intervention, either through angioplasty (a balloon introduced by catheter into the heart which is then expanded to ''crack'' plaque in narrowed arteries) or through bypass surgery. The cost per surgical procedure has actually declined. Nevertheless, surgery is now deemed appropriate for an ever-larger percentage of patients with heart attacks and ischemia.

Whether greater technological innovations (and expenses) will continue is the

[10] One might expect that in present value terms, the 90 year-old's expenditures would be less than the 79 year-old's, because the bulk of expenditures occur further in the future. On the other hand, secular growth in real Medicare spending would tend to increase spending for the 90 year-old who receives terminal care 11 years later. When the discount rate is equal to secular growth in Medicare spending (say 3 percent annually for each), then simple cross-sectional sums are the appropriate present value measures of Medicare spending by age.

major source of uncertainty for projections of the Medicare trust funds. Official long-term predictions by the Health Care Financing Administration (HCFA), the most recent of which was published in 1992, are sobering. Overall, national health spending is projected to reach 26.5 percent of GDP by 2020 and 32 percent by 2030. While spending nearly one-third of GDP on health care may appear at first implausible, the forecast is based on conservative estimates of the trend of real health care spending that stretch back 30 years. Of course, more recent projections would be likely to reflect the moderation in overall health care expenditures during the mid-1990s. According to 1997 Congressional Budget Office projections, Medicare spending is predicted to rise from 2 percent of GDP in 1996 to 8 percent of GDP in the year 2035.[11]

As many observers have noted, the pressures placed on Medicare are considerably more acute than those for Social Security (Kuttner, 1996). Strictly speaking, the Medicare ''crisis'' is a crisis for the baby boomers' parents, and not for the baby boomers themselves. Yet the trends in medical technology that are fueling the short-term crisis are clearly crucial for the long-term viability of the Medicare program, so it is worthwhile to examine prospects for future growth, both short-term and long-term, more closely.

First, there are some indications of a short-term moderation in health care expenditures. Real health care costs (including Medicare) rose just 1.0 percent per year in real terms during the three years 1994–96, down from the 6.6 percent real increase during 1990 (Ginsburg and Pickreign, 1997). Some research has suggested the increased role for managed care has contributed to the slowdown in expenditures (Gaskin and Hadley, 1997), while others suggest the slowdown is associated with employees paying a larger share of their health care expenses, and scaling back overall utilization (Krueger and Levy, 1997).

On the other hand, Medicare expenditures have continued to rise, most recently by 5 percent in real terms during 1996 (Levit et al., 1998). Expenditures are projected to rise from 2.6 percent of GDP in 1997 to 3.4 percent in 2008 (CBO, 1998), which is the year when the Medicare trust funds are predicted to run out of money. Recent proposals by President Clinton to expand coverage to people under age 65 would increase further the growth in Medicare expenditures, albeit with growth in sources of revenue.

It might seem inconsistent to project continued long-term growth if the Medicare trust funds run dry within a decade. We suspect that as the Medicare trust funds inch closer to depletion, the government will respond not just by raising more revenue, but by reducing expenditures. This point was underscored by Getzen (1992), who used OECD data to focus on country-level changes in

[11] These projections also largely explain the Auerbach and Kotlikoff (1994) simulations which find that future generations, on present trends, would face 82 percent tax rates. The projected increase in health care spending from 13.6 percent (current) to 32 percent (in 2035) is amplified into a much larger tax increase because in the Auerbach and Kotlikoff scenario, future generations end up bearing most of the additional health care costs for generations currently alive.

health care costs. He found little evidence that the fraction of the population over age 65 was correlated with health spending as a share of GDP, or that the change in the share of the population over age 65 was correlated with the change in the share of health spending in GDP. In other words, increased demand for health care is offset by an ''adjustment to budget realities'' by a reduction in per capita expenditures.

Where might this adjustment to budget realities take place in the United States? One possibility is for incremental change, tucking back on reimbursements here, raising taxes or premiums there. Another possible source of saving comes from the tremendous variability in Medicare spending by region (Wennberg and Cooper, 1997). For example, Skinner and Fisher (1997) found that the elderly population in Miami and Minneapolis had similar levels of health as measured by rates of (age-sex-race-adjusted) heart attacks, stroke, hip fractures, and overall mortality rates. Yet per capita price- and illness-adjusted Medicare spending in Miami ($7874) was more than twice the per capita spending in Minneapolis ($3722). Adjusting per capita Medicare costs in high-cost regions (with appropriate price and illness adjustments) to costs in regions like Minneapolis restored the short-term Medicare trust funds to a healthy balance in 2005. In theory, a voucher plan like that proposed by Aaron and Reischauer (1995) with payment amounts benchmarked to Minneapolis could solve the short-term Medicare trust-fund crisis, albeit with possible effects on health care practice patterns (and provider incomes) in Miami.

There are three other sources of possible slowdowns in Medicare spending. First, just 11 percent of Medicare enrollees are enrolled in managed care, leaving room for future cost saving through managed care enrollment. Managed care firms as well appear less likely to invest in expensive technology (Cutler and Sheiner, 1997). Second, there is an increasing realization that many of the expensive procedures used in modern medicine may not help (or may even harm) the marginal patient. McClellan, McNeil and Newhouse (1994), for example, found that diagnostic catheterization and subsequent surgery for heart attack patients had little impact on mortality of the ''marginal'' patient. A randomized clinical trial designed to intervene early in the disease management of Veteran's Administration patients found that those receiving the intensive treatment actually did *worse* than the control group (Weinberger, Oddone and Henderson, 1996). Of course, the problem is to identify clinically which patients are the ones to gain little from the expensive procedures.

Finally, there is increasing evidence that well-informed patients may not want interventions that expose them to side effects, like incontinence in the case of prostate removal or death from complications of the surgery. In a Canadian study, heart attack patients shown videotapes describing the various options for management of their problem were less likely to choose surgical intervention than the general Canadian population, and at rates well below those in the United States (Morgan et al., 1997). Similar results hold for the management of prostate cancer (Flood et al., 1996). Again, to the extent that patient preferences are given more weight in the future, it may be the case that demand for expensive surgical treatment will actually decline.

We recognize the potential for these factors to moderate Medicare growth in the short-term, and such moderations would, if permanent, have far-reaching implications for the long-term balance of the Medicare trust funds. Still, we expect technological developments in health care to continue to fuel expenditure growth (Schwartz, 1987). Even in the shorter-term, the main factor behind increasing health care costs, particularly in the Medicare program, has been technological progress towards more advanced diagnostic and surgical techniques, with many more methods moving from experimental to routine use. For example, some surgeons now use small localized entry points to perform heart surgery so they no longer need to break ribs and subject the patient to as high a degree of post-operation risk. This promises to increase overall spending if, as is likely, it makes eligible a larger number of ''gray area'' patients who wouldn't have risked the earlier open-heart surgery.

Another example of technology that is moving past clinical trials is implantable defibrillators that detect erratic electronic pulses in the heart (ventricular fibrillation) and deliver shocks to regain rhythmic, normally paced heartbeats. There is increasing evidence that they are highly effective for reducing sudden cardiac death among high-risk patients; a recent randomized trial was stopped prematurely because the survival outcomes of the patients with the defibrillators were so dramatically better (Nisam, 1997). However, they are also quite expensive, with overall costs (including maintenance) estimated at $88,000 (Owens et al., 1997). Given continued improvements in the size of the units and methods of surgical implantation (and hence fewer adverse side effects), we expect an expanding market among people with lower risks of sudden cardiac death. These types of medical innovations—expensive and with a large potential market—hold the greatest promise for a steady, long-term increase in the real share of GDP devoted to health care spending.

Of course, there is nothing that requires technological advancements to cost more. They could also yield health improvements at reduced costs. In a Scandinavian randomized clinical trial, the cholesterol-lowering drug simvastatin was shown to reduce the incidence of subsequent coronary events, leading to a reduction in mortality of 30 percent among those with preexisting heart disease (SSSSG, 1994; Sacks et al., 1996). The cost of the drug treatment was nearly paid by the consequent reduction in direct (hospital) and indirect (patient able to return to work) costs, without even accounting for the improvement in longevity (Johannesson et al., 1997). Some observers (and investors) are optimistic that new families of drugs can reduce substantially mortality from cancer (Langreth, 1998). Clearly, were technological change as simple as adding folic acid to breakfast cereal (Malinow et al., 1998), technological developments could help control costs. Nonetheless, on balance we suspect that technology will increase the overall share of GDP spent on health care, albeit at substantially lower rates than currently projected.

Conclusion

Will the federal government have to raise taxes to ever higher levels while slashing Medicare and Social Security benefits? Or will members of the baby boomer generation enjoy financial golden years as they retire amidst budget surpluses and ever improving health? With all due caution, we suggest that the prospects for longevity are considerably brighter than even those projections deemed optimistic by the Social Security Administration. It does not seem likely that the U.S. population will start to bump against biological limits to health, nor does it seem likely that baby boomers will experience more years of frailty and poor health. This is the good news for baby boomers.

The bad news is that the Social Security and Medicare trust funds may face fiscal stress in the next century, regardless of what reforms are taken in this century. There is a tremendous degree of uncertainty associated with long-term projections; even a 4 percentage point hike in the payroll tax today leaves a 22 percent chance of the Social Security system going bankrupt by 2070 (Lee and Tuljapurkar, 1998a,b). The same point holds more forcefully for the Medicare trust funds.

Currently, many proposed Social Security reforms involve a larger role for equity markets in trust fund balances or in pre-funded employee saving accounts. These proposals can potentially reduce the risk of default by increasing the rate of return on Social Security contributions, and by breaking the link between future fertility rates and trust fund solvency. On the other hand, they add risk because of uncertainty about the Dow Jones Industrial Average in the next century. Lee and Tuljapurkar (1998) recently evaluated a policy reform which would increase the share of equity in the trust fund to 90 percent by 2000, with an assumed average real rate of return equal to 7 percent. In a deterministic model, this plan places the Social Security system in balance through 2097. But in the stochastic simulation, the median date of exhaustion is delayed to only 2045, and there is still a two-thirds chance of depletion by 2072!

Despite the large risk of Social Security and Medicare trust funds running short of money, there is considerable uncertainty about how such shortfalls would be dealt with by future governments. We suggest that the appropriate policy response to possible trust fund exhaustion, now and in the future, should depend on the causes of the problem.

One reason why the trust funds could run dry is lagging growth in real wage rates or poor asset returns. In this case, the younger generations are unexpectedly worse off, and from a generational perspective, it might be better to cut benefits to the elderly instead of raising taxes further on the working population.

By contrast, suppose the trust funds are depleted because of low fertility rates but reasonable economic growth, or because of higher-than-expected frailty in the elderly population, or because of an outbreak of a virulent strain of influenza that strikes the working population as well as the elderly (Webster, 1997). In these outcomes, the burden should be born differently. Tax increases on the fortunate (but perhaps fewer) younger generations would help cushion the retirement for the relatively less fortunate elderly population. Still other developments, like increased demand for institutional care, could gut the Medicaid budget and require cross-subsidization of some sort from Medicare or Social Security trust funds.

A thornier question is what should be done if the Social Security and Medicare trust funds are troubled because of positive developments: higher-than-expected lifespans and technological innovations in medical care. As Newhouse (1992) has noted, the public seems to be more concerned with increased health care costs, but are less likely to recognize the benefits that such spending has provided. Many new medical interventions do provide substantial improvements in survival and functioning (Cutler, McClellan, Newhouse and Remler, 1996). Should the elderly be expected to reduce their non-medical consumption in return for the unexpected improvements in health functioning and lifespan? If these technological developments raise the marginal utility of income for the elderly (because they live longer and enjoy improved health functioning), then economic theory counsels against cutting non-medical consumption. On the other hand, the elderly are enjoying a positive windfall in health functioning, and on equity grounds shouldn't they be willing in return to reduce non-medical consumption? One possible policy response to increased longevity and improved health functioning is to increase the retirement age; this would minimize the necessity for reducing benefits but ensure that the generations who are living longer are also paying more into the Medicare and Social Security systems.

Steuerle (1998) has argued that it makes little sense to ''straightjacket'' future expenditures without knowing whether the future government could better spend its money elsewhere. We agree; how the government responds to the Social Security and Medicare financing problem should depend on whether the crisis is caused by unexpectedly high levels of frailty or unexpected extra years of disability-free retirement for the baby boom generation.

Appendix
Stochastic Forecasting Methods for Mortality, Population, and Social Security

In this paper, we draw at several points on results of newly developed stochastic forecasts of mortality, population and its age distribution, and of the long term finances of the Social Security system. Each builds on the preceding. The stochastic mortality forecasts (Lee and Carter, 1992) are based on the model: $\ln(m_{x,t}) = a_x + k_t b_x + e_{x,t}$, where $m_{x,t}$ is the death rate for age x in year t, a_x and b_x are parameters for each age x, and k_t is a parameter for each year t. This model is fit to U.S. data back to 1900. The resulting time series for k_t is modeled as a random walk with drift, and forecast accordingly. Using the estimated equation above, the forecasts of age specific death rates and their probability distributions are derived, and used to generate forecasts of life expectancy. The basic model can also be used to generate survival curves corresponding to any given life expectancy, by varying *k* deterministically until the implied life expectancy corresponds to the target. A fitted stochastic model of fertility (Lee, 1993) is developed in a very similar way.

Net migration is taken as given by the Social Security intermediate assumption (900,000 per year). Stochastic population forecasts (Lee and Tuljapurkar, 1994) are generated from an initial population age distribution by repeated stochastic simulations of the evolution of the population, based on Monte Carlo methods and the stochastic models of fertility and mortality just described. The set of stochastic population simulations is the basis for stochastic forecasts of Social Security finances (Lee and Tuljapurkar, 1998a, b). In addition, simple constrained mean time series models are used to fit and forecast the time series of productivity growth rates and real interest rates. These, together with cross-sectional estimates of age profiles of payroll tax payments and benefits received, which are suitably modified by productivity growth and policy changes, form the basis for the Social Security projections.

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