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Demographic Effects on Personal Saving in the Future

Frederic L. Pryor*

After briefly examining the various proposed causes for the decline in the U.S. personal saving rate in the past decade, this essay then argues that a shift in the demographic composition of the population will be a much more important cause for a decline in personal saving in the future. A change in the balance between those in the labor force who are saving and retirees who are dissaving will result in a considerable fall in the aggregate saving rate under most assumptions. The simulation model used to examine this phenomenon takes into account the interest rate, the growth rate of the economy, the retirement age, the growth of population, and the life expectancy. Attention is also given to certain consequences of the fall in the saving rate, such as changes in the interest rate, changes in asset prices, and a decline in the GDP growth rate.

1. Introduction

Analyses of the long-term growth of the U.S. economy generally focus primary attention on the rate of technological change. It is generally assumed that saving to finance the necessary investment will not be a problem. In this essay, I use a simulation model incorporating a lifetime income approach toward saving to argue that this assumption is wrong. More specifically, I show that in the long run, personal saving will decline as a shift in the demographic balance between savers (those in the working ages) and dissavers (retired workers), and, as a result, economic growth will taper off, especially since it seems unlikely that the decline in personal saving will be offset by increases either in business or government saving or in greater capital inflows from abroad.

The argument proceeds in three steps. The two building blocks of the argument are the behavior of personal saving and the age structure of the population, which are discussed in section 2. In section 3, I present a simulation model to provide some idea about the magnitudes of the changes involved in the saving rate when the age structure of the population shifts. In section 4, I explore several variations of the model and, in section 5, some of the most important implications of the predicted changes in saving.

2. Setting the Stage

The Saving Rate

According to the National Income and Product Accounts (NIPA), which measure saving as a flow of resources, the annual rate of personal saving (excluding expenditures for consumer durables) as a percentage of GDP followed an inverted U-shape pattern, rising from 5.2% in the 1950s to 6.7%

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in the 1980s before falling to 4.6% in the 1990s.¹ Business saving as a percentage of GDP rose about 2 percentage points between the 1950s and the 1970s and subsequently leveled off for the rest of the century so that it did not offset the fall in personal saving in the 1990s. The flow of funds data from the Federal Reserve reveal similar trends from the 1950s through the 1980s and a more dramatic fall in the last decade of the century.

Such a picture of the saving rate becomes muddled if we measure saving in terms of changes in personal net worth (stock data). By this yardstick, the ratio of saving to the GDP did not change between the 1980s and the 1990s. Such results seem primarily due to a rise in asset prices and the resulting capital gains rather than any activity giving rise to growth in real investment. I return to this phenomenon in section 4.

For economic growth, the crucial fact is that, as a share of GDP, domestically financed investment remained roughly constant from the 1950s through the 1980s and then fell 2 percentage points in the 1990s, a circumstance giving rise to concern about the fall of domestic saving. As a result, many economists have focused considerable attention on the causes underlying this short-term fall in the saving rate during the 1990s (when saving is defined in terms of flow data) and whether this phenomenon will become more serious in the future.

Various arguments are offered to explain the changes observed in the flow of saving during the 1990s. Some, such as Bosworth, Burtless, and Sabelhaus (1991) and Parker (1999), argue that it can be traced to a fall in the saving rate at all age-groups.² Others, such as Gokhale, Kotlikoff, and Sabelhaus (1996), provide contrary evidence that the fall came from a redistribution of income from the young to the old and a decline in the saving rate of the elderly due to a fall in the need for saving both for bequest purposes and for precautionary purposes.³ Still others stress the fact that since most saving in the United States in recent years has been through unrealized capital gains, much of the lower saving measured in more traditional ways is due to a wealth effect, a hypothesis that is hotly disputed.⁴

¹ These data are drawn from the revised GDP accounts from the official NIPA data that come from U.S. Department of Commerce, Bureau of Economic Analysis (1998), and Web site (<http://www.bea.doc.gov/bea/dn1.htm>), tables 5.1 and 5.2. The data from the flow of funds data come from the Web site of the Board of Governors of the Federal Reserve (<http://www.federalreserve.gov/releases/z1/current/z1r-3.pdf>), table F.9. The stock data are compiled from balance sheet information from table B.100. Gale and Sabelhaus (1999) have an excellent analysis of the various problems in defining and measuring saving and the trends according to various definitions.

² Using SIPP (Survey of Income and Program Participation) data, Venti and Wise (1996, p. 29) argue the reverse, namely, that in recent years personal saving has increased, particularly as a result of government tax measures to encourage saving for retirement. If current trends continue, they claim that "the baby boom generation will accumulate substantially larger levels of personal financial assets than their older counterparts and thus after retirement will have much larger pools of accessible assets upon which to draw to meet unexpected contingencies." Their use of disposable income as the denominator of the calculations raises problems since it refers only to a rather arbitrary definition of money income and, moreover, does not include all sources of income such as claims on future pensions. This can be circumvented by using asset data, an approach followed by Gokhale, Kotlikoff, and Sabelhaus (1996).

³ Saving for precautionary purposes has declined because of the expansion of various types of government insurance programs (disability insurance, unemployment insurance, various types of emergency welfare programs, and so on) to help families reduce risk. Moreover, the rising share of wealth held in annuities such as Social Security and private pensions eliminates the precautionary savings needed to prevent outliving one's assets. The savings need for bequest purposes has also declined because of the deterioration in family solidarity, as shown by the declining share of the elderly living with their children and the rising fraction of marriages ending in divorce.

⁴ Parker (1999) presents evidence that the wealth effect accounts for no more than 20% of the rise of the consumption rate (which, of course, is mirrored by the fall in saving). I argue here, however, that the wealth effect may become considerably more important in the future. Auerbach and Kotlikoff (1990) provide evidence that certain other factors, such as increased government consumption to the net national product (NNP) in the 1980s, large government deficits in the 1980s, saving disincentives, and the behavior of stock prices, can explain only a very small fraction of the change in the saving rate. They also dismiss another set of hypothesized causes, such as business cycle conditions, changes in income equality, and an increase in female labor force participation.

Table 1. Estimates of Future Population Growth and Elderly Dependency Ratios

Actual data	Average Annual Population Growth, 1995–2050	Elderly Dependency Ratios, 1960, 1980, and 1995		
		17.7%	19.9%	21.9%
Forecasts		2010	2030	2050
Census Bureau				
Low population growth	0.13%	21.8%	36.3%	35.2%
Medium population growth	0.74	22.3	37.6	37.9
High population growth	1.24	22.7	38.3	39.9
Social Security Administration				
High Social Security cost	0.42	21.8	38.3	44.6
Medium Social Security cost	0.59	21.4	35.4	37.0
Low Social Security cost	0.80	20.8	32.5	30.9
Lee and Tuljapurkar (low and high estimates define the 95% confidence limit)				
Low population growth	0.03	22.3	40.9	51.5
Median population growth	0.63	22.3	36.4	39.1
High population growth	1.23	22.6	33.1	30.6

Note: The elderly dependency ratio is the ratio of the population over 64 to those in the working ages from 20 through 64. Census Bureau estimates come from U.S. Department of Commerce, Bureau of the Census (1996). For the low and high estimates, I had to make several minor adjustments; nevertheless, these estimates do not affect the unexpected results that the elderly dependency ratios have a direct rather than inverse relation to the population growth rate. The Social Security Administration estimates come from the U.S. Social Security Administration (1999, table II-H-1). The Lee and Tuljapurkar (1994) estimates come from their table 2. I estimate the elderly dependency ratio from their population estimates, rather than their direct estimates of this ratio, to achieve consistency with the other calculations in this essay. Their stochastically estimated dependency ratios are slightly different because of the lognormal distribution they used in their estimates. A more lucid explanation of their stochastic estimating procedures than in their original article can be found in Lee and Tuljapurkar (1998). For none of these estimates are the assumptions about immigration specified in much detail, although immigration may well be the crucial determinant of future U.S. population growth.

While these various microeconomic effects may be important in the short run, I show in the simulation analysis here that some much more important long-term changes due to shifts in the age structure of the population will take place, and these will prove to have a more lasting impact.

Demographic Changes

A major part of the model deals with the changing age structure of the population and the ratio between retired to active workers. For analysis of the age structure, one key concept is the elderly dependency ratio, which is the ratio of the elderly (those over 64) to those in the working ages. Table 1 presents not just the estimates by the Census Bureau and the Social Security Administration but also some much more sophisticated estimates by Lee and Tuljapurkar (1994; hereafter L-T), who use probabilistic methods to take into account uncertainties about birth and death rates.

From these three sets of estimates, we can draw two simple conclusions. First, the nation is likely to face a dramatic rise in the elderly dependency ratio in the next half century. Second, the range of these estimated ratios is very large. For instance, the L-T calculations give a 95% probability that in 2050 the dependency ratio will fall somewhere between 30.6% and 51.5%. If uncertainties about the future of immigration policies are taken more adequately into account, the range of these estimates would undoubtedly be larger.

The next step is to consider the ratio of retired to active workers. This ratio depends, of course, not just on the elderly dependency ratio but also on the age of retirement, a phenomenon requiring us to take into account two sets of circumstances:

(i) Life expectancy is increasing. In 2000, a 65-year-old person could expect to live 15 more years; by 2050, this will be closer to 20 years. Moreover, because of advances in medicine, the young-old (i.e., those between 65 and 75) are healthier than a generation ago.

(ii) From the mid-1960s to the mid-1980s, the percentage of men from 60 to 69 in the labor force declined (Quinn 1999). Since then, however, this percentage has leveled off. For women in the same age cohort and in the same period, the pattern was more irregular. In general, however, the percentage in the labor force remained roughly the same until the mid-1980s, when it began to increase. In the 1990s, many of those who would have retired were either taking bridge jobs or postponing retirement. A variety of factors underlay these changes, including changing health status, evolving patterns of home ownership and pension availability, and changes in mandatory retirement laws, Social Security payments to the working elderly, and the degree to which inflation eroded savings.

In looking at the future of saving, these demographic considerations have two important implications. First, it is necessary to take into account both the rising life expectancy and the possible postponement of retirement. Second, if the customary retirement remains the same, future cohorts will have to have a higher annual saving rate to finance the longer retirement period brought about by the longer life span. If, by way of contrast, future cohorts shift their retirement age so that the length of retirement remains the same, then they will need a lower annual saving rate because they will be able to spread accumulation of a given amount of retirement funds over a longer lifetime.

3. The Impact of Aging on Saving

The analysis focuses on aggregate net saving, that is, the result of gross saving by active workers and gross dissaving by retired workers. I begin the analysis with some highly unrealistic assumptions about the hyperrationality of savers and then relax them after the mechanics of the model are clear.

The Model

For individuals, I start by assuming complete foresight and a lifetime income approach toward saving. With full knowledge of how their incomes will change up to their retirement, workers decide on their saving and consumption rate each year to achieve three goals: to maintain a constant level of consumption over their working lifetime, to have enough savings during their retirement to finance some selected fraction of this consumption each year thereafter, and to exhaust their savings in their final year. The future growth and interest rates of the economy are constant, which individuals know when making their saving decisions.⁵ All workers are assumed to have the same annual income so that the results of the calculations for one worker can be easily aggregated for the entire working population.⁶ The initial model also assumes an equilibrium situation, with the only shocks coming from the changing age structure, the changing life expectancy, and the changing retirement age that are introduced by the simulator. This simple approach allows the implications of the basic mechanism

⁵ I argue in section 5 that growth will actually fall and that interest rates will rise. Although the model can be complicated to take these changing parameters into account in the optimization procedures for determining saving, the results are simpler to interpret when a *ceteris paribus* approach is used. The reader can interpret the growth and interest rates used in the model as “average” rates if the changes in these parameters are considered important.

⁶ The income pattern of the average worker incomes actually rises for several decades before leveling off. Taking this phenomenon into account has only a minuscule effect on the simulation results while enormously complicating the calculations. In the form presented in this essay, the simulations can be carried out on a spreadsheet program.

to be understood and the results to be presented in a systematic and quantitative fashion before complications are introduced.

Each year, the L-T population estimates are divided between workers and retirees. Active workers include all those from 25 up to the age of retirement, and retired workers are all those over the preselected retirement age.⁷ Of course, in the real world only a fraction of those between 25 and 65 participate in the labor force, and the number of retirees must be multiplied by a similar fraction to determine the number of retired workers. It should, however, be clear (and the simulation results confirm this intuition) that the chosen participation ratio has no impact on the simulation results about changes in the net saving rate.⁸

Workers are assumed to have labor income increasing at a fixed percentage each year for their working lifetime, which takes into account higher labor productivity due to technical change and capital accumulation. With a full knowledge of how their incomes will change up to their retirement, they save (or dissave) so as to have the same consumption every year of their working lifetime and, after retirement, to have enough savings to allow them a certain fraction of this consumption during their years of retirement (the consumption replacement ratio).

Once savers know the future growth and interest rates, they simultaneously decide their consumption replacement ratio and their saving pattern during their working life. If one of these is known, the other can be easily determined. In the lifetime income approach used in this discussion, both decisions depend on the degree to which savers discount their consumption during retirement. Nevertheless, as I show here, looking at the saving decision in terms of the consumption replacement ratio rather than the saving ratio and the discount rate provides a simpler way of understanding what is happening not only to saving but also to many other economic phenomena that, up to now, have been considered unrelated.

At the time of death, which is assumed to be known, all individuals will have exhausted their savings. Although the model features complete certainty about the age at death, this is not an essential feature of the calculations.⁹ In addition to the cohort of active workers, I assume, to simplify calculations, three cohorts of retired workers (65-69, 70-84, and over 84). Following the same approach used for active workers, I further assume that within each of these three separate cohorts, the rates of dissaving are the same for all, an assumption that has only a minuscule impact on the numerical results and is made for ease of calculation and interpretation. For additional simplicity, I initially assume that Social Security and pension accounts are part of personal saving.

Given these assumptions, the actual choice of the saving rate depends on the consumption replacement ratio, the interest rate, and the annual growth of labor income. Further rationality on the part of workers is assumed by setting the predicted growth rate of their income to be equal to its actual value over time. To provide a numerical example, if the initial average income of workers is 100, their desired consumption replacement ratio is one, their income growth is 1.8% a year, the annual interest rate on savings is 3%, and the workers work 45 years and retire for 15, they would plan to consume 122.5 each year. As a result, they would dissave for the first several decades of their work life, but during the two

⁷ I placed the starting age of work at 25 so that the initial working life of 40 years would be roughly similar to that occurring around 2000. This meant that the L-T population estimates of the 20 to 64 cohort had to be modified accordingly.

⁸ This can be seen by comparing two situations, one where both adults in the family participate in the labor force, then another where only one adult works outside the home. In the first case, the per capita income (and saving) is twice as high, but this should not influence either the percentage of income saved under the lifetime income approach followed in this model. In retirement, per capita consumption in the first case is twice as high, but as a percentage of lifetime income it is the same.

⁹ Alternatively, the date of death is not known, but all retirees purchase an annuity from an insurance company, which knows exactly the average age of death and has no administrative costs.

decades of working, they would save enough so that their total savings (plus interest on this account) is sufficient to finance an annual consumption at 122.5 during their 15 years of retirement as well. From the data underlying this estimation, we can calculate that the ratio of their accumulated saving to their accumulated income (work income plus net interest income) during their working lifetime is 21.8%.

The assumption that workers exhaust their savings by time of death means, of course, that they have no bequest motive for saving. As I argue here in more detail, this simplification may not be totally unrealistic in the coming decades.

One implication of these assumptions is that the average consumption of retirees is usually a fraction of the consumption of current workers, unless the consumption replacement ratio is considerably above unity. This is because the income of those currently in the labor force is higher than that of retired workers when the latter were working and making their consumption and saving decisions. In the previous numerical example where the consumption replacement ratio is unity, retirees between 70 and 84 will consume only about 60% of what a current worker is consuming.¹⁰ Moreover, if the rate of the growth of average income increases, the average consumption of retirees becomes an even lower fraction of the average consumption of workers because the gap between the annual income during the working years becomes greater.

There are several strings to be tied so that the entire model can be viewed as a whole. Since I am using the L-T population forecasts and wish consistency between these estimates and my calculations, I assume that between 2000 and 2050, the life expectancy annually rises by 0.1 years so that in 2050 the life expectancy is 85. I also assume that interest income (or borrowing costs) are transactions with an “external sector,” which is simply a bookkeeping device to keep the financial flows balanced. Net income flows from this sector are not, however, very great. I further assume that in 2000, workers start working at 25 and plan to retire at 65 so that they can have 15 years of retirement. Nevertheless, the model allows the planned retirement age to be raised as life expectancy increases. The presence of dependents under 25 does not appear explicitly in the model, but I show here how changes in the consumption replacement ratio can take changing family size into account. Technical aspects and more details of the simulation model, as well as other assumptions to simplify the calculations, are outlined in Appendix B, located at my Web site (<http://www.swarthmore.edu/SocSci/Economics/fpryor1>).

In brief, the core of the model is the annual calculation of combined saving of workers and dissaving of retirees, using projections of the U.S. demographic structure to derive the number of workers and retirees. I have not specified the institutional context of saving, for instance, whether it occurs through the Social Security system or through withheld business profits that are used for investment purposes. The hyperrationality assumption means that individuals with Social Security accounts or who own shares in businesses take fully into account the saving carried out in their name when they make their decisions about how much of their personal income they will save. After the basic model is presented, I relax these and a number of other restrictive assumptions, primarily by showing how they can be related to changes in the consumption replacement ratio.

The Main Simulation Result

Table 2 presents the parameters and the results of the simulation that will be used as the basis of comparison when the parameter values are changed. They represent the simulation results using my

¹⁰ In actuality, per capita consumption of those over 65 is about 79% of those between 25 and 65, most likely because Social Security benefits have been raised in a fashion to narrow this consumption gap. My model does not take this phenomenon directly into account, but, as argued later, such a policy acts in a similar manner as raising the consumption replacement ratio because it lowers the current consumption of active workers and raises the consumption of retired workers.

Table 2. Initial Simulation

Parameters	Median L-T estimate	
Population growth	0.63	
Consumption replacement ratio	1.0	
Participation rate	1.0	
Interest rate	3.0%	
Annual per capital growth of labor income	1.8%	
Retirement and age of death		
2000	65 and 80 years	
2050	70 and 85 years	
Statistics on annual saving	2000	2050
Ratio of saving of workers to total production	25.1%	22.5%
Ratio of dissaving of retirees to total production	11.7	13.8
Net saving (gross saving minus gross dissaving)	13.4	8.7
Change in net saving (percentage points)	-4.8%	

evaluation of the most realistic values for the various parameters. In later discussion, these are referred to as the “initial simulation.” Several features deserve particular attention.

The workers in this model have an impressive annual saving rate in 2000, but it is offset in part by considerable dissaving on the part of retirees so that net saving for the country as a whole is 13.4%. This is 3.8 percentage points below the preliminary value of net private domestic saving in the United States in 1990s.¹¹ Part of the difference between simulated and actual results is due to the net inflows of foreign investment funds into the United States, which are not taken into account as private saving in the model and which were equal to about 1.2% of the GDP in the 1990s. Part of the remaining difference of 2.6 percentage points is due to saving of private businesses. As noted previously, the model implicitly assumes (at least in the initial discussion) that the activities of business (and Social Security) are completely transparent so that individuals take them fully into account when making their own saving decisions. This, of course, does not seem to be the case. And part of the discrepancy between simulated and actual saving is due to the influence of other factors not included in the model.

Comparing these results with the previously noted estimations of Auerbach and Kotlikoff (1990), my estimated net saving rate of 8.7% of the GDP in 2050 shown in Table 2 is considerably higher than their estimate of 2.6% of the net national product (NNP; roughly 2.3% of the GDP, which I use as my denominator) in 2040. Their saving model of constant age-specific saving rates, however, does not take into account either changes in life expectancy or the retirement age. Under their demographic assumptions, my estimated net saving rate turns out to be roughly 5.1%. In brief, the two approaches toward saving behavior are very different, but the final estimated net saving rate are within 2.8 percentage points.

The decline in gross saving of active workers over the half century is due to the fact that although they still have 15 years of retirement, in 2050 they will have 45 years of working life to accumulate their retirement savings rather than 40 so that their annual saving rate does not need to be as great. The total gross saving rate of active workers minus the total gross dissaving rate (consumption of the retired workers) is the net saving rate and is shown in the table to fall 4.8

¹¹ Data on total private saving come from the NIPA, table 5.1, line 2, and for net foreign investment from table 4.5, line 45. Private savings includes both business and personal saving, but in this model, business saving is considered part of personal saving carried out by businesses for their individual owners.

Table 3. The Ratio of Net Annual Saving to GDP Using Different Parameters

	2000	2050	Change
(A) L-T population projections			
Low population	13.4%	5.0%	−8.4%
Medium population	13.4	8.7	−4.8
High population	13.4	11.3	−2.0
(B) Annual growth rates of labor income per worker			
0.9%	10.3%	4.3%	−6.0%
1.2%	11.5	6.0	−5.5
1.5%	12.5	7.4	−5.1
1.8%	13.4	8.7	−4.8
2.1%	14.2	9.7	−4.5
2.4%	14.8	10.6	−4.2
(C) Consumption replacement ratio			
0.8	11.1%	11.4%	+0.4%
1.0	13.4	8.7	−4.8
1.2	15.7	5.9	−9.8
(D) Retirement age			
65	13.4%	10.5%	−3.0%
70	13.4	8.7	−4.8
(E) Interest rate			
3%	13.4%	8.7%	−4.8%
5%	10.2	5.6	−4.6
7%	7.4	3.1	−4.3

Note: These results are derived from the simulation model discussed in the text and in Appendix B on my Web page (<http://www.swarthmore.edu/SocSci/Economics/fpryor1>). All parameters are the same as in the initial simulation shown in Table 2 except those under examination.

percentage points over the half-century period, which amounts a decline of slightly more than a third. This change in the net saving rate is the key statistic of the analysis.¹² When other factors not included in this simple model are taken into account (see the following discussion), it may represent an upper limit to the fall in saving.

These simulations generate considerable numbers, but to avoid clutter I report only three critical statistics for each simulation: the initial and final net saving rates and the change in the net saving ratio. Table 3 reports the partial equilibrium results when the major parameters are changed, while all other parameters of the initial simulation are held constant.

Panel A of the table depicts the effect of population growth on the level and change in net saving. Since, as shown in Table 1, faster growth means a lower elderly dependency ratio, the ratio of retired to active workers will also be lower. As a result, the rate of aggregate dissaving by retired workers falls, and the decline in the net saving ratio is also less. Clearly, the fall in the saving ratio between 2000 and 2050 is quite sensitive to a change in the age structure of the population.¹³

Panel B of Table 3 shows that a faster growth of labor income increases leads to a decreasing decline in the net saving rate. This comes about because, as pointed out previously, the faster the

¹² These results and some of the conclusions in later discussion are derived from a simple model presented in Appendix C on my Web page at <http://www.swarthmore.edu/SocSci/Economics/fpryor1>.

¹³ In equation C1 in Appendix C on my web page, the only expression that is affected by a change in the population growth rate is $[(1 - a)/a]$, where a = the proportion of adults who are active workers. With the falling elderly dependency ratio, this bracket expression rises, and the saving rate increases as well, other factors remaining constant.

Table 4. Changes in Net Saving between 2000 and 2050 with Different Consumption Replacement Ratios and Changes in Other Parameter Values

Consumption Replacement Ratios (ρ)	0.8	1.0	1.2
Median population growth, annual per capita income growth = 1.8%, interest = 3%			
1. Retirement in 2050 at 70	+0.4%	-4.8%	-9.8%
2. Retirement in 2050 at 65	-2.4	-3.0	-3.5
Median population growth, annual per capita income growth = 1.8%, interest = 7%			
3. Retirement in 2050 at 70	-0.1	-4.3	-8.5
4. Retirement in 2050 at 65	-4.6	-5.7	-6.8
Low population growth, annual per capita income growth = 1.8%, interest = 3%			
5. Retirement in 2050 at 70	-2.6	-8.4	-14.2
6. Retirement in 2050 at 65	-7.6	-9.3	-10.9
High population growth, annual per capita income growth = 1.8%, interest = 3%			
7. Retirement in 2050 at 70	+2.5	-2.0	-6.5
8. Retirement in 2050 at 65	+1.2	+1.4	+1.6
Median population growth, annual per capita income growth = 0.9%, interest = 3%			
9. Retirement in 2050 at 70	-0.3	-6.0	-11.6
10. Retirement in 2050 at 65	-4.8	-5.9	-6.9
Median population growth, annual per capita income growth = 2.4%, interest = 3%			
11. Retirement in 2050 at 70	+0.6	-4.2	-8.4
12. Retirement in 2050 at 65	-1.2	-1.6	-1.9

growth of worker income, the smaller the ratio of a retired worker's consumption to that of an active worker. As a result, the higher growth rates of labor income are associated with a lower rate of dissaving (in relation to the current GDP) of retired workers, and therefore the net saving rate does not fall as rapidly.¹⁴ What is important to realize, however, is that this effect is relatively small. More specifically, an increase in the annual growth rate of worker income of 1.5 percentage points is associated with only a 1.8-percentage-point decline in the change of the net saving rate.

Panel C of Table 3 displays the results of varying the consumption replacement ratio (ρ), which is simultaneously determined with the individual's annual saving rate and reflects the degree to which savers value a dollar of current and future consumption. I discuss in greater detail later (and in Appendix A) that its actual value is highly controversial but that it is probably between 1.0 and 1.2. In trying to understand the simulation results, another complication arises because in the model the consumption replacement ratio must be combined with other parameters of the model in the algebraic expression to determine the net saving rate, which means that a number of complex interaction effects are occurring that prevent easy interpretations. For instance, in Table 3 an increasing consumption replacement ratio is associated with greater net saving in 2000 but with less net saving in 2050. For this reason, it seems most useful to focus on the change in net saving between these two end points with a variety of parameter values, an exercise whose results are reported in Table 4.

Of the 36 simulation results reported in Table 4, 30 reveal a decrease in the net saving ratio by 2050, when various consumption replacement ratios and other parameters are plugged into the simulation model. The exceptions occur only with a high population growth rate and a retirement rate

¹⁴ In equation C1 in Appendix C on my Web page, z (the ratio of the income on which a retired workers based their saving to the income of a current worker) declines, and this, in turn, raises the aggregate saving rate.

at 65 or with a low consumption replacement ratio, and they suggest two counteracting mechanisms that are sometimes sufficiently strong to offset the general results. In the first case, a high population growth results in a smaller share of retired people so that total dissaving declines in comparison to total saving. In the second case, it is worthwhile to note that when the consumption replacement ratio decreases, the net saving rate decreases more slowly since the working years in which savings takes place is much longer than the retirement years when dissaving takes place.¹⁵ Thus, relatively low consumption replacement ratios are associated with relatively higher net savings ratios, and in certain cases, this is enough to offset the general impact of other factors which lower the net saving between 2000 and 2050. This effect gives rise to what might be called the “paradox of profligacy,” namely, that low saving for future retirement is associated with a smaller decline (or even an increase) of net saving in the future.

Panel D of Table 3 also shows the effects of a change in the retirement age, but more details are presented in Table 4. If the retirement age remains at 65 rather than rising to 70, the impact on net saving is quite mixed. In 10 out of 18 cases, keeping the retirement age at 65 results in a more favorable change in the net saving situation (e.g., less negative) than when it is raised to 70. Several offsetting factors are at work. On the one hand, when the retirement age remains at 65, gross saving increases considerably since workers must save for a much longer retirement, so this results in more net saving, other factors remaining constant. Moreover, the base level of consumption on which they base their retirement spending is lower because consumption during the working years was less because of higher saving. On the other hand, the relative number of retired workers is much greater than when the retirement age is 70. The parameters of the model determine which of these offsetting factors dominates the results.¹⁶

Finally, as shown in Panel E of Table 3, the impact of the interest rate is not strong. The simulation results are the result of a complex interaction of several variables because the interest rate has an impact on the lifetime income and the choice of a consumption level, the ratio of total average lifetime income to total average lifetime work income, the accumulated saving needed for retirement, and the ratio of consumption of retired to current workers.¹⁷

It is useful to investigate this matter in more detail because if the saving drought occurs, the interest rate is bound to rise. Table 5 presents the results of another set of simulations showing the changes in net saving when the change in interest rate is accompanied by changes in other parameters as well.

The results in Table 5 are quite mixed. The table reveals four cases of the paradox of profligacy; otherwise, the net saving ratio decreases in all cases. In 10 out of 18 cases, a higher interest rate leads a more favorable change in the net saving ratio (i.e., a smaller decline). This also occurs in the combination of parameter values I believe most likely (reported in line 1, $\rho = 1$). Although the interest rate in these simulations is changed 4 percentage points, in 15 out of 18 cases the change in the net saving ratio is less than 2 percentage points. In brief, the results are relatively insensitive to the

¹⁵ This can be shown by differentiating equation C2 in Appendix C on my Web page: $(\delta\sigma/\delta\rho) = [(1-k)/(k-\rho k + \rho)] - \rho(1-k)[1/(k-\rho k + \rho)]^2(1-k)$, which, after rearrangement and simplification, yields $(\delta\sigma/\delta\rho) = [(1-k)k]/[\rho(1-k) + k]^2$. Both numerator and denominator are positive, and since k (the percentage of an adult life span spent working) lies between 0 and 1, the numerator is positive and less than unity, so $0 < \delta\sigma/\delta\rho < 1$, and saving rises more slowly than the consumption replacement ratio.

¹⁶ From the equations in Appendix C on my Web page, it can be readily demonstrated that the relative values of the saving rate and the relative percentage of the adult life span spent working (w in the previous footnotes) determine which effect dominates.

¹⁷ The response of saving to a situation where the interest rate is not constant but is rising over time is discussed here in the analysis of general equilibrium effects.

Table 5. Changes in Net Saving between 2000 and 2060 with Different Interest Rates and Changes in Other Parameter Values

Consumption Replacement Ratios (ρ)	0.8	1.0	1.2
Median population growth, annual per capita income growth = 1.8%, retirement age = 70			
1. Interest = 3%	+0.4%	-4.8%	-9.9%
2. Interest = 7%	-0.1	-4.3	-8.5
Median population growth, annual per capita income growth = 1.8%, retirement age = 65			
3. Interest = 3%	-2.4	-3.0	-3.5
4. Interest = 7%	-4.6	-5.7	-6.8
Low population growth, annual per capita income growth = 1.8%, retirement age = 70			
5. Interest = 3%	-2.6	-8.4	-14.2
6. Interest = 7%	-3.1	-8.0	-12.9
High population growth, annual per capita income growth = 1.8%, retirement age = 70			
7. Interest = 3%	+2.5	-2.0	-6.5
8. Interest = 7%	+2.0	-1.6	-5.2
Median population growth, annual per capita income growth = 0.9%, retirement age = 70			
9. Interest = 3%	-0.3	-6.0	-11.6
10. Interest = 7%	-0.9	-5.7	-10.6
Median population growth, annual per capita income growth = 2.4%, retirement age = 70			
11. Interest = 3%	+0.6	-4.2	-8.9
12. Interest = 7%	+0.1	-3.8	-7.6

interest rate. If, however, the interest rate is not held constant but is changing over time, this conclusion may have to be modified, but before such a complication is discussed here, several additional factors require attention.

4. Variations on the Theme

Changing Some of the Rationality Assumptions

The realism of some of the assumptions of the model can be questioned, for instance, that savers do not act with the rationality I have assumed.¹⁸ For instance, individual savers do not know the future growth and interest rates, and, moreover, the assumption that the growth rate remains constant as the saving rate declines stretches credulity even more. It is, therefore, important to see what happens when these assumptions are relaxed.

The consumption replacement ratio ρ represents not just the degree to which savers discount their consumption during their retirement years but also their best guesses about what economic growth will be. In this respect, it can be said to depend on how pessimistic or optimistic their view of the future is in comparison to what actually will happen.

This part of the problem can be explored by asking what happens if the growth rate of labor income is actually different from what it turns out to be. Suppose that the actual growth rate is lower

¹⁸ Some might object to the separation of the decision to retire and the decisions about saving. Nevertheless, a more exact modeling of a simultaneous retirement and saving decision does not yield results noticeably different from those obtained by blending the results of separate simulations with the different parameters.

than the growth foreseen by savers. Since net saving is greater when the growth rate is higher, workers will save more than they need to in order to meet their goals of a specified consumption replacement ratio. If, for instance, actual growth turns out to be 1.2% a year but the savers believe it to be 1.8% (and do not ever catch on to what is really happening), a quick simulation shows that the net saving rate does not fall 4.8 percentage points between 2000 and 2050, as predicted by the original model, but only 1.8 percentage points in the period. Thus, conservatism in judging changes in economic reality (in this case, extreme conservatism that lasts a half century) acts like an increase in the consumption replacement ratio and, in most cases, slows down the decline in net saving. By way of contrast, unrealistic pessimism about the growth rate leads to a greater fall in the net saving rate.

We can also, of course, assume that savers are not sufficiently rational to save according to the lifetime income approach. One alternative savings model is that they save a constant proportion of their income each year. Experiments along these lines, however, show that if the replacement ratio is the same, the simulation results are little different.¹⁹ It is possible, of course, to abandon any saving function rationalized by theory and assume, in the manner of Auerbach and Kotlikoff (1990), that the age-specific saving rates are constant, an approach that predicts even greater declines in the saving rate. The further we move from theory, however, the less able we are to determine the effects of different parameters such as the growth or interest rate on the final saving level.

Looking at individual saving in terms of the replacement ratio also makes it possible to interpret changes in the annual saving rate in terms of changes in parameters of the model. For instance, many have argued that the recent fall in the savings rate reflects the fact that workers today have a higher rate of time preference and want to spend their money while it is in hand. This can be viewed as a decline in the consumption replacement ratio (shown by Engen, Gale, and Uccello 1999), and the implications of such a change can, in turn, be simulated by the model. Another interesting situation arises if individual savers do not take into account either the saving carried out in their name through withheld earnings of the corporations in which they own stock or the Social Security payouts promised by the government. Then such saving by corporations and government can be interpreted as a type of involuntary saving that can be considered an increase in the consumption replacement ratio, and the retirees will have more assets to liquidate during their retirement than they expected.

In brief, various saving behaviors that deviate from the strict assumptions originally set forth can be taken into account in the model by interpreting them in terms of different values for the consumption:replacement ratio. We can loosen the assumptions of strict rationality of the model and still obtain useful results from the model.

Such considerations raise anew, however, the question about the reasonable value of the consumption:replacement ratio to use in this kind of analysis. Considerable disagreement exists in the literature about what the value of ρ actually is or should be.²⁰ Most analyses do not take into account the consumption of retirees taken in the form of transfers in kind, such as Medicare. Although the values chosen for the simulation reflect the range of ratios found in the literature, my own intuition is that the ρ is probably between 1.0 and 1.2 when all types of consumption are taken into account; my

¹⁹ In major part, this similarity is due to my assumption that within the working-age population, the population in each age year is the same. Thus, in the lifetime income approach, the high saving rate of those approaching retirement is offset by the dissaving of those just entering the labor force so that overall saving for a given retirement ratio is roughly the same as the average saving using a Keynesian type of saving function.

²⁰ Three main approaches to this problem can be found in the literature. Some derive this rate using a dynamic stochastic optimization model, others use the advice of personal finance gurus, and still others use information derived from consumption budgets of consumption units headed by people of different ages. The derived rates range generally from 0.8 to 1.2. For further discussion of this matter, see Appendix A.

reasoning is discussed in greater detail in Appendix A. Although the short-term decline in the net saving rate in the late 1980s and 1990s suggests that ρ is falling, the decline in average family size and the rising medical expenditures of the elderly act in the opposite direction.

Other Factors Influencing Saving: Partial Equilibrium Effects

Investigating how certain exogenous changes might affect particular parameter values of the model gives additional perspective on the results. In this respect, the most important parameter is the consumption replacement ratio ρ , and it is useful, therefore, to consider how changes in other parameters not taken into account in the model might influence the value of ρ .

Family Size

In part, the consumption replacement ratio ρ reflects the number of children in a family. If a family has a large number of children, the parents generally have a lower personal consumption than in a smaller family (assuming they do not allocate a fixed amount of consumption to divide among all children). Their saving rate to replace a given fraction of their consumption during their working years for their retirement period is, therefore, lower, even while the national net saving rate in the middle of the 21st century is higher because these retirees are dissaving less. But there is another impact of a larger family size as well since more children leads to a more rapidly growing population. As a result, the slower decline in the long-term net saving rate arising from a lower ρ arising from a larger family size reinforces the slower decline in net saving occurring with faster population growth shown in panel A of Table 3 (which does not take this factor of the number of children on family saving into account). In brief, larger families dampen the long-term decline in the net saving rate in two respects.

Changing Medical Needs of the Elderly

An important part of consumption of the elderly is for medical care. According to Cutler and Meara (1999), medical costs are rising faster for the elderly than any other segment of the population. If the elderly wish to maintain other parts of consumption and to cover such rising medical costs, then they must raise their saving during their lifetime, which reflects a higher consumption replacement ratio. Of course, most of the saving for medical expenditures of the elderly is carried out through Medicare taxes during the working years (which lowers current consumption and raises forced saving), and most of the expenditures for medical purposes after retirement are drawn from the Medicare trust fund. But the institutional form through which such saving and expenditures is not important; it is the ratio of total expenditures of retired workers (including medical care) to their expenditures during their working years that is the key.

Political Clout of the Elderly

Up to now, I have assumed that Social Security payouts are based on what a worker puts into the system. But the current system features intergenerational transfers from the workers to the retired. When the elderly are able to use their political muscle to raise the Social Security payouts over and above what they would have received on the basis of their own contributions, the consumption replacement ratio increases. That is, consumption of active workers is lowered, while consumption of retired workers is raised.

Precautionary Saving

The model assumes that there is no motive for saving to avoid running out of income in old age. With the increasing annuitization of income during retirement through pensions and Social Security, this motive of saving declines, and, in this respect, the model appears realistic, and no re-interpretations of the results are necessary.

Saving for Bequests

Up to now, I have assumed that there is no bequest motive. In recent years, some, such as Gokhale, Kotlikoff, and Sabelhaus (1996), have argued that the importance of passing on an inheritance to others is declining. More specifically, the high U.S. divorce rate and the high mobility of both children and their parents (either divorced or still married) means that contact between family members is decreasing and the desire for leaving large sums to descendants is ebbing. Some informal confirmation of this assumption is provided by the sight of white-haired drivers behind the steering wheel of expensive cars with bumper-stickers proclaiming, "I'm spending my kids' inheritance," or the advice of popular advice columnists such as Ann Landers who tell their readers that they owe their children nothing after raising them and paying for their education.

On a more analytic level, saving for bequest purposes raises some problems because the one-to-one relation between annual saving and the consumption replacement ratio assumed in the model is broken. That is, the bequest motive either raises saving during the working years or lowers consumption during the retirement years so that the simulation results represent only an upper limit of saving decline. Moreover, bequests also change the saving and consumption behavior of those receiving them. Of course, all these effects could be added to the model, but for analytic simplicity, I omit such an exercise since I wish to focus primarily on demographic effects on saving.

A Very Brief Comment on Changes in the Labor Supply

I noted previously that when the labor force participation rate is fixed over the entire period, its designated value has no impact on the results. It might be asked, however, how changing this participation ratio over time might affect the results. Experiments along these lines show that the net saving results are also not changed when the labor force participation ratio changes, at least when they occur in even increments over the 50-year period. Other experiments with modification of different parts of the model revealed nothing of interest.

5. Some Broader Implications of the Simulation Results

At this point, it is necessary to step beyond the confines of the partial equilibrium model, not just to take into account the impact of other economic actors but also to consider some general equilibrium effects.

Other Sources of Saving

Although these simulation results suggest in most cases a fall in the personal saving rate, this does not necessarily mean that the total saving rate will decline. Since the model focuses only on voluntary personal saving, it is important to take into account other types of saving in the economy

before generalizing about the overall saving rate. Three other sources of saving deserve attention: foreign capital inflows, business saving, and government saving.

Since aging of the population is occurring in almost all industrialized countries (Bosworth and Burtless 1998), sooner or later they will face a declining personal saving rate in the future as well. As a result, they will have less capital to export, and, therefore, this does not seem a promising source for offsetting the fall in personal saving in the United States. Moreover, if the Euro strengthens in the coming decades, it may serve as an alternative safe haven for funds from the developing countries so that this source of capital imports into the United States will decline.

Another source of saving is from retained profits by businesses, which are usually reinvested. Such decisions act, among other things, to raise the value of the company's stock. Auerbach and Hassett (1991) argue that because of such impacts, consumers are able to "pierce the veil of corporate saving" and, at least in part, to take it into account in making their personal saving decisions. If the substitution between these two forms of saving is not one to one, then some of this business saving represents a type of involuntary personal saving. As noted previously, such involuntary saving acts to raise the consumption replacement ratio, and, as the elderly cash in their assets to finance their retirement saving, their consumption will be higher. In the literature, however, I have found no credible argument to suggest that the rate of such business saving will change in the future. Moreover, if it does increase so that ρ rises, under most parameter values the net saving ratio will fall more in the future because the retirees will be spending at a higher rate. Thus, a higher rate of business saving is hardly the answer to the drought in personal saving.

Similarly, involuntary personal saving might occur through the government sector as well. If it comes about through higher Social Security taxes, then it can be argued that individuals will pierce this government veil and take these forced savings into account in their voluntary saving decisions. Again, if the substitution is not one to one, net personal saving might fall less than it should have, and a higher consumption replacement ratio will result. But this has a paradoxical impact. As the government tries to "save" Social Security either by increasing social security taxes or by raising the retirement age, such measures act to raise the consumption:replacement ratio and may, in most situations, lead to a greater fall in net saving for the entire economy in the future so that by 2050 the effect should be relatively small.

Similarly, the government can raise the current rate of saving by running budget surpluses and lowering the national debt. Nevertheless, temptations either to return part of this forced saving in the form of reduced taxes or to increase government expenditures is strong among politicians wishing to be reelected.

General Equilibrium Effects

Although business and government saving do not seem very promising offsets to the fall in personal saving, one credible possibility deserves attention. As the saving rate falls, the interest rate may rise, and asset prices would fall, which could, in turn, introduce some offsetting effects so that the simulation results presented so far could represent only extreme values of the actual fall in net saving. At this point, the analysis becomes complicated, and I can touch on only the most important counteracting effects.

Saving and Interest Rates Once Again

To the extent that higher real interest rates induce more personal saving, investment could increase, and economic growth could be higher. But empirical evidence (e.g., Hall 1988) suggests that

the impact of a change in the real interest rate on saving or consumption (i.e., the intertemporal rate of substitution) is small. The theoretical evidence is also not strong: In the short run, income and substitution effects offset each other. In the long run, the simulations carried out in Table 5 show that the effect of a higher interest rate on net saving is usually small, and in only half the cases does the net saving rate show an increase. Even though workers may make lifetime saving decisions in a different manner than I have modeled, it seems difficult to imagine how these would offset the demographic effects.

Wealth Effects

Any long-term rise in the interest rate would, of course, result in a fall of asset prices. A useful starting point is the difference between changes in net saving as measured, respectively, by flow and stock data (Gale and Sabelhaus 1999). By the end of the 1990s, the stock data reveal saving to be twice the rate of net investment. Most of this alleged saving, however, represents a capital gain resulting from a revaluation of assets that is reflected in a rising value of Tobin's q (Tobin and Sommers 2000). Obviously, a fall in saving and a rise in real interest rates can reverse this process. Moreover, as increasingly more people holding high-priced assets retire and cash them in to finance their retirement, the downward pressure on these asset prices becomes greater. This change will affect both personal and pension fund portfolios so that those with pension plans on a defined contribution basis will receive much less than they expected (and pension plans with defined benefits may face bankruptcy).

Such a fall in personal wealth may well result in more saving as people scramble to replace part of their portfolio losses. Several offsetting effects could occur from such additional short-term saving. If it results in increased investment and growth, the long-term fall in saving could be reduced (Table 3, panel B). But if it leads to Keynesian type of recession or if the fall in asset prices leads to a loss of investor confidence, then saving over the long term could be even further reduced. Given that the primary focus of this analysis is demographic, further discussion and modeling of these effects must be left to another time and place.

Other Offsetting Effects

We can imagine other offsetting factors to those presented in the partial equilibrium model. Any rise in consumption and corresponding decline in saving and investment means that investment has less to fall in case of a loss of investor confidence. This means that aggregate demand shocks to the economy would be smaller and that, as a result, recessions would be milder. This, in turn, could result in a smaller decline in the long-term saving rate.

Another possible offsetting effect could come through the government, assuming that current laissez-faire attitudes toward the economy persist for the next half century. But problems arise because many such measures could only have a short-term effect. If, for instance, saving of workers is encouraged in the short run, in the long run when these savers retire, they will draw down their savings in greater annual amount than if such measures had not been taken, which would have a negative impact on net saving at that time. Or if the government uses tax funds to shore up pension plans and banks so that private saving is safer, people might end up saving less because their precautionary savings needs are lower. If, by way of contrast, the government used tax funds to invest directly or indirectly in the economy, such offsetting effects of private saving might be reduced, and, because the growth rate would be higher, the decline in the saving rate would be less. Or if the

government allowed more immigration of young foreign workers, the decline in the elderly dependency ratio (and the net saving rate) could be partially offset.

In brief, to the extent that these or other compensating effects occur, the decline in saving will be less than I have indicated so that my estimates represent an overly pessimistic case for the future net saving ratio. While it would be interesting to theorize about this situation in greater detail, we run face to face into two inescapable facts. First, so many factors must be taken into account that a complex general equilibrium model is necessary to cover the major possibilities that lie outside my demographic focus. Second, any final conclusions drawn from any such more complex model would undoubtedly depend on parameters whose values are unknown since little relevant empirical evidence is at hand.

Economic Growth: Once Again

Up to now, I have also assumed that economic growth is exogenous, but a changing saving rate can have an important influence. This situation is complicated, however, because the impact of a falling saving rate on economic growth depends on whether technological change is exogenous to changes in the capital stock (i.e., disembodied). If so, then a Solow type of neoclassical growth model leads to the result in the short run, the per capita GDP will grow more slowly, but in the long run the growth rate will be the same as before.²¹ If, however, technological change is endogenous and, let us say, partially a function of previous capital accumulation (reflecting, e.g., that the new technology has to be embedded in new equipment), then a decline in the saving rate will lead to slower growth in both the short and the long run, a conclusion that seems more realistic.

To forecast the future growth rate of the United States, we must investigate what happens to such key variables as the rate of technical change, the rate of depreciation, the rate of saving, and the ratio of capital to output. In the 1990s, gross private domestic investment and consumption of fixed capital (depreciation) were, respectively, 17.4% and 12.3% of the GDP. Other things being equal, if the private saving rate falls more than 5.1 percentage points, it will no longer cover depreciation, and the net capital stock would start to shrink. At this point, GDP growth could be maintained only in one or both of two events: if governmental saving and foreign capital inflows offset the decline of private saving or if technical change affecting the entire capital stock (disembodied technical change) were sufficiently high to offset the impact of the declining capital stock. Neither seems very likely.

In the initial simulation, where I tried to give the most realistic values to the different parameters, the saving rate falls 4.8 percentage points between 2000 and 2050. Most of the other simulations reported in the various tables result in a fall of the saving rate between 4 and 6 percentage points. This suggests that capital accumulation will be much slower. Unless technical change increases dramatically, it therefore seems likely that economic growth will be considerably lower in 2050 than at the beginning of the 21st century, other things being equal. The variable least likely to remain constant is the capital/output ratio. If this falls, each unit of investment will lead to more economic growth. From 1950 through 1999, this ratio fell at an annual rate of 0.12%; from 1975 through 1999, it fell at an annual rate of 0.34%; and in the 1990s, its annual rate of decline was considerably higher, presumably because of the increased investment in computing equipment. Economic events in the

²¹ This counterintuitive long-term result occurs because, at greater investment, the productivity of additional units of capital investment declines because of diminishing returns. When the capital stock is sufficiently large, the growth induced by additional investment will be quite low. If saving and investment are lower, the capital stock will also be lower so that the impact of diminishing returns will be much less.

opening years of the new millennium suggest that dramatic upsurge in technological change, which is occurring primarily in one sector, may not last long.

Thus, the most likely outcome of a decline in the saving rate that I have described is a decline in the rate of economic growth. As shown in Table 3, as the growth rate of annual income falls, the net saving rate also declines so that the fall in economic growth and in net saving reinforce each other.

Other Considerations and a Brief Summary

For the most part, this discussion of a decline in the net saving rate in the future is detached from any institutional context. As such, my argument about the saving drought is much broader than the current discussion about crises in particular types of saving. For instance, in recent years considerable concern has been expressed about the future bankruptcy of the Social Security system, although recently some skepticism about the reality of this threat has been raised (Baker and Weisbrot 2000). Others, such as Schieber and Shoven (1997), provide evidence that some decades from now the solvency of private pension funds is also in doubt. Their argument rests on many of the same demographic circumstances that I have discussed here. But these two types of crises are only particularly manifestations of a more general decline in net saving that seems likely to occur.

One last issue regarding Social Security also deserves mention. In their simulations of the Social Security system, Lee and Tuljapurkar (1998) argue that the results for 2050 are particularly sensitive to changes in GDP. In their particular model, they do not, however, take into account the decline in the national saving rate and the slowdown in the growth rate. If such considerations are factored into their simulations or those of others, then the future financial health of the Social Security appears even more precarious.

The government faces several basic policy options to offset the deceleration in per capita growth. The purpose of this essay, however, is to diagnose, not to prescribe. In this era of unbounded optimism about future growth, it is not my intention to make pessimism once more a fashionable trait among economists. Nevertheless, by a model focusing primarily on the relative consumption of active and retired workers and the relative population size of these two groups, it should be clear that the personal saving rate seems likely to fall considerably over the next half century, even if my estimates represent an upper limit. The simulations provide some idea of the magnitudes involved under different assumptions. Alternative sources of saving do not seem promising, and as a result, the implications are unsettling: The growth of output per worker will decline, the interest rate will rise, and asset prices will decline. These are problems that economic policymakers need to face squarely.

Appendix A: A Note on the Consumption Replacement Ratio

The magnitude of the consumption replacement ratio is not known, and for this reason I use three quite different rates in my simulations. Most of the literature focuses only on the issue defined in terms of the decisions of individual savers and does not take into account the other factors outlined in the text. Three main approaches to this problem can be distinguished.

Engen, Gale, and Uccello (1999) present a sophisticated stochastic, dynamic programming model, taking into account, among other things, random shocks to income during the working lifetime, the time-preference rate, the interest rate, and the growth rate of income. They end up with a median replacement rates of 80% or 72%, depending on whether the time preference rates are, respectively, 0% and 3%. Comparing the results of this theoretical model to actual data of income and assets from several surveys, they draw a startling conclusion: Although the national saving may be low, U.S. individuals may still be saving at their optimal rate. Nevertheless, as Carroll (1999, p. 168) has noted, "The 'dirty little secret' of the modern dynamic stochastic optimization model [is that] with multiple realistic kinds of uncertainty, and with plausible assumptions about other parameters, the model can predict a very wide range of behavior, depending on the precise configuration of parameter values."

A second approach looks at the popular financial literature to see what financial gurus are advising the general public. In a brief review, Engen, Gale, and Uccello (1999) note that most advocate saving so that the replacement of consumption is roughly between 65% and 85%. A third approach is to look at budgetary needs of those at different ages. Engen, Gale, and

Uccello (1999) point out that retired workers have no commuting expenses and lower mortgage expenses (since these are usually paid off by the time of retirement). Further, their families are smaller (the number of "equivalent adults" in the family falls from 1.68 to 1.30). On the other hand, the *Consumer Expenditure Survey* (U.S. Department of Labor 2000) for 1998 shows that the increase in average out-of-pocket medical expenses on an equivalent adult basis represents roughly 4% of consumption expenditures on an equivalent adult basis of a family headed by a person between 25 and 65. Moreover, in 1998, per capita in-kind income for the elderly through Medicare and Medicaid (U.S. Census Bureau 1999) amounted to about 35% of the consumption (on an equivalent adult basis) of a family headed by a person between 25 and 65. Added to the amount of saving advocated by personal finance experts, the true consumption needs of the retired range from 85% to 125% of those in the working ages. Gokhale, Kotlikoff, and Sabelhaus (1996) approach the budget needs from a different angle and divide government expenditures on those at different ages in a more precise manner. They argue that the ratio of nonmedical expenditures of those who were 70 and 80 years old to those who were 30 and 40 ranged between 0.63 and 0.91 in 1987-1990, but they also point out that much of this higher expenditure of the elderly was due to a redistribution of income to them through the Social Security system.

Given the lack of agreement, I have used a range of consumption replacement ratios that encompasses most of the estimates that are derived in these three different ways.

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