PENSION REFORM IN THE PRESENCE OF FINANCIAL MARKET RISK

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Pension Reform in the Presence of Financial Market Risk

As their populations grow older, the industrial countries face steep increases in public pension costs. Nearly all the rich countries operate defined-benefit pension programs in which retirees' pensions are tied to their past earnings. Most programs are financed on a pay-as-you-go basis and are funded with payroll taxes imposed on current workers and their employers. Typical proposals for reform have focused on straightforward adjustments to the basic system, ranging from proportional increases in tax rates to various methods of scaling back future benefits, including delays in the retirement age and smaller cost-of-living adjustments to offset the impact of price inflation. Debate that is limited to these options is inherently divisive, however. The policy choice between tax increases and benefit cuts is viewed from the perspective of a zero-sum conflict in which the benefits or taxes of one generation or group of workers must be sacrificed in the interest of maintaining the incomes of another. The total amount of future resources available for consumption is assumed to be fixed, and the debate is over how to divide a fixed future pie between workers and retirees and between high- and low-wage workers.

However, the discussion has also highlighted a third approach to reform. If countries change their pension systems in advance of sharply higher pension costs, it is possible to prepare for the added retirement costs by funding a portion of the future liabilities through increased saving. By boosting capital formation and economic growth, higher saving has the potential to increase the incomes – and the welfare – of future workers and retirees. In effect, the advance funding of future retirement benefits provides a mechanism by which the current generation of workers can pay for a larger portion of its own retirement.

Additions to saving accumulated in a pension fund can be invested in a variety of ways. If funds are accumulated in a single national fund, officials of the fund must decide how to allocate assets across a variety of investment options. If instead funds are accumulated in millions of individual investment accounts, then decision-making over asset allocation would be left up to individual workers. In either case, the future path of asset accumulation and level of pension benefits depend crucially on the investment earnings of the fund, which in turn will depend on portfolio choice and the future sequence of investment returns.

In this paper, we consider investment accumulation and pension adequacy in light of financial market risk. We examine evidence on the likely success of collective and individual retirement accounts in providing for the future retirement incomes of typical workers. Using historical information on U.S. financial market returns, we create simulated data on future financial market performance to evaluate the market risks facing contributors in two kinds of advance-funded pension systems. The first is a single collective retirement system providing defined-benefit retirement benefits, as in the traditional U.S. Social Security system. The second is a private system based on individual investment accounts. The paper examines pension accumulation and retirement income levels in the context of a broader model of the economy. In particular, we investigate the impact of pension fund accumulation and the saving flows it generates on the investment-saving balance of the U.S. economy and on the development of the future capital stock, labor productivity, and wages. These impacts of pension fund saving can affect the rate of return on capital and hence can influence the retirement incomes flowing out of individual retirement accounts. Financial market returns can also affect worker welfare under a traditional, defined-benefit system, because the flow of investment earnings will affect the level of contributions needed to finance future pension obligations.

Our analysis demonstrates that the financial market risks of a private retirement system are empirically quite large. Although some of these risks are also present in a collective retirement system that provides defined-benefit pensions, the collective system has one important advantage over private pensions. Because a public system is backed by the taxing and borrowing authority of the state, it can spread risks over a much larger population of potential contributors and beneficiaries. This makes the risks more manageable for active and retired workers, many of whom have little ability to insure themselves privately against financial market risk.

The remainder of the paper is organized as follows. In the next section we consider the broader policy debate about pension reform and describe two basic policy approaches to achieving advance funding of future pension obligations. The second section describes our model of the U.S. economy and the framework used to assess the effects of uncertain financial market returns on saving and investment and on the accumulation of retirement pension rights for individual workers. In the next section we define specific pension reform options and show how these alternatives are affected by financial market uncertainty. The final sections of the paper describe our simulation results. First we consider the impact of reform on the investment-saving balance and on workers' retirement incomes under the standard assumption of stable investment returns. Next we consider the impact of pension reform under the more realistic assumption that investment returns are uncertain and highly variable from one year to the next. The paper ends with a brief discussion of policy implications.

Policy background

Many proposals for pension reform rest on the assumption that it is desirable to move away from pay-as-you-go financing to advance funding of pension liabilities. The principal

advantage of advanced funding is that asset accumulation in the pension fund can boost national saving, thereby increasing investment and future national income. In a previous paper, we constructed a neoclassical growth model to assess the macroeconomic benefits of a strategy of funding a larger fraction of future pension liabilities.[1] Our findings suggest that a relatively small increase in funding, if it resulted in increased saving and investment equivalent to about one percent of U.S. GNP, could boost the growth of the economy enough to offset all of the added costs to future American workers of supporting a larger retired population. That is, while future workers' taxes or contributions would still need to rise to cover larger benefit payments, the increase in future pre-tax wages would be large enough to increase future workers' after-tax incomes and consumption.

While the gains from advanced pension funding are widely recognized among economists, there is no consensus how best to achieve it. Proponents of advanced funding do not agree, for example, whether the additional saving should take place within the present public pension system or in newly created private investment accounts. The U.S. Social Security system currently generates an annual surplus in excess of $100 billion, and the surplus funds are set aside in a reserve that will be used to finance a portion of future benefits. The Clinton Administration went further in proposing to augment the reserve thorough transfers from a general fund budget that was in surplus. If the additions to reserves represented net additions to national saving, the policy would significantly increase national wealth at the same time that it raises the percentage of future pensions financed out of capital income flows.

On the other hand, many commentators question the viability of saving within the public sector. They doubt that legislators and the president could exercise sufficient discipline to avoid

[1] Bosworth and Burtless (1997).

using those funds in other parts of the budget – implicitly borrowing from the Social Security fund to pay for programs that would otherwise be financed with income taxes or other general revenues.[2] Opponents of a buildup in public pension reserves usually favor private retirement accounts, on either a mandatory or voluntary basis. They believe the buildup of reserves in these private accounts is less likely to be offset by reductions in other forms of saving.[3]

People who favor a move toward advance funding also disagree on how retirement pensions should be determined. Most public pension systems currently provide defined-benefit pensions. In a defined-benefit system, monthly retirement benefits are based on the average of a worker's past earnings. This system has the advantage that pensions are closely linked to a worker's income in the years before retirement. Moreover, the financial market risks faced by the fund are spread broadly over a large number of workers and worker cohorts. Implicitly, investment earnings are reflected in lower contribution rates.

Proponents of individual retirement accounts usually favor defined-contribution systems. The ultimate retirement benefit is less certain, because it depends largely on the investment returns of portfolios that are selected by workers. However, two decades of exceptional returns in the U.S. stock market have persuaded many Americans that high returns on stock market investment can be expected to persist in the future. Thus, many believe that an individual investment account offers a better pension without the need for greater rates of contribution.

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[2] In the late-1990s, in pledging not to use the Social Security reserve to finance other programs, members of Congress resorted to the term 'lock box' in referring to the reserve. But with a new Administration and the passage of a few years, the term 'lock box' has vanished from the political discussion and the overall budget is back in deficit.

[3] For a discussion of the substitution between pensions and other forms of wealth see Gale (1998) and Poterba and others (1998).

Defined-contribution pension plans offer less scope for redistribution in favor of low-income workers than a traditional defined-benefit pension, however. Redistribution in favor of low-wage and other kinds of workers must take place outside of individual investment accounts. To duplicate the Social Security program's success in keeping down poverty among the elderly, a defined-contribution system must supplement the pensions from individual retirement accounts with a minimum, tax-financed pension or with public assistance payments.[4] The benefit formula of Social Security is skewed if favor of workers with low lifetime wages. It provides less generous benefits, relative to contributions, to workers who have high lifetime earnings. The redistributional element has long been a source of conflict between advocates and opponents of the current system. Any shift of the basic retirement system away from defined-benefit and toward defined-contribution pensions will raise this issue to the forefront.

The financial market risk facing a retirement fund is sensitive to the portfolio choices of the fund managers. The Social Security fund has traditionally maintained a conservative and uncontroversial investment policy. All of its assets are held as U.S. government bonds. In contrast, privately-managed defined-benefit plans allocate less than 10 percent of their portfolios to government bonds. A substantial share of their assets are invested in corporate bonds, and one-half to two-thirds of their assets are invested in equities. Other rich countries, including Canada, have begun to diversify their public pension fund reserves and now hold corporate equities as well as government bonds in their public pension reserve funds. For many decades public-employee pension funds, even in the United States, have backed their pension promises

[4] It is conceptually possible to subsidize the contributions of low earners, but it would be difficult because of part-time work and the fact that some low-income earners later have high earnings. The issue is made even more complex in the United States because the existing system provides a spousal benefit. The issues are somewhat simpler in some other industrial countries where public pension benefits are proportionate to past contributions or earnings.

with corporate bonds and equities as well as government bonds. The expected rate of return on a portfolio that includes corporate stocks and bonds is higher than the expected return on a portfolio consisting solely of government bonds. On the other hand, the year-to-year variability in returns is also higher in the case of a mixed portfolio, exposing the pension fund to some risk that the fund will not contain enough reserves to finance adequate pensions.

One disadvantage of a funded collective retirement system is that government officials would be forced to decide how to invest the assets accumulated in the pension fund. If retirement savings are invested in corporate equities, public officials would have to decide how to vote shares in corporate elections. By contrast, in an individual retirement account system these decisions can be left to millions of individual workers when they choose how to invest their retirement savings. The influence of public policymakers over retirement investment decisions in an individual account system is much smaller than it would be under a collective, defined-benefit system.

The policy of advanced pension funding also has macroeconomic consequences relevant to the discussion of pension reform. In particular, a policy of investing higher pension savings domestically will drive down the rate of return on the domestic capital stock, thus reducing the investment earnings of any retirement fund. The magnitude of the decline is potentially large because future increases in saving will occur against a backdrop of much slower growth in the U.S. labor force. Slower labor force growth will in turn reduce the domestic demand for capital. Of course, part of an increase in pension saving could be invested outside of U.S. borders, in the wider global economy where the demand for capital is likely to remain stronger than it is in an aging United States. If all the increase in pension saving were invested abroad, however, the impact of higher U.S. saving on future American wages would be small. Without an increase in

the stock of domestic capital, U.S. wage income would be left largely unaffected by the increased saving generated by advance pension funding.

In this paper, we increase the realism of past macroeconomic models by incorporating stochastic variation in the equity return. This offers a method to explore the implications of financial risk in the evaluation of advanced pension funding. In earlier work, one of the present authors used historical data on market returns for bond and equity investments in the United States and four other major industrial countries to evaluate the magnitude of the financial risk for the pension annuities of workers retiring at various times in the past.[5] The present study builds on that work by embedding the process of pension accumulation within a broader model of the economy. This allows us to evaluate the impact of advanced pension funding on aggregate saving, capital formation, and the returns to capital and labor. In addition, there is a feedback effect on future retirement income through the influence of added investment on wages and the rate of return on capital.

To assess the impact of financial market risk within a funded pension system, we consider two policy approaches to advance funding. The first is based on maintaining the traditional defined-benefit Social Security program, and the second involves introduction of new mandatory individual investment accounts and gradual reductions in pensions under the existing Social Security system.

Under the first policy option, we assume that Congress will enact payroll tax rate increases over the next several decades to avert program insolvency and generate a large Social Security Trust Fund reserve. One by-product of this policy is that currently promised Social Security benefits could be paid in full, with part of the future benefits financed out of investment

[5] Burtless (2001).

earnings of a much larger (and always growing) Trust Fund reserve. By adding to national saving, especially during the next few decades, this policy boosts future wages, pension contributions, and retirement benefits through its effect on domestic capital formation. We assume that pension reserves are invested in a mixed portfolio of government bonds and corporate equities. Investment returns on corporate equities are assumed to vary from year to year based on the historical pattern of U.S. equity returns observed over the 1871-2000 period. Fluctuations in Social Security Trust Fund returns do not directly affect pension benefits, which would continue to be determined under the present defined-benefit pension formula. Instead, fluctuations in Trust Fund returns would force legislators to make adjustments in the Social Security contribution rate. If the Trust Fund earned unexpectedly low returns for a number of years, for example, the contribution rate would have to rise to offset the loss in investment income. If returns were unexpectedly high, the contribution rate could be reduced.

Under the alternative method of creating advance funded pensions, new pension accumulation would take place in millions of retirement accounts maintained by individual workers. To make the two advance funding policies roughly comparable, we assume that the allocation of stocks and government bonds in an average worker's retirement portfolio is the same as that in the (reformed) Social Security Trust Fund. When workers reach retirement age, funds in their individual investment accounts are converted into level real lifetime annuities backed by government bonds. After individual retirement accounts are established, we assume that benefits under the traditional Social Security program will be gradually scaled back. In particular, we assume currently scheduled benefits will continue to be paid until the Trust Fund falls below a crucial threshold. At that time, monthly Social Security benefits will be trimmed often enough so that the traditional program remains solvent on a pay-as-you-go basis without

any increase in the current payroll tax rate (12.4 percent of covered wages). Reductions in monthly Social Security benefits will be offset, in whole or in part, by annuity payments financed out of the new individual investment accounts. The accumulation of pension reserves in individual retirement accounts will result in additions to capital formation and future wage incomes. In contrast to fund accumulation in the Social Security Trust Fund, however, a policy of accumulating reserves in individual retirement accounts will force workers to bear financial market risk through fluctuations in their monthly pension benefits. Poor investment earnings in an individual retirement account will produce low monthly retirement pensions; high rates of return will generate generous monthly benefits. On the other hand, the combined contribution rate for pensions would remain stable under the individual account reform plan, regardless of financial market fluctuations. If workers prefer to accept uncertainty in their retirement income rather than uncertainty in their future contribution rate, they might prefer individual account defined-contribution pensions over collective retirement plans that provide defined-benefit pensions.

Simulation Model

We evaluate financial market risk within a model that takes account of the dynamic effects of pension reform on aggregate output, wages, and interest rates. This framework allows us to measure the feedback effects of advance funding on workers' earnings and pension benefits. The dynamic effects of reform are sufficiently large so that they substantially affect our interpretation of the impact of reform. Our analysis is performed by combining a small neoclassical growth model with a microeconomic simulation model. This combination permits us to measure the impact of alternative reforms on a representative set of individual workers. The microeconomic model is based on a small number of earnings patterns that reflect the

diverse career wage profiles of recent American workers. The profiles allow us to calculate individual pension benefits, lifetime net incomes, and internal rates of return and thus to examine the distributional impact of reform. In the remainder of this section we first describe the macroeconomic model and then the microeconomic simulation model used in our evaluation.

The macroeconomic model. We evaluate the macroeconomic effects of reform using a small simulation growth model calibrated to match the 75-year economic and demographic forecasts of the Social Security Trustees. At the core of this model is a Cobb-Douglas production function for the nonfarm business sector. Under the assumptions of the model, capital (*K*) and labor (*L*) are combined in period *t* to produce total output (*Y*),

$$(1) \quad Y_t = A(t) K_t^{a} L_t^{1-a},$$

and where *A(t)* is an efficiency parameter that rises from year to year as a result of technical progress. Capital's share is set at 0.28 on the basis of historical data from the U.S. national income and product accounts. Labor supply is assumed fixed at the future annual levels specified in the Social Security Trustees' intermediate forecast. The capital stock is calculated from information published by the Department of Commerce and projected as the cumulative sum of investment, *I*, with a constant geometric rate of depreciation, δ:

$$(2) \quad K_t = (1 - \delta) K_{t-1} + I_t .$$

The compensation rate for labor, *w*, and the gross rate of return on physical capital, *r*, are determined by the marginal conditions :

$$(3) \quad w = \partial Y / \partial L = (1-a)(Y/L),$$

$$(4) \quad r = \partial Y / \partial K = a (Y/K).$$

The rate of return from the model is scaled to the after-tax return reported for nonfinancial corporations.[6] In addition, the rate of interest on government bonds and the equity rate of return are both tied to movements in *r* by equating a weighted average of the bond and equity yield with the rate of return on corporate capital.[7] We assume a 75-25 split of capital earnings between debt and equity

$$(5)\quad .75\, r_e + .25\, r_b \;=\; .75(1-t)\, r,$$

where τ equals the corporate tax rate. The path of the future bond rate is the same as predicted in the Trustees' 2001 Report, and, at the margin, we assume that the financial market rates move proportionately with a smoothed measure of the after-tax rate of return on capital.[8]

As emphasized in the introduction, the critical aspect of any reform of the pension system revolves around its impact on aggregate saving, but the magnitude of the saving response is subject to considerable uncertainty and debate within the economics profession. An increase in pension fund saving could lead to offsetting reductions in public- or private-sector saving. In the absence of any consensus about the behavioral responses to reform, we have designed the model in a way that allows us to evaluate a variety of different assumptions about the saving offset. For saving in the public sector (S_g), we differentiate between net saving in the Social Security system

[6] Profits as reported in the national accounts and used in our model refer to earnings from domestic operations, but the stock market valuations of U.S. companies also reflect their overseas operations. We should emphasize that it is difficult to find a link in the historical data between changes in the rate of return on real capital and the financial market rate of return. For a discussion, see Poterba (1998) and Howe and Pigott (1992).

[7] This assumes that the 'q-ratio,' the ratio of the market value of the firm to the replacement cost of it's capital, is equal to unity. The data for nonfinancial corporations are taken from Board of Governors of the Federal Reserve, *Flow of Funds Accounts of the United States*, table B102. A scalar adjustment of 0.75 is used to relate the return of nonfinancial corporations to the return generated in of the model.

[8] The trustees' assumption concerning the future rate of return on bonds is higher than the historical average. It averages about 2¾ percent in the baseline simulation.

and in other budgetary accounts. In addition, in some of the following analyses we distinguish between saving in new defined-contribution pension accounts (S_{dc}) and other forms of private saving (S_p). In the simulations reported below, only half of any increment to saving within Social Security and the individual accounts is assumed to represent a net addition to national saving. Thus, we allow for some offset to OASDI saving within the other government accounts, and we follow recent empirical research in allowing for an equal magnitude of offset between the individual account saving and other private saving.

Investment is divided between domestic (I_D) and foreign investment (I_F), and the domestic investment is further disaggregated among government, housing, inventories, short-lived information-processing equipment, and other business capital. Thus,

$$(6) \quad I_D + I_F \equiv S_g + S_p + S_{dc} + D,$$

where D represents capital depreciation. If the United States were a closed economy, I_F would be zero by definition. Annual additions to the U.S. capital stock could be calculated simply from knowledge of S. In an open economy, I_F can be positive or negative depending on whether the nation runs a current account surplus or deficit. In the model, saving can be used domestically or flow out into a global economy. In the following analysis, however, we make the simplifying assumption that any increment to national saving flows into domestic capital. In addition, a change in the saving rate is modeled in net terms so that it is not dissipated over time by an increase in depreciation charges.[9]

[9] In other papers we have compared the implications of an open-economy versus a closed-economy assumption about the allocation of additional saving generated by pension reform. See Bosworth and Burtless (1997).

Under our baseline assumptions about future saving and investment, the growth of the business capital stock parallels that of output, yielding a constant return to capital. By implication, the domestic rate of investment must decline moderately as labor force growth slows in the future, reducing the demand for capital. In order for the rate of return to remain unchanged, the net national saving rate in our baseline model of the economy must drift down from about 5 percent of net national product (NNP) in the 1990s to about 3 percent of NNP in 2020 and thereafter.[10]

The implications of a change in saving behavior for the overall economy can be illustrated by considering a simple change in net national saving from the path assumed under the baseline assumptions. Table 1 shows the impact of an increase in the national saving rate equal to one percent of NNP that begins in the year 2001 and is maintained throughout the 75-year simulation period. In this simulation we assume that all of the extra saving is invested domestically. At the margin, the additional saving flows mainly into the business sector. The higher investment rate leads to a cumulative rise in the capital stock and hence in the flow of capital services. The increase in capital services steadily builds up to a 15-percent increase above the baseline flow after 25 years and a 40-percent increase after 75 years.

Since there are diminishing returns on capital, the increase in capital services translates into a much smaller rise in GDP. Real GDP is 3 percent larger than in the baseline after 25 years and 8 percent larger by 2075. Furthermore, much of the increase in gross output is used up financing a higher level of depreciation on a bigger capital stock. Thus, the gain to NNP – gross

[10] In the intermediate projections of the Trustees' Report, reduced labor force growth leads to a decline in the growth of GDP from an annual rate of 3.4 percent between 1975 and 2000 to 1.6 percent from 2050 to 2075. The slower growth requires a lower rate of domestic investment and saving if the real rate of return is to remain unchanged, as assumed in the Trustees' projections.

national product minus capital depreciation – is only about 2 percent in 2025 and 5 percent in 2075. The increased rate of saving implies a lower level of consumption through the first 10 years after 2000, but consumption is 0.9 percent above the predicted baseline level by 2025 and 3.7 percent higher in 2075.

One of the most striking features of the macroeconomic response to higher saving is the sharp decline in the return to capital. The rate of return falls by 17 percent after 25 years and by 39 percent after 75 years. This decline follows directly from the substantial rise in the ratio of the capital inputs to output. The drop in the rate of return implies a very large redistribution of income, with capital owners losing and laborers gaining as a result of the change in relative returns. While the return on capital falls, the real wage is 10 percent above its baseline level by 2075. This reflects a considerably faster rate of improvement in wages compared with either GDP or NNP.

Social Security finances. The macroeconomic model includes a set of equations that predict future revenues and outlays of the Social Security system. Social Security revenues consist of payroll taxes, the income taxes levied on OASDI benefit payments, and the interest earnings of the Trust Fund. The annual number of beneficiaries is determined exogenously and matches the intermediate forecast of the 2001 Annual Report of the OASDI Trustees. The average OASDI benefit payment is a weighted average of the mean annual benefit paid to each surviving cohort of pensioners. For a particular cohort of retirees, the average real benefit is a function of the economy-wide average wage when the cohort reaches age 60. The cohort weights are set exogenously to match the population projections of the Social Security Trustees, but the initial real pension received by a cohort is adjusted in line with changes in the economy-wide real wage, which is determined within the model (see equation 3 above). The Trust Fund

reserve is simply the cumulative sum of past Social Security revenues (including interest earnings) less program outlays.

While our baseline forecast is designed to match the intermediate forecast of the OASDI Trustees in most respects, the official forecast is highly unrealistic in showing a large and growing deficit in the program after 2024 and a large and growing debt after 2037. We have modified the Trustees' intermediate forecast to reflect a more plausible prediction, namely, that the Social Security program will eventually be modified to ensure long-term solvency. In our baseline forecast, we assume that the program will be changed when the OASDI Trust Fund reaches a dangerously low level – 100 percent of annual benefit payments – and the contribution rate will be periodically adjusted to maintain pay-as-you-go ("Paygo") financing after that year. This policy will require a series of tax increases, beginning in 2033, tax hikes that eventually result in a 6-percentage-point increase in payroll taxes by 2075.[11]

The effect of an increase in the aggregate saving rate on Social Security finances is illustrated in the lower panel of Table 1. As noted above, a higher saving rate increases the pace of real wage growth. A rise in the level of real wages causes a nearly equivalent percentage increase in tax revenues and, with a lag, a faster rate of increase in real benefits. Since the rise in taxes precedes the growth in benefit payments, the Trust Fund balance is improved. Even though interest rates decline as the rate of return on capital falls, the larger Trust Fund reserve produces a net gain in interest income. After 50 years, the gain in interest income is about half the size of the addition to payroll taxes as a source of higher OASDI revenues.

[11] Equivalently, we could have introduced benefit reductions after 2033 with identical macroeconomic implications. That is because the baseline balance in the non-retirement accounts of the government is constructed to offset the surplus in the OASDI accounts and achieve an overall baseline saving rate for the government sector of zero percent of NNP. Our choice of a particular baseline for

Faster economic growth can reduce the burden that pension obligations place on active workers. To show this, we have measured the impact of policy changes on the pension "burden." The burden is defined as the rise in OASDI pension payments as a share of NNP.[12] As shown in Table 1, that cost is projected to rise by 3 percent of NNP between 2000 and 2075. However, through a policy of increased current saving, the current generation of workers can reduce the burden on future workers by raising the level of the capital stock and future incomes. The net reduction in the burden on future workers is measured as the rise in NNP minus any increased investment requirements and the induced increase in public pensions. The result of boosting the net national saving rate by 1 percent of NNP is a future income gain that nearly equals the added retirement cost that is caused by an older U.S. population. Clearly, even modest increases in national saving and the growth of national income can go a long way toward offsetting the future burden of an aging population.

Microsimulation model. The distributional impact of reform can only be determined by measuring the effects of a policy change on representative individual workers. We calculate reform impacts on eleven representative workers. The specific earnings profile of each worker was estimated with information from the Census Bureau's 1990-1993 Survey of Income and Program Participation (SIPP) matched to Social Security earnings records (SSER).[13] The SSER records contain information on Social-Security-covered earnings by calendar year for the period from 1951 through 1999. The profiles of relative earnings are based on the observed and

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government saving has only minor implications for the evaluation of alternative policy changes, because the effects of all policy changes are evaluated in comparison to the same baseline forecast.

[12] These payments represent only a portion of the future consumption of the elderly (costs that must be financed out of the production of active workers), because we exclude retirees' consumption financed with their own private saving or current labor earnings.

predicted earnings of all Social-Security-covered workers born between 1931 and 1965. The calculations were performed on a sample that included all workers in the sample with at least one year of covered earnings. We measure earnings at each age relative to the economy-wide average wage in that year as reported by the Social Security Administration.

Workers are classified into nine categories based on the average *level* of their relative earnings over their career (low, middle, and high) and the *trend* in their career earnings profile (declining, level, and rising). For purposes of calculating workers' retirement benefits under the current Social Security formula, it is enough to know the level of their career wages (specifically, the highest 35 years of indexed earnings). On the other hand, the trend or time path of earnings has a major impact on benefits under a defined-contribution pension plan. Contributions into a defined-benefit account in the early years of a worker's career earn investment returns over a longer period, providing a larger pension per dollar contributed than contributions made late in the career.

For each of the approximately 65,000 workers in our original sample, we measured career earnings using observed and predicted earnings in the 40 years between ages 22 and 61.[14] However, to classify workers according to their lifetime profile of earnings, we focussed only on the last 30 years of the career.[15] That is, to estimate the average level and the trend in career

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[13] Further details about the data set are provided in Toder (1999, especially chapters 2 and 8). See also Bosworth, Burtless, and Steuerle (1999) and Bosworth and Burtless (2000).

[14] Our classification of earnings profiles excludes workers who become disabled or die before reaching the early retirement age (62). This is because our analysis excludes potential Social Security benefits obtained under the Disability and Survivors' Insurance programs (see below).

[15] Our classification scheme ignored a worker's earnings before age 32, because nearly all workers have low but sharply rising earnings early in their careers. Many workers have very low earnings while they are in their twenties because they are still in school. Note that our estimates of career-average earnings include years in which individual workers may have zero earnings. When the Social Security Administration calculates economy-wide average earnings in a given calendar year, workers with zero earnings are obviously excluded from the calculation.

earnings, we ignored wages earned between ages 22 and 31. We divided the 30-year period between ages 32 and 61 into three 10-year subperiods. The average "level" of a worker's earnings is the simple average of relative earnings over the 30 years. The "trend" is defined as the direction of change in 10-year average earnings between the first and third decades of the three-decade period.[16] This classification scheme produces 3 x 3 = 9 categories of workers classified by the level and trend of their earnings. The average profiles are calculated using the observed and predicted earnings of workers who have enough earnings to become entitled to a standard Social Security retirement benefit and who do not become disabled or die before the early retirement age.[17] In addition, we created a "composite" earnings profile to reflect the weighted average earnings profile of workers in all nine of these stylized earnings groups. Finally, we separately calculated the average earnings profiles of workers who have positive lifetime earnings but do not earn enough covered wages in their careers to become eligible for Social Security retirement benefits.

The 11 estimated age-earnings profiles are displayed in Figure 1. Each chart in the figure shows a single age-earnings profile. At a given age, the chart shows the worker's annual earnings measured as a percentage of economy-wide earnings at that age. The figure shows a remarkable diversity of earnings patterns. There are as many workers who have a declining trend in career earnings as there are workers with a rising wage profile. The percentages of men

[16] We computed the trend in career earnings as $t = (C-A) / (C+A)$, where A is the worker's earnings between ages 32 and 41 and C is average earnings between ages 52 and 61. When $t < -1/9$ we classified the career earnings profile as "declining;" when $t > 1/9$ we classified the profile as "rising." Other career earnings paths were treated as "level." Note that a worker's earnings each year were calculated as the ratio of his or her actual earnings to the economy-wide average earnings in that year.

[17] To qualify for an Old-Age Insurance (OAI) pension at age 62, workers must accumulate at least 40 quarters of Social Security earnings credits by the end of the calendar year in which they attain age 61. A worker who earns slightly more than $3,000 per year in (indexed) wages for at least 10 years would meet this qualification requirement.

and women in each category are shown at the top of the charts. Not surprisingly, the distribution of women's earnings is much lower than that for men, but women are more likely to have a rising trend over their career. In general, the shape of the age-earnings profile of men and women *within* a category is very similar. The important difference between the two sexes is in the distribution of workers across the different categories.

Because each worker's earnings at a given age is measured relative to the economy-wide average wage in the same year, it is straightforward to link the microeconomic analysis to the annual predictions of the real wage derived in the macroeconomic model. For a representative worker attaining age 62 in a particular year, we can use the wage profile shown in Figure 1 and the sequence of real annual wages predicted by the macro model to calculate the worker's lifetime earnings and the OAI pension to which the worker would become entitled under either the current or a reformed benefit formula. Table 2 displays the OAI pension replacement rate and the internal rate of return on OAI contributions for representative workers in selected retiree cohorts over the period from 2000 through 2075. The calculations are based on the intermediate forecast in the 2001 OASDI Trustees' Report, except that we assume OASDI payroll tax rates are raised in 2033 and later years to maintain program solvency on a Paygo financing basis (see discussion above). The replacement rate is computed as the ratio of a worker's lifetime benefits to after-tax lifetime earnings.[18] The internal rate of return is obtained by equating the discounted

[18] Our measure of the replacement rate differs from some other measures of pension replacement because we use lifetime measures of real pension benefits and net-of-OAI-payroll-tax earnings in our calculation.

real value of contributions and benefits over an individual's life.[19] Thus, the internal return reflects both the effects of changes in tax rates and benefits.

The redistributive impact of the Social Security benefit formula is clearly apparent in Table 2. Among workers who reach the early retirement age in 2000, the replacement rate of low-wage workers ranges between 67 percent and 76 percent, while the replacement rate for high-wage workers is just 32 percent to 38 percent. The replacement rate will decline in the future, however, because of the scheduled increase in the normal retirement age (the earliest age for collecting an unreduced Social Security pension). Thus, the replacement rate for a worker with average earnings and a level wage profile will decline from 44 percent in 2000 to 40 percent by 2050. Our tabulations of the internal rate of return show a similar pattern of more favorable treatment for low-wage than high-wage workers. Once again, however, net benefits received by workers in later cohorts are less favorable than those received by workers who retire in 2000. Not only will younger cohorts face a higher retirement age than older cohorts, they will also have to pay progressively higher payroll tax rates in order to keep the Social Security system solvent. As a small offset for their higher lifetime taxes, workers in younger cohorts will collect retirement benefits for a longer period. The Social Security Actuary predicts that younger workers will have higher life expectancy at age 62 than older cohorts. The predicted improvement in life expectancy is fully reflected in our calculation of the internal rate of return and in the Social Security Administration forecast of future benefit outlays.

[19] Our calculation of taxes and benefits is limited to the OAI component of the Social Security program. It ignores contributions and benefits under the Disability and Survivors' Insurance programs. Most advocates of individual retirement accounts favor the continuation of the existing Disability and young Survivors' insurance programs and argue for full or partial replacement of the retirement benefits program.

Individual accounts. If the Social Security program is reformed through benefit reductions rather than tax hikes, policymakers may wish to establish individual retirement accounts so that retirees can partly or fully make up the loss of income associated with smaller OAI pensions. To investigate retirement income flows that would be generated by investment accounts, we assume that workers would contribute a fixed percentage of their Social-Security-taxable earnings to individual retirement accounts beginning in 2001. (Workers who are 58 years old or older in 2001 would be exempt from contributing to individual retirement accounts.) Using the relative earnings profiles in Figure 1 and the real wage predictions generated by the macro model, it is straightforward to calculate the profile of investment account contributions that would be made by representative workers in each cohort of retirees. To calculate the investment earnings of the accounts, we assume that workers invest in a fixed proportion of equities and Treasury bonds, with portfolios rebalanced at the end of each year to maintain the preferred allocation of stocks and bonds. At the age of 62, workers retire and convert their retirement accumulations into level, single-life annuities. Workers are required to purchase an annuity is fixed in real terms. To calculate the real annuity payment, we use the intermediate mortality projections of the Social Security Actuary and assume that the insurer uses the real interest rate on U.S. government bonds as the opportunity cost of funds.[20] We assume that workers in each cohort can purchase fair annuities. That is, in calculating the annuity payment we make no allowance for administrative costs or profit in the sale of the annuities. During the initial years of the retirement accounts' existence, new contributions plus the investment

[20] Note that while individuals earn a weighted average of the bond and equity yield during their working years, the funds earn only the bond rate of return after workers have retired and converted their retirement savings to an annuity. Expected pensions would be higher – but subject to greater financial risk – if workers could purchase variable annuities backed by a mixed portfolio of stocks and bonds.

earnings of the accounts would constitute a major addition to national saving. When the new system is mature, and retiring workers have contributed to their accounts over a full career, withdrawals from the accounts would become economically significant, lessening the impact of the accounts on national saving. This follows from the fact that the annuity payments will be used to finance consumption of retired workers, so the net contribution of the retirement accounts to national saving will be dramatically reduced.

Financial market risk. We evaluate the implications of financial risk by adding a stochastic term to the equation for the equity return,

$$(7) \qquad r_{ei} = r'_{ei} + m_i .$$

Using data on equity returns covering the period of 1871 to 2000, we have estimated that the standard deviation in the annual return is 17 percentage points. This estimate is used to generate random sequences of deviations in the annual return for repeated simulations of the model over the 75-year projection period.[21] Our results are based on a sample of 100 sequences of random deviation terms for equity returns. To evaluate each policy option, we use identical sequences equity return deviations in performing the macro- and micro-economic model simulations.

A substantial part of equity returns consists of realized and unrealized gains. The presence of capital gains complicates the calculation of the contribution of equity returns to national saving. Economists have long debated the appropriate definition of saving and particularly the question of whether to include capital gains and losses.[22] It is helpful, however,

[21] Shiller (1989) and Burtless (2000). We have not modeled the auto-correlation or mean reversion process that may be embedded in annual equity returns. For a discussion of these issues see Poterba and Summers (1988), Shiller (1989), Kim, Nelson, and Startz (1991), and Lo (1997).

[22] For more discussion of the role of capital gains in saving, see the various essays in Hendershott (1985). See also Bradford (1990), Eisner (1991), and Gale and Sabelhaus (1999).

to distinguish the concept of saving from that of net wealth accumulation. The standard definition of saving is derived from national income and product account (NIPA) concepts. Under the NIPA definition, saving is the portion of the current period's production (real resources) that is not consumed. The unconsumed portion of output is therefore available for investment in productive assets, and the additional assets will enable an increase in future consumption. This definition of saving excludes the revaluation of existing assets.

On the other hand, net wealth accumulation – including capital gains and losses, but adjusted for general inflation – is more relevant for purposes of measuring changes in individuals' economic well-being. By enabling workers to make larger future consumption claims, an increase in wealth improves individuals' well-being, regardless of whether the increase in wealth comes from "saving" (under the NIPA definition) or a revaluation of existing assets. If all investors were forward looking and perfectly knowledgeable about the future, the changes in valuation would necessarily reflect changes in the productivity of capital. In practice, however, revaluations of the capital stock as reflected in the stock market seem much more random.

In the macroeconomic model we exclude capital gains and losses from the definition of saving in order to measure correctly the impact of pension account saving on the real resources available for investment. Thus, aggregate saving within the individual retirement accounts is defined in terms of three components: the annual flow of new contributions, the capital income

flow exclusive of the stochastic component of financial market returns, and the annuity outflow (which we assume will be consumed).[23]

$$(8) \qquad s_i = c_i + (r'_{ei} \cdot A_i) - a_i$$

This treatment is not appropriate in the microeconomic model, however, because individuals can convert accumulated capital gains into retirement consumption, regardless of whether the gains reflect the future real income flows from capital investment or a transitory bubble associated with stock market exuberance. Each worker's annuity is determined on the basis of the market value of the worker's account accumulation at time of retirement. This implies that unanticipated positive capital gains will reduce saving in individual account pensions by generating larger annuity payments to new retirees and permitting a higher level of consumption among the retired. Because the annuity payments are treated as a subtraction from saving (see equation 8 above), the increase in average annuities made possible by a large capital gain reduces the flow of saving from the individual accounts. One can perform a similar calculation of the impact of capital gains on saving in the Social Security system when the Trust Fund investment portfolio is enlarged to include corporate equities. Capital gains have no direct impact on Social Security benefits paid to retirees, however, since Social Security payments are determined by a defined-benefit pension formula rather than the current value of the portfolio held by the Trust Fund. Instead, an unanticipated capital gain obtained by the Trust Fund allows the Social Security system to provide the same stream of real retirement benefits with a lower contribution rate. By allowing the Social Security system to eliminate or postpone a payroll tax increase that

[23] In the case of individual accounts, a small adjustment is made for the bequests of those who die prior to converting to an annuity. We assumed that 20 percent of the stock of bequests is consumed in each year.

would otherwise be needed, a large capital gain indirectly reduces the net saving that takes place in the system.

The Policy Options

In an earlier section, we loosely described two basic policy alternatives for moving toward advance funding of the nation's pension liabilities. Under the first option, advance funding would occur within the existing Social Security system. Under the second, a gradually smaller Social Security program would be financed on a Paygo basis and advance funding would occur in new individual retirement accounts. To implement the first policy, we assume that the OASDI tax rate is periodically increased, beginning in 2001, so as to maintain the system in *close actuarial balance* (CAB) over a 75-year horizon. "Close actuarial balance" is a concept used in the OASDI Trustees' Reports to evaluate the solvency of the system. It requires that the present discounted value of OASDI revenues over the 75-year forecast period be within 95 percent of the present discounted value of OASDI program costs. (Both revenues and costs are usually expressed as ratios of the present discounted value of taxable payroll so that the surplus or deficit of the program can be stated in terms of the payroll tax rate change that is needed to produce exact actuarial balance.) OASDI "revenues" are defined to include the initial reserves of the fund. "Costs" include an allowance for a permanent reserve equal to one year of benefit payments. In effect, the initial balance of the program plus the next 75 years' of income must be large enough to pay for 76 years of program costs. The discount rate used to assess actuarial balance is the expected rate of return on the fund's assets in each successive year of the forecast period. Note that the expected rate of return on equities excludes the stochastic deviation of annual returns from their long-run average. Thus, when we consider stochastic variation in the equity return in our analysis we do not need to make any special adjustment in the discount rate

used to evaluate close actuarial balance. The discount rate we use is simply the expected rate of return on the Trust Fund portfolio. The stochastic component in equity returns affects the assessment of close actuarial balance through its impact on the initial Trust Fund balance. An unanticipated capital loss reduces the value of the Trust Fund portfolio, possibly triggering a payroll tax hike that would be unneeded if Trust Fund assets had continued to grow at a steady pace.

The rule implies a continuation of Paygo financing for *current* cost levels combined with advanced funding of all future *increases* in the cost rate. Given that the OASDI system currently has an actuarial deficit equal to 2 percent of taxable payroll, the immediate impact of this policy rule is to boost the payroll tax rate by 2 percentage points in 2001. In the longer term, the payroll tax hike will generate a much faster accumulation of Trust Fund reserves and a major rise in OASDI saving. Additional tax increases are needed in later years to maintain actuarial balance. By 2075 the payroll tax rate must increase by a cumulative total of 3.9 percentage points if Trust Fund assets are invested in a portfolio consisting solely of government bonds. A smaller tax increase would be needed if Social Security's investment portfolio consisted of a mix of equities and government bonds.

The second reform we consider involves a more thorough restructuring of the current system. Traditional Social Security pensions – rather than tax rates – are adjusted beginning in 2035 to maintain OASDI solvency on a pay-as-you-go basis. By 2075 the traditional Social Security benefit must be scaled back by a third compared with the benefit promised under current law. The benefit reductions are partially offset by the introduction of new individual accounts, which are established in 2001. Workers younger than 58 years old in 2001 are required to contribute 2 percent of Social-Security-covered wages to their retirement accounts.

This is the same increase in total pension contributions that is initially required under the first (CAB) policy option. As noted above, workers are assumed to invest their contributions in a portfolio that contains fixed proportions of equities and government bonds.

Both policy options generate sizeable increases in saving. The major initial difference between the two plans is that in the CAB option, saving takes place within a collective, public retirement system, whereas in the IA option the accumulation occurs in millions of private accounts.[24] The time profile of pension fund saving is illustrated in the top panel of Figure 2. These specific calculations are performed under the assumption that the investment portfolios of both the Social Security Trust Fund and the individual retirement accounts consist solely of U.S. government bonds. In addition, there is no stochastic element in the investment returns. Both these simplifying assumptions help clarify the flows of fund accumulation and decumulation generating the impact on national saving. The two reforms produce a large initial increase in saving, but the accumulation under the IA policy option is eroded faster in future years as a result of large annuity outflows when the IA system becomes fully mature. There is no further increase in the pension contribution rate after 2001 under the IA plan. In contrast, additional contribution increases are needed after 2001 under the CAB option in order to maintain the long-term solvency of OASDI. Thus, there is a more rapid build-up of pension fund assets and greater saving under the CAB reform plan. Ultimately, the growth of the Trust Fund slows, and the contribution of Trust Fund accumulation to saving declines.

For comparison purposes, the top panel in Figure 2 also shows the saving that is implicit under the assumed baseline policy (see the lowest line in the chart). In that policy, both

[24] Under both policy options, the addition to national saving is measured in inflation-adjusted dollars. If R_t is the fund assets at the end of the year and ? is the rate of inflation over the year, the addition to saving is defined as $R_t - R_{t-1}$ (1 +?).

currently scheduled taxes and pension benefits remain unchanged until the Trust Fund reaches a dangerously low level. Payroll taxes are then increased just fast enough to finance benefits on a Paygo basis. This baseline policy produces a path of Trust Fund accumulation that adds to saving until 2020 when the Trust Fund balance begins to fall. A 14-year period of Trust Fund decline produces negative saving. When the OASDI program fails the Paygo test in 2034, the payroll tax rate is increased just fast enough so that the Trust Fund reserve increases at the same rate as benefit outlays. By 2075 the tax must be raised by 6 percentage points to finance currently promised benefits.

In our simulations we assume that the changes in Trust Fund savings generated in the Paygo baseline would be offset by changes in the balance of other government accounts. We specifically assume in our baseline projection that the overall government budget, including the surplus or deficit of the Social Security system, will be in balance over the 75-year forecast period. Using this baseline assumption, we can calculate the net increase in saving that is produced by pension reform. The net increment to national saving in the CAB and IA options is measured relative to OASDI saving that is predicted to occur in the Paygo baseline. The time profiles of net additions to national saving under the two policy reforms are displayed in the bottom panel of Figure 2. We have also incorporated the assumption of a 50 percent offset in other forms of private or public saving. Some of the peculiarity in the time profile is explained by our baseline assumption about the accumulation of savings in an unreformed Social Security system. We assume that Congress will delay Social Security reform until the Trust Fund contains less than one year's benefit payments. This will require a rapid sequence of tax increases (or benefit reductions) after 2033 to maintain OASDI solvency. By implication, the net saving that will take place in Social Security will change dramatically between 2033 and 2037.

The more important lesson in the bottom panel of Figure 2 is that the net addition to saving under the CAB plan is usually higher than under the IA plan. Moreover, the two policy options differ substantially in how they deal with investment risk. Under the first option, variations in investment returns have no immediate impact on pension benefits. Instead, fluctuations in return lead to variations in the contribution rate. Under the IA reform option, individual workers bear the full risk of variations in investment earnings as increases or reductions in their retirement pensions. In the first set of policy simulations described below, we ignore financial risk and evaluate the macro- and micro-economic effects of reform in the absence of a stochastic element in returns. In our second set of simulations, we explore the effects of financial market risk in investment returns.

Non-Stochastic Simulations

The effects of the policy reforms on the aggregate economy are displayed in Tables 3 and 4. These and later results are derived under the assumption that *one-half* of the net annual increment in pension fund reserves, whether in the OASDI Trust Fund or the individual investment accounts, represents an increment in net national saving. Thus, we implicitly assume that exactly one-half of the increment in pension reserves is offset by reductions in other forms of public or private saving. If instead we had assumed that all of the increase in pension fund assets represented an increase in net national saving, the impact of fund accumulation on the economy would be even larger than the effects we show.

Table 3 shows the impact of adopting a CAB rule for the OASDI fund. The three panels in the table show the effects of investing Trust Fund reserves in different mixes of equities and government bonds. No matter which investment mix is selected, adoption of the CAB rule will result in an immediate increase in the tax rate in 2001. The increase amounts to 2 percentage

points if the fund assets are invested solely in government bonds (see the top panel). Under the assumption that additions to pension reserves (above those that are scheduled to occur in the baseline policy) will add to national saving, the advance funding policy will produce an immediate jump in investment and a more gradual rise in the capital stock and GDP. If the Trust Fund reserve is invested solely in bonds, a second tax increase of 0.9 percentage points will be needed in 2026, and a third of 1 percentage point is required in 2053. The tax rate increases occur sooner, but are ultimately smaller, than the tax hikes needed under the baseline policy (i.e., adoption of Paygo financing after the Trust Fund falls below 100 percent of annual benefit payments). If the Trust Fund is invested in government bonds and Congress adopts our proposed CAB rule, the boost to national saving would reach a peak of 1 percent of NNP in 2025. The CAB policy requires a consumption sacrifice in the first decade after it is adopted, but it would generate significant and growing improvements in consumption in the decades after 2025. By 2050, the net gains in consumption are sufficient to offset a large proportion of the increased burden on future workers associated with population aging.[25] Finally, the additions to the stock of capital lower its rate of return but increase both before- and after-tax real wages.

A shift in the Trust Fund investment allocation away from bonds and toward equities increases the expected return on reserves. As shown in the middle and bottom panels of Table 3, the expected improvement in investment returns actually reduces the future gains in GDP, real wages, and consumption that result from an advance funding policy. There is a straightforward explanation for this effect. The use of a higher discount rate to compute the OASDI actuarial balance raises the weight placed on years in the first decades of the forecast, when the Trust

[25] A reduction in the burden by 2050 of 2.0 percent of NNP compared with the baseline cost increase of 2.7 percent shown in Table 1.

Fund has a large surplus even without any tax hike. The higher discount rate reduces the weight of years in the more distant future, when there is a substantial shortfall of annual revenues compared with predicted outlays. If the Trust Fund holds a 50/50 portfolio of stocks and bonds, the initial tax increase needed in 2001 is only 1.1 percent compared with a required tax hike of 2.0 percent when the reserve is invested solely in government bonds. In effect, the use of a high discount rate leads policymakers to delay or reduce their response to future financing problems. The result is a much smaller initial rise in the tax rate and thus a smaller increase in national saving. By providing a higher future flow of investment earnings, the higher return reduces the need for high labor taxes, leaving workers with a higher after-tax income, but less national saving.[26]

This implication of the discount rate for the timing and amount of OASDI tax or benefit changes is an often-overlooked byproduct of shifting a pension fund's investment allocation toward higher yielding equities. If instead policymakers continued to use the government bond rate when planning tax increases but invested Trust Fund reserves in a mix of bonds and equities, they would adopt policies that are very inconsistent over time. For example, when we simulate a CAB policy that uses the bond rate as the discount rate and combine this with an investment strategy in which half of Trust Fund reserves are invested in stocks, the result is an excessive buildup of reserves over time, far in excess of future funding requirements.

Table 4 shows the aggregate effects of introducing individual retirement accounts. In the early years of the forecast period the impact of the reform on national saving, and hence on

[26] The effects of increasing rates of return on pension contributions and net saving are evident in the behavior private fund managers responsible for defined-benefit pensions. Many defined-benefit pension programs became over-funded in the 1980s as a result of greatly increased returns in their equity portfolios. Many fund managers ceased making new contributions to the funds, and a few tried to

GDP, is similar to that of the CAB policy. However, between 2015 and 2033 the increment to national saving under the IA plan is smaller than it is under the CAB policy (see Figure 2). Under the IA policy, continued population aging after 2033 leads to progressively larger OASDI benefit cuts rather than to further increases in the pension contribution rate. By 2050, the traditional OASDI pension has been cut 25 percent compared with benefit payments under the baseline policy. In 2075 the increase in GDP is about one third smaller under the IA reform than under the CAB policy. As is the case in the CAB policy simulation, the increased capital accumulation that is financed with IA fund saving drives down the rate of return on capital. By 2050 the rate of return falls 13 percent in comparison with its level in the baseline. The fall in the rate of return is particularly important for owners of individual retirement accounts, because the investment return in their accounts is a crucial determinant of their ultimate retirement income. The real return determines not only the size of their pension accumulation at the point of retirement, it also affects the price they must pay for a retirement annuity. As the real interest rate declines, workers receive smaller annuity payments for each $1,000 they have accumulated in their individual accounts.

Under the IA reform plan, increases in the percentage of pension assets invested in equities lead to bigger gains in national saving and to faster growth in total output and real wages. The effects are surprisingly small, however, and they are mainly concentrated in the first decades of the forecast period. In part, this is because the shift in the portfolio to a 50/50 mix of stocks and bonds only raises the average return by 1-1½ percentage points. Moreover, a higher rate of return raises the individual account saving of a cohort of workers during its working

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withdraw part of the unanticipated capital gains from the pension fund and convert them into profits for the sponsoring firm.

years, but after the cohort retires there is an offsetting decline in saving because the cohort obtains a larger annual annuity payment. Thus, some of the extra saving that is generated by a higher rate of return is only temporary.

Table 5 shows the microeconomic consequences of reform under the two basic policy alternatives. The results in the table were obtained under the assumption that both the OASDI Trust Fund and workers with IA accounts invested in portfolios consisting of a 50/50 mix of bonds and equities.[27] Results for the CAB policy simulation are only displayed for a single representative worker, namely, a worker with the "composite" wage profile (one that gives appropriate weights to all workers who become entitled to Social Security retirement benefits). The CAB reform option has very similar proportional impacts on workers with different earnings profiles, although there is a small difference in the lifetime income improvement depending on the trend in earnings over a worker's career. Because wage gains are larger in the second half of the 75-year projection period than in the first half, workers who earn most of their career wages late in their careers enjoy proportionally larger improvements in lifetime total income than workers who earn most of their earnings when young or middle aged. No matter what their career earnings profile, however, all workers in a cohort receive an OAI pension that increases by the percentage gain in economy-wide average wages when the cohort attains age 60. Thus, workers born in the same year all receive the same percentage improvement in pensions regardless of whether they have high, average, or low lifetime wages. In the short-run the rise in payroll taxes reduces after-tax earnings, but there is a net wage gain to workers retiring after 2020. In comparison with the Paygo baseline, the earnings of workers who retire in the later

[27] Results obtained under alternative assumptions regarding the investment mix are reported in appendix tables.

years of the simulation rise both because of the induced effects of the policy on economy-wide wages and because of a smaller required increase in the payroll tax rate. The average gain in total lifetime income, wages plus pensions, rises to 3.6 percent for workers retiring in 2050 and 6.3 percent by 2075.

The simulation with individual accounts generates somewhat smaller gains in after-tax earnings for the average worker (column 2) because the policy leads to a smaller increment to national saving and economy-wide wages (Table 4). On the other hand, the increase in taxes is limited to the 2 percent contribution for the IA account, compared to an ultimate increase of 6 percentage points by 2075 required to maintain the old system on a Paygo basis.

The IA policy has large distributional consequences for pensions. In years before 2025, individual accounts are attractive to most retirees because the reductions in the OAI pension are small, while the IA annuities provide a growing net gain in pension income for workers at all wage levels. The IA policy seems progressively less attractive in later years, however. For the average worker retiring in 2050, the OAI pension is scaled back by 26.3 percent, while the mature individual account system provides an annuity that approximately offsets the loss of traditional pension benefits. The relative gains and losses in pension income differ widely across the wage profiles. Workers must all give up equal percentages of their Social Security pension. Because the traditional defined-benefit pension is calculated under a formula that greatly favors low-wage contributors, while the individual account offers a pension strictly proportionate to earnings, the substitution of defined-contribution for defined-benefit pensions is less advantageous for low-wage workers. Thus, measured as a percent of the baseline pension, the IA annuity provides a much larger gain in retirement income for high-wage than for low-wage workers. Not surprisingly, the IA pension is more attractive to those workers who earn a

substantial portion of their income early in their career. Even among high-income workers there is a substantial difference in the pension between those with declining and rising age-earnings profiles. The net distributional impact of the IA reform is to produce sizeable net losses in pension income for low-income workers which are offset by gains to workers with high lifetime wages.

By 2075 the Paygo financing rule leads to further reductions in OAI pensions. Annuities financed out of 2-percent-of-earnings individual investment accounts are no longer sufficient to maintain most workers' pension income at the baseline level. The net change in pension income is negative for all but two of the high-wage groups. Nonetheless, the IA reform produces gains in total *lifetime* income for all groups. Advance funding increases net saving and pre-tax wages. Since the pension contribution rate is lower under the IA policy than it is under the baseline policy, the increase in lifetime income occurs before most workers retire. Note that the percentage gains in lifetime income are much larger for middle- and high-income earners than for workers with low lifetime wages.[28]

The relative distributional consequences of the CAB and IA policies do not change appreciably using different assumptions about the mix of equities and bonds in the investment portfolio, as shown in the appendix tables. An increase in the proportion of assets invested in equities has only a minor effect on the lifetime income of workers under the CAB policy, but there is a substantial rise in pension income in the IA simulations. For example, increasing the fraction of the individual accounts that is invested in equities from zero to 70 percent boosts the

[28] Individual accounts can be designed that do not produce these adverse distributional effects. For example, if traditional Social Security pensions were reduced by a smaller percentage for low-wage than for high-wage workers, as proposed under two of the reform plans suggested by President Bush's 2001 Social Security Commission, the adverse impact on low-wage workers could be lessened or eliminated.

pension income of persons retiring in 2050 by about 9 percent. Their lifetime income rises by 2 percent. (The gain in expected retirement income would of course be greater if workers were assumed to purchase variable annuities rather than level annuities backed by government bonds.)

The simulations clearly show the importance of using pension reform to boost national saving. If there is no increase in saving, the choice among the reforms is driven by distributional considerations regarding tradeoffs between the young and the old and between high and low-income earners. Without an increase in net saving, there is no income gain to be divided between future workers and retirees. If pension reform generates extra saving, cumulative increases in future NNP can yield gains for both workers and retirees. At the same time, an increase in capital formation also causes a decline in the market rate of return, which somewhat reduces the flow of investment income available to finance pensions. This effect is particularly important for the IA policy, because the value of individual account annuities depends critically on financial market rates of return.

The implications of the policy simulations can be summarized briefly. Under the assumptions of this exercise, advance funding of OASDI generates the larger net gains in future income than the IA accounts because the CAB policy has the larger impact on saving. Analysts have long debated whether accumulation of reserves in a public trust fund would actually raise public saving, however. Reserve accumulation in a public fund requires a strong political commitment to avoid using the reserves for public consumption. There will be no increase in national saving if a larger surplus in OASDI is offset by bigger deficits in other government budget accounts. It is also true, of course, that creation of new, mandatory IA pensions may lead to offsetting reductions in other forms of private saving, especially in types of saving, such as company pensions, that are already earmarked for retirement. As noted above, our estimates of

the net impact of pension fund accumulation on national saving reflect the possibility that there will be some offset in other forms of public or private saving if additional funds are accumulated in the OASDI Trust Fund or in new individual retirement accounts. Only one-half the additional funds accumulated in these reserves is assumed to represent a net increment to national saving.

If a system of individual accounts were to replace part of the existing defined-benefit system, the critical distributional effects will flow out the choice of how to scale back the traditional, defined-benefit pension. A proportional cut in the OAI pension will result in a substantial redistribution of retirement income away from workers with low lifetime wages and in favor of workers with higher wages. The retirement income gains are particularly large for workers who earn most of their wages early in their careers.

Finally, the shift of retirement portfolios toward higher yielding assets boosts pension incomes and contributes to a higher level of saving in the IA policy. However, a decision to invest a portion of the Social Security Fund in higher-yielding equities in the CAB simulations yields surprisingly small benefits because of the way it interacts with the rule for maintaining close actuarial balance. A higher discount rate reduces the need for additional payroll tax contributions in the short run, so it lowers the impact of Social Security reserve accumulation on national saving and hence on future national output.

Stochastic Simulation

The analytical results in the previous section were derived under the standard neoclassical assumption that financial market rates of return are closely aligned with the real marginal return on capital. In fact, financial market returns vary widely from one year to the next and often bear little apparent relation to the underlying physical return on capital. In this section we evaluate

pension reform when financial market returns deviate strongly but randomly from the marginal return on capital, with deviations that may persist for a decade or longer.

We model this process by including a stochastic term as part of the return to equities as in equation (7). The bond rate is modeled without a stochastic element. Although the analysis could be extended to cover the case in which both the equity and bond returns include random components, our simplification seems defensible for a couple of reasons. First, much of the apparent randomness in historical government bond returns is the result of capital gains and losses faced by bond holders who are assumed to sell their bond portfolios at the end of each year. A bond holder who continues to own a bond until maturity faces far less capital risk than implied by the standard calculations. Since all bond buyers in our simulations are assumed to hold bonds to maturity, capital market risk is irrelevant. Second, some of the historical risk of holding government bonds has been the result of unanticipated changes in price inflation. The introduction of price-indexed government bonds in the 1990s has largely eliminated this risk.

We assess the implications of random variation in equity returns by comparing the results of 100 replications of the model implemented in the previous section. Each year's equity return includes a normally distributed random shock, which is assumed to have a standard deviation of 17 percentage points.

Tables 6 and 7 show the mean outcome and the standard deviation for a set of key variables affected by advance pension funding under the two policy options considered in the previous section. Both the mean and the standard deviation are reported as percentages of the variable in a baseline simulation in which taxes were raised as required to maintain solvency on a Paygo basis. We show the variability of outcomes in three future years -- 2025, 2050, and 2075.

For the macroeconomic outcomes, shown in Table 6, it is important to remember that capital gains and losses derived from random deviations in the equity return are not directly included in the definition of saving. In the CAB calculations, for example, stochastic variations in the equity return affect on the economy by altering the value of the OASDI Trust Fund, possibly affecting whether the Fund is in close actuarial balance. A large capital gain in the current period will improve the actuarial status of the Fund and possibly result in a lower OASDI tax.

For the IA simulations, the realization of accumulated capital gains or losses is delayed until a worker cohort reaches retirement age. The gain or loss will then influence the size of the annual annuity payout. Thus, any particular shock to the equity return has a damped and delayed impact on saving, measured as the fund inflow minus the outflow. After a cohort's annuity payout rate has been determined, variations in the equity return have no further impact on post-retirement consumption because the portfolio used to finance annuity payments is assumed to consist solely of government bonds.

These factors are clearly evident in the top panel of Table 6, which shows the implications of investing pension fund accumulation in a 50/50 mix of stocks and bonds. In the CAB simulation, the magnitude of response to variation in equity returns is large and grows in successive decades of the forecast period. The standard deviation of the wage rate, for example, rises from 0.3 percent in 2025 to 2.3 percent in 2050, and to 4.8 percent by 2075.[29] The variation in outcomes also increases over time under the IA policy. However, after the IA system becomes fully mature, about 40 years after it is first established, the variability in outcomes stops

[29] The variation in the wage rate is larger than that for NNP, because financial risk affects the economy through changes in capital formation. In the production function, capital-labor substitution leads to larger effects on wages than output.

rising. In an IA system the pension annuity is a fixed proportion of the accumulated funds at time a cohort reaches retirement. Any shock to the rate of return on pension assets is ultimately dissipated by an offsetting change in fund outflows, limiting the cumulative impact of shocks in the rate of return on the overall economy. Consequently, the variability in the aggregate outcomes in 2075 is quite similar to that in 2050.

The most striking result, however, is the large difference in the magnitude of change in key macroeconomic variables between the CAB and IA simulations. In the case of the CAB simulation, the financial market risks are experienced by workers as variations in the OASDI tax rate. The standard deviation in payroll tax rates under the CAB policy is 3.3 percentage points (18 percent of the baseline value of 18.4) in 2075. Changes in the tax rate have immediate effects on pension contributions, and thus on national saving and capital formation. In the case of individual accounts, however, financial risks are experienced by workers as variations in their pension benefits rather than their contribution rates, with much smaller implied effects on national saving. As a result the consequences for the variability of NNP are much reduced. The standard deviation of change in the wage rate in 2075 is ten times larger under the CAB policy alternative than it is under the IA policy (4.8 versus 0.5 percent). The results displayed in Table 6 reveal much more evidence in the CAB policy than in the IA policy of a feedback effect on macroeconomic variables from financial market shocks.[30]

[30] Because of the size of the feedback effect of shocks in the equity return on the required OASDI contribution rate, the dynamics can be quite unstable in the CAB policy. A large capital gain reduces the required tax rate and hence reduces national saving and capital formation. The effect of a smaller capital stock is to reduce the average wage and further increase in the rate of return on capital. This further reduces required contributions to the OASDI program, cutting still further the net contribution of pension saving to capital formation. If positive errors in the equity return persist long enough, changes in the OASDI contribution rate can lead to sizable net reductions rather net gains in saving.

Differences between the two policies in the allocation of financial market risk are also evident in the microeconomic results shown in Table 7. Results in the table focus only on the findings for an average worker who has the composite age-earnings profile. For a person retiring in 2075, the variation of lifetime wage income in the CAB simulation is 1.8 percent of the baseline wage, compared to only 0.4 percent in the IA simulation.

The implications of financial market risk for pension income are somewhat more complicated. Overall, the variation in pension benefits is larger in the IA simulations than in the CAB simulations. In fact, the standard deviation on income from the IA annuity is about 40 percent of the mean predicted annuity (10.5% / 26%). Because the IA annuity accounts for an average of only about one-fourth of total pension income, however, the standard deviation of total pension income is much lower -- just 11 percent of the average total pension in the 100 simulations. This variability in total pension income is nonetheless much greater than that of pension income under the CAB policy (11 percent versus 4.8 percent). Note that the variability in the OAI pension is particularly large in the CAB simulations and is in fact greater than the variation in lifetime wage income. This surprising result follows from the fact that the OAI pension is indexed to the economy-wide wage of a just single year, the year in which the worker cohort attains age 60. Therefore, the standard deviation of the OAI pension in the CAB simulations, 4.8 percent in 2075, is the same as the standard deviation of the economy-wide wage shown in Table 6. In the IA simulation, the OAI pension is affected by changes in the benefit formula needed to maintain Social Security solvency and also by changes in the economy-wide wage when a worker reaches age 60. Because there are much smaller fluctuations in the aggregate economy under the IA policy, there is also substantially less variability in the OAI pension.

The effects of investment risk can also be evaluated in terms of the internal rate of return that workers obtain on their contributions to the pension system. Under the CAB policy, the standard deviation of the internal rate of return for the OAI pension, shown in Table 7, is 29.6 percent in 2075, compared to a mean increase above the baseline of 25 percent in the 100 simulations. Changes in the internal rate of return mainly reflect variation in the tax rate required to maintain actuarial balance. The corresponding variation in the internal rate of return on OAI pension contributions is far smaller under the IA policy, reflecting the smaller variation in macroeconomic outcomes. The standard deviation of OAI returns under the IA policy is less than 0.1 percent. On the other hand, the standard deviation of the internal return on IA contributions is significantly larger, 53 percent of its baseline value.[31] Overall, the variation in the internal rate of return for total pension income is greater in the CAB simulations.

The implications of varying the proportion of equities and bonds in the investment portfolio are illustrated in the bottom panels of Tables 6 and 7. In these panels, the proportion of retirement savings that are invested in equities is increased to 70 percent. This would seem to be a reasonable option only for the IA policy option. At the aggregate level, the standard deviation of the average wage increases by only about 0.2 percent (from 0.4 to 0.6 percent of the baseline), and the impact on the economy remains relatively small. At the individual level, the increased weight assigned to equities raises the standard deviation of the individual account pension by 60 percent, from 10.5 to 16.9 53 percent of the baseline.

[31] The variation is considerably less than the approximately 12 percent standard deviation for the annual return, reflecting the smoothing of returns over a 40 year work life. In a portfolio with a 50 percent allocation to equities, the 17 percent S.D. of the equity return translates into a 12 percent S.D. for the overall portfolio.

The results in Tables 6 and 7 highlight the importance of selecting a sound rule for adjusting the OASDI payroll tax if Social Security adopts a policy of significant advance funding and Trust Fund assets are invested in securities that have substantial financial risk. Under the close actuarial balance adjustment rule implemented in this paper, a sequence of exceptionally poor equity returns can lead policymakers to boost the payroll tax rate, thus producing a sizeable increase in national saving and inducing further reductions in the expected return on capital. A succession of exceptionally good returns, on the other hand, can reduce required tax rates and produce shortfalls in national saving. These effects of investment returns on the payroll tax rate – and on the wider economy – are even larger if the Trust Fund is invested in a riskier portfolio. In view of the link between shocks in investment returns, the payroll tax rate, and national saving, policymakers would be well advised to adopt a conservative policy of adjusting the contribution rate in reaction to surprises in the return on Trust Fund assets. A slow and cautious response to investment surprises does not place retirees' pensions at risk, because under the policy of advance funding the reserves held in the Trust Fund will be several times larger than is the case under a pay-as-you-go financing policy. Even with a sequence of poor returns, the Trust Fund will hold enough reserves to guarantee pensions for a considerable time.

Conclusion

We have examined two alternative reforms of the U.S. pension system that are aimed at pre-funding part of future pension liabilities and increasing national saving. The first policy expands the role of advance funding in the existing Social Security system by moving toward a policy of tax increases that are large enough to maintain close actuarial balance over a 75-year horizon. Under the alternative policy, the traditional Social Security program adopts pay-as-you-go financing after 2033 and a new system of individual investment accounts is adopted to

supplement (reduced) pensions under the traditional system. Advance funding takes place in the new individual investment account system. In previous research, we have found both of these approaches to be effective as methods of boosting saving, but they have very different distributional implications on future cohorts of retiring workers. A system of individual investment accounts can reduce the favorable treatment that low-wage workers receive under the current Social Security system.

The findings reported here show the implications of investing part of the pension fund accumulation in assets which are subject to significant financial market risk. We used historical data on the variability of equity returns in a simulation framework and explored the implications of financial risk to assess alternative approaches to pension reform. A major conclusion is that the magnitude of financial risk is empirically quite large. It is reflected in sizeable variability of after-tax wage earnings and pension incomes. For a typical worker, the standard deviation of the annuity from an individual investment account with a portfolio consisting of 50 percent stocks and 50 percent government bonds exceeds 40 percent of the expected annuity. If the portfolio consists of 70 percent equities and 30 percent bonds, the standard deviation of the annuity rises to about 60 percent of the expected annuity.

Surprisingly, some of the risks connected with advance funding can be even greater when assets are accumulated within the traditional Social Security program rather than individual investment accounts. Although advance funding in Social Security holds out the promise of raising national saving and future output even more than fund accumulation in individual accounts, the variability of returns on Trust Fund investments can have more far-reaching effects on the aggregate economy. A sequence of unexpectedly high investment returns on Trust Fund reserves might induce policymakers to reduce the Social Security contribution rate, lessening the

flow of net savings from Trust Fund accumulation. The reduced rate of saving would in turn slow the growth of the capital stock, possibly increasing the real return on capital and reducing still further the required contribution rate for Social Security. The variations in contribution rates associated with random fluctuations in investment returns can thus result in substantial variability in national saving and the average wage. This leads in turn to significant indirect effects on OAI pensions, in addition to the changes in pre-retirement wage income. For individual accounts, the investment risks are experienced by workers as variations in their annuity income, but the feedback effects of financial market fluctuations on the wider economy are small. Although advance funding within the Social Security program holds out the promise of securing defined-benefit pensions that are more predictable and secure than those that could be supported by an individual account system, the large size of the Social Security Trust Fund in a partially advance funded system presents problems of its own. If reserves of the Social Security system are invested in assets with sizeable financial market risk, policymakers must be very cautious in changing the contribution rate in response to shocks in investment returns.

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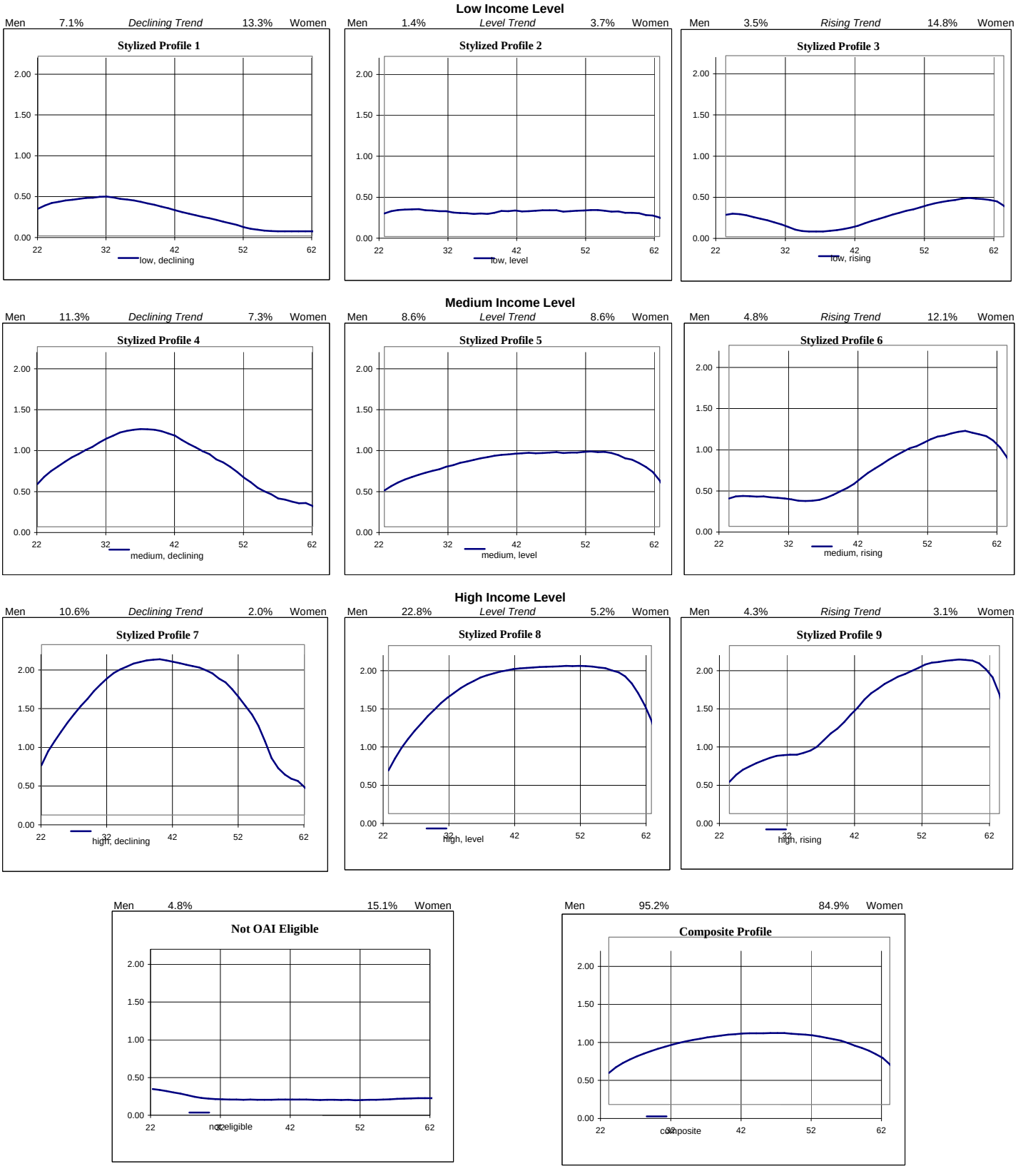
Figure 1. Stylized Age-Earnings Profiles, 1926-1965 birth cohorts (all earnings)

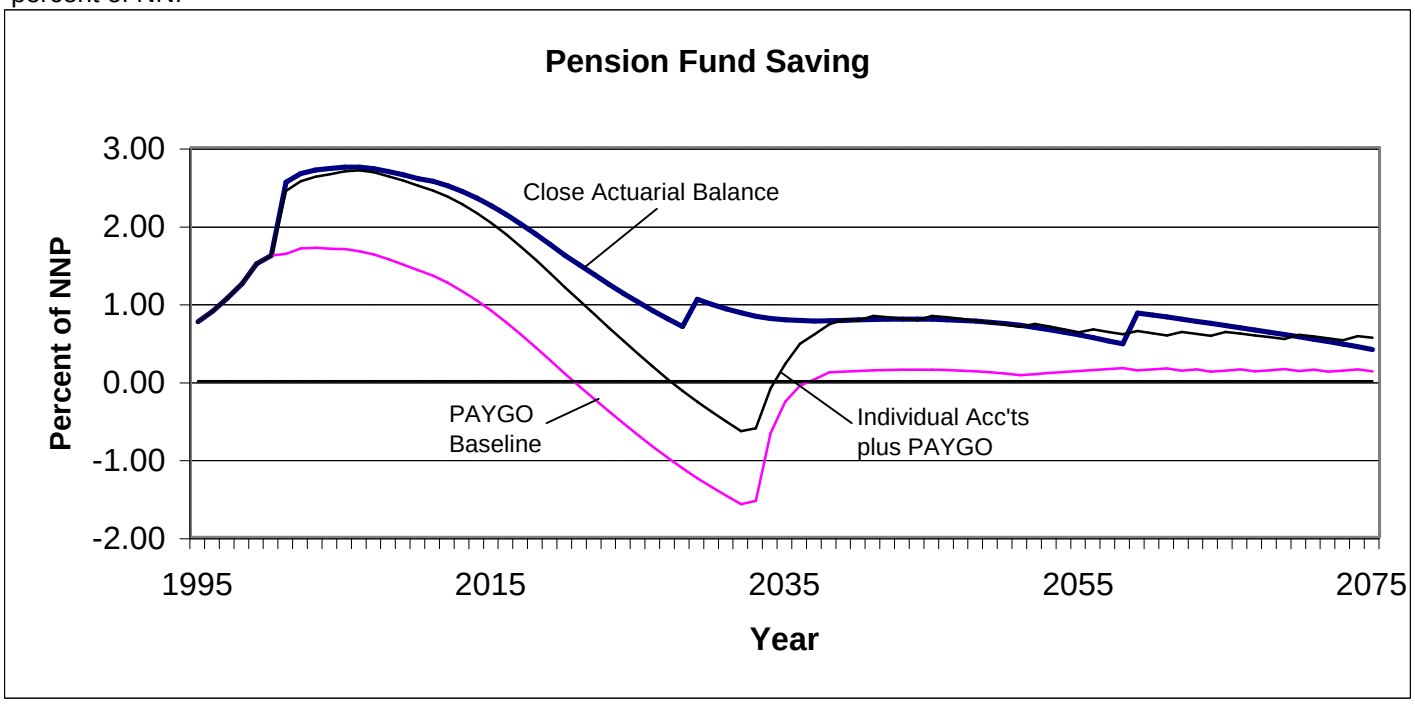
Earnings measured as a percent of economy-wide average earnings

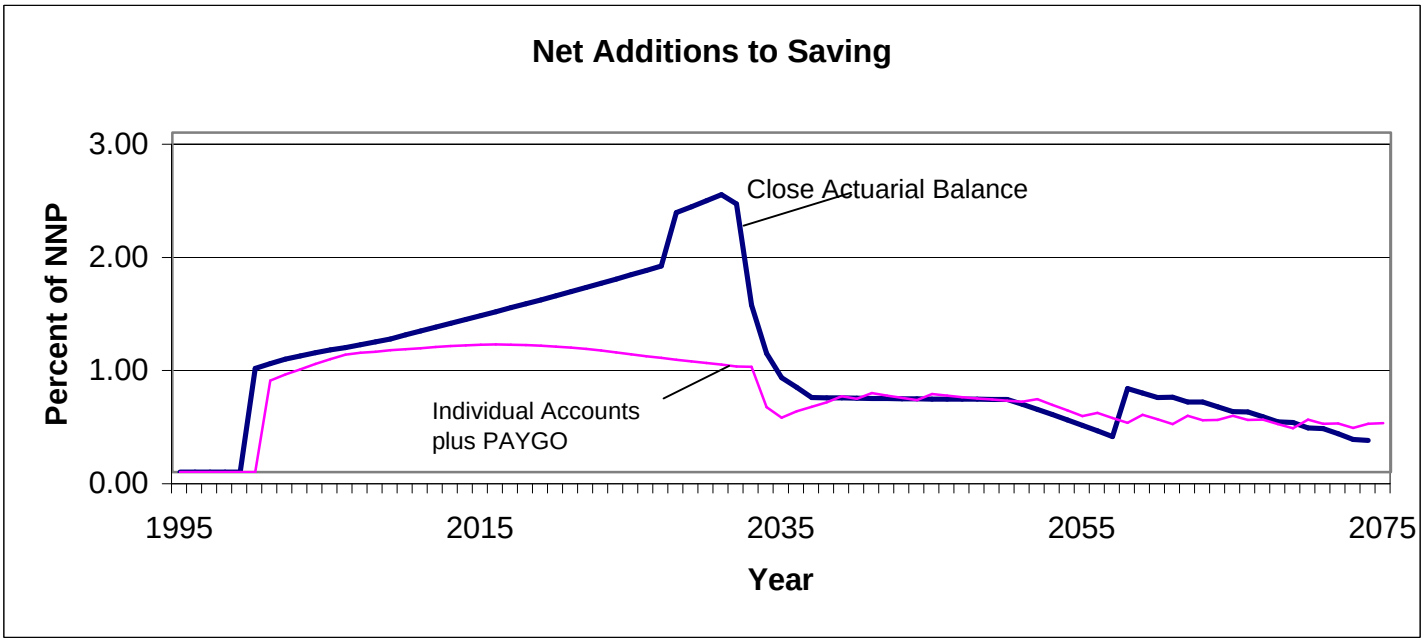


Source: Authors' tabulations of matched SIPP-SSER files (1990-1993 SIPP panels).

Figure 2. Addition to Net Saving Under Alternative Pension Reforms, 2001-75

percent of NNP





Source: Authors' calculations as explained in the text.

Net additions to saving are defined as the increment of pension saving relative to the baseline of the simple PAYGo rule for the OASDI fund balance.

Table 1. Economic Response to a Permanent One Percent Increase in National Saving, Invested Domestically, 2000-2075

Percentage change from baseline

Year	Capital Services	GDP	NNP	Consumption	Rate of Return	Wage Rate
2000	0.0	0.0	0.0	0.0	0.0	0.0
2010	5.6	1.1	0.7	-0.4	-7.4	1.5
2025	15.0	2.9	1.9	0.9	-16.7	4.0
2050	28.7	5.6	3.6	2.5	-28.6	7.3
2075	41.2	8.0	4.8	3.7	-38.6	10.1

	OASDI Program					
	Revenues			Expenditures	Burden[b]	
	Tax[a]	Interest[a]	Total		Baseline	Change
2000	0.0	0.0	0.0	0.0	0.0	0.0
2010	1.2	0.2	1.4	0.1	0.4	0.4
2025	3.1	0.7	3.8	1.4	2.4	-0.7
2050	6.7	3.9	10.6	4.1	2.7	-2.1
2075	9.5	7.6	17.1	7.0	3.0	-2.9

Source: Authors' calculations as explained in the text.

a. Percent of total revenue.

b. The burden is defined as the net increased consumption cost of pensions above the level of 2000, exprssed as a percent of NNP.

Table 2. Replacement Rates and Internal Rates of Return, by Profile, 2000-2075

Tax rates increased to maintain pay-as-you-go solvency

Earnings profile	Level of earnings	Trend in earnings	Lifetime relative earnings*	Replacement Rate (%) Retiring in: 2000	2025	2050	2075	Internal Rate of Return (%) Retiring in: 2000	2025	2050	2075
1.	**Low**	**Declining**	0.32	73	72	70	72	5.5	4.3	4.1	3.4
2.		**Level**	0.35	67	62	61	62	5.7	4.5	4.1	3.4
3.		**Rising**	0.29	76	67	67	69	6.7	5.3	4.8	4.2
4.	**Middle**	**Declining**	0.93	45	43	42	43	4.2	3.2	2.9	2.2
5.		**Level**	0.91	44	41	40	41	4.3	3.3	2.9	2.3
6.		**Rising**	0.78	47	42	42	43	4.9	3.9	3.2	2.6
7.	**High**	**Declining**	1.69	34	32	31	32	3.9	2.4	2.0	1.4
8.		**Level**	1.88	32	29	29	30	3.6	2.3	1.8	1.2
9.		**Rising**	1.54	38	33	34	34	3.9	3.0	2.4	1.8
Composite			1.00	43	39	39	40	4.2	3.2	2.8	2.2
Not OASI Eligible			0.04	na	na	na	na	na	na	na	na

Source: Authors' calculations as explained in the text.

*Arithmetic average of the relative wage for ages 22 to 61, divided by the average for the composite.

Note: The replacement rate is defined as average annual pension benefits divided by average after-tax annual earnings from age 22 to 61.

Table 3. Economic Response to the Adoption of Close Actuarial Balance Policy Rule, 2001-2075

Percentage change from baseline

Trust Fund reserves invested solely in government bonds

									OASDI Program				
	Capital				Rate of	Wage	Saving	Tax Rate Change		Tax	Interest		Trust Fund	Change in
	Services	GDP	NNP	Consumption	Return	Rate	Rate	CAB	PAYGO	Revenues[a]	Receipts[a]	Expenditures	Assets[a]	Burden
Year	(1)	(2)	(3)	(4)	(5)	(6)	(7)	(8)	(9)	(10)	(11)	(12)	(13)	(14)
2010	3.0	0.6	0.4	-0.3	-4.2	0.8	0.6	1.97	0.00	13.2	7.5	0.1	10.0	0.3
2025	10.2	2.0	1.3	0.4	-12.1	2.7	1.0	1.97	0.00	14.7	22.0	0.9	28.2	-0.3
2050	19.7	4.0	2.8	2.4	-19.9	5.1	0.5	2.90	4.30	-3.2	30.9	3.1	43.6	-2.0
2075	22.7	4.7	3.2	3.0	-22.7	5.8	0.2	3.90	6.00	-5.4	28.1	4.7	41.4	-2.5

Trust Fund reserves invested in 50/50 mix of equities / bonds

									OASDI Program				
	Capital				Rate of	Wage	Saving	Tax Rate Change		Tax	Interest		Trust Fund	Change in
Year	Services	GDP	NNP	Consumption	Return	Rate	Rate	CAB	PAYGO	Revenues[a]	Receipts[a]	Expenditures	Assets[a]	Burden
2010	2.0	0.4	0.2	-0.4	-2.9	0.6	0.6	1.05	0.00	7.1	10.9	0.0	7.1	0.4
2025	8.8	1.7	1.1	0.2	-10.8	2.4	0.9	1.05	0.00	8.5	26.0	0.7	25.0	-0.1
2050	17.7	3.6	2.5	2.2	-18.1	4.6	0.4	1.98	4.30	-8.8	33.4	2.8	39.4	-1.9
2075	20.4	4.2	2.9	2.8	-20.6	5.3	0.2	2.97	6.00	-10.8	30.0	4.2	37.0	-2.3

Trust Fund reserves invested in 70/30 mix of equities / bonds

									OASDI Program				
	Capital				Rate of	Wage	Saving	Tax Rate Change		Tax	Interest		Trust Fund	Change in
Year	Services	GDP	NNP	Consumption	Return	Rate	Rate	CAB	PAYGO	Revenues[a]	Receipts[a]	Expenditures	Assets[a]	Burden
2010	1.7	0.3	0.2	-0.4	-2.5	0.5	0.6	0.74	0.00	5.1	11.9	0.0	6.1	0.4
2025	8.5	1.7	1.1	0.1	-10.5	2.3	0.9	0.74	0.00	6.5	28.0	0.6	24.3	-0.1
2050	17.1	3.5	2.4	2.1	-17.5	4.5	0.4	1.66	4.30	-10.7	34.6	2.6	38.1	-1.8
2075	19.4	4.1	2.8	2.7	-19.8	5.1	0.2	2.65	6.00	-12.6	30.6	4.1	35.2	-2.2

Source: Authors' calculations as explained in the text.

a. The changes in taxes and interest receipts are measured as a percent of total receipts, and the change in the Trust Fund is expressed as a percent of NNP. OASDI data are compared to a Paygo simulation because both interest income and assets are highly negative in the baseline.

Table 4. Economic Response to the Introduction of Individual Accounts With Paygo Benefit Cuts in OASDI

Percentage change from baseline

Individual Account reserves invested solely in government bonds

Year	Capital Services (1)	GDP (2)	NNP (3)	Consumption (4)	Rate of Return (5)	Wage Rate (6)	Saving Rate (7)	OASDI Program: Benefit Reduction (8)	Tax Revenues[a] (9)	Interest Receipts[a] (10)	Expenditures (11)	Trust Fund Assets[a] (12)	Change in Burden (13)
2010	2.8	0.5	0.3	-0.3	-3.8	0.8	0.6	0.0	0.6	0.1	0.1	0.2	0.3
2025	8.2	1.6	1.1	0.5	-9.6	2.2	0.6	0.0	1.7	0.4	0.8	1.0	-0.4
2050	12.7	2.6	1.8	1.5	-13.5	3.4	0.4	-25.0	-22.0	-1.6	-23.4	-1.9	-3.0
2075	14.9	3.2	2.2	1.9	-15.9	3.9	0.3	-32.0	-28.6	-1.9	-29.9	-2.3	-4.0

Individual Account reserves invested in 50/50 mix of equities / bonds

Year	Capital Services	GDP	NNP	Consumption	Rate of Return	Wage Rate	Saving Rate	OASDI Program: Benefit Reduction	Tax Revenues[a]	Interest Receipts[a]	Expenditures	Trust Fund Assets[a]	Change in Burden
2010	2.9	0.6	0.3	-0.3	-4.1	0.8	0.6	0.0	0.6	0.1	0.1	0.2	0.3
2025	9.2	1.8	1.2	0.5	-10.8	2.5	0.7	0.0	2.0	0.4	0.8	1.1	-0.3
2050	14.9	3.1	2.1	1.7	-15.8	3.9	0.4	-25.0	-21.7	-1.6	-23.2	-1.8	-3.2
2075	17.6	3.7	2.5	2.2	-18.4	4.6	0.3	-33.0	-28.3	-1.9	-30.6	-2.2	-4.3

Individual Account reserves invested in 70/30 mix of equities / bonds

Year	Capital Services	GDP	NNP	Consumption	Rate of Return	Wage Rate	Saving Rate	OASDI Program: Benefit Reduction	Tax Revenues[a]	Interest Receipts[a]	Expenditures	Trust Fund Assets[a]	Change in Burden
2010	3.0	0.6	0.3	-0.3	-4.1	0.8	0.7	0.0	0.6	0.1	0.1	0.2	0.4
2025	9.7	1.9	1.3	0.5	-11.3	2.6	0.8	0.0	2.0	0.4	0.9	1.1	-0.3
2050	15.9	3.3	2.3	1.8	-16.7	4.2	0.5	-25.0	-21.5	-1.7	-23.1	-1.9	-3.3
2075	18.7	3.9	2.6	2.4	-19.5	4.9	0.3	-32.0	-28.0	-1.9	-29.4	-2.3	-4.3

Source: Authors' calculations as explained in the text.

a. The changes in taxes and interest receipts are measured as a percent of total receipts, and the change in the trust fund is expressed as a percent of NNP. OASDI data are compared to a Paygo simulation because both interest income and assets are highly negative in the baseline.

Table 5. Changes in Lifetime Earnings and Pensions by Earnings Profile and Retirement Cohort Under Alternative Pension Reforms, Funds Invested 50 percent in equities

Percent of baseline value

Year of Retirement	Actuarial Balance Composite	Individual Accounts									
		Composite	Low Income			Middle Income			High Income		
			D	L	R	D	L	R	D	L	R
Lifetime After-Tax Earnings											
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.2	-0.7	-0.6	-0.6	-0.5	-0.8	-0.7	-0.7	-0.8	-0.7	-0.7
2050	3.4	2.1	0.7	1.9	2.9	1.3	2.1	2.9	1.6	2.2	2.7
2075	6.6	5.5	5.0	5.4	5.8	5.2	5.5	5.8	5.4	5.6	5.8
Lifetime Social Security Pension											
2000	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
2025	2.4	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8	-10.8
2050	4.6	-26.3	-26.3	-26.3	-26.3	-26.3	-26.3	-26.3	-26.3	-26.3	-26.3
2075	5.3	-30.7	-30.7	-30.7	-30.7	-30.7	-30.7	-30.7	-30.7	-30.7	-30.7
Lifetime Individual Account Pension											
2000	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	-	15.8	6.2	9.3	9.2	13.4	15.3	16.4	19.5	21.7	20.5
2050	-	27.0	19.2	18.3	14.3	28.0	26.2	22.0	36.1	35.5	28.0
2075	-	25.3	17.8	17.0	13.4	26.1	24.5	20.7	33.7	33.3	26.3
Lifetime Total Pension											
2000	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
2025	2.4	4.9	-4.7	-1.5	-1.6	2.5	4.5	5.5	8.6	10.9	9.7
2050	4.6	0.7	-7.1	-8.0	-12.0	1.7	-0.1	-4.3	9.8	9.2	1.7
2075	5.3	-5.4	-12.9	-13.6	-17.3	-4.5	-6.1	-9.9	3.0	2.6	-4.4
Lifetime Total Income											
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.5	0.3	-1.8	-0.9	-0.8	-0.1	0.2	0.5	0.6	0.9	0.9
2050	3.6	1.8	-1.6	-0.7	-1.3	1.4	1.7	1.5	2.9	3.2	2.6
2075	6.3	3.4	-0.5	0.2	-1.0	3.2	3.2	2.6	5.0	5.1	4.0

Source: Authors' calculations as explained in the text.

Lifetime earnings are aggregated for ages 22-61. The change in the Social Security and individual account pension are both expressed as a percent of the Social Security pension in the baseline.

D = declining age-earnings profile, **L** = level profile, and **R** = rising profile.

Table 6. Summary of Variation in the Results of 100 Stochastic Replications, Selected Macroeconomic Variables, 2025, 2050, and 2075.

Percent, scaled by equivalent variables in Paygo baseline

Variable	2025		2050		2075	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Close Actuarial Balance 50/50 Equity/Bond						
Wage Rate	102.6	0.3	105.1	2.3	105.9	4.8
Net National Product	101.2	0.1	102.7	1.0	102.9	2.3
Real Equity Yield	82.8	347.9	69.5	313.3	81.1	313.5
Real Bond Rate	94.4	0.6	87.9	5.2	86.1	11.8
Tax Rate	113.3	9.1	88.4	15.1	82.4	17.8
Individual Accounts 50/50 Equity/Bond						
Wage Rate	102.5	0.1	103.9	0.4	104.6	0.5
Net National Product	101.2	0.0	102.1	0.2	102.5	0.2
Real Equity Yield	82.9	348.0	74.0	314.9	84.5	310.1
Real Bond Rate	94.4	0.2	90.5	0.9	88.4	1.1
Tax Rate	100.0	0.0	74.3	0.0	67.4	0.0
OASI Benefit Reduction	100.0	0.0	74.9	0.4	67.5	0.5
Close Actuarial Balance 70/30 Equity/Bond						
Wage Rate	105.4	1.2	109.2	7.4	109.1	13.0
Net National Product	102.3	0.4	104.3	3.6	103.4	7.2
Real Equity Yield	73.7	330.1	57.4	299.2	77.0	313.9
Real Bond Rate	88.8	2.0	80.3	19.6	84.0	39.9
Tax Rate	112.0	19.9	87.9	21.5	80.8	27.0
Individual Accounts 70/30 Equity/Bond						
Wage Rate	102.6	0.1	104.2	0.6	104.9	0.7
Net National Product	101.3	0.1	102.2	0.3	102.6	0.4
Real Equity Yield	82.5	347.9	73.0	314.6	83.4	309.8
Real Bond Rate	94.1	0.3	89.9	1.5	87.8	1.7
Tax Rate	100.0	0.0	74.3	0.0	67.4	0.0
OASI Benefit Reduction	100.0	0.0	74.9	0.4	67.5	0.5

Source: Authors' calculations as explained in the text.

Table 7. Summary of Variation in the Results of 100 Stochastic Replications, Selected Microeconomic Variables, Retirement in 2025, 2050, and 2075.

Percent, scaled by equivalent variables in Paygo baseline

Variable	2025		2050		2075	
	Mean	Standard Deviation	Mean	Standard Deviation	Mean	Standard Deviation
Close Actuarial Balance						
50/50 Equity/Bond						
Lifetime After-tax Wages	100	0.1	104	0.3	107	1.8
Total Pension Benefits	103	0.3	105	2.3	106	4.8
Lifetime OASI Benefits	103	0.3	105	2.3	106	4.8
Individual Account Benefits	n/a	n/a	n/a	n/a	n/a	n/a
Total Lifetime Income	101	0.0	104	0.5	107	2.2
Internal Rate of Return - OASI	96	0.8	100	7.3	125	29.6
Internal Rate of Return - Indiv. Acc'ts	n/a	n/a	n/a	n/a	n/a	n/a
Individual Accounts						
50/50 Equity/Bond						
Lifetime After-tax Wages	99	0.0	102	0.3	106	0.4
Total Pension Benefits	105	5.0	100	10.6	96	10.8
Lifetime OASI Benefits	89	0.2	74	0.4	69	0.4
Individual Account Benefits	16	4.8	27	10.3	26	10.5
Total Lifetime Income	100	0.9	102	2.0	104	2.2
Internal Rate of Return - OASI	91	0.2	76	0.5	89	0.7
Internal Rate of Return - Indiv. Acc'ts	98	37	109	39	141	53
Internal Rate of Return - Total Pension	92	4.8	84	11.2	103	15.2
Close Actuarial Balance						
70/30 Equity/Bond						
Lifetime After-tax Wages	101	0.1	107	1.6	111	7.2
Total Pension Benefits	105	1.2	109	7.4	109	13.0
Lifetime OASI Benefits	105	1.2	109	7.4	109	13.0
Total Lifetime Income	102	0.1	107	2.6	111	8.2
Internal Rate of Return - OASI	99	1.0	103	13.8	151	251.8
Internal Rate of Return - Indiv. Acc'ts	n/a	n/a	n/a	n/a	n/a	n/a
Internal Rate of Return - Total Pension	99	1.0	103	13.8	151	47.3
Individual Accounts						
70/30 Equity/Bond						
Lifetime After-tax Wages	99	0.0	102	0.3	106	0.6
Total Pension Benefits	106	7.8	103	17.2	98	17.4
Lifetime OASI Benefits	89	0.3	74	0.6	70	0.6
Individual Account Benefits	17	7.6	29	16.7	29	16.9
Total Lifetime Income	100	1.4	102	3.3	104	3.6
Internal Rate of Return - OASI	91	0.3	76	0.9	89	1.1
Internal Rate of Return - Indiv. Acc'ts	101	53	110	55	144	74
Internal Rate of Return - Total Pension	93	7.2	86	16.6	106	22.6

Source: Authors' calculations as explained in the text.

Table A1. Changes in Lifetime Earnings and Pensions by Earnings Profile and Retirement Cohort Under Alternative Pension Reforms, Funds Invested in Bonds

Percent of baseline value

Year of Retirement	Actuarial Balance Composite	Individual Accounts									
			Low Income			Middle Income			High Income		
		Composite	D	L	R	D	L	R	D	L	R
Lifetime After-Tax Earnings											
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	-0.1	-0.8	-0.6	-0.7	-0.6	-0.8	-0.8	-0.7	-0.8	-0.8	-0.8
2050	3.1	1.7	0.4	1.6	2.5	1.0	1.7	2.5	1.3	1.8	2.3
2075	6.4	4.9	4.4	4.9	5.2	4.7	4.9	5.2	4.8	5.0	5.2
Lifetime Social Security Pension											
2000	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
2025	2.7	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2	-11.2
2050	5.1	-26.8	-26.8	-26.8	-26.8	-26.8	-26.8	-26.8	-26.8	-26.8	-26.8
2075	5.8	-31.1	-31.1	-31.1	-31.1	-31.1	-31.1	-31.1	-31.1	-31.1	-31.1
Lifetime Individual Account Pension											
2000	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	-	13.6	5.1	8.0	8.3	11.2	13.2	14.5	16.5	18.8	18.0
2050	-	22.0	14.7	14.6	11.9	22.2	21.4	18.6	28.9	29.1	23.6
2075	-	20.9	13.9	13.9	11.3	21.0	20.3	17.8	27.5	27.7	22.5
Lifetime Total Pension											
2000	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
2025	2.7	2.4	-6.1	-3.2	-3.0	0.0	2.0	3.2	5.2	7.5	6.7
2050	5.1	-4.8	-12.2	-12.2	-15.0	-4.7	-5.5	-8.2	2.1	2.3	-3.3
2075	5.8	-10.1	-17.2	-17.2	-19.8	-10.0	-10.7	-13.3	-3.6	-3.3	-8.6
Lifetime Total Income											
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.4	-0.2	-2.2	-1.3	-1.3	-0.6	-0.3	0.0	0.1	0.4	0.4
2050	3.5	0.5	-3.2	-2.1	-2.4	-0.1	0.4	0.4	1.4	1.9	1.4
2075	6.3	2.0	-2.2	-1.2	-2.2	1.6	1.8	1.4	3.4	3.7	2.8

Source: Authors' calculations as explained in the text.

Lifetime earnings are aggregated for ages 22-61. The change in the Social Security and individual account pension are both expressed as a percent of the Social Security pension in the baseline.

D = declining age-earnings profile, **L** = level profile, and **R** = rising profile.

Table A2. Changes in Lifetime Earnings and Pensions by Earnings Profile and Retirement Cohort Under Alternative Pension Reforms, Funds Invested 70 percent in equities

Percent of baseline value

Year of Retirement	Actuarial Balance Composite	Individual Accounts									
			Low Income			Middle Income			High Income		
		Composite	D	L	R	D	L	R	D	L	R
Lifetime After-Tax Earnings											
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.2	-0.7	-0.6	-0.6	-0.5	-0.7	-0.7	-0.6	-0.8	-0.7	-0.7
2050	3.5	2.2	0.8	2.0	3.1	1.5	2.3	3.1	1.8	2.3	2.9
2075	6.7	5.8	5.2	5.7	6.1	5.5	5.8	6.1	5.6	5.8	6.1
Lifetime Social Security Pension											
2000	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
2025	2.3	-10.7	-10.7	-10.7	-10.7	-10.7	-10.7	-10.7	-10.7	-10.7	-10.7
2050	4.5	-26.1	-26.1	-26.1	-26.1	-26.1	-26.1	-26.1	-26.1	-26.1	-26.1
2075	5.1	-30.4	-30.4	-30.4	-30.4	-30.4	-30.4	-30.4	-30.4	-30.4	-30.4
Lifetime Individual Account Pension											
2000	-	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	-	16.7	6.6	9.9	9.7	14.3	16.2	17.2	20.8	23.0	21.6
2050	-	29.3	21.2	19.9	15.4	30.7	28.4	23.6	39.3	38.4	29.9
2075	-	27.1	19.4	18.4	14.3	28.3	26.4	22.0	36.3	35.6	27.9
Lifetime Total Pension											
2000	0.0	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2	-0.2
2025	2.3	6.1	-4.0	-0.8	-1.0	3.7	5.6	6.6	10.2	12.4	11.0
2050	4.5	3.2	-4.9	-6.2	-10.7	4.6	2.3	-2.6	13.2	12.3	3.8
2075	5.1	-3.3	-11.0	-12.0	-16.2	-2.1	-4.1	-8.5	5.9	5.2	-2.5
Lifetime Total Income											
2000	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0	0.0
2025	0.6	0.5	-1.6	-0.7	-0.6	0.1	0.5	0.7	0.8	1.1	1.1
2050	3.7	2.4	-0.9	-0.1	-0.8	2.1	2.3	2.0	3.5	3.8	3.1
2075	6.3	4.0	0.3	0.8	-0.5	3.9	3.8	3.1	5.7	5.7	4.6

Source: Authors' calculations as explained in the text.

Lifetime earnings are aggregated for ages 22-61. The change in the Social Security and individual account pension are both expressed as a percent of the Social Security pension in the baseline.

D = declining age-earnings profile, **L** = level profile, and **R** = rising profile.