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Prospects for Social Security Reform

Edited by Olivia S. Mitchell, Robert J. Myers, and Howard Young

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Frontispiece: Special Treasury securities, stored in a federal government filing cabinet in West Virginia, represent $700 billion in Social Security Trust Fund assets. Photo: Jeff Baughan.

II
Assessing the Economic Impact of Social Security Reform

Chapter 5

Social Security Money's Worth

John Geanakoplos, Olivia S. Mitchell, and Stephen P. Zeldes

"Money's worth" measures play a prominent role in the U.S. social security reform debate. For example, the Social Security Advisory Council (1997) recently scored three reform plans according to the internal rate of return, the discounted benefit-to-tax ratio, and the net present value, and it concluded that all three plans would substantially improve social security's performance on money's worth criteria. In the popular press, pundits and politicians compare rates of return anticipated under the current social security system with historical average returns on U.S. capital markets. After realizing how much higher market returns have been than those projected on social security, some observers conclude that shifting from our current underfunded social security system to an individual-account, defined contribution program would lead to higher returns for all. Thus presidential candidate Stephen Forbes (1996) declared that "the average worker retiring today receives a lifetime return of only about 2.2 percent on the taxes he has paid into the system. Contrast this with the historic 9–10 percent annual returns from stock market investments. . . . The advantages of an IRA-type approach are overpowering."[1]

This chapter offers a critical assessment of money's worth measures as they are used in the context of social security reform. These measures have been used for two distinct purposes by policy analysts: to compare how different groups fare relative to each other under a *given* social security system,[2] and to compare how a given group fares under *alternative* systems. In this chapter we concentrate on money's worth measures as used in the second context—for instance, in comparing cohorts' returns under the current, pay-as-you-go, mostly unfunded system with returns under other systems that require more or less funding, different benefit structures, or some other format altogether. In so doing, we are interested in assessing how alternative social security systems would affect different cohorts over time.

The study begins with a stylized model of multiple generations. We assume a constant annual real interest rate of 2.3 percent and a constant growth rate of 1.2 percent, and simulate the actual economy to a surprising degree of accuracy. We show that declining social security returns are the inevitable result of having instituted an unfunded (pay-as-you-go) retirement system that delivered benefits to people already old at the time the system started. We prove that in an ongoing social security system, with or without a trust fund, the net present value of transfers to all generations must sum to zero. If early participants received substantial positive transfers from the system, then later generations must receive negative transfers. Later generations must earn low rates of return on their social security contributions because early cohorts received high returns. Part of social security taxes should thus be seen as payments on past debt incurred to transfer money to retirees soon after system startup, not as investments in assets producing future income.

An important element of system reform concerns the fate of the accrued benefits for past contributions. There are several ways of computing this liability. Goss (forthcoming) describes a method similar to what we will call the straight-line method that at shut-down would entitle someone who worked three-quarters of his or her worklife to three-quarters of the retirement benefit. We propose instead a constant-benefit calculation, one that allocates to each dollar of contributions the same present value in benefits (discounted to the contribution date). The former method gives accrued benefits in our stylized economy of $9.1 trillion discounted to 1997; the latter gives $9.9 trillion. If the social security system were ever shut down, this $800 billion difference might be an important source of controversy.

A popular argument suggests that if social security were privatized, everyone could earn higher returns. We show that this is false. That is, suppose the old unfunded system were shut down and workers' new payroll taxes were invested in capital markets. Suppose that explicit debt were issued to replace accrued benefits, and the path of this explicit debt were kept identical to what the path of the present value of accrued benefits would have been in an ongoing system. Then after-tax returns on privatized accounts would be identical to the low returns received under the old system. For example, in our stylized economy, workers receive only 71 cents in benefits in present value terms for each dollar of contributions to the current system. In a privatized system, each dollar of contribution would have to be taxed 29 cents to make payments on the bonds replacing accrued benefit obligations, yielding the same 71 cents of benefits.

Next we turn to an analysis of how money's worth measures are derived in practice, drawing on and comparing the pioneering research of Leimer (1994), Goss (forthcoming), and Advisory Council (1997). Their results reveal that the U.S. social security system heavily subsidized more than 50 birth cohorts alive when the system was implemented. When these groups

pass on, they will have received a net subsidy of around $9.7 trillion (in $1997 present value terms). The current unfunded liability, or the present value of accrued benefits minus the current trust fund, is $8.9 trillion calculated according to a method close to the straight-line method. This is close to the $9.1 trillion obtained in our stylized economy, and it suggests that the constant-benefit method would have produced something like $9.7 trillion for the actual U.S. economy. According to both Leimer and Advisory Council estimates, actual rates of return have fallen steadily through time. Under current law, they will not fall as low as we projected in our stylized economy, but that is because current law cannot be sustained. Our social security system is in actuarial imbalance; that is, based on a 75-year horizon, the present value of projected future tax revenues under current law is projected to be less than the present value of future projected benefits by about $3 trillion (Goss, forthcoming). Raising future taxes, or cutting benefits, to bring the system into actuarial balance will reduce returns to levels very close to those presented in our stylized model.

We also examine the Advisory Council money's worth estimates for three reform plans involving investment in the stock market through a central trust fund or individual accounts. Money's worth estimates for these plans are higher than those for other reforms that restore actuarial balance by raising taxes or cutting benefits. In fact, the more money a plan puts into the stock market, the better it "looks" according to the money's worth measures. But this approach is incorrect, in that it replaces uncertain outcomes with their expected values and then discounts them at the risk free rate. This might have the effect of assigning a higher money's worth to one plan even though everyone would be better off under some other plan. Money's worth numbers must be adjusted to reflect risk. In general, how they should be adjusted depends on a detailed knowledge of household preferences. Nevertheless, we show that one does not need to know preference parameters under four conditions pertaining to optimization, intergenerational tradeoffs, price stability, and spanning. Then market value defines a money's worth measure with the property that any reform producing a higher money's worth will also give higher welfare, independent of household preferences. Under these conditions, one should not assign a money's worth of $3.85 to $1 of stocks and a money's worth of $1 to $1 of bonds, yet in effect this is what the Advisory Council does. In the real world, of course, one or more of these conditions is likely to fail, so a utility-independent money's worth measure does not exist. We discuss how to modify market value money's worth when some of the conditions are violated. This moves the results toward the non-risk adjusted numbers, but by no means all the way.

Next, we apply the theoretical analysis to concrete reform proposals and provide estimates of how money's worth measures should be modified. Recognizing that some households are constrained from holding stocks themselves, we find that there is likely to be a gain from social security diversi-

TABLE 1. Cash Flows in a Stylized PAYGO Social Security Model: Ongoing System

IRR (%)	PVB/PVT (%)	NPV ($1997)	Cum NPV ($1997)	Birth Year	Calendar Year 1938	1948	1958	1968	1978	1988	1997	1998	2008	2018	2028	2038	2048	2058	2068
		63	94	1860	8.3														
		379	2458	1870	9.3	9.3													
97.0	2263	596	7856	1880	−3.6	10.5	10.5												
11.1	336	393	12698	1890	−4.1	−4.1	11.8	11.8											
4.7	162	193	15525	1900	−4.6	−4.6	−4.6	13.3	13.3										
2.2	98	−8	16352	1910	−5.2	−5.2	−5.2	−5.2	15.0	15.0									
1.2	71	−166	15233	1920		−5.9	−5.9	−5.9	−5.9	16.9	16.9	16.9							
1.2	71	−149	13672	1930			−6.6	−6.6	−6.6	−6.6	19.1	19.1	19.1						
1.2	71	−133	12271	1940				−7.5	−7.5	−7.5	−7.5	−7.5	21.5	21.5					
1.2	71	−120	11013	1950					−8.4	−8.4	−8.4	−8.4	−8.4	24.2	24.2				
1.2	71	−107	9885	1960						−9.5	−9.5	−9.5	−9.5	−9.5	27.3	27.3			
1.2	71	−96	8872	1970							−10.7	−10.7	−10.7	−10.7	−10.7	30.7	30.7		
1.2	71	−87	7963	1980									−12.0	−12.0	−12.0	−12.0	34.6	34.6	
1.2	71	−78	7147	1990										−13.5	−13.5	−13.5	−13.5	39.0	39.0
1.2	71	−70	6415	2000											−15.3	−15.3	−15.3	−15.3	43.9
1.2	71	−63	5757	2010												−17.2	−17.2	−17.2	−17.2
1.2	71	−56	5167	2020													−19.4	−19.4	−19.4
1.2	71	−50	4638	2030														−21.8	−21.8
1.2	71	−45	4163	2040															−24.6
		Total annual contributions			−184	−207	−233	−263	−296	−333	−371	−375	−423	−477	−537	−605	−682	−768	−865
		Total annual benefits			184	207	233	263	296	333	371	375	423	477	537	605	682	768	865
		Annual deficit			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0
		PV (1997$) of trust fund*			0	0	0	0	0	0	0	0	0	0	0	0	0	0	0

Source: Authors' calculations. See text for explanation. Entries are in billions of 1997$ unless indicated otherwise.
Notes: "Ongoing" refers to computations performed for an unfunded open ended Social Security program assumed to continue into the infinite future.
* Also equal to cumulative NPV (1997$) of annual surplus.

fication into stocks. But this gain is only about 20 percent as large as the Advisory Council analysis has suggested.

We are sympathetic to policymakers' efforts to assess whether workers and retirees get their money's worth from the social security system. Yet our analysis shows that popular money's worth measures are often biased when used to compare workers' and retirees' positions under different reform scenarios. In particular, a correct money's worth calculation would show that the net advantage of privatization and diversification are substantially less than popularly perceived.[3]

Money's Worth Measures in a Stylized Economy

To illustrate key issues, we begin with a stylized version of an unfunded social security system in an overlapping generations economy model with no uncertainty. We show how to calculate money's worth measures in this economy; they are unambiguous and easy to compute. We then explain why these money's worth measures are low under our current system, and use this model to analyze the transition costs of moving to a privatized system.

Consider a matrix of numbers with each row (i) representing a birth year and each column (j) representing a calendar year (see Table 1). For simplicity we shall assume all individuals born in the same year are identical. Entry (i,j) represents the total net cash flows in year j to or from all individuals born in year i. Contributions (or taxes) are represented as negative entries and benefits as positive entries.

Assume that all households enter the workforce at 20, retire at 60, and live until age 80. People pay social security taxes each year they work and receive social security benefits during each year of retirement. We let real earnings for each cohort be constant over the worklife, but productivity growth and population growth cause the aggregate earnings, social security taxes, and social security benefits of households born in year t to be $(1+g)$ times as great as those of households born in year i. For this discussion, we also assume that there is no uncertainty. The model is normalized so that total social security benefit payments in the table are equivalent to actual aggregate U.S. system benefits in 1997 (= $371 billion).

In keeping with the Advisory Council's predictions of future long run productivity growth, we suppose that the rate of growth g is 1.2 percent.[4] We further assume that our stylized social security system began in 1938 and will continue to operate forever, as a pay-as-you-go (PAGYO) program with no accumulated trust fund. That is, the model posits that every retired individual over the age of 60 began to receive benefits in 1938, funded fully by taxes raised on workers during that same year. These benefits are equal to what the worker would have received, had he paid social security taxes (at the same rate as current workers) all of his life. Likewise in each calendar year thereafter we suppose the total of all taxes raised from workers is equal to

the total of all benefits paid to retirees. Thus the sum of each column in Table 1 is equal to zero. We display only part of Table 1, extending 75 years into the future, but in principle these cash flows would continue infinitely into the future. To make the table easier to read, every tenth row and column of the underlying matrix are shown.

In this stylized framework, one can easily evaluate the different money's worth statistics. All widely used measures of social security money's worth are single numbers that are used to compare the stream of social security taxes paid by an individual with the stream of social security benefits received. We focus on the three most popular measures. The real "internal rate of return" (IRR) is the inflation-corrected discount rate that equates, for each individual, the present value of the stream of social security benefits to the present value of the stream of the taxes paid. The "benefit/tax ratio" (PVB/PVT) represents, for each individual, the present value of lifetime social security benefits received divided by the present value of lifetime social security taxes paid. Finally, the "net present value" (NPV) is equal to the present value of social security benefits minus the present value of taxes paid.[5]

The internal rate of return (IRR) for each cohort appears as the first column; computing it does not require a market interest rate (discount rate). Column two lists the ratio of the present value of benefits to the present value of taxes for each cohort (PVB/PVT). The net present value of benefits minus taxes (NPV) for each cohort i appears in the third column of Table 1.[6] Each present value is taken as of 1997, and uses the annual real rate of interest (r) for discounting. We assume a value for r of 2.3 percent. This is approximately the arithmetic average of the annual real rate of interest earned on intermediate maturity government bonds over the last 70 years, as is shown below. It is also consistent with the Advisory Council's (1997) estimate of the average future real rate of interest.

The fact that r is greater than g is very important to the qualitative features of a pay-as-you-go social security system such as the one sketched here, although the exact magnitudes of the numbers are not. If instead r were less than g forever, then any expansion of a pay-as-you-go social security system would make everybody better off, at least up until the point that the market interest rate r rose back to g. Indeed, if $r < g$, it is not even possible to assign a finite number to total social security benefits.[7] Most economists, we believe, would subscribe to the idea that the real market rate of interest is greater than the rate of growth of the economy.[8]

The supposition that $r > g$ allows us to discount the future to a finite number. But it also makes the past loom large. As we shall see, one extremely important reason that our social security system imposes such a burden on today's young is that the system transferred a great deal of wealth to the generations retiring just after the Great Depression. Since $r > g$, the present value in 1997 of a transfer in 1940 is a larger fraction of 1997 GDP than the actual transfer was of its contemporaneous GDP.[9]

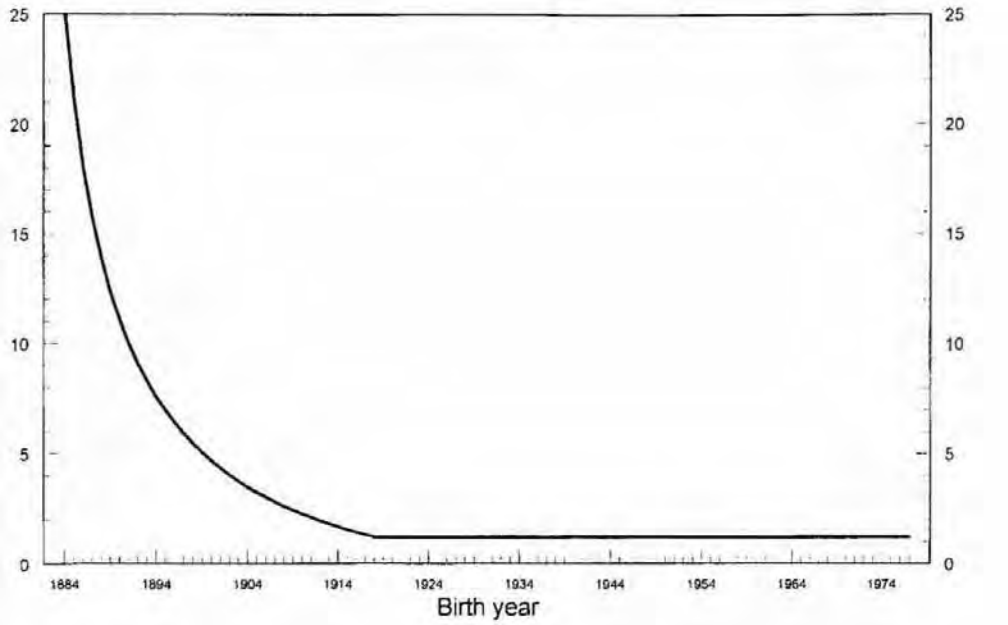

Figure 1. Real internal rate of return on social security, stylized PAYGO model. Source: Authors' calculations based on stylized PAYGO model.

Internal Rates of Return Must Fall in a Pay-as-You-Go Social Security System

This framework generates a time series of IRR's by birth year, plotted in Figure 1. It will be noted that IRRs start out very high: in fact they are infinite for the very first set of cohorts, fall to about 15–20 percent for early cohorts, and then decline toward 1.2 percent.[10] Early participants earned returns much higher than the market rate of interest (2.3 percent, in our stylized model), while later participants earned rates that were below the market rate of interest. While not shown in the figure, Table 1 indicates that the PVB/PVT ratio started out much above one and ended up below one. Similarly, the NPV for each cohort is positive for early generations and negative for later generations.

It is easy to see that the falling IRR is not a result peculiar to our example, but instead is an outcome produced in any steadily growing economy with a pay-as-you-go system. Generations born before 1918 received all their benefits but did not pay taxes in some or all of their working years. Clearly, then, their rate of return will be very high. By contrast, generations born after

1918 pay taxes from the first year they work, so their internal rate of return must be equal to the rate of growth g of the economy.[11] It must be emphasized that these deteriorating money's worth patterns appear even though we hold constant life expectancy and the age structure of the population. That is, falling money's worth in this model is *not* due to the aging of baby boomers, increased life expectancy, or massive administrative inefficiency, but rather to the simple arithmetic of the pay-as-you-go system.

The Redistributive Implications of a Pay-as-You-Go Social Security System

We next exploit the connection between IRR and NPV to explain why IRRs must fall, and also to make clear the inherently redistributive nature of a pay-as-you-go social security system. Recall that IRR is greater than the rate of interest if and only if NPV is greater than zero. The analytical advantage of NPV over IRR is that NPVs can be aggregated. In a pay-as-you-go social security system, the sum of the NPVs across all cohorts must be zero. If one cohort gets net benefits from the system, the other cohorts must pay. If one cohort has an IRR bigger than r, some other cohort must have an IRR less than r. We now explain why.

The entry for the ith row of the fourth column of Table 1 is the cumulative NPV: that is, the sum of the third column across all rows up to and including row i. We can see that after 1910 or so, the number steadily drops toward 0 as we go down the column (i.e., as i increases). We claim that, in a steady state economy in which $r>g$, this cumulative NPV must always tend to zero as i grows indefinitely large.

Since the entries in the matrix in Table 1 grow at rate g but are discounted back at rate $r>g$, we can safely sum present values over all the infinite entries after the system began in 1938. We need not worry about diverging series or the order in which we take the sums and present values. Each column in Table 1 sums to zero because the system is pay-as-you-go. It follows that the present value of each column sum must equal zero, and therefore that the sum across *all* columns of these present values must be zero as well. Changing the orders of summation and present value, it follows that the sum of the present value of all the rows must also be zero, as claimed.[12]

Since the early generations under the system receive large net present value surpluses from social security, it follows that, on average, current and future generations must lose money to social security (in present value terms). In an unfunded PAYGO system every generation after the initial few *must* lose money in present value terms under social security. Because rates of return were high for the first generations, rates of return must be low for later generations.

In this stylized example we supposed that the social security system never built up a trust fund. The same logic applies, however, if the system borrows

money or accumulates a trust fund: in either case, the sum of the NPVs across all generations must be zero. It is only necessary that the trust fund borrows and invests at the rate of interest r, and that the contemporaneous value of the trust fund grows at a rate smaller than r. Under these circumstances, the present value as of a fixed year (say 1997) of the trust fund will increase from some year T to $T+1$ only to the extent that taxes exceed benefits in that year (in present value). In other words, the cumulative NPV of the column sums up to any year T plus the present value of the trust fund in year T must sum to zero for all T. If the contemporaneous value of the trust fund grows at a rate less than r, then the present value of the trust fund must eventually converge to zero. Hence the cumulative column NPV must also converge to zero. As above, this implies that as we go to the limit the cumulative cohort (row) NPVs also converge to zero.

Consider, for example, a variation on Table 1 in which income grows faster than g for some years, say from 1938 to 1973, and then reverts to a growth rate of g forever after. Suppose the tax *rates* are the same as in Table 1 and held constant forever, and the benefit rates are held constant at least until 1973 and increased sometime thereafter. Then the social security system would build up a trust fund in the years up to 1973, from which it could ultimately increase benefits. This, however, would not change the previous conclusions. To the extent that early generations receive benefits in excess of their contributions, later generations must make up the deficit. The presence of the trust fund is a sign that previous NPVs and IRRs were not as high as they could have been. In and of itself, the presence of the trust fund is not sufficient for future IRRs to be above r.

Investment Illusion

Many people look at their low money's worth numbers from social security and assume that these must be the result of systemic administrative inefficiency. Because social security taxes are paid early in life and benefits are received later in life, they tend to think of the taxes as investments paying inadequate dividends. These people believe that, if their contributions could instead be invested in capital markets, they would achieve a higher benefit. However, this perception suffers from investment illusion, since social security taxes should instead be thought of as payments on an old debt. This can be illustrated by imagining a sickly patriarch with no money facing huge medical bills. His children might be called upon to pay the bills. If the expenses were sufficiently high and the number of children sufficiently low, one might imagine that the third generation, the grandchildren, would also be asked to pay. They could do so by waiting until they grew up and their parents got old to give them some money, thus partly repaying and also reenacting their parents' gift to the patriarch. If the bills were astronomically high, and the children and grandchildren together

could not afford them in their entirety, the debt might be rolled over to the fourth generation, the great-grandchildren. By renewing the gift each generation, all the descendants of the patriarch can share in the paying of his medical bills. Each generation would pay money when young, and receive less back when old. This fourth generation might never have known or even heard of the patriarch, yet as a result of his legacy they would be born into an obligation to their parents. Not knowing or caring about the health of the patriarch, they might be tempted to renege on the debt and let him face the consequences of less medical care. But by the time they would make this decision his life and illness and medical care would have already come and gone. Defaulting on the debt would hurt not the patriarch but rather the third generation, their parents. This would likely prove difficult to do.

Our social security system functions something like this parable of the family and the sick patriarch. As illustrated earlier, initial cohorts attaining old age after the Great Depression received a net transfer, in turn imposing costs on succeeding generations—perhaps long after they and the reasons they needed so much care have been forgotten. Furthermore, by the iron logic of compound interest, payment deferred is payment increased; thus $100 borrowed once at 2.3 percent real interest requires payment of $2.30 plus an inflation correction every year in perpetuity, long after the purpose of the original loan is forgotten.[13] It is tempting to think that the small number of early generations receiving the transfer and the robust economic growth of the last five decades must surely dwarf the tiny transfers made when the social security system was established. Indeed, if this parable were only about one family, its subsequent success might eventually enable succeeding children to pay off the original loan in its entirety. But this is not the case for an entire economy, since the technological breakthroughs that enriched the economy also helped to maintain high real interest rates, rates that increased the burden of the repayment.[14] In addition, many generations subsequent to the first did not help pay the interest or repay the principal of the initial implicit debt but instead received transfers themselves that caused the implicit debt to grow faster than the rate of interest.

The Unfunded Liability of Social Security

An important question relevant to the current social security reform debate is what would happen if the current system were shut down and replaced by a different system. In such an eventuality, we believe it inconceivable that previously promised benefits would be completely eliminated. The cohort of 1938, for example, which worked and paid into the old system for 40 years, could not be abandoned without benefits at the age of 60 if the system were shut down in 1998.

To give an idea of policy alternatives using our stylized model, we evaluate a "1997 shut-down" scenario which includes only contributions made and benefits received through 1997, plus future benefits accrued based on contributions through 1997 but to be paid after 1997. The present value as of 1997 of all accrued future benefits ($PVAB_{1997}$) represents benefits already "earned" by workers in the system. These are the liabilities that people in our stylized example might be worried about losing if circumstances suddenly changed. If, for example, the population did not continue to grow at the same rate, or if future taxes were reduced, or if the system shut down, these accrued benefits might be in jeopardy. In general, the unfunded liability as of the end of 1997 (UL_{1997}) is defined as the present value of these accrued benefits (in 1997 dollars) minus any accumulated trust fund (TF_{1997}); i.e., $UL_{1997} = PVAB_{1997} - TF_{1997}$. There are no assets in the system to guarantee these unfunded liabilities, except the implicit promise of the government to tax future generations.[15] In our pure pay-as-you-go example there is no accumulated trust fund, so the unfunded liability of the system is simply equal to the present value of all accrued benefits.

It is not necessarily obvious how accrued benefits would be assigned in the event of an actual shutdown of the current social security system; one can think of several potential formulas. The first approach we will call the "straight line" method. Suppose that a system shutdown occurred in 1997, at which point a given worker has labored for s years out of the normal 40. That worker would then be entitled, after age 60, to a benefit worth $s/40$ of the value that he would have received had the system continued in operation and had he continued to work until age 60, at the same average real wage. The straight line accrued benefits as of 1997 in our stylized example are presented in the penultimate line of Table 2a. In the last line we compute their present value (that is, the unfunded liability) to be $9.1 trillion ($1997).

One might say that the straight line method provides a lower bound on social security's unfunded liability, because a dollar of contributions in the last year of a worker's career yields the same benefits as a dollar contributed 40 years earlier. By contrast, if the worker could have deposited his or her contributions in the bank, a dollar contributed at age 20 would yield much more at age 61 than a dollar contributed at age 60. By ignoring the time value of money, the straight line method gives smaller rates of return, and smaller benefit/tax ratios to younger workers at the time of shutdown. In columns 1 and 2 of Table 2a, we see that IRR and PVB/PVT decline as the cohorts get younger at shutdown. PVB/PVT, for example, drops all the way to 51 percent.

An alternative formula for accrued benefits, which we call the constant IRR method, assigns accrued benefits so that a worker gets the same internal rate of return on actual taxes and benefits as he or she would have earned

TABLE 2a. Cash Flows in a Stylized PAYGO Social Security Model: Shutdown Case (Straight Line Method)

IRR (%)	PVB/PVT (%)	NPV ($1997)	Cum NPV ($1997)	Birth Year	Calendar Year 1938	1948	1958	1968	1978	1988	1997	1998	2008	2018	2028	2038	2048	2058	2068
		63	94	1860	8.3														
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1.2	70	−135	12268	1940				−7.5	−7.5	−7.5	−7.5		20.4	20.4					
1.0	63	−120	10984	1950					−8.4	−8.4	−8.4			16.9	16.9				
0.9	57	−90	9936	1960						−9.5	−9.5				12.3	12.3			
0.8	51	−45	9271	1970							−10.7					6.1	6.1		
				1980															
				1990															
				2000															
				2010															
				2020															
				2030															
				2040															
Total annual contributions (past)					−184	−207	−233	−263	−296	−333	−371								
Total annual contributions (after shutdown)												0	0	0	0	0	0		
Total annual benefits (past)					184	207	233	263	296	333	371								
Total annual benefits (accrued as of shutdown)												375	392	347	256	138	35		
PV ($1997) benefits accrued as of shutdown											9106								

Source: Authors' calculations. See text for details. Entries are in billions of 1997$ unless otherwise indicated.
Notes: "Shutdown" refers to computations performed for an unfunded Social Security program terminated in 1998. Benefits accrued prior to 1998 are assumed to be paid, but no future benefits are accrued. Method for accrual: straight line.

having worked until 60 at the same average wage. Since the constant IRR method gives some time value to money, the accrued benefits are somewhat larger with this method than with the straight line method. Table 2b presents the accrued benefits with the constant IRR method for our stylized example. Note that the IRR in column 1 remains constant at 1.2 percent. The unfunded liability now works out to $9.5 trillion.

Goss (forthcoming) proposed a method of calculating accrued benefits that closely resembles the straight line method, and that agrees with it when there is no productivity growth in the economy. When there is positive growth, the Goss method lies somewhere between the straight line method and the constant IRR method.

The simplest approach to figuring accrued benefits, which we term the "constant benefit/tax ratio method," or "constant benefit" method for short, provides that each dollar of social security contributions generates the same $\$b$ in benefits in present value terms (discounted back to the year the contribution was made). For our stylized case, b equals 0.71, which is the ratio of the present value of benefits to the present value of contributions for any generation that contributed to the program over a 40-year worklife. Table 2c summarizes the result of implementing the constant benefit/tax ratio method. Since the constant benefit/tax ratio method fully recognizes the time value of money, we would expect to see the highest accrued benefits under this method. Indeed, we find that the unfunded liability works out to be $9.9 trillion. The divergence between methods for calculating accrued benefits may become an important source of controversy if social security is ever shut down and workers stake their claims to accrued benefits.

The annual social security transfer. Table 1 reports the present value of the transfer that each birth cohort makes or receives over the course of its life after the economy reaches the steady state (where generations pay taxes for the full 40 years). Another way of looking at the transfer is in annual terms for all cohorts together. The transfer a cohort makes in year t is the difference between the contributions it makes in that year and the present value of the benefits those contributions bring, which in turn depends on the formula for accrued benefits. In the simplest case, where there is a constant benefit/tax ratio, 29 cents on every dollar of contributions is transferred to pay off the implicit debt. In 1998 for example, Table 1 tells us that total contributions are $375 billion. We know that those households will only get back 71 cents on each dollar in present value of benefits. Hence the transfer made that year, in 1998 dollars, is (.29) × ($375 billion) = $108.8 billion. Had we used the straight line method or the constant rate of return method for generating accrued benefits, the transfer would have been slightly lower (because under these methods households would have already given up greater transfers in prior years).

No matter how accrued benefits are calculated in a steady state economy the transfers made by all cohorts in year $t+1$ must equal $(r-g)$ × (un-

TABLE 2b. Cash Flows in a Stylized PAYGO Social Security Model: Shutdown Case (Constant IRR Method)

IRR (%)	PVB/PVT (%)	NPV ($1997)	Cum NPV ($1997)	Birth Year	Calendar Year														
					1938	1948	1958	1968	1978	1988	1997	1998	2008	2018	2028	2038	2048	2058	2068
		63	94	1860	8.3														
		379	2453	1870	9.3	9.3													
97.0	2263	596	7856	1880	−3.6	10.5	10.5												
11.1	336	393	12698	1890	−4.1	−4.1	11.8	11.8											
4.7	162	193	15525	1900	−4.6	−4.6	−4.6	13.3	13.3										
2.2	98	−8	16352	1910	−5.2	−5.2	−5.2	−5.2	15.0	15.0									
1.2	71	−166	15233	1920		−5.9	−5.9	−5.9	−5.9	16.9	16.9	16.9							
1.2	71	−149	13672	1930			−6.6	−6.6	−6.6	−6.6	19.1	19.1	19.1						
1.2	70	−132	12273	1940				−7.5	−7.5	−7.5	−7.5		20.6	20.6					
1.2	67	−106	11091	1950					−8.4	−8.4	−8.4			18.1	18.1				
1.2	64	−74	10199	1960						−9.5	−9.5				13.9	13.9			
1.2	61	−36	9661	1970							−10.7					7.4	7.4		
				1980															
				1990															
				2000															
				2010															
				2020															
				2030															
				2040															
Total annual contributions (past)					−184	−207	−233	−263	−296	−333	−371								
Total annual contributions (after shutdown)												0	0	0	0	0	0		
Total annual benefits (past)					184	207	233	263	296	333	371								
Total annual benefits (accrued as of shutdown)												375	397	366	286	161	43		
PV ($1997) benefits accrued as of shutdown											9532								

Source: Authors' calculations. See text for details. Entries are in billions of 1997$ unless indicated otherwise.
Notes: "Shutdown" refers to computations performed for an unfunded Social Security program terminated in 1998. Benefits accrued prior to 1998 are assumed to be paid, but no future benefits are accrued. Method for accrual: IRR = 1.2%

TABLE 2C. Cash Flows in a Stylized PAYGO Social Security Model: Shutdown Case (Constant PVB/PVT Method)

IRR (%)	PVB/PVT (%)	NPV ($1997)	Cum NPV ($1997)	Birth Year	Calendar Year 1938	1948	1958	1968	1978	1988	1997	1998	2008	2018	2028	2038	2048	2058	2068
		63	94	1860	8.3														
		379	2453	1870	9.3	9.3													
97.0	2263	596	7856	1880	−3.6	10.5	10.5												
11.1	336	393	12698	1890	−4.1	−4.1	11.8	11.8											
4.7	162	193	15525	1900	−4.6	−4.6	−4.6	13.3	13.3										
2.2	98	−8	16352	1910	−5.2	−5.2	−5.2	−5.2	15.0	15.0									
1.2	71	−166	15233	1920		−5.9	−5.9	−5.9	−5.9	16.9	16.9	16.9							
1.2	71	−149	13672	1930			−6.6	−6.6	−6.6	−6.6	19.1	19.1	19.1						
1.2	71	−129	12277	1940				−7.5	−7.5	−7.5	−7.5		20.8	20.8					
1.3	71	−94	11177	1950					−8.4	−8.4	−8.4			19.1	19.1				
1.4	71	−60	10421	1960						−9.5	−9.5				15.3	15.3			
1.5	71	−27	10001	1970							−10.7					8.6	8.6		
				1980															
				1990															
				2000															
				2010															
				2020															
				2030															
				2040															
Total annual contributions (past)					−184	−207	−233	−263	−296	−333	−371								
Total annual contributions (after shutdown)												0	0	0	0	0	0		
Total annual benefits (past)					184	207	233	263	296	333	371								
Total annual benefits (accrued as of shutdown)												375	402	383	312	182	50		
PV ($1997) benefits accrued as of shutdown											9907								

Source: Authors' calculations. See text for details. Entries are in billions of 1997$ unless indicated otherwise.
Notes: "Shutdown" refers to computations performed for an unfunded Social Security program terminated in 1998. Benefits accrued prior to 1998 are assumed to be paid, but no future benefits are accrued. Method for accrual: PVB/PVT = 71%

funded liability at the end of year t). For instance, under the constant benefits/tax ratio plan, we calculated above that transfers in 1998 = \$108.8 billion. Define UL_t as the unfunded liability at the end of year t. If we instead calculate the transfers as $(r - g) \times UL_{1997}$, this equals $(.023 - .012) \times$ (\$9.9 trillion) = \$108.8 billion. The same would hold true under the other plans, though the transfer is harder to compute. Let us see why.

Consider what would happen if the system did not shut down until 1998 rather than in 1997. Recall that $UL_t = PVAB_t - TF_t$. This implies that:

$$\Delta UL_{1997,1998} = \Delta PVAB_{1997,1998} - \Delta TF_{1997,1998}.$$

The change in the present value of accrued benefits from 1997 to 1998 can be derived as the sum of three terms. It includes first a term $r \times PVAB_{1997}$ because the old accrued benefits are now one year closer, and so their present value must go up by the rate of interest between 1997 and 1998. Second, accrued benefits are increased according to the benefit formula $f(C_{1998})$, as a result of the additional contributions made in 1998 (C_{1998}). Third, unfunded liabilities are diminished by the benefits B_{1998} paid out in 1998. Thus:

$$\Delta PVAB_{1997,1998} = r \times PVAB_{1997} + f(C_{1998}) - B_{1998}.$$

The transfer (TRANS) in 1998 is the difference between contributions in 1998 and the corresponding change in accrued benefits. Defining the annual social security surplus (SUR) as the difference between annual contributions and annual benefits,[16] we have:

$$TRANS_{1998} = C_{1998} - f(C_{1998}),$$

$$SUR_{1998} = C_{1998} - B_{1998},$$

$$\Delta PVAB_{1997,1998} = r \times PVAB_{1997} - TRANS_{1998} + SUR_{1998}.$$

Similarly, we can decompose the change in the trust fund from 1997 to 1998 into three components. First, it increases by $r \times TF_{1997}$ because it earns interest. Second, it rises due to additional contributions made in 1998, and third, it falls due to benefits paid during 1998. This gives:

$$\Delta TF_{1997,1998} = r \times TF_{1997} + SUR_{1998}.$$

Putting these together yields:

$$\begin{aligned}\Delta UL_{1997,1998} &= \Delta PVAB_{1997,1998} - \Delta TF_{1997,1998} \\ &= r \times (PVAB_{1997} - TF_{1997}) - TRANS_{1998} + SUR_{1998} - SUR_{1998} \\ &= (r \times UL_{1997}) - TRANS_{1998}.\end{aligned}$$

TABLE 3. Social Security Present Values by Birth Year: Stylized PAYGO Model

Birth Year	*Age in 1997*	*PV of Past Benefits Received Less PV of Past Contributions Made*	*PV of Future Benefits Already Accrued Based on Past Contributions*	*PV of Future Benefits to be Accrued Less Future Contributions to be Made*	*Row Total (NPV from Table 1)*	*Cumulative Row Total*
1859–1917	80+ (dead)	15.7[a]	0[a]	0[b]	15.7[c]	15.7
1918–1937	60–79 (living and retired)	−6.2[a]	3.1[a]	0[b]	−3.1[c]	12.6
1938–1977	20–59 (living and working)	−9.5[a]	6.0[a]	−.9[b]	−4.4[c]	8.2
1978+	≤19 (not yet working or not yet born)	0[a]	0[a]	−8.2	−8.2	0
	Total	0[d]	9.1	−9.1	0	

Source: Authors' calculations.
[a] Derived from Table 2a.
[b] Derived from Tables 1 and 2a.
[c] Derived from Table 1.
[d] Equal to accumulated trust fund (=0 since system is PAYGO).

Rewriting this gives $TRANS_{98} = r \times UL_{1997} - \Delta UL_{1997,1998}$.

Next, realize that in a steady state system all the accrued benefits in matrices 2a,b,c must grow at the rate g as the shutdown year rises. In particular, comparing the 1998 and 1997 shutdown scenarios shows $UL_{1998} = (1+g) \times UL_{1997}$ or $\Delta UL_{1997,1998} = g \times UL_{1997}$, no matter how accrued benefits and hence unfunded liabilities were measured (provided they are linear functions of all the contributions). Putting these together, we get $TRANS_{1998} = (r-g) \times UL_{1997}$, as was to be shown. We deduce that the transfer made in 1998 under the straight line method of figuring accrued benefits is \$100.1 billion = (0.023 − 0.012) × (\$9.1 trillion). Under the constant ratio method it is \$104.5 billion = (0.023 − 0.012) × (\$9.5 trillion).

Table 3 summarizes the transfers for different cohorts and distinguishes between the transfers paid in the past and those to be paid in the future, in this stylized model. (Later we offer a similar table based on actual U.S. data.) For illustrative purposes, the cohorts are collected into four groups: past participants no longer alive (birth years 1859–1917), those currently alive and retired (birth years 1918–1937), those currently alive and working (birth years 1938–1977), and those currently too young to be working or not yet born (birth years 1978+). The column labeled row total gives the NPV (or net subsidy) aggregated from Table 1.

The early birth cohorts (those no longer living in 1997) received net subsidies of \$15.7 trillion (in 1997 present value dollars). Subsequent co-

horts will receive negative net subsidies; that is, they will pay transfers. If the system continues, those currently living and retired will pay $3.1 trillion in net transfers, those currently working will pay another $4.4 trillion in net transfers, and those yet to be born will pay $8.2 trillion in net transfers.

The next step is to determine how much of that total transfer has already been made and how much is yet to be collected. For those already dead or not yet working, the answers are obvious. But for those who are currently working or retired, we need to use a combination of Tables 1 and 2a. The third column of Table 3 gives the present value of past cash flows and the fourth column gives the present value of future benefits already accrued (both from Table 2a).[17] The sum of these two is the net subsidy (positive entries) or net transfer (negative entries) based on contributions already made. The fifth column is calculated based on the difference between Tables 1 and 2a, and is equal to the net subsidy to be received based on future cash flows. In this stylized model, current workers have already paid $3.5 trillion more than they have accrued (= −9.5 + 6.0), leaving only a $0.9 trillion net transfer to be paid based on future contributions.

Reform Options in the Stylized Economy

We turn next to a brief evaluation of reform options in this stylized economy. To do so it is useful to clarify three often-confused terms: privatization, prefunding, and diversification of social security.[18] By privatization, we mean replacing the current social security system with a defined contribution system of individual accounts held in workers' names. By prefunding, we mean reducing the system's unfunded liability, whether explicit or implicit. And by diversification, we mean investing social security funds in a variety of private capital market assets, via either individual accounts or the social security trust fund. These concepts are distinct. It is possible for a reform plan to implement any one or two without the other(s). In what follows we focus on reforms with prefunding and privatization; in subsequent sections we take up the diversification issue in detail.

Privatizing social security without prefunding does not improve welfare in the stylized economy. Consider what would happen in this stylized economy if the social security system were privatized so that all new contributions were channeled into individual accounts.[19] Suppose that all past contributions were ignored and no benefits accrued under the current system were paid. In this case, all future social security taxes would earn the market return of 2.3 percent, almost double the 1.2 percent under the current system. But then the entire $15.7 trillion cost of subsidizing cohorts born prior to 1917 would, in effect, be carried by the current middle-aged and old who would then have paid into the system for years without being entitled to any benefits. Column 3 of Table 3 shows that current retirees would lose $6.2 trillion and current workers would lose $9.5 trillion.

Alternatively, one could shut down the old system and privatize but continue to pay all benefits accrued to date, based on past contributions. Recognition bonds could be issued to workers and retirees for the full amount of their accrued benefits. The \$15.7 trillion burden carried by current workers and retirees would then be reduced to \$6.6 trillion (= 15.7 − (3.1 + 6.0)); the recognition bonds would equal the system's current unfunded liability of \$9.1 trillion. If the government did not default on these bonds, new taxes would have to be raised to pay interest on the recognition bonds. One way to do so would be to set the new taxes to keep the path over time of recognition bond debt the same as the path of implicit debt under the current system.[20] In this event, these new taxes would correspond exactly to the transfers described in the last section. In other words, it can be shown that the new taxes raised would eliminate *all* the higher returns on individual accounts. Current workers and retirees would themselves face extra taxes, which would raise their net loss back to the \$7.5 trillion (= 3.1 + 4.4) it was scheduled to be under the current system. Let us see why.

As pointed out earlier, the implicit tax paid in each year through the continuing social security system is $(r-g)$ × (the unfunded liability at the end of the previous year). If suddenly, at the end of 1997, social security were privatized and recognition bonds were issued, their market value would have to equal the unfunded liability of \$9.1 trillion (or to \$9.9 trillion if accrued benefits are calculated according to the constant PVB/PVT method). The government would then have a choice whether to pay off the recognition bond coupon payments in their entirety as they came due or to roll over some of the debt. Suppose the government decided to keep the recognition bond debt growing at the same rate g as the economy. Then taxes in 1998 would have to be raised in the amount $(r - g)$ × (unfunded liability of 1997). The extra taxes needed to finance the payments on the recognition bonds would thus be identical to the transfers made in the old social security system. This is true, not just for 1998 but, by the same logic for every year thereafter. By choosing the tax rates appropriately, the tax burden could be made to fall exactly on the same people who were contributing more to social security than they were receiving in benefits.[21] Aside from the transfers, participants in the current pay-as-you-go social security system are in effect earning the bond rate of return on their money. In a privatized system in which households invested their forced saving in bonds, they would have to pay in new taxes exactly what they paid before in transfers.

To emphasize this point, Table 4 presents a simplified two-period version of the stylized economy. For each cohort, all the work years are summarized into one period (period 1) and all the retirement years into another (period 2). Under the pay-as-you-go system, all period 1 contributions by the young (T_1) are used to fund benefits to the old (also = T_1). From the vantage point of period 0, the present value of these benefits, equal here to the unfunded liabilities, is $T_1/(1+r)$. Since aggregate wages grow at rate g,

TABLE 4. Rates of Return with Privatization but no Prefunding in a Two-Period Model

time →	*0*	*1*	*2*	*3*
Current style PAYGO system				
payments by young	$T_1/(1+g)$	T_1	$T_1(1+g)$	$T_1(1+g)^2$
receipts by old	$T_1/(1+g)$	T_1	$T_1(1+g)$	$T_1(1+g)^2$
rate of return		g	g	g
unfunded liability[a]	$T_1/(1+r)$	$T_1(1+g)/(1+r)$	$T_1(1+g)^2/(1+r)$	$T_1(1+g)^3/(1+r)$
Privatized system with no prefunding (that begins in period 1)				
outstanding "recognition bond" debt	$T_1/(1+r)$	$T_1(1+g)/(1+r)$	$T_1(1+g)^2/(1+r)$	$T_1(1+g)^3/(1+r)$
payments by young (= deposits to accts ignoring tax)		T_1	$T_1(1+g)$	$T_1(1+g)^2$
receipts by old (ignoring tax)		T_1	$T_1(1+r)$	$T_1(1+g)(1+r)$
rate of return (ignoring transition tax)		r	r	r
payments by young		T_1	$T_1(1+g)$	$T_1(1+g)^2$
new taxes on young to finance debt payments		$(r-g)T_1/(1+r)$	$(r-g)T_1(1+g)/(1+r)$	$(r-g)T_1(1+g)^2/(1+r)$
net deposits to individual accounts (after new taxes)		$T_1(1+g)/(1+r)$	$T_1(1+g)^2/(1+r)$	$T_1(1+g)^3/(1+r)$
receipts by old		T_1	$T_1(1+g)$	$T_1(1+g)^2$
rate of return (including transition tax)		g	g	g

Notes:

[a] Unfunded liability after taxes received and benefits paid for the period.

g = growth rate of wage base = rate of return on social security under current PAYGO system.

r = real riskless rate of return = rate of return on privatized system ignoring transition costs > g

Privatization occurs by issuing recognition bonds to pay for accrued benefits (rolling over enough interest and principal to keep the debt/GDP ratio constant), and channeling all new contributions into individual accounts.

the young in period 2 will contribute $T_1(1+g)$, the same amount that will be paid out to the old. The rate of return that young households will receive on their period 1 social security payments is $[T_1(1+g)/T_1] - 1 = g$.

What would be the effect of privatizing the social security system just after time 0? This could be accomplished by leaving social security tax rates undisturbed but, from time $t = 1$ onward, putting all future social security contributions into individual accounts invested in bonds instead of transferring them to the old. The generation that is young in period 1, and every succeeding generation, would then receive when old the returns from the riskless asset. To make payments to the period 1 old, "recognition bonds" would need to be issued to fully cover the present value of the social security benefits they would have received under PAYGO. If these bonds were issued in period 0, they would have to be of size $T_1/(1+r)$, namely the outstanding unfunded liabilities.[22]

If we ignore any additional taxes to pay interest on these recognition bonds, then all the contributions of the period 1 young are paid directly into individual accounts. In period 2, these households will receive a payout from their accounts of $T_1(1+r)$; that is, they will receive rate of return $r > g$ on their contributions. However this does not reflect their net proceeds, since the government must also collect *new transition taxes* to pay at least some of the interest on the new recognition bonds.

Each period $t > 0$, the government must either pay off the recognition bond debt by raising new transition taxes, or roll it over by borrowing again from the generation t young. Suppose the government were to collect only enough new transition taxes to keep the outstanding debt from the recognition bonds growing at the same rate as the economy (g), that is, keeping the debt/GDP ratio constant. Then at each date t the value of the outstanding recognition bonds would be exactly equal to the unfunded liability under the old pay-as-you-go system. New transition taxes (assumed for simplicity to be raised on the young) would initially (in period 1) have to equal $(r-g)$ $T_1/(1+r)$.[23] Therefore, *net* deposits into individual accounts (these taxes are paid) would equal $T_1 - (r-g)\ T_1/(1+r) = T_1(1+g)/(1+r)$. When they are old, they will get back this amount multiplied by $(1+r)$, which equals $T_1(1+g)$. Since they pay T_1 and receive back $T_1(1+g)$, the net rate of return to the old people, after taking account of the tax to finance the relevant interest payments on the recognition bonds, is exactly g! In other words, participants under the privatized system receive the identical rate of return as under the unfunded pay-as-you-go system. This is true not just in period 2 but in all subsequent periods as well. It is also true regardless how large the difference is between r and g.[24]

Notice also that the pattern of payments in a privatized system with the above debt path is identical to the pattern of payments in a pay-as-you-go system. Generation 1's investment in the riskless asset when young is tantamount to buying the recognition bonds when it is young via its privatized

social security account. Generation 1 then cashes out (i.e., it sells the bonds) to generation 2 when it is old. As before, generation 1 gives up money when it is young and receives money when it is old (previously called social security benefits, and here called interest and principal on bonds). Thus in a dynamically efficient economy in which the market return is r, the return to the social security participant is $g < r$, because the transfer each generation makes to the start-up generation is on the order of $r - g$.

This point is a general one. When money's worth measures exclude the extra transition taxes needed to finance interest payments on the recognition bonds, they yield a misleading indicator of the value of switching to a privatized system. In this example, there is no change in any net cash flows to any households, yet the naive money's worth comparison would indicate a large gain moving from a pay-as-you-go system to a privatized system.[25]

Privatizing and prefunding social security. Suppose, alternatively, that taxes were raised disproportionately on current cohorts so that the outstanding value of recognition bond debt started out lower, and/or grew over time at a rate slower than g (possibly even decreasing over time). In this case, privatization would be accompanied by prefunding. This outcome is favored by many economists, who believe that social security prefunding would increase national saving.[26] Prefunding could also occur under the current system if taxes were raised or benefits cut and the proceeds deposited into a central trust fund. Many also believe that prefunding is more likely to occur if accompanied by some privatization, on the political argument that Congress is less likely to increase government spending or cut taxes outside social security if the accumulation of any increased social security surplus is done in private accounts rather than through a central trust fund (see, e.g., Feldstein 1998a).

How prefunding would change cohort-specific money's worth measures is of some interest. The higher prefunding diminishes the recognition bond debt facing later cohorts, and consequently prefunding reduces taxes needed to repay the interest on this smaller debt. For these later cohorts, then, returns earned on social security contributions net of recognition bond taxes are higher than anticipated under the current system. But for current workers, returns on a prefunded system net of the higher taxes are inevitably lower than under the current system. For this reason, it should be clear that the current debate should focus on whether this tradeoff is worth making, rather than whether there is a free lunch.[27]

Money's Worth Measures in Practice

We now turn to money's worth measures calculated for the actual economy, as opposed to the stylized system described above.[28] Money's worth measures figured prominently in the Social Security Advisory Council's recent report (1997), where the Council compared outcomes under benchmarks based on the current system with outcomes under three specific reform plans.[29]

Practical Issues in Measuring Money's Worth

In calculating money's worth estimates, a number of practical questions arise. In this section, we discuss the most important of these.

Should estimates be based on actual cohort data or hypothetical worker data? Two approaches to computing cohort measures of social security money's worth are prevalent in the literature. One technique is to use actual administrative data on all individuals (or on a sample of individuals) in a cohort, following them over their worklives and into retirement. This micro-based approach relies on longitudinal data, usually the Social Security Administration's Continuous Work History Sample (CWHS); among those taking this tack are Leimer (1994) and Duggan, Gillingham, and Greenlees (1993).

A second technique calculates tax and benefit profiles for hypothetical workers or households. This approach is much simpler since actual people do not have to be tracked over time, and for this reason it is the more prevalent approach in policy settings.[30] For example, the Office of the Actuary at the Social Security Administration (SSA) used the simulated worker approach in its money's worth analysis for the Advisory Council (1997).[31] It must be noted that the SSA hypothetical earnings profiles are not derived from *actual* cohort specific age-earnings profiles. Rather, the SSA "average" worker experiences earnings growth at the same rate as the growth in economy-wide average covered earnings. Of course, there is no theoretical reason for these to be the same. For example, economy-wide earnings growth could be zero, even though each individual cohort might enjoy 5 percent per annum (or for that matter any arbitrarily high) real wage growth over its lifetime due to experience-related productivity growth. Alternatively, economy-wide earnings growth could be 1.2 percent even if no individual experienced any real wage growth over his or her lifetime; this was assumed in the stylized example of the last section. Hence social security taxes paid and benefits received for the SSA "average" simulated earner will almost certainly misrepresent taxes and benefits of an actual cohort. Whether the bias is consistently positive or negative is a subject for future research.

Which taxes and benefits should be included? In computing money's worth measures, experts disagree about which social security payroll taxes should be included. For instance, some actuaries offer these computations using only taxes paid by employees (e.g., Myers and Schoebel 1992). By contrast, most economists contend that taxes paid by employers should also be included in the money's worth computation, because workers pay for employer-side social security taxes out of reduced wages (Gruber 1995). The estimates we present below include both the employee and the employer-side contributions, that is, the full 12.4 percent payroll tax currently dedicated to the program.

A related issue pertains to which social security benefits should be con-

sidered and to whom they should be attributed. Some previous studies examine only retirement benefits, which overlooks the important role of disability payments available through the social insurance system. Other studies have focused only on single worker benefits, which ignores the important spouse and survivor benefits payable if an insured worker with dependents dies. The Office of the Actuary appropriately, in our view, counts the entire relevant set of benefits including retiree, spouse, survivor, and disability insurance payments in its money's worth calculations.[32] If spouse and survivor benefits are included, there is the added question of *which* birth cohort these should be attributed to—the male or female member of the married couple, or the children. The Office of the Actuary makes the simplifying assumption that the husband and wife are of the same age, and attributes children's benefits to the workers' cohort.[33] By contrast, Leimer (1994) assumes that benefits paid to a surviving spouse or dependent child, for example, accrue to that spouse's or child's birth cohort, rather than the cohort of the working member(s) of the household.

Should historical social security taxes and benefits be computed ex-ante or ex-post? When comparing social security benefit and tax streams, the question arises as to whether money's worth computations should be undertaken on an ex-ante or ex-post basis. In other words, should *actual* histories be used for taxes, benefits, and opportunity costs of funds, or should *expected values* be employed? If expected values are used, as of what date or on what information set should the measures be conditioned?

In practice, most estimates use realized (or ex-post) macroeconomic data on earnings, real interest rates, and tax and benefit rules.[34] They also use realized values of cohort earnings (for actual cohort estimates) or economy-wide earnings (for hypothetical worker estimates). Actual mortality patterns are also used to determine the size of the taxpaying population through time, by cohort.[35]

How should future taxes and benefits be forecasted? To analyze the money's worth of social security for generations that are still living, future taxes and benefits by cohort need to be forecasted. These forecasts, and therefore the resulting money's worth estimates, are highly dependent on underlying estimates of future economic and demographic factors, along with forecasted paths for future social security benefit and tax rules. In each case, of course, there is ample room for professional disagreement. Demographers disagree about what is the best forecast of future fertility, immigration patterns, and mortality. Economists disagree about the best forecast of real wage growth, labor force participation, retirement patterns, disability rates, and unemployment, as well as the magnitude of behavioral effects. Yet others argue about future evasion rates. There is also controversy about whether the economic and demographic forecasts are internally consistent; a discussion of the assumptions used to make social security forecasts is provided by the Technical Panel on Assumptions and Methods (1997).[36]

Money's worth calculations are inevitably a mix of historical and forecasted data. Measures for cohorts retiring when the system was new, in the 1940s and 1950s, reflect mainly ex-post data for taxes, benefits, discount rates, and mortality. More recent system entrants are not yet fully retired, and few have died as yet. As a result, the more recent is the birth cohort, the less important are historical data and the more important are ex-ante forecasts for money's worth estimates.

What discount rate should be used? Two of the three money's worth measures, NPV and PVB/PVT, require the selection of a rate to discount cash flows. In practice, the SSA discounts past real benefit and tax flows using a rate equal to the realized historical real yield on trust fund assets. To discount future flows, the agency uses the intermediate assumptions for the real rate on U.S. Treasury Special Public Debt Obligations.[37] No adjustment is made to the discount rate to take into account the riskiness of the cash flows, an important issue that we return to below.[38]

Finally, to compare net present values across cohorts, the dollar tax and benefit amounts must be expressed in common units.[39] Leimer (1994) uses interest rates to convert into a common year's dollars. By contrast, the Office of the Actuary expresses all dollar figures in constant wage units, by calculating present values as of age 22 and converting these to a common year's dollars using the actual past and the expected future nominal wage index.

Policy Analysts' Money's Worth Estimates

In this section, we present money's worth estimates based on "real world" data on the U.S. system, and compare these with estimates from the stylized model contained in Table 1. We present estimates of money's worth measures under current law and various reform proposals.

Present law and reforms that leave intact the basic structure of social security. We begin with estimates based on historical data and current U.S. law; this benchmark is commonly termed the "Present Law" (PL) case. We hasten to add, however, that the system is in actuarial imbalance: that is, the present value of expected future benefits exceeds the trust funds plus the present value of expected future contributions.[40] For this reason, present law is not a particularly useful benchmark. We therefore also examine two reforms that keep the basic structure of social security the same, but either raise taxes or cut benefits to eliminate the 75-year actuarial imbalance. The "Holdtax" reform maintains current tax rates constant and cuts benefits sufficiently to make the payouts consistent with the revenue raised. The "Holdben" reform keeps benefit formulas constant, but assumes taxes are increased as needed to finance these benefits.[41]

An excellent study of cohort money's worth using administrative data is that of Leimer (1994), which uses administrative data through 1988 and the 1991 Trustees Report assumptions.[42] Figure 2 presents estimates of IRRs by

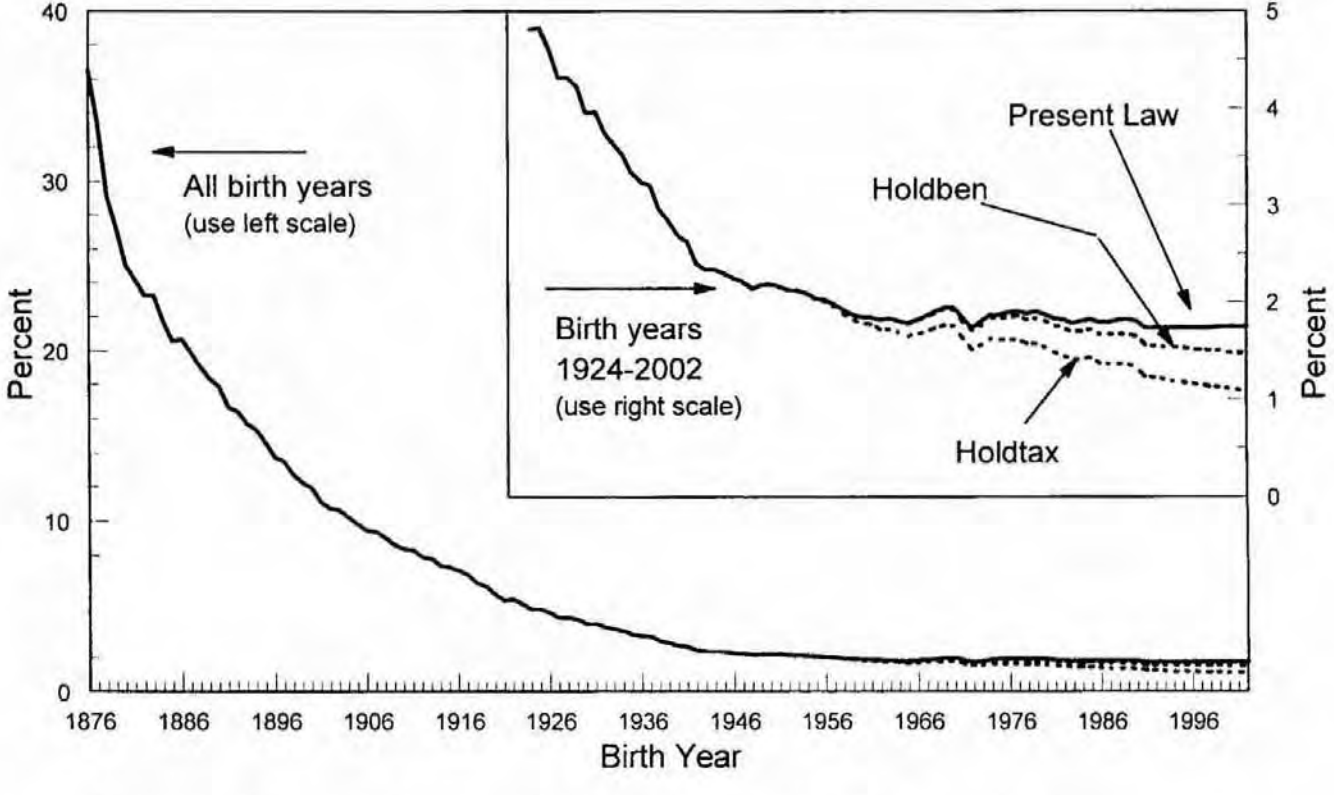

Figure 2. Estimated real internal rates of return on social security contributions. Source: Derived from Leimer (1994).

cohort from this study. Consistent with popular discussion of social security, Leimer's results indicate that early cohorts received very high IRRs—real returns per annum of almost 40 percent. Later birth cohorts fare worse, with IRR figures predicted to remain below 2 percent in real terms into the foreseeable future.

Comparable estimates produced by the Office of the Actuary are shown in Figure 3, based on the hypothetical worker approach described above. We present a "composite worker" estimate equal to a weighted average of a range of worker types (e.g., varying by sex, marital status, age-earnings profile).[43] Under the present law simulation, the internal rate of return will fall from 5 percent for the 1920 cohort to 2.5 percent for workers born in the 1960s; thereafter it remains around 2.5 percent. Under the Holdben approach, returns are roughly similar for cohorts until 1970; thereafter tax increases required to maintain benefit promises drive down the IRR to below 2 percent. Under the Holdtax profile, returns fall below 2 percent sooner, for the group born in the late 1950s. In other words, under either solvency scenario, members of the baby boom generation will be the first generation in the history of social security to receive rates of return on their taxes significantly below the market rate of return. This result is what gives rise to comments such as those quoted as the outset of this chapter.

In Table 5 we compare the IRR paths derived using Leimer's "actual" data with those using the SSA "composite worker" data. It is interesting to note that the IRR estimates tell substantially the same story regarding trend over time: IRRs are projected to be much lower for future cohorts than for past workers.[44] Nevertheless, there are important differences between the two projections, in that the returns projected by the Office of the Actuary exceed Leimer's for the baby boom generations forward; and the magnitude of the difference is substantial, on the order of 20 to 30 percent. The differences are probably due to the fact that Leimer's estimates are based on 1991 rather than on 1997 figures and use actual rather than hypothetical worker data.

We next present NPV estimates for the benchmark case. Figure 4 illustrates the results using (our modification of) Leimer's estimates, where we focus only on the Holdben scenario. The first series in the figure (left scale) presents the NPV of social security for each birth cohort converted from 1989 to 1997 dollars using the appropriate interest factors. (Comparable numbers based on our stylized model appear in the third column of Table 1.) The figure clearly demonstrates that the social security system has redistributed wealth substantially toward earlier birth cohorts. This is consistent with the stylized model, which showed that in the start-up phase of an unfunded defined benefit pension plan the initial elderly receive retirement benefits above what they paid into the system. More surprising to many will be the size and persistence of the wealth transfers under social security over time. That is, based on these computations, it appears that the

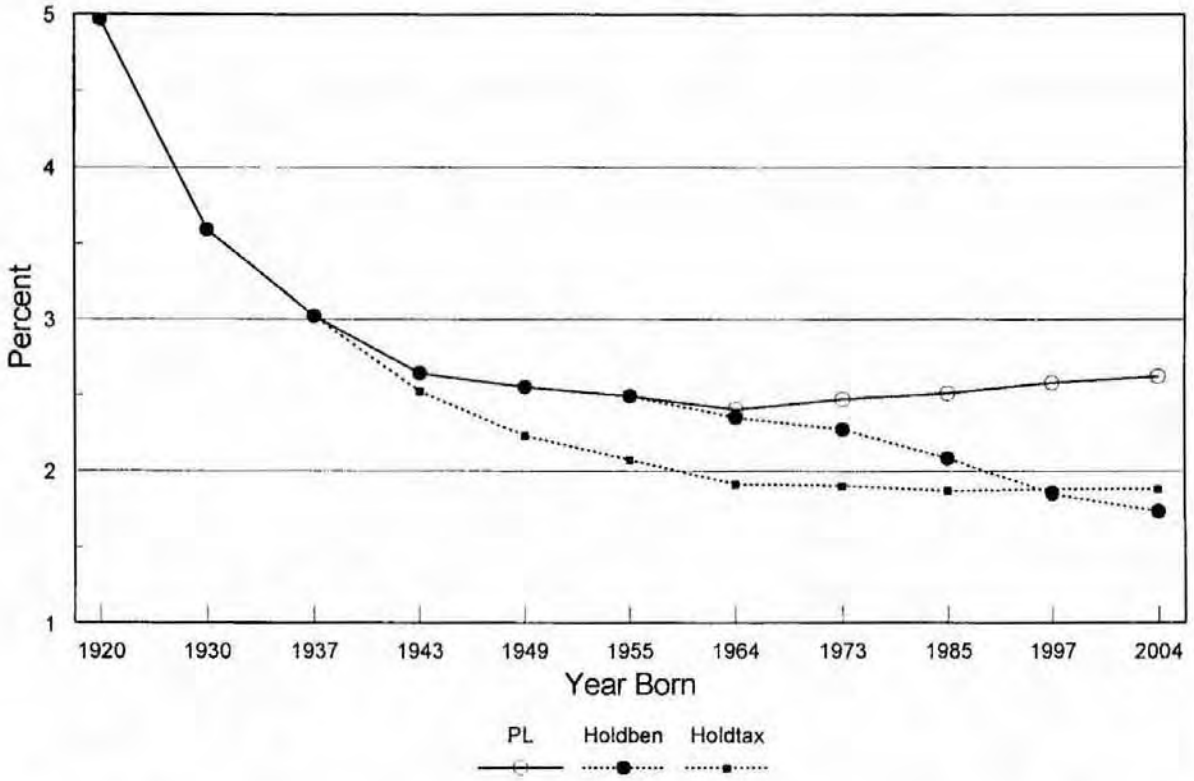

Figure 3. Social security IRR, Benchmarks: Present Law, Holdben, Holdtax for composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

TABLE 5. Internal Rates of Return (IRR) Estimates Using Alternative Methods

Birth Year	*IRR Leimer (1994) Holdben Type Plan*	*IRR Advisory Council (1997) Holdben Type Plan*	*Percentage Difference*
1920	5.68	4.97	−13
1930	3.95	3.59	−9
1937	3.20	3.02	−6
1943	2.33	2.64	13
1949	2.17	2.55	18
1955	2.04	2.49	22
1964	1.80	2.35	31
1973	1.76	2.27	29
1985	1.72	2.08	21
1997	1.51	1.85	23
2004	1.45	1.73	19

Sources: Col. 2 from Leimer (1994); Col. 3 = Composite worker estimate derived by authors from data provided by the SSA Office of the Actuary; Col. 4 = (Col 3 − Col 2) / Col 2.

U.S. social security system continued to deliver positive and substantial net benefits well after the first generation of retirees aged out of the program. Indeed, the evidence shows that the social security subsidy was granted to more than 50 birth cohorts, with NPVs turning negative only for cohorts born after 1937.

The second series (right scale) in Figure 4 represents the cumulative sum of the first series, that is, the sum across all birth cohorts prior to the indicated year of the NPVs. This corresponds to column 4 in our stylized example. This cumulative net transfer reaches its maximum in 1937 at approximately $9.7 trillion in present value ($1997). It is of interest to note that this $9.7 trillion figure is in the same ballpark as the cumulative net present value of $12 trillion for 1937 generated in our stylized example in Table 1. By 1977 Leimer's accumulated NPV fell to $7.2 trillion, while our stylized number fell to $8.2 trillion. In general, we should expect Leimer's numbers to be a bit smaller than ours, because the economy actually grew faster than 1.2 percent between 1938 and 1997. This is partly offset by the fact that generations born between 1908 and 1937 in fact continued to receive subsidies from social security, whereas in our stylized example, they did not.

These results are combined with other estimates of social security unfunded liabilities from Goss (this volume) in Table 6 to approximate the net transfers already paid and to be paid by different sets of cohorts, in a way directly comparable to Table 3. Here we see that the system's cumulative net subsidy to date, counting all those living and working today, stands at about $7.2 trillion (last column, third row). This figure is in the same range as our stylized model's $8.2 trillion valuation. Future benefits already accrued

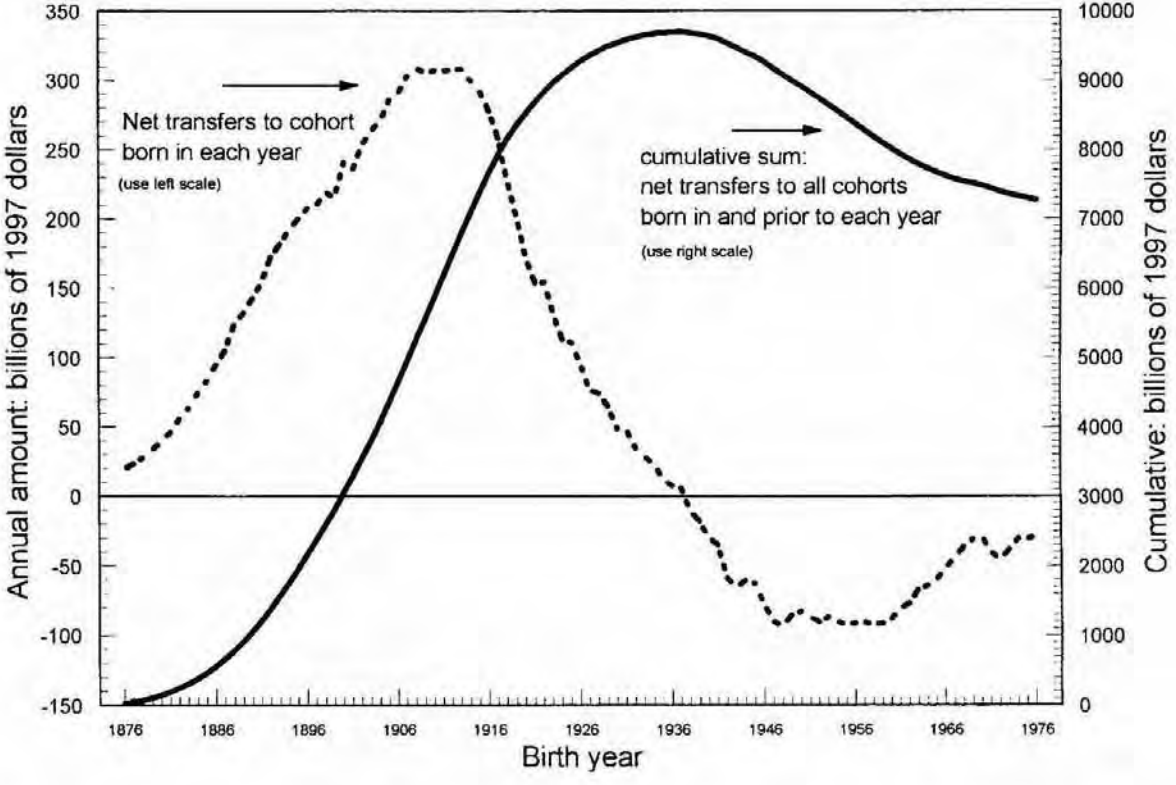

Figure 4. Social security net intercohort transfers. Source: Leimer (1994) tax increase balanced budget scenario and authors' calculations. All figures are present values as of 1997.

TABLE 6. Social Security Present Values by Birth Year: U.S. System

Birth Year	*Age in 1997*	*PV of Past Benefits Received Less PV of Past Contributions Made*	*PV of Future Benefits Already Accrued Based on Past Contributions*	*PV of Future Benefits to be Accrued less Future Contributions to be Made*	*Row Total*	*Cumulative Total*
1859–1917	80+ (dead)	7.9[c]	[0][d]	0	7.9[a]	7.9
1918–1937	60–79 (living and retired)	−8.5[c]	9.5	[0][d]	1.8[a]	9.7
1938–1977	20–59 (living and working)			−1.7[c]	−2.5[a]	7.2
1978+	≤19 (not yet working or not yet born)	0	0	−7.2	−7.2[c]	0
	Total	−0.6[c]	9.5[b,c]	−8.9[c]	0	

Notes: [a] Derived from Leimer (1994)
[b] Derived from Goss (1998)
[c] Derived from Trustees Report (1998) (accumulated trust fund)
[d] Derived from authors' assumptions
[e] Derived from the above and economic theory

based on past contributions are $9.5 trillion. If we subtract the current value of the trust fund of about $0.6 trillion, we arrive at the estimate of the unfunded liability of $8.9 trillion, close to what we found in our stylized model. This can be divided into two pieces. The transfer still to be paid by current workers (based on future contributions and the corresponding benefit to be accrued) is about $1.7 trillion, while the burden "owed" by future cohorts not yet working or not yet born is on the order of $7.2 trillion.

Next we illustrate the other money's worth estimates, under the alternative benchmark scenarios. Advisory Council estimates of the path of the net subsidy are given in Figure 5, and the PVB/PVT ratio in Figure 6. The patterns depicted indicate that both the net subsidy and the benefit to tax ratio would be projected to rise given present law (PL) but these paths are not feasible since the current system is unsustainable. More realistic projections under the Holdben and Holdtax scenarios indicate that the net subsidy would remain substantially negative, and the benefit-to-tax ratio would remain well below 100 percent, into the foreseeable future. There are also interesting distributional differences across the benchmark scenarios: thus the negative net subsidy is more similar across cohorts under the Holdtax plan, while as-yet-unborn cohorts pay more over their lifetimes in the Holdben approach.

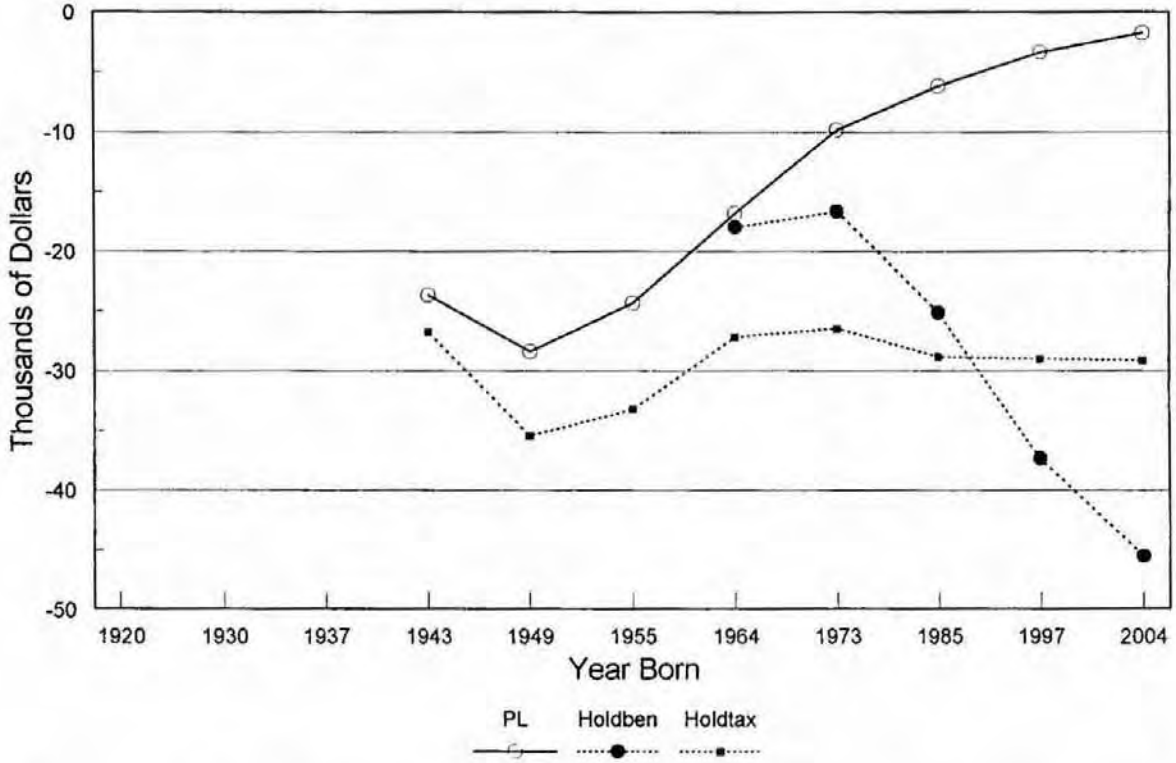

Figure 5. Social net subsidy, Benchmarks: Present Law, Holdben, Holdtax for composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

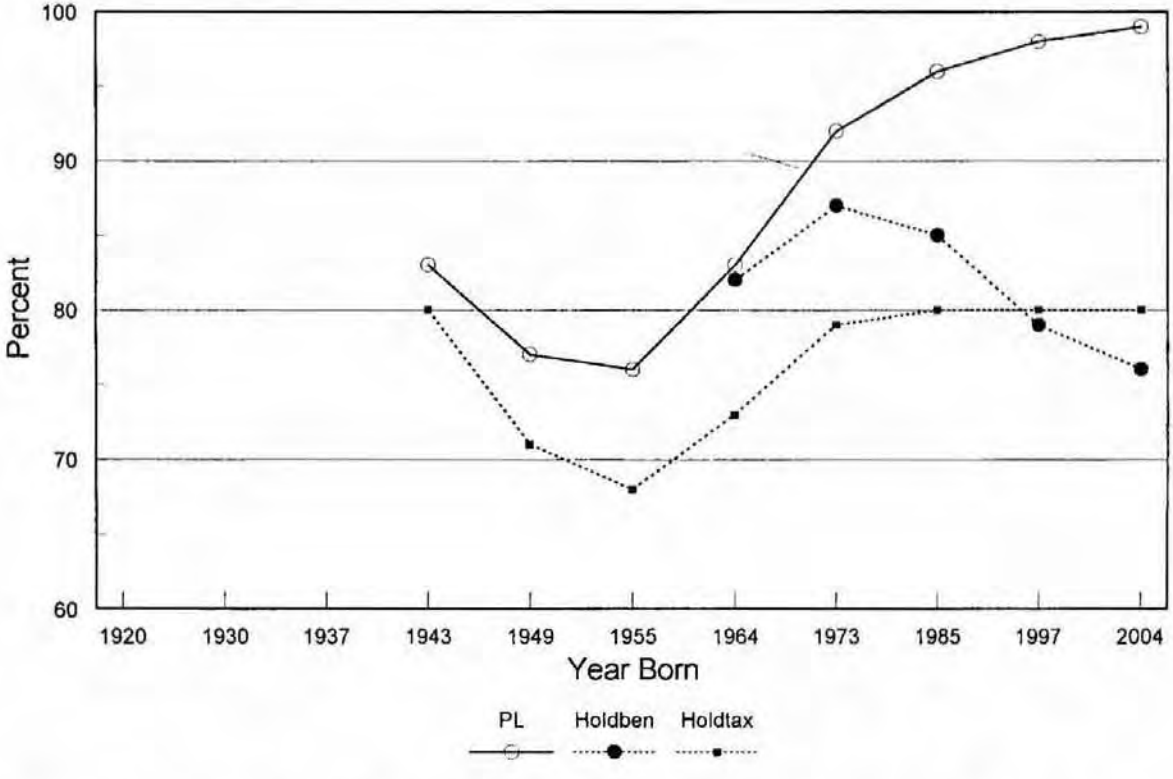

Figure 6. Social security PVB/PVT, Benchmarks: Present Law, Holdben, Holdtax for composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

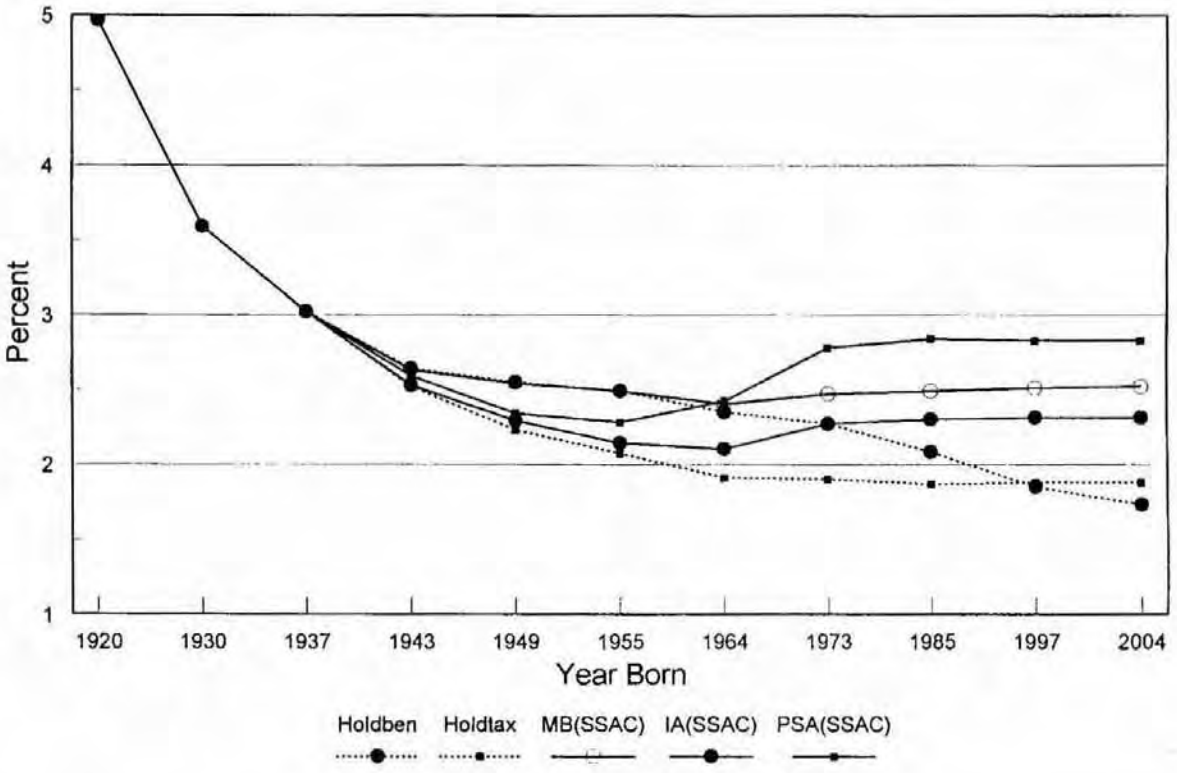

Figure 7. Social security IRR: SSAC proposals, composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

Money's worth estimates for more fundamental reform options. Next, we compare the money's worth statistics for the three Advisory Council plans described in Chapter 1 of this volume, along with the Holdben and Holdtax benchmarks. In this case, we present the Advisory Council estimates for the "Maintain Benefits" (MB) approach, which attempts to keep benefit promises more or less fixed by raising tax revenue to finance them; the "Individual Account" (IA) approach, which pares down government-paid benefits somewhat and creates a small individually-owned government-managed defined contribution account; and the "Personal Security Account" (PSA) plan, which would cut benefits to a relatively low uniform per-worker payment, supplementing this with a privately-managed defined contribution plan like that of a 401(k) pension.[45]

The IRR profiles associated with these options appear in Figure 7, where both Holdben and Holdtax profiles end up with IRRs under 2 percent in the long run. The Advisory Council reform plans all have projected IRRs greater than Holdtax IRRs for all cohorts depicted, and they exceed Holdben IRRs for birth cohorts after 1973. Comparing the three reform proposals, the PSA plan's return is projected to be highest, followed by MB plan returns, and then IA plan returns for birth groups after about 1960.[46]

Net social security subsidy patterns appear in Figure 8, where once again the PSA plan dominates the others for cohorts born after the mid-1960s. Figure 9 provides the money's worth ratio (PVB/PVT) patterns by reform plan. The benefit-to-tax ratio for the PSA plan dominates those of the other two reform plans for virtually all birth cohorts, and rises above 100 percent for cohorts after about 1970. Thus it is understandable how one could conclude that each of these three plans—and probably the PSA plan in particular—would be preferable for most cohorts relative to Holdben or Holdtax. Below we show that this conclusion is not generally warranted.

Conceptual Framework for Evaluating Money's Worth Measures: When Is a Single Statistic Sufficient?

Having seen how social security money's worth is computed in practice, we turn next to describing the conditions under which a single statistic accurately reflects the costs and benefits of different social security programs. Not surprisingly, the main difficulty is that the future cannot be perfectly predicted. One approach, favored by the Advisory Council (1997), is to replace the vast multiplicity of possible future worlds with a single average scenario in which all cash flows are discounted at the riskless rate of interest. The trouble with this approach is that households might strongly prefer the average outcome for sure rather than the distribution of possible outcomes; that is, people might be willing to pay much more for the certain plan than for the uncertain plan, yet the Advisory Council approach would assign both plans the same money's worth. Money's worth measures that ignore the

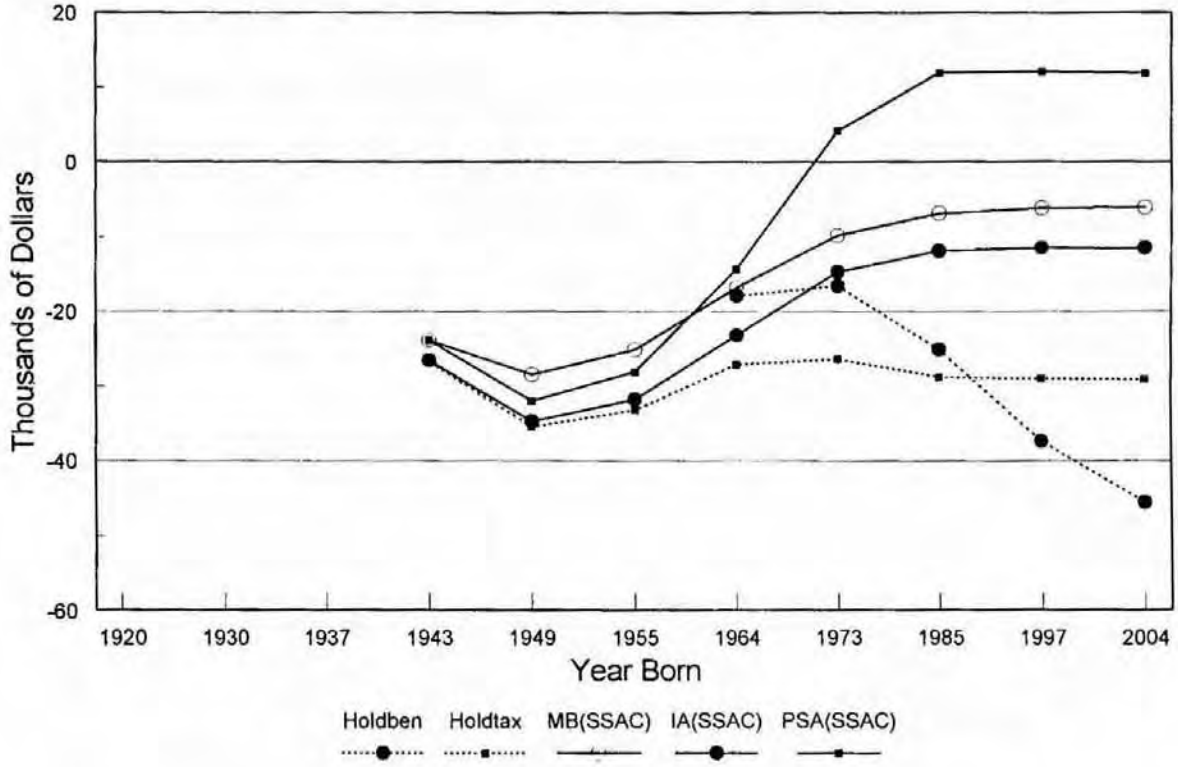

Figure 8. Social security net subsidy, SSAC proposals, composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

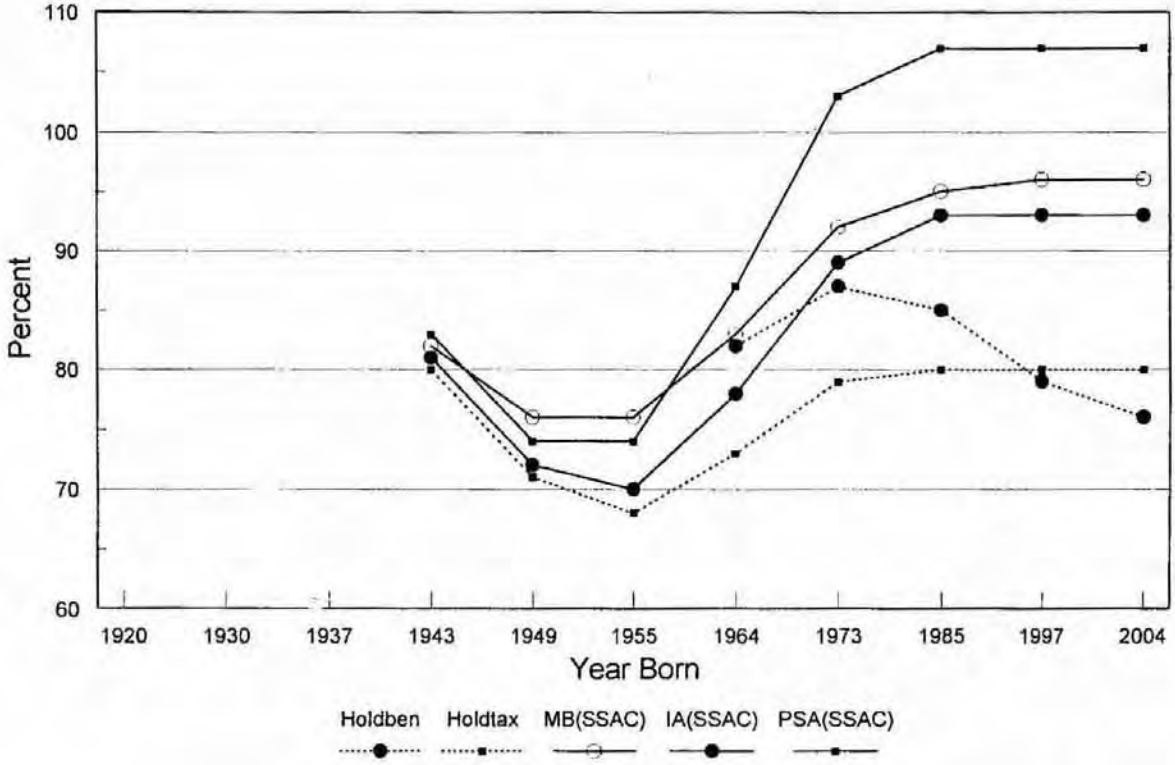

Figure 9. Social security PVB/PVT, SSAC proposals, composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

disutility of risk are then biased in favor of uncertain plans that offer high average outcomes.

The underlying point is that money's worth measures should reflect choice and welfare. That is, it would be undesirable to assign a higher money's worth to one plan over a second, when we knew the first plan would reduce the welfare of all participants as compared to the second. In the most general situation, then, accurate money's worth numbers require a detailed knowledge of all households' preferences, including their attitudes toward risk. Since these preferences are not generally known, it might seem hopeless to derive a useful set of summary statistics that can be used for comparing different social security systems.

There is, however, a set of special conditions under which precise money's worth numbers *can* be obtained without knowledge of individual preferences. This scenario serves as our benchmark case in the analysis below. We show that under such conditions, the type of money's worth measures offered by groups such as the Advisory Council are biased whenever there is any genuine uncertainty about outcomes, and the bias is usually in favor of privatization. In actuality, of course, none of these special conditions is satisfied precisely, so we then consider how one might adjust money's worth estimates to account for deviations from the theoretical case. This adjustment moves some components of the theoretically sound money's worth calculations in the direction of the Advisory Council numbers, but other components move in the opposite direction. In any case, a substantial bias in the non-risk adjusted approach remains.

Simple Money's Worth Measures Require Four Conditions

Four conditions must hold for the risk-adjusted net present value money's worth measure to correctly compare the welfare effects of different social security regimes. These four conditions pertain to optimization, intergenerational tradeoffs, price stability, and spanning. If all are satisfied, and all relevant cash flows are included, then the net present value measure extended to the uncertainty case (via the risk-adjusted probabilities or risk-adjusted discount rates) accurately summarizes the costs and benefits of different social security regimes. The four conditions together are sufficient (as well as necessary) to insure that a higher NPV guarantees higher welfare, no matter what the form of the household utility functions.[47] When one or more of these conditions fails, an accurate money's worth calculation requires specific knowledge of individual preference orderings. In this case, we say that a utility-independent money's worth does not exist, or for short, that simple money's worth measures are not valid.

Inconsistent optimization and forced savings. The first condition that must hold for money's worth measures to be valid is that households must be

consistent optimizers. In other words, people must understand the investment opportunities available to them, which in turn should be defined by market prices and taxes, and they must be "foresightful". For example, if consumers immediately spent every dollar of income they received, then the timing of taxes and benefits would be crucial to welfare, and no single number could possibly summarize a lifetime stream of taxes and benefits (without explicit knowledge of peoples' utility functions).

Experts long have argued that a primary rationale for social security (and the reason the current system has survived so long) is that many households left to their own devices would undersave and then, when old, either live in poverty or throw themselves on the mercy of the rest of society.[48] Thus the raison d'être of social security contradicts the first necessary condition for the validity of money's worth. By taxing individuals when they are young and employed, and paying them when they are old and retired, social security in effect is a forced savings plan (assuming that workers cannot undo everything by borrowing when young against their future social security income). But standard money's worth measures miss completely the benefits of this forced saving aspect of social security. Indeed, if the rate of return on the social security taxes were equal to the riskless real interest rate, then none of the money's worth measures would discern any difference between social security plans of different sizes; no social security at all would rank on a par with the social security system currently in place.[49]

As it happens, most reform plans, including all those proposed by the Advisory Council, maintain approximately the same amount of forced saving—that is, they differ more over what is to be done with the taxes than in how high they should be. The next three conditions, therefore, are likely to have a larger impact on the accuracy of money's worth measures in the present context.

Intergenerational and intragenerational tradeoffs. The second necessary condition for money's worth to be accurate when comparing different social security regimes is that the relative ranking of the plans should not differ across households. For example, one social security program might be less generous to the current old, but more generous to future generations. In this event, money's worth numbers would be informative because they would reveal the intergenerational tradeoffs, but they would not in themselves suggest which was the better plan across all households.

Similarly, a key motive for the current social security program is intragenerational redistribution—transferring consumption from wealthier members of a cohort to less well-off ones. Comparing the current program to say a privatized system that has less redistribution would give money's worth rankings that differ across types of individuals. In general, there are likely to be benefits and costs to society from redistributive policies that are not captured by money's worth measures (Myers 1996).[50]

Stable prices (and stable shadow prices). A third necessary condition that must be satisfied in order for money's worth numbers to reflect welfare unambiguously is that prices should not change across regimes. Below we discuss the importance of modeling the general equilibrium impact of a massive social security structural change. Here we simply point out that, if a new social security regime were to change real interest rates, then discounting the cash flows at the old interest rates would give a biased assessment of household opportunities. If changes in social security taxes change the shadow price on leisure, then measuring money's worth with the old after-tax wages would also give a distorted picture. We also note that changes in the social security tax rates or benefit rules may change relative incomes, and since households are heterogeneous, this in turn may change demand for various goods and assets, which in turn might change many prices. Once prices change across regimes, it is impossible to rigorously rank alternative regimes by a one-dimensional statistic like money's worth.

Spanning. The fourth necessary condition for the validity of money's worth calculations is that households must be able to duplicate all social security income streams (including benefits and taxes) using cash flows of securities that can be marketed and traded by all households. This condition is usually called "spanning." When spanning obtains, it is appropriate to represent each income stream with its market value, that is, by the price of the marketed security (or combination of securities) giving the identical cash flow. The reason, of course, is that a household decision-maker who had the money instead of the income stream could purchase the same cash flow; conversely, with the income stream, he or she could sell the cash flow and get the money. A gift of either the income stream or its market price would, in the end, yield the person the same utility assuming that he or she optimized the rest of the portfolio after receiving the gift. When such an income stream is small, its market price is the correct measure of its money's worth, even if the person does not reoptimize after receiving the stream. The reason is that by optimizing his portfolio before being given the income stream, the consumer will have chosen to hold enough similar income streams so that the marginal utility of the new income stream is equal to the marginal utility of its market price.

In a world with no uncertainty, with households that are foward-looking and that can borrow and lend at some common riskless rate of interest, all income streams are in effect marketed. But in a world with uncertain payoffs and incomplete markets, there may be no market price to attach to a future stream of contingent cash flows. Also many households may not have access to all capital markets, even if they exist. In this event, and in the absence of detailed knowledge of individual utility preferences, no money's worth statistic can accurately summarize the welfare benefit of the social security income streams. Below we offer ways to guess what the money's worth of

social security might be when spanning fails, provided that households have special kinds of preferences.

Let us next consider the situation where a payment stream is marketed but we cannot directly observe its market price. This frequently occurs when an income stream is a complicated linear combination of marketed streams, but is not directly marketed itself. (This situation also arises when we try to forecast the future. We know, for example, that in five years stocks and bonds will both be marketed, but we do not now know what those market prices will be.) One can ascertain what the market price would have to be by applying the principle of "no arbitrage": that is, if one stream of payments is a linear combination of other streams, then its price must be the same linear combination of the other market prices. To implement this scheme we would have to find the right linear combination of marketed securities to reproduce the cash flow of the stream in question, an exercise that is often quite time-consuming. The so-called arbitrage pricing theorem assures us that there is always a direct way, which we now describe, of computing the market price without explicitly finding the spanning securities.

When a marketed income stream is perfectly predictable (it can fluctuate over time, but in a way that leaves no room for surprises), then its market price can be obtained by discounting each of its cash flows by the riskless rate of interest for the corresponding maturity. When the cash flow is stochastic but still marketed, the market price can still be recovered, but only through a much more complicated calculation that takes into account the extra risk. This is a multi-step process: one must forecast first the collection of possible cash flow paths, and the probability of each; one must also forecast the collection of possible short interest rate paths, and the probability of each. Additionally one must estimate the joint probabilities of interest rate paths and cash flow paths. (The security will be worth less if its high cash flows only occur on paths that also exhibit high interest rates.) Finally, one must also forecast the joint probabilities of the interest rate cash flow paths and economy-wide aggregate consumption. (Cash flows that are high only along paths in which the economy as a whole is rich, effectively pay only when people do not need the money, and they should therefore be worth less.) In the end, money's worth values will depend on the expected cash flows discounted at the riskless rate, and (negatively) on some measure of the covariance of the cash flows with a benchmark measure of aggregate consumption.[51]

This complicated series of estimates and calculations is sometimes referred to as "discounting the expected cash flows at the *risk-adjusted* interest rate," or the "risk-adjusted net present value." The final result is likely to be quite different from discounting expected cash flows at the *riskless* rate of interest. In practice, the full-bodied calculation is very difficult to do correctly, although Wall Street research has applied this methodology to spe-

cific security cash flows. The non-risk-adjusted approach, namely discounting expected cash flows using the riskless interest rate, is only appropriate if the cash flows are independent of both interest rates and aggregate consumption. This point is frequently overlooked when policymakers value social security cash flows.

Money's Worth with Optimization, Generational Homogeneity, Stable Prices, and Spanning

Under the maintained hypotheses of optimization, generational homogeneity, stable prices, and spanning, the correct money's worth measure of any social security plan for any individual is the risk-adjusted net present value, calculated as the market value of his or her stream of benefits minus the market value of the stream of contributions. More precisely, suppose the market value of benefits less taxes is higher for every generation under one social security system than it is under a different social security system. Then (assuming optimization, stable prices, and spanning), the welfare of every generation must be higher in the first system than in the second, no matter what the preferences of the households regarding consumption, impatience, or attitudes toward risk. The proof of this assertion is immediate. Since prices are the same across the two plans (stable prices), and since individuals properly exploit their opportunities (optimization), and since the first plan offers each individual more opportunities than the second plan (spanning plus higher market values), the comparison does not depend on preferences.

Though the assertion is straightforward, its implications are often missed. We shall apply our analysis to the current reform debate below, but here we list three implications. Subsequently we explore the meaning of money's worth if the spanning and stable prices hypotheses fail.

Stock market money's worth. The stock market is a marketed collection of assets, just as are bond markets. One approach to social security reform involves replacing the trust fund's bond holdings with stock holdings; other reforms involve privatization, where individuals are permitted to invest directly in the capital market. It is tempting to presume that the substitution of stocks for bonds would dramatically improve the money's worth of social security, since the stock market has historically earned a much higher rate of return than government bonds. We have just seen, however, that, under the assumptions stated above, marketed income streams such as stock market returns should be assigned a money's worth equal to their market prices. A dollar's worth of stocks can be worth no more than a dollar's worth of bonds, and so a switch between bonds and stocks should not alter money's worth, correctly calculated.

This conclusion might seem odd, given that the arithmetic average an-

nual real total return from 1926 to 1996 was 9.4 percent on the S&P 500 stock index, while it was only 2.3 percent on intermediate term government bonds (Ibbotson and Associates 1997). But to understand the conclusion it is necessary to ask what drove the historical pattern of returns and whether it is reasonable to expect the past to characterize the distribution of future returns.[52] Three possible explanations of the past returns immediately come to mind, two of which suggest the future might well be like the past. None of these explanations contradicts the view that a dollar of stocks should have the same money's worth as a dollar of bonds.

One explanation is that stocks are riskier than bonds; that is, stocks historically have a much higher standard deviation of return than bonds. And more important, stock market returns are correlated with aggregate consumption — the stock market pays off most just when people are the wealthiest and need the money the least. The higher expected returns are necessary to compensate investors for the higher risk, as we have seen in the past and may continue to see in the future.

Some have argued, however, that the higher risk is not sufficient to explain the high historical returns — this is the so-called "equity premium puzzle" (Mehra and Prescott 1985). Others have argued that over a sufficiently long time horizon stocks are actually less risky than Treasury bonds or bills. For example, there are no 22-year periods since 1926 in the U.S. in which stocks did not outperform bonds.[53] This suggests another explanation for the high return on equities: many people may be irrationally afraid of holding stocks. Yet another possibility is that the performance of the U.S. stock market has been uniquely favorable; that is, the U.S. received a particularly good realization of history that we should not expect to be repeated. Using data gathered from all stock markets in existence around the world since 1900, Brown, Goetzmann, and Ross (1995) show that stocks on average just barely outperformed bonds.

Our conclusion that a dollar of stock and a dollar of bonds should have the same money's worth holds regardless of the explanation, provided our four assumptions are maintained. For example, if households are irrationally afraid of holding stocks, it might seem to follow that the social security system should not fall prey to these irrational fears, and therefore it ought to encourage or force additional investment in the stock market. But under the assumptions of optimization and spanning this will not help. That is, households who are irrationally afraid of stocks will probably avoid equities if offered choice in individual accounts, for the same reason they hold too few stocks in the remainder of their portfolios. If they were in turn mandated to hold some nonzero amount of equities, they will be aware that their social security money is now subject to stock market risk, and they will compensate by holding fewer stocks in their own portfolios (or even by selling stocks short).[54] In other words, the same anxiety that causes an inves-

tor to value a dollar of stocks equal to a dollar of bonds ought also to be recognized by the social security participant if part of social security is invested in equity.

What about a future move into stocks? In order to calculate the money's worth for future generations of holding stock in social security, we require—but of course do not know—future stock prices. Therefore it is understandable that analysts seek to forecast stock payoffs and then back out the money's worth of holding stock in the future. But a rigorous application of money's worth would still have to assign a future dollar's worth of stocks the same value as a future dollar of bonds.

Risky benefits and contributions. Since current benefits under our pay-as-you-go system actually depend on the gross domestic product (GDP), that in turn is correlated with the stock market, similar reasoning suggests that we should regard current social security benefits as risky and discount them at a higher risk-adjusted rate. Tax revenues, too, depend on GDP and are probably correlated positively with stock returns, so we should regard these cash flows as risky under the current social security program and discount them using a risk-adjusted rate as well. It is likely that the appropriate rates for discounting taxes and benefits will differ.

Privatizing may not matter. Suppose the current social security program were replaced by a system of individual accounts. Suppose also that taxes were raised in order to pay off the current unfunded liabilities. As argued in the first section of this chapter, in a world of certainty, these taxes can be raised so that the market value of the taxes on each household is exactly equal to the market value of the old social security plan. The same logic can be extended to the case of uncertainty. It follows that that if there is optimization, stable prices, and spanning, then no household money's worth will change, and welfare will be unaffected.

Choosing Between the Money's Worth Measures

In keeping with the Advisory Council's usage, we have presented three different money's worth measures—the internal real rate of return, the benefit-to-tax ratio, and the net present value metric. There remains the question of which of these money's worth measures is most useful, and for what purpose.

The IRR and PVB/PVT have the advantages that they are unit-free and easy to understand. They facilitate comparisons between different birth cohorts inside the same social security plan.[55] However, these measures can lead to incorrect conclusions when comparing systems of different scale.

The shortcomings of the IRR and PVB/PVT measures can be illustrated as follows. Consider a social security system in which taxes are the sum of one component (T_A) representing the portion of the social security tax invested at the riskless market interest rate and returned to the worker as

benefits later in life, and a second component (T_t) representing the interest that must be paid on government bonds given to the old at the system's inception and rolled over into the indefinite future, interest that never reverts back to the worker. As we have seen, our current social security system resembles this hypothetical situation. All three measures of money's worth will reflect the fact that every cohort after the start-up ones gets a "bad deal" compared to no social security system at all.

Now let us compare our hypothetical system to another one in which T_A is increased. If all households are rational and able to participate fully in capital market transactions, the size of the social security taxes that earn the riskless return would be completely irrelevant. That is, households will simply undo in their own private portfolios whatever the social security system forces them to invest. This truth is revealed by the NPV measure of money's worth, but is confused by both IRR and PVB/PVT. Consider first the NPV:

$$\text{NPV} = \text{PVB} - (T_A + T_t) = [T_A(1+r)]/(1+r) - (T_A + T_t) = -T_t.$$

Increasing the portion T_A of social security that reflects a riskless return on taxes collected has no effect on NPV. On the other hand, if we measured money's worth by the PVB/PVT method we would get:

$$\text{PVB/PVT} = \text{PVB}/(T_A + T_t) = T_A/(T_A + T_t)$$

and this number increases (converging to 1) as the program is expanded and T_A is increased (to infinity). Similarly, it can be shown that increasing T_A will raise the IRR, because the IRR is a weighted average of the return on T_A and the return on T_t.

The general point is that any reform plan that increases the size of social security through an increase in the funded part will show an improvement in the PVB/PVT and IRR, even though the correct measure, NPV, will show no change. In other words, part of the apparent superiority of these reform plans over the pay-as-you-go benchmark is based on the misleading advantage that comes with greater scale when the wrong measure of money's worth is used to compare plans.

Overall, our view is that the risk-adjusted NPV measure is most helpful for ranking alternative social security plans. In a world with spanning and optimization, this measure corresponds precisely to market price and is therefore the correct money's worth statistic. The same cannot be said for IRR or PVB/PVT.

Money's Worth When Spanning Fails

Though money's worth measures are informative given the four theoretical conditions just described, we recognize that none of these conditions is likely to be perfectly satisfied in the real world. As described above, in a

world with uncertain payoffs and incomplete markets, there may be no market price to attach to a future stream of contingent cash flows. For example, even under the current pay-as-you-go system, benefits are contingent on a variety of economic factors and not easily reproduced via a portfolio of marketed securities. In practice, benefits vary with aggregate shocks like demographic changes; as we have seen in the past, the larger the pool of young workers, the higher tend to be the benefits to old workers. Benefits also tend to depend on productivity changes (i.e., the higher the average wage of young workers, the higher the benefits to old workers), and, most important, they depend on policy changes. It is difficult to find a marketed security that pays off precisely when Congress decides to change social security benefit rules. Additionally, retiree benefits also depend on idiosyncratic shocks to earnings, length of life, and disability. Once again, it is hard to find a marketed security that pays off precisely when a particular household has a few bad earnings years.

The stock market and limited participation. More than half of all U.S. households invest no money in the stock market, either directly or indirectly. This strongly suggests that the spanning hypothesis—that every household can freely trade every asset—is violated. If so, "constrained" households might be helped by a policy that increased their stockownership levels. The question is, how does this change the way that money's worth calculations should be done?

Consider a "constrained" household that holds no stock because it faces a fixed cost of learning about the stock market or because it has no wealth outside of social security. Suppose the household's income is independent of stock market returns. Then the correct money's worth from a small incremental holding of stock can be obtained by discounting the expected payoff of the stock at the risk-free rate.[56] That is, the appropriate money's worth for constrained households from small equity investments is the non-risk-adjusted money's worth. The reason is that the first few dollars of stock bring negligible risk, and therefore increase utility proportional to their expected payoff, with no risk adjustment.

In our view, the fundamental rationale for social security investment in the stock market rests on the existence of people who are currently constrained from holding equities. It is interesting to note that those who would benefit the most from social security investments in equity are probably the poor, since this group is least likely to hold stocks now.

Quantifying the money's worth to a constrained household of a large movement into the stock market is more difficult. It is clear, however, that a discount rate higher than the risk-free rate should be used in computing the money's worth of the stock payoffs.[57] The reason is that, as households gain more exposure to stocks, they would perceive their old age income as more and more at risk.

Suppose the trust fund invests in the stock market, and pays out benefits that depend correspondingly on the return from its stock market investments. Quantifying money's worth as a whole of these trust fund investments in the stock market depends on a host of questions. For example, how many of the households that do not currently hold stock are constrained, and how many of them chose not to hold stocks? For those that are constrained, how much stock would they have held, were they not constrained? In other words, how risk averse are they, and how independent is their income of stock returns? Finally, how big is the stock market investment?

Below, we offer quantitative answers to these questions. For now, we summarize by saying that in the presence of constrained households, a shift of one dollar of social security trust fund investments from bonds into stocks should raise social security money's worth, correctly calculated (even though it does not change market value), but by much less than the non-risk-adjusted money's worth would suggest.

Accounting for idiosyncratic risk. There are several reasons that the non-risk adjusted approach to money's worth estimates for the current social security system are too low, arising from the failure of the spanning assumption described above. Such failures arise because many of the risks that households face — uncertainty about earnings, length of life, disability, and health expenses — may not be fully insurable or hedgeable in private markets. These events are not perfectly insurable due to moral hazard and adverse selection. While the government cannot overcome moral hazard, it can overcome adverse selection by making participation mandatory; indeed, this is one of the rationales for mandatory national social security systems.[58]

To the extent that social security provides insurance with no private substitute or an imperfect private substitute, it is inappropriate to discount the expected benefits at a risk-free rate.[59] That is, the benefit flows of the current social security system are negatively correlated with individual income, and hence the discount rate should be *smaller* than the riskless rate. The non-risk-adjusted approach to money's worth calculations therefore tends to understate the benefits of social security because it calculates benefits at actuarial probabilities, neglecting the insurance premium that participants would be willing to pay beyond those expected benefits to receive the social security stream of benefits.

As an example of this problem, consider longevity risk. Under a mandatory national social security system, longevity risk is pooled since social security benefits are annuitized, paying benefits irrespective of how long the retiree lives. If the private markets could not provide annuities at all, households would be exposed to the risk of living too long (and outliving their resources). They would likely hedge against this by saving more; that is, they would be forced to give up resources when they are younger. They would be made worse off by this loss of government-mandated insurance.[60] If the

private markets did provide annuitization, but less efficiently due to adverse selection, households would again be worse off in an ex-ante sense.[61]

Accounting for intergenerational aggregate risk. Social security's contingent benefit and tax streams share risk across generations. The most important way the current system does so is by making retiree benefits for one generation depend explicitly on the wage bill of the next generation; this creates a type of earnings insurance for the young of one generation paid for by the old of the previous generation. It is hard to imagine even a fledgling private market arising to displace this type of intergenerational risk-sharing since the young and the old are never young at the same time, when they might perceive the advantage of entering into a generational contract. Reforms that rely heavily on individual stock market accounts would no doubt reduce the level of intergenerational insurance, a fact overlooked by standard money's worth calculations.[62]

To pursue this idea further, one might imagine restructuring social security benefit and tax formulas in order to provide better old-age consumption insurance by making both depend inversely on the past few decades of stock market performance. This recognizes that a generation blessed with remarkable stock market returns (such as the current baby boomer cohort) might not require as much compensation when it is old, because it would be able to accumulate more than the average generation. Such a generation would then receive lower government-supplied benefits, in turn reducing the taxes paid by the next generation's young. Conversely, a generation experiencing abnormally low stock returns (e.g., the Great Depression) would receive higher benefits, financed by raising taxes on the next generation. Depending on how sharp are the tax changes, the burden of poor stock market performance could be shared by several succeeding generations.

This type of intergenerational risk pooling could be implemented more directly by leaving the benefit formula unchanged but instead investing part of the social security trust fund in the stock market. Taxes on the next generation to pay the benefits would be raised or lowered depending on the performance of the equity market. If the trust fund held stock, then unconstrained households would, in equilibrium, hold correspondingly less, and so their risk exposure would be reduced as in the above insurance scheme.[63] In effect, the stock is transferred to the next generation because its taxes would rise precisely when the market performed poorly (Smetters, this volume; Bohn 1998; Diamond 1997). This scenario implies that the money's worth of a social security defined-benefit system coupled with trust fund investment in the stock market should be higher than a mechanical computation obtained by discounting trust fund stock returns at a risky rate.

A more general point can be made as follows. The stocks of any generation are assets to which neither constrained households living at that time,

nor future generations (constrained or not), have access. Social security reforms that effectively take stock out of the hands of today's unconstrained households, and transfer their returns to today's constrained households and to tomorrow's households, do not change the market value of the system. But they can very well improve risk-bearing in a world in which spanning fails, and therefore improve welfare. Both non-risk-adjusted money's worth and market based, risk-adjusted NPV miss this beneficial result.[64]

General Equilibrium Effects and Money's Worth

Almost any social security reform is likely to alter relative prices in the economy. For example, if a significant amount of money were transferred from bonds to stocks by the social security system, and if not all individuals could fully offset these changes in their own portfolios, then stock prices could be expected to rise and bond prices to fall. Consequently the return on bonds would be expected to rise and the return on stocks would fall. This implies that the historical spread between stocks and bonds, so key to the alleged advantage of social security investment in stocks, would diminish.

The beneficiaries of privatization would then be old stockholders who would gain from the rise in stock prices but would not live long enough to be hurt by the fall in subsequent returns. The losers would be future workers with access to the stock market who would then earn lower returns on their stock investments. The menu of investments undertaken by the economy would also probably change, moving to more adventurous risky projects, since the old stocks would now be effectively spread out over more people (including some of the previously constrained households). These subtleties are missed by market-driven money's worth, and by non-risk-adjusted money's worth measures.

Changes in social security may also produce changes in lifetime wealth and effective tax rates on labor. Workers may respond by changing their labor supply, which in turn might alter equilibrium wages. All these direct and indirect effects of social security reform are missed by standard money's worth measures. Under the current social security system, taxes paid while young do not directly translate into benefits received while old. As we have seen, for the typical workers, each payroll tax dollar raises the present value of expected future benefits by less than a dollar (e.g., only 71 cents), and therefore alters hours and retirement age decisions.[65]

Suppose social security taxes were increased to improve funding of the system, and the revenues were not reflected in higher retirement benefits for current workers but rather were used to reduce the transfers paid by future generations. This would likely increase the distortion in the labor supply decision of current workers, and, assuming substitution effects dominate income effects, reduce labor supply. It would, however, reduce distor-

tions faced by future workers, since they would receive a better return on each dollar of social security contributions. In general, the effects of various reform options on labor supply depend on how the transition burdens are shared. Similarly, if the system's progressivity were altered by moving to individual accounts, this would raise the net benefit per dollar of contributions for some groups and lower it for others, thus altering labor supply and retirement incentives.[66] None of these effects are captured by standard money's worth estimates.

Money's Worth and the Current Reform Debate

In this section we examine two of the more prominent types of social security reform proposals, in light of our critique of money's worth. The first sort of plan we assess is usually referred to as (partial or full) privatization, where the objective is to replace (part or all) of the current social security system with a system of individual defined-contribution accounts. The second type of proposal we evaluate is one which would maintain the defined-benefit nature of the current social security system, but would change the program's investment policy: part or all of the social security trust fund would be held in equities. Our goal is to evaluate money's worth measures in each case.

Money's Worth of Individual Accounts

Perhaps the most prominent argument offered in favor of privatization is that individual accounts would pay a higher rate of return than would the current system. The recent Advisory Council report (1997) suggested that moving toward a system of individual accounts would raise the rate of return that participants receive under the social security program. Echoing Forbes (1996) cited above, Michael Tanner of the Cato Institute argued for privatization because "the system remains a bad deal for most Americans, a situation that is growing worse for today's young workers. Payroll taxes are already so high that even if today's young workers receive the promised benefits, such benefits will amount to a low, below-market return for those taxes. Studies show that for most young workers such benefits would amount to a real return of one percent or less on the required taxes. For many, the real return would be zero or even negative. These workers can now get far higher returns and benefits through private savings, investment, and insurance."[67]

This justification of individual accounts flows from two premises. First, proponents note that projected rates of return promised under the current social security system are low, between 1 and 1.5 percent in real terms (Board of Trustees 1997). Second, if the past is a reliable guide to the future, real returns anticipated on private investments are likely to be much higher

even than riskless rates of return, which themselves are higher than 2 percent. For example, real stock returns averaged 9.4 percent and real government bond returns averaged 2.3 percent per year, over the 1926–1996 period in the U.S. (Ibbotson and Associates 1997). Proponents then conclude that if social security were privatized and people were allowed to invest their contributions directly in U.S. capital markets, everyone would achieve higher rates of return and be better off. The problem is that the two premises on which the argument rests are accurate, but as we shall show next, it is not correct to make the subsequent leap to the policy prescription.

To understand why, we proceed in three steps. Our starting point considers a simple case where social security is privatized with no additional prefunding. In this first case, we assume that the future is known with certainty and the only available assets are riskless bonds. This sheds light on the effect of moving to mandated individual accounts where these accounts can be held only in riskless bonds. Next, we examine the changes arising from prefunding, achieved by raising taxes on current workers, so as to decrease the social security system's unfunded liability. Finally, we study the results when we add uncertainty and allow individuals to shift assets in their individual accounts from riskless bonds into stocks.

Privatization without prefunding: the certainty case. A fundamental error of the simple privatization argument is that it ignores the accrued benefits earned for past contributions by current workers and retirees. If these are paid in full without changing the degree of prefunding in the system, and if the money is raised via taxes on private accounts invested only in bonds, then the excess of market return above the current social security return will be completely dissipated in the new taxes.

Suppose the old social security system were shut down and all new social security taxes deposited into individual accounts earning the riskless market rate of return. It is important to acknowledge that privatization *could* be implemented with no additional prefunding. For example, if the old social security system were shut down, the government could issue each former participant "recognition" bonds equivalent to the present value of accrued benefits under the old system (which they would then be required to hold in an individual account until retirement). Since the government selects the mix of new taxes and borrowing from which to pay the principal and interest on these recognition bonds, it could choose to keep the explicit recognition bond debt growing along exactly the same trajectory that the old unfunded liability would have followed had the old system continued. Prefunding would then be the same, because the new recognition bond debt would have precisely replaced the old unfunded liability.

For concreteness, let us assume an economy that is in a steady state of growth g equal to 1.2 percent with a riskless rate of interest r equal to 2.3 percent. Then each individual (after the start-up generations) would look

forward to a 1.2 percent return under the old pay-as-you-go social security system, versus a 2.3 percent return if the same money were invested directly in (riskless) bonds. While 2.3 percent may not seem much higher than 1.2 percent, the accumulated difference grows large over a long worklife. For example, given constant real contributions for 40 years, and constant real benefits paid out over 20 years so as to yield a rate of return of 1.2 percent, the benefits would need to be raised by about 40.8 percent in order to increase the rate of return to 2.3 percent. Put another way, individuals who had individual accounts earning the riskless market return could pay 29 percent (40.8/1.408) less each year into their individual accounts and still receive the same retirement benefit as they would get from their social security contributions.

But as we showed above, this apparent gain is illusory. If the government were to shut down the old underfunded social security system and move to individual accounts, funds would still need to be raised to cover accrued social security liabilities. Suppose we use $9.9 trillion as our estimate of the unfunded liability.[68] One method for covering these liabilities would be to issue $9.9 trillion in recognition bond debt, and then to roll over just enough interest and principal to keep this debt growing at the rate the unfunded liability would have grown under the old system.

Computing the exact path of payments required to achieve this target precisely is beyond the scope of this chapter, but we can derive a reasonable approximation based on the steady state scenario discussed above. The required extra taxes to keep the debt-to-GDP ratio constant would clearly need to be $(r-g) \times$ (value of the bonds). With a real interest rate of 2.3 percent, a growth rate of 1.2 percent, and an unfunded liability of about $9.9 trillion fully transformed into recognition bond debt, this would involve taxes equal to $109 billion in the first year (=(2.3 percent − 1.2 percent) × $9.9 trillion).[69] Using the current OASDI benefits of about $375 billion, and ignoring the current operating surplus by assuming these are equal to contributions,[70] the required new taxes represent 29 percent of annual payroll tax collections, or about 3.6 percent of payroll. Put another way, the new tax required to cover payments on the new recognition bond debt would equal 29 percent of all contributions to the new individual accounts.[71] This is equivalent to every generation (forever) paying a 29 percent commission or load on all funds invested in the individual accounts. But this is the entire surplus from market returns. It is worth emphasizing that, as long as r is greater than g, the conclusion still holds: all the extra returns from investing in capital markets will be dissipated by these transition costs. It does not matter whether the difference between the return on capital markets and the return on the existing social security system $(r-g)$ equals 1.1 percent, 3 percent, or even 10 percent!

Many popular discussions of social security privatization ignore these

transition costs entirely. For example Beach and Davis (1998) of the Heritage Foundation state:

> If Americans were allowed to direct their payroll taxes into safe investment accounts similar to 401(k) plans, or even super-safe U.S. Treasury bills, they would accumulate far more money in savings for their retirement years than they are ever likely to receive from Social Security. Had they placed that same amount of lifetime employee and employer tax contributions into conservative tax-deferred IRA-type investments—such as a mutual fund composed of 50 percent U.S. government Treasury bills and 50 percent equities—they could expect a real rate of return of over 5 percent per year prior to the payment of taxes after retirement.

Some analysts are more circumspect. For example, the Advisory Council made a concerted effort to include additional transition taxes in their money's worth calculations. The PSA plan puts 5 percent of pay into workers' individual accounts and imposes a 1.52 percent transition tax that lasts until 2070.[72] This added tax is incorporated into the Advisory Council's money's worth calculations (1977: 177).

Senator Moynihan has proposed to reform social security through partial privatization. In his plan, workers from now on would be allowed to deposit up to 2 percent of their payroll tax into an individually-managed account.[73] The rest of the system would apparently function like a scaled down version of the current social security system, except that all the current accrued benefits would continue as liabilities of the new system. Because the current social security system is running a surplus, for the next 10 or 15 years the Moynihan plan has the effect of redirecting into individual accounts the surplus that would have otherwise flowed into the social security trust fund. Though workers will earn high market returns on the 2 percent that goes into their individual accounts, the system will eventually be unable to maintain the same benefit formula appearing in the current social security system because the trust fund will be smaller. Though the rate of return on the privatized piece will be above the current social security return, the rate of return on the non-privatized piece will fall, leaving the total return unaffected.

Privatization with increased prefunding. Issuing recognition bonds that grow in value at the same rate as the unfunded liability would have grown under the current system is only one of several ways to finance the transition toward a privatized social security system. (Recall that in a steady state, the current system's unfunded liability will grow at the same rate as GDP.) A dramatic (and probably unpopular) alternative would be to finance the transition cost with a one-time lump sum tax, levied on each current worker. This would generate a tax bill of about $68,000 per worker ($9.9 trillion/147 million workers). Another equally dramatic solution would be to default completely on all the accrued benefits, forcing current workers and

retirees to shoulder the entire $9.9 trillion loss. Both these alternatives reduce the debt of the social security system relative to what the unfunded liability would have been, and thus in our terminology they constitute a shift toward greater funding.

Many economists believe that reducing social security's unfunded liability would enhance national saving and output, and hence they support prefunding on its own merits.[74] But increasing the system's funding level would not immediately raise the rate of return on social security. Indeed, the $68,000 tax would reduce the return of today's workers, and defaulting on the unfunded liabilities would reduce the return of today's retirees and older workers. In general, cohorts that are required to pay higher transition taxes would receive a lower rate of return (less than g), while later cohorts would expect a higher return (eventually r, if the debt were paid off entirely). Feldstein and Samwick (1996, 1997) would require members of the baby boom generation to pay higher taxes, so that their children and future generations would benefit relatively more. Alternatively, the trust fund could be increased by cutting benefits, helping future generations as in the Feldstein-Samwick approach, but at the expense of current retirees instead of current workers. Under a partially funded social security system (i.e., one with a trust fund), the rate of return on social security would be a weighted average of g and r, where the weight on r depends directly on the size of the trust fund.[75]

Privatization without prefunding: incorporating uncertainty. Consider now a privatized system with individual accounts and with recognition bonds replacing all the accrued benefits. Suppose there is also uncertainty in the world, and that workers have the option of moving the money in their individual accounts from riskless assets to risky securities, such as stocks, which have higher expected returns.

It is clear from our analysis in the previous section that, if all households have access to stock investments on their own (i.e., if spanning and optimization hold), then permitting equities in the individual accounts will have no effect on anyone's wellbeing. In effect, the stocks that workers buy for their individual social security accounts will be purchased from their own private portfolios. Their overall portfolios will end up absolutely unchanged.[76] The next question is what would be the effect of this switch from bonds into stocks on money's worth measures. As described earlier, conventional money's worth estimates are based on expected values of contributions and payouts and do not incorporate any adjustment for risk. Inasmuch as mean equity returns are higher than mean bond returns, this change in investment pattern would then raise the individual accounts' internal rate of return as typically computed, as well as the NPV and the PVB/PVT ratio.

As an example, consider switching $100 from bond into stocks for 30 years. Figuring out the "money's worth" of this change depends on how one values the stock. Of course, transferring $100 from bonds into $100 of stocks

does not change the market value of the position, nor does it change the welfare of anybody in the system, assuming spanning and optimization. But the conventional money's worth approach yields a very different answer. The Advisory Council's methodology assumed that stocks would return an annual 7 percent real rate and bonds would pay 2.3 percent. Someone who invested $100 in stocks would see the money grow in expected value by 7 percent per year over 30 years, to $761. Discounting this amount to the present using a 2.3 percent rate produces a net present value of $385 = $100 × $(1.07)^{30}/(1.023)^{30}$. According to this calculation, $285 of value has supposedly been created, that is, the estimated net present value of this change is $285. But we would contend that a *risk-adjusted* discount rate should be used to measure the true money's worth of stocks and, under spanning, the appropriate risk-adjusted rate is the expected return on stocks, 7 percent. Naturally, using a 7 percent rate to discount future risky cash flows earning 7 percent produces a present value equal to $100 = $100 × $(1.07)^{30}/(1.07)^{30}$ and a net present value of zero.

In other words, money's worth calculations using an appropriate risky discount rate deviate considerably from those found in the literature, since all benefit payouts that depend on stock market returns must be discounted by a higher rate than the Treasury risk-free rate.[77] In general, a money's worth measure that assumes high returns on stock but discounts by a risk-free rate will overstate the benefit of social security diversification, and the overstatement will be greater the more stock assumed held in the social security accounts.

Policy analysts have not computed money's worth measures for individual account plans correcting for risk in the manner we suggest. However a useful set of equivalent calculations is available from the Office of the Actuary for variants of the IA and the PSA plans. Specifically, these alternative money's worth statistics assume that the rate of return earned on stocks is equal to that on bonds (approximately 2.3 percent). All three of the money's worth statistics (IRR, NPV, PVB/PVT) based on this approach are well below those reported earlier, and, indeed, most of the money's worth advantage for the IA and PSA plans relative to the Holdtax benchmark disappears (Figures 10, 11, and 12).[78]

A somewhat different analysis applies if spanning does not hold. As we have argued elsewhere (Geanakoplos, Mitchell, and Zeldes 1998), some households are probably unable to access the capital markets on their own. Economic theory suggests that allowing some portion of the individual accounts to be held in equities could well make these households better off. This is because people whose income is uncorrelated with stock returns should hold some stock in their portfolios, so as to benefit from the higher expected returns stocks provide compared to safe assets. Such constrained individuals would find that changing the first dollar from bonds to stocks would raise returns with negligible added risk. Additional stock investments

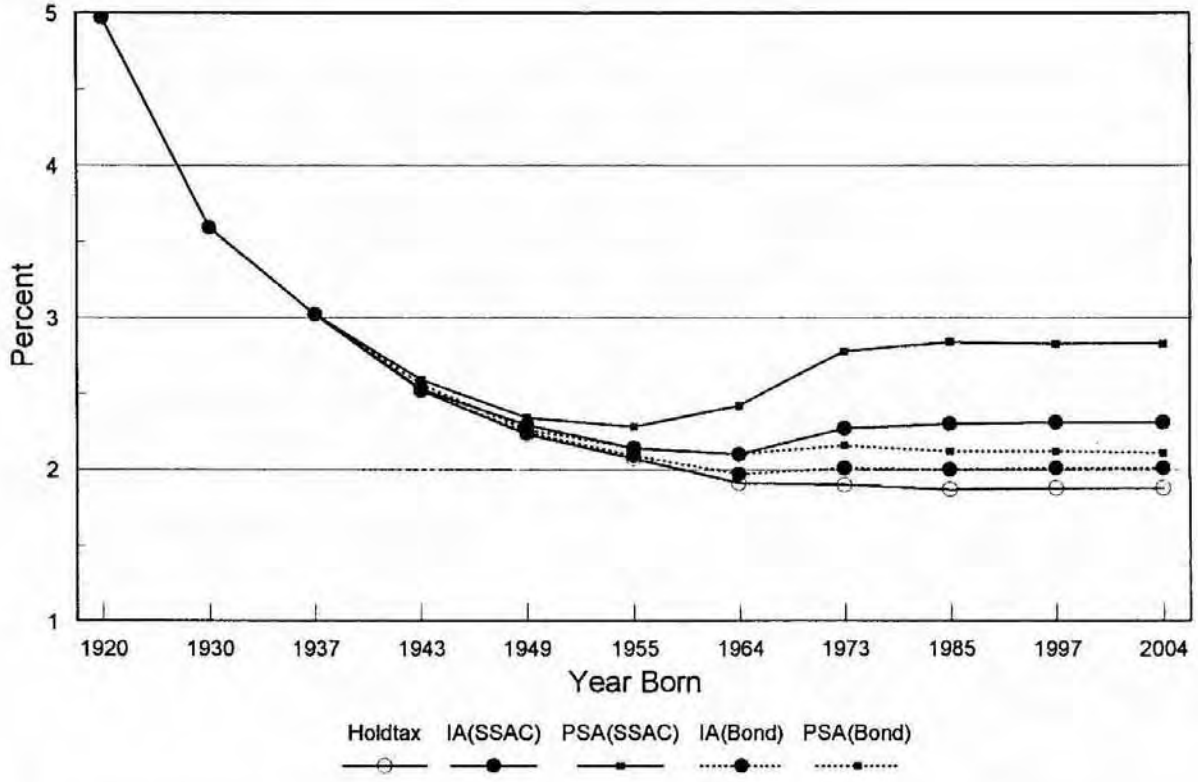

Figure 10. Social security IRR: IA and PSA plans. Mixed stock/bond returns versus bond return for composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

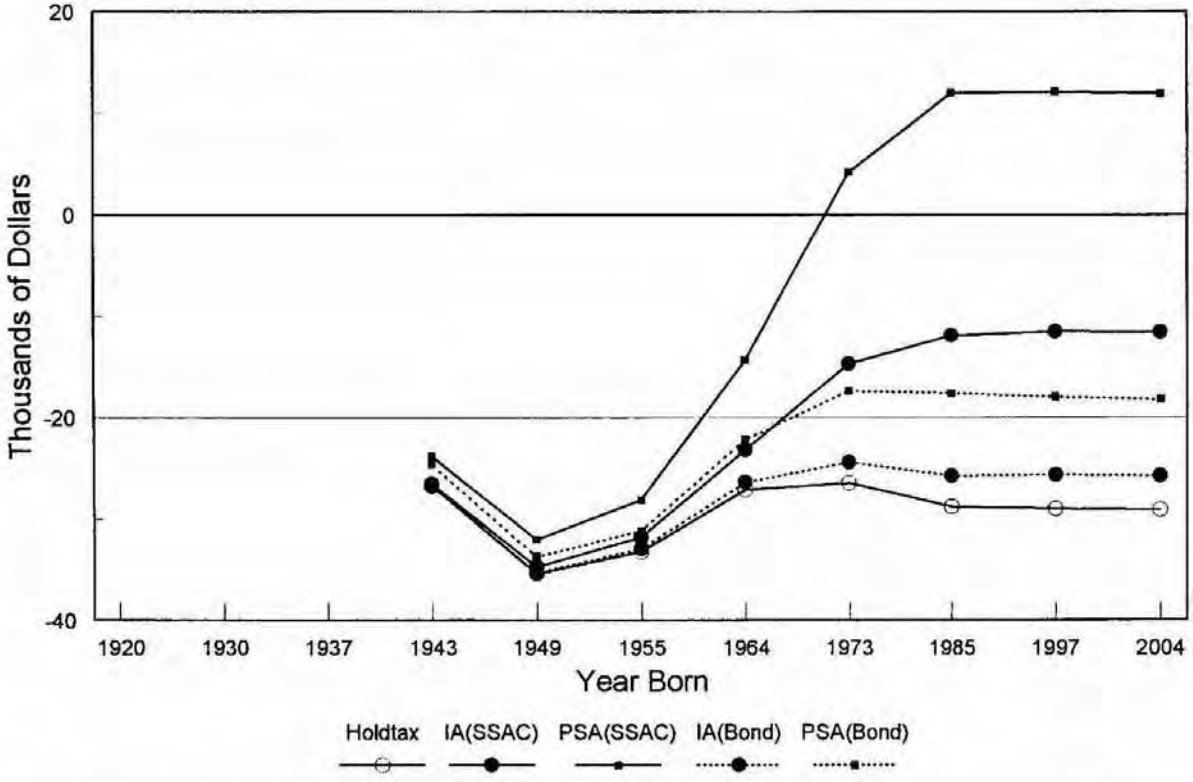

Figure 11. Social security net subsidy, IA and PSA plans. Mixed stock/bond returns versus bond return for composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

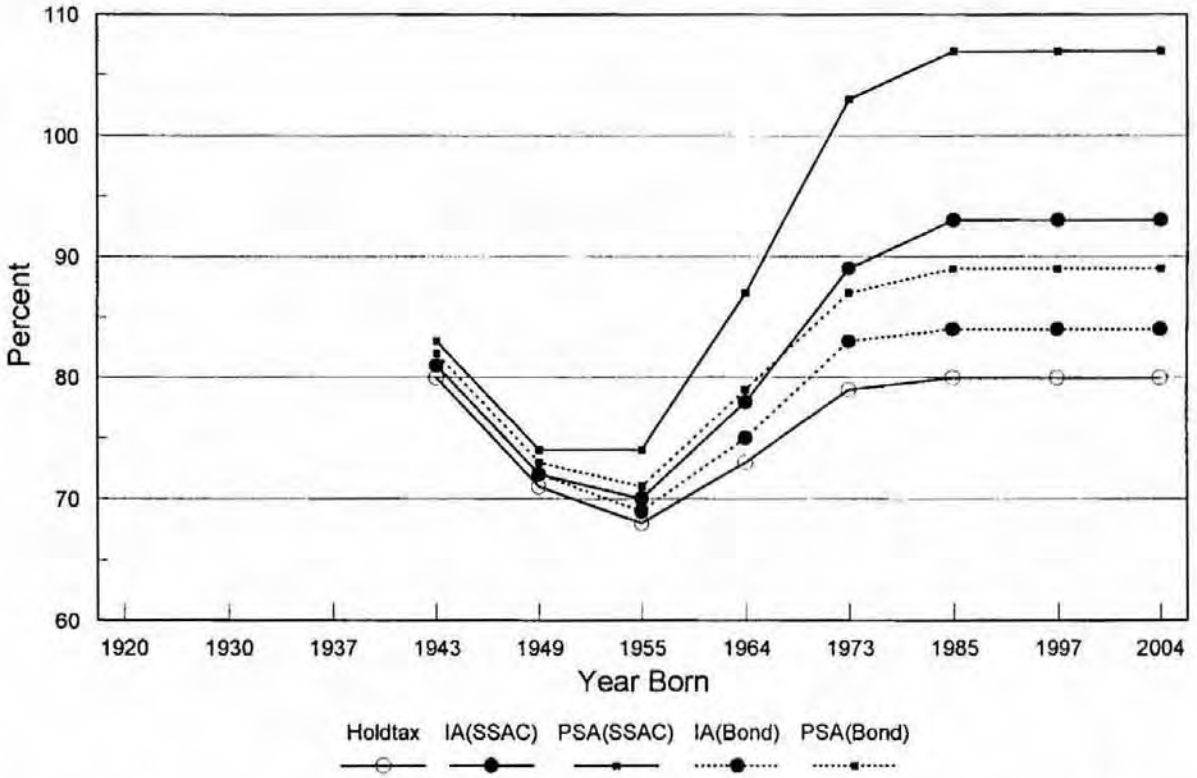

Figure 12. Social security PVB/PVT, IA and PSA plans. Mixed stock/bond returns versus bond return for composite worker. Source: Unpublished data supplied by the SSA Office of the Actuary.

would raise returns further, but at the cost of additional risk, so that risk-adjusted returns would rise, but by less than non-adjusted returns. (Sooner or later risk-adjusted returns would actually fall. Determining the optimal level of stock investment in the accounts depends on household wealth levels and their risk tolerances.)

Additional research must evaluate how many people are constrained in their private portfolios from holding stock, what types of people they are, and how much they would benefit from investing part of their individual accounts in equities under a privatized system. Some two-fifths of the U.S. population held stock in 1995, either on their own account or in defined contribution pensions or mutual funds (Kennickell, Starr-McCluer, and Sunden 1997; Ameriks and Zeldes, in progress). Of the remaining three-fifths, some are young and will perhaps accumulate stock later in life; half of the middle-aged population (44–54) held some stock in 1995. This is probably a lower bound estimate of future stockownership over individuals' work-lives for two reasons. First, these estimates are based on a cross-section of households at only one point in time. Second, there has been a secular upward trend in stockholding by households, one likely to continue. Not all those currently lacking stocks would necessarily benefit greatly from additional equity exposure. For example, very risk-averse workers who face a small fixed cost of market entry might benefit a bit but not very much from putting some equities in their individual social security accounts. Furthermore, some people would not benefit at all from holding stocks—for example, those whose pay or business income is sufficiently highly correlated with the equity market.

A back-of-the-envelope guess about the magnitude of these effect might go as follows. Consider a fully constrained household with no wealth outside social security. This household should regard the first $100 of stock in its individual social security account as almost riskless, and therefore attach a present value to it of $385 as calculated earlier. The substitution of $100 of stock for $100 of bonds thus increases net present value by $285. Additional increments of stock, however, lead to more substantial risk for this household. Suppose, for example, that 2 percent of payroll, or one-sixth of all social security contributions, were allowed to be put into stock through individual accounts. If we presumed that the optimal (unconstrained) portfolio consisted of half stocks and half bonds, this would move the constrained household one-third of the way toward this optimum. Using a linear interpolation,[79] this lowers the average gain to investing in stock, from $285 to $(5/6)(285) = \$237$ for this constrained investor.[80] Assuming that about half of the population is constrained, and that only half of these are substantially constrained, an investment of 2 percent of payroll from social security contributions into equities in private accounts would therefore bring a present value gain in the aggregate of approximately $59 ($= (1/2) \times (1/2)$ ($237)) for each $100 in stock.[81] This figure is far smaller

than the gain of $285 attributed by a non-risk-adjusted calculation, but sufficiently larger than zero to justify further investigation.

A related consideration is that allowing additional equities to be held in household portfolios would likely increase the demand for, and hence lower the return on, stocks.[82] This would moderate the benefits to constrained households, who in the main are likely to be younger workers, and would actually hurt young unconstrained workers who have not yet accumulated stocks. (Conversely, older and wealthier people who held stock prior to the change would tend to benefit by the increased demand for stock.)[83] It is interesting to note that the potential for this cross-generational wealth transfer—away from today's young—has been overlooked by those who would argue that the young would be most likely to experience higher returns from individual accounts.

When evaluating individual accounts, it is essential to recognize still other types of risk in addition to the stock market risk that has been our focus thus far. Recall that participants' exposure to risk in earnings, health, length of life, and inflation would rise under an individual account plan as compared to the current defined benefit plan. If private financial markets cannot provide all the benefits that the national old-age program offers, or provides them less efficiently, this raises the risk-adjusted return on the government run plan relative to an individual account plan, but is not reflected in standard non-risk-adjusted money's worth estimates. On the other hand, publicly-run, underfunded programs are subject to political risk, which many believe is greater than in an individual account model. Current workers in a pay-as-you-go system are unsure that future (born and unborn) generations will support them when they are old; they well know that benefit and tax payments vary according to political pressures. Since there is no market that can be used to protect against such risk, those potentially more able to bear the risk cannot trade with those less willing to bear it. Correcting for political risk would very likely increase the money's worth of a funded, individual account plan.

In summary, money's worth measures should not be compared across plans containing different levels of funding and portfolio compositions unless transition costs are incorporated and appropriate risk adjustments are carried out. Once these adjustments are undertaken, some people would benefit from individual accounts, others would see no change in their money's worth, and yet others would see declines. On balance, risk-adjusted money's worth would be significantly less favorable toward individual accounts than the typical analysis implies.

Money's Worth of Investing the Trust Fund in Equities

Some analysts find it attractive for social security to move toward equity investments, but believe that diversification into stocks is better achieved

through central trust fund investment rather than individual accounts. Thus Munnell and Balduzzi (1998: 5) contend that "investing in equities could provide a lot of additional money to the trust fund," a logic that explains why architects of the Maintain Benefits plan for the Advisory Council proposed to devote 40 percent of the trust fund to equities. Since the Advisory Council did not risk-adjust its money's worth measures, this change in trust fund investments substantially boosts the money's worth value of the MB plan, as compared to a reform that was otherwise similar but invested only in bonds.[84]

For the population at large, it should be obvious that shifting the trust fund into equities will have some of the same effects that we saw when discussing the shifting of individual accounts into equities.[85] The exact effects depend on who bears the risk of the trust fund investments. If the risks are passed on directly to the beneficiaries, and households understand this, then unconstrained investors would offset changes in the social security account by altering their private portfolios, as we saw above. For these households, there would be no net change in the correctly calculated money's worth of an MB-type plan from investing the trust fund in equities, once the additional risk of holding equities is taken into account. Constrained households as well as financially unsophisticated or irrational households (Advisory Council 1997: 114) might be better off if the social security program undertook stock investments on their behalf. But some would be worse off, including those who optimally chose to hold only a small amount of stocks before the change, perhaps because they are risk averse. These people might be forced to hold too much equity in their social security account after the trust fund bought stocks. In general, the more heterogeneous are constrained households in their risk tolerance, and the wiser we think constrained households would be in their investment choices, the more attractive is privatization relative to trust fund investment as a means of achieving diversification. The more homogeneous are constrained households in their tolerance of risk, and the more myopic we think constrained households would be in their investment choices, the more attractive is trust fund investment as a means of achieving diversification.

An alternative approach to risk bearing would be to have all stock market risk borne by future taxpayers through tax rate changes.[86] As described earlier, this could improve intergenerational risk sharing as compared to the status quo. Estimating the value of this potential intergenerational risk pooling is a research question of substantial theoretical and practical interest, one left to future research.

Conclusion

The most popular argument in favor of social security privatization is that it would increase rates of return for all retirees. We have shown that this

argument is false. The U.S. social security system's unfunded liability stands at around $10 trillion, based on the constant benefit/tax ratio method for calculating accrued benefits. Privatizing the system would allow households to earn market returns on their social security contributions. But if those contributions were taxed just enough to keep the unfunded liability a constant fraction of GDP, then in the absence of uncertainty, extra market returns would be entirely dissipated. Future workers would not perceive any higher *net* investment returns than they would under the current social security system, because, for every dollar of social security contributions, they would have to pay about 29 cents in tax to meet payments on the unfunded liability inherited from transfers to previous generations. If part of the unfunded social security liability were paid down faster via new taxes, or if the system's unfunded liability were reduced (for example by cutting accrued benefits), then it would be possible for future generations to earn more after privatization than they would from the current system. But these gains will come at the expense of either today's workers or today's retirees.

Some policy analysts use money's worth calculations to endorse privatization for the purposes of increasing workers' investments in equities. They support their contention by reminding us that equity returns have historically been higher than bond returns. But we show that extending money's worth to a world of uncertainty is a difficult business. If four assumptions pertaining to optimization, time homogeneity, stable prices, and spanning hold, then market value gives the correct measure of an asset's money's worth. Under these circumstances, the alleged superiority of equity returns over bond returns is irrelevant, since one dollar of stocks is worth no more than one dollar of bonds. This contrasts with computations offered by the Advisory Council attributing a money's worth of about $3.85 per dollar of stock, obtained by discounting expected stock returns of 7 percent using a riskless rate of 2.3 percent.

In the real world the four assumptions required for money's worth measures may not hold, with the spanning assumption especially likely to fail. In its absence, market value will not provide an accurate measure of money's worth. We estimate that if social security equity holdings reached 2 percent of payroll, then each dollar of stock would yield about $1.59 of money's worth rather than $3.85. Our analysis depends on the educated guess that perhaps one-quarter of households are substantially constrained from holding stock. The failure of spanning also changes our assessment of current social security benefit streams. That is, the market probably can duplicate some but not all of the socially provided benefits (such as real annuities, income insurance, and disability insurance). Once the value of the social insurance benefits is taken into account, the money's worth advantage of privatization becomes smaller than generally recognized by advocates.

There are other costs and benefits of social security reform that are difficult to incorporate into money's worth measures but which may neverthe-

less exert an important influence in the growing debate. Under the current system, no markets exist to protect against future benefit and tax changes when people are most vulnerable during retirement. Under an individual account format, by contrast, these political risks may be diminished, and people may also have a greater sense of ownership and control over their individual accounts. It is also possible that privatization may make prefunding more politically feasible. On the other hand along with these accounts may come the danger of inexperienced investors making imprudent decisions.

In sum, money's worth measures are well suited to comparing benefits and costs for different income groups, and even different cohorts, under the same social security system. But the typical approaches do not fare well at making comparisons across different reform plans, primarily because they do not properly account for differences in risk and/or transition costs. Developing money's worth measures that are capable of this task is more difficult. Further efforts to adapt money's worth measures to incorporate these elements will play a compelling role in the continuing debate over social security restructuring.

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Notes

1. In a similar vein, Stephen Moore (1997) of the Cato Institute appeared before Congress to "enumerate the economic advantages of converting out of our pay-as-you-go government-run Social Security system to a program of PSAs. . . . Privatization offers a much higher financial rate of return to young workers than the current system . . . if Congress were to allow a 25 year old working woman today to invest her payroll tax contributions in private capital markets, her retirement benefit would be two to five times higher than what Social Security is offering."

2. So this first approach might compare returns under the current system for a minimum-wage worker to that of a high-wage worker in the same cohort, or for a single worker to those paid to a married couple. Or one might analyze how an earlier cohort fared vis à vis a cohort born at some later date using a money's worth measure.

3. As we discuss below, there are other reasonable rationales for supporting social security privatization; see Mitchell and Zeldes (1996). For example, a privatized individual account system may better protect benefits against political risk than the

current (projected to be insolvent) system. In addition, an individual-account system may induce fewer labor supply distortions than the current system if the individual-account plan is less redistributive than the current program, and it is likely to provide households with expanded options for portfolio choice. And compared to a federally-run plan that invests the social security trust fund directly in the capital market, an individual-account plan may be better insulated against politicians' efforts to influence investment decisions.

4. This is somewhat lower than for the historical period between 1938 and 1973, but not so different from actual growth rates since then.

5. Leimer (1996) also mentions the payback period and the net transfer as a percentage of the present value of lifetime earnings in an excellent summary of these and other money's worth measures.

6. The fourth column is the cumulative NPV (i.e., the running sum of column 3). We will return to this later.

7. It would not make sense to calculate present values of infinite streams in a social security program with r less than g. In such a case the calculations would be completely dominated by events in the distant future.

8. The conditions under which discounting is feasible ($r>g$) are the same as those for the dynamic efficiency of an economy. In a world with time-varying but non-stochastic r and g, the required condition is that a type of average of r is greater than average g. If r and g are stochastic, the analysis becomes significantly more complicated. Abel et al. (1989) argue that the empirical evidence supports dynamic efficiency, even in a stochastic world.

9. To the extent that the actual historical rate of growth was closer to the real market rate of interest, our stylized numbers will exaggerate the importance of the past. But we shall see when we look at actual numbers that our stylized numbers still convey appropriate magnitudes.

10. For very early cohorts, the IRR is infinite in this model because these people received benefits but paid no taxes. In the actual U.S. system, only those who had made some contributions received any benefits.

11. To see this, note that each column of taxes and benefits must sum to zero by definition in a pay-as-you-go system. The column under 1997, for example, sums to zero because taxes raised in that year are exactly equal to benefits paid in our hypothetical pay-as-you-go system. But these same 1997 numbers turn out also to equal the present value, in 1997 dollars but figured at a rate of return g, of the benefits and taxes of the generation born in 1918. Hence the rate of return on the taxes paid by the 1918 cohort is g, as claimed. By the homogeneity property of rates of return, the rate of return of every other cohort born after 1918 must also be g.

12. This follows from the commutative law of addition for absolutely convergent series. Note that for any finite set of entries, such as those shown in Table 1, we do not expect the cumulative sum of the row NPVs to be zero just because the corresponding cumulative NPV of the column sums is zero. The first t rows cover a very different set of entries from the first t columns. It is only when we consider the infinite sum that all the columns cover exactly the same set of entries as all the rows.

13. Thus extra consumption by the Depression-era generations must be paid for by an infinity of reduced consumption when added over all future generations. One might well ask whether a social planner ought to weight the importance of the Depression-era generation so heavily that this would be seen as a fair exchange: that is, when should one discount the welfare of future generations at the market rate of (real) interest? The answer to this question is moot, of course, since the decision was made by the social security system's architects in the 1930s. But a similar question may be formulated going forward, namely, how much do future generations owe the gen-

eration that kept the nation together during the Depression, fought and won World War II, and built the markets that enabled future generations to be so productive?

14. Indeed we show below that one natural way of spreading the debt burden is to tax each generation in the same proportion $k(r-g)$ of its income. As long as $r-g$ is the same, higher g does not reduce the proportional burden of the debt overhang from the Depression-era generations.

15. The concept of unfunded liability is different from that of actuarial imbalance. Actuarial imbalance is defined as the present value of expected benefits over some period (often 75 years) minus the present value of expected tax receipts over the same period, minus the current value of the trust fund. The U.S. currently has a 75-year actuarial imbalance of about 2.2 percent of payroll per year, or about $2.9 trillion dollars in present value (Goss, this volume).

16. This surplus is equal to zero in our stylized pure PAYGO system.

17. Since the accumulated trust fund in our setup is zero, the sum of the entries in the fourth column equals the unfunded liability, $9.1 trillion.

18. For a longer discussion of these distinctions see Geanakoplos, Mitchell, and Zeldes (forthcoming).

19. See also Leimer's (1991) analysis of this topic.

20. In a steady state, this would correspond to keeping constant the ratio of outstanding recognition bond debt to GDP.

21. There are different ways of measuring accrued benefits, and each method would require a different tax scheme to make taxes in a privatized system just equal to transfers in the current social security system. We give one example. Suppose accrued benefits are defined according to the present benefit/cost ratio method. Then a proportional tax of $(1 - .71) \times 12.4$ percent $= 3.6$ percent would leave everyone exactly as well off in a privatized system as he would have been in the current pay-as-you-go social security system. For the straight line method, taxes would need to be cohort-specific. In particular, taxes could be reduced for current workers and kept at 29 percent for future workers.

22. This simple example is not too dissimilar in spirit from what Chile did in 1981 as it privatized a major portion of its old-age retirement program (Mitchell and Barreto 1997).

23. Observe that the ratio of new transition taxes $T_1 (1+g)^{t-1}(r-g)/(1+r)$ to income $Y_1 (1+g)^{t-1}$ for each generation depends on the difference $r-g$, not on the magnitude of g, for small values of r and g.

24. A higher r makes privatized returns higher but, as we have just seen, it also increases the interest burden of the unfunded liability.

25. By the same argument, if transition costs are ignored, the other money's worth measure comparisons are also biased in favor of privatizing social security.

26. This presumes that improved funding of social security has a sufficiently small effect on the government budget deficit. For a discussion of this point see the discussion in Technical Panel on Trends and Issues in Retirement Income (1997). There is no reason to believe that privatization without prefunding would necessarily increase national saving (see for instance Mitchell and Zeldes 1996).

27. This point is acknowledged by some analysts (e.g., Feldstein 1997, 1998b) though most popular accounts of privatization overlook the point, as we have noted above.

28. Examples of previous studies focusing on the tax and benefit flows under social security include Boskin and Puffert (1987), Boskin et al. (1987), Caldwell et al. (1998), Duggan et al. (1993), Hurd and Shoven (1985), Leimer (1994), Moffitt (1984), Myers (1996), Myers and Schoebel (1992), Panis and Lillard (1985), and Steurle and Bakija (1994).

29. As explained below, the fact that the current social security system faces insolvency implies that is it not a viable benchmark. In other words, alternative reforms must be compared to benchmarks that have incorporated changes sufficient to make the overall system solvent.

30. One reason the representative worker (or set of workers) is used for Social Security Administration money's worth computations is that year-by-year payroll tax data on individuals are not available for years prior to 1951. The Social Security Administration is able to compute benefits because it keeps data on the sum of the wages on which taxes were paid, which is all that is required to construct benefit amounts (Myers 1993: App. 2-5). While exact data are not available for these very early birth cohorts, approximations could be made based on the data that are available.

31. Hypothetical workers' money's worth calculations have also been undertaken by many researchers, most recently Caldwell et al. (1998).

32. If these benefits are not included, the full tax rate should not be included either.

33. Personal communication, Office of the Actuary, SSA, August 1997.

34. See Miron and Weil (1998) for a historical comparison of ex-ante and ex-post tax and benefit rules.

35. Because these calculations follow all those alive at around the time of labor market entry and take into account mortality probabilities, they naturally differ from a computation that compares benefits received versus taxes paid by those surviving to age 65 (e.g., Thompson 1983).

36. Forecasts of future mortality are developed by age and sex, and show a continuing gradual improvement in life expectancy over time. For a full discussion of social security program benefit formulas and eligibility requirements see Myers (1993) and Board of Trustees (1998) or see www.ssa.gov on the internet.

37. For the future, the forecasted real rate is equal to 4.3 percent in 1997, falling to 3.4 percent by 2000, and to 2.3 percent by 2010 where it is assumed to hold (Board of Trustees 1996: 56–57).

38. As we note below, there is no particular reason to use the historical rate of return on trust fund assets to discount benefit and taxes since the social security system is essentially unfunded (trust fund assets at the end of 1997 equaled approximately 175 percent of one year's benefit outlays). The riskiness of tax and benefit flows are, in principle, not related to the riskiness of trust fund assets.

39. For IRR and PVT/PVB, the choice of units is irrelevant.

40. This is based on the intermediate cost assumptions in the Trustees Report (Board of Trustees, various years). These present values are typically calculated using a 75-year horizon as described in Goss (this volume).

41. For the Advisory Council (1997) estimates, the Holdben plan raises payroll taxes to keep the OASDI trust fund ratio from falling below 100 percent. The Holdtax plan cuts benefits as needed so payroll taxes need not be raised.

42. Leimer's estimates were derived based on data as of 1991. We are hopeful that in the future additional microeconomic data will become available from the Social Security Administration to update the Leimer computations, but these are not available as of this writing.

43. The underlying IRR, NPV, and PVB/PVT estimates were kindly supplied to us in 1997 by the SSA Office of the Chief Actuary for a range of birth cohorts and workers of several stylized types. To create the weights for the composite worker we used Table W, p. 205 (Advisory Council 1997). The IRR composite worker figures represent weighted averages of the underlying worker types, rather than being the IRR for a composite worker.

44. The graph only includes data going back to the 1920 birth cohort, because data for earlier cohorts were not available to us.

45. See Chapter 1 for a more complete description of the Advisory Council plans.

46. These IRR "crossovers" illustrate the key point that one birth cohort will perceive its money's worth differently from another cohort's, depending on how it is likely to fare under the plan.

47. The conditions that must be met in order to compare *different* social security regimes can be significantly weakened when comparing welfare of different people or sets of people (say, different income classes) under the *same* regime. For example, it may be reasonable to support that, though all people are myopic, they are all similarly myopic; it may be acceptable to suppose that all individuals in the economy face the same prices (though across different social security regimes, prices can change), and so on.

48. See, e.g., Kotlikoff (1989) and Tobin (1996). One reason the young might undersave is myopia: they fail to foresee their eventual discomfort when old. Ex-post, each cohort will realize that it should have saved more and consumed less when it was young. Another reason the young (or some subset of the young) might undersave is that they might act strategically, in that they count on the sympathy of their children or the government to support them in old age (the "Samaritan's dilemma"; cf O'Connell and Zeldes 1993).

49. In the presence of borrowing constraints and no myopia, money's worth is biased in the opposite way: workers would be made worse off by a larger plan than a smaller plan (or no plan), even if the plans all paid market rates of return and had identical money's worth measures.

50. There is a fine line between redistribution and insurance (discussed below); what differentiates the two is the information set that we condition on. From the perspective of someone with no information about lifetime wages and mortality prospects other than population averages, transfers from high-earners to low-earners can be seen as insurance. Ex-post, however, households have more information about lifetime earnings profiles as well as life expectancy. In the light of this additional information, social security transfers are seen as redistribution.

51. Precisely which measure of aggregate consumption, and how big the penalty should be per unit of covariance, does depend on the particular prices of the marketed securities. So the arbitrage pricing theorem does not really free us from checking all the marketed securities. But it clarifies precisely how the non-risk-adjusted approach might go wrong.

52. The Advisory Council (1997) assumed a future mean real return on stocks of 7 percent, lower than the historical arithmetic average.

53. For related evidence see Siegel (1997).

54. We can capture the phenomenon of "irrational risk aversion" while maintaining our hypothesis of optimization by supposing that, in addition to the utility they get from the financial payoffs of the stock, households also get disutility from holding these securities (for concreteness, say they lose $\epsilon \times S^2$, where S is equal to the dollar value of shares held). In equilibrium, stocks will necessarily have a higher return in order to get people to hold them and be compensated for the disutility.

55. It is not clear how best to compare NPVs across cohorts. The Advisory Council report (1997) selected an aggregate earnings index to convert NPV estimates into a common year's dollars; this is only one of many alternative choices.

56. "Small" means that the payoffs to the individual from the portion of his social security benefits that depend on stock returns are small relative to his consumption in those periods when he is receiving benefits.

57. A rate higher than the risk-free rate, but lower than the return on equity,

should also be used for households who already have 100 percent of their financial assets in the stock market and would like more.

58. We recognize that even in a mandatory national social security program, people can and do evade taxes for at least part of their work lives (Manchester, this volume). To the extent that such evasion is possible, it may produce adverse selection—for example, by people expecting not to live very long. This will undermine a national program's ability to pool retirement system risk across the population.

59. Consider the analogy to homeowners' fire insurance. Suppose no private market for fire insurance existed, and the government introduced this insurance at actuarially fair rates. If there were no administrative costs, the NPV of this insurance, based on discounting expected cash flows at a risk-free rate, would equal zero. Yet ex-ante households would clearly be better off with the insurance, as it reduces the risks faced by households.

60. Households would be worse off in an ex-ante sense, prior to any private information being revealed.

61. If individuals waited until retirement age to purchase annuities (as is currently generally the case), the private markets are likely to be plagued by substantially more adverse selection than if indiviudals annuitize at earlier ages. For an empirical assessment of the adverse selection and administrative costs on private annuities, see Mitchell et al. (1999). Even if no adverse selection were present, if the government could provide annuities with lower administrative cost, current money's worth estimates would underestimate the value of the current system relative to a privatized one. The reserve would be true if the private sector costs were greater than that of the government. A similar argument holds for disability insurance coverage.

62. Some intergenerational insurance would remain in both the IA and PSA proposals developed by the Advisory Council (1997) since both include a mandatory minimum defined-benefit guarantee financed by pay-as-you-go taxes.

63. Constrained households would be better off under this approach because under the previous plan they would effectively be forced into a short position in the stock market.

64. There is no particular reason that the government should undertake this risk-sharing through social security. In fact, the argument above assumes that no other tax and transfer scheme is accomplishing the same risk sharing.

65. For recent surveys of the literature on how social security has influenced retirement in the United States over time, see Diamond and Gruber (1997) and Lumsdaine and Mitchell (forthcoming).

66. We also recall that these distortions go hand in hand with increased insurance (Diamond 1977).

67. Tanner's testimony to the Social Security Advisory Council (March 5, 1995) is reported on the internet at www.socialsecurity.org/testimony/. A number of World Wide Web sites now provide taxpayers with the opportunity to compare their own rates of return under a system of privatized accounts to those under the current social security system; see for example www.socialsecurity.org. Some of these sites provide money's worth results using the rate of return, while others provide anticipated levels of retirement income under alternate scenarios.

68. As described earlier, Goss (this volume) uses a method close to the straight-line method to estimate the U.S. unfunded liability to be $8.9 trillion, close to the $9.1 trillion in our stylized model using the straight-line method. We have no estimates of the U.S. unfunded liability computed according to the constant PVB/PVT method described in the first section, but it seems reasonable to assume that it would be close to the $9.9 trillion estimate from our stylized model using the PVB/PVT method.

69. Subsequent payments would rise at 1.2 percent per year.

70. OASDI taxes inflows in 1997 were actually closer to $415 billion, or about $45

billion more than benefits, because the current baby boom demographics have given rise to a temporary surplus.

71. Had we used the straight line method for computing accrued benefits, giving an unfunded liability of $9 trillion, and had we used actual OASDI contributions of $400 billion, then we would have obtained a ratio of new taxes to payroll contributions of about ($99 billion)/($400 billion) = 25 percent, as given in our earlier paper (Geanakoplos, Mitchell, and Zeldes 1998).

72. See the Advisory Council report (1997) and Chapter 1 (this volume) for more discussion of the specifics of the PSA plan.

73. For a description of the Social Security Solvency Act of 1998 (S. 1792) see the internet site at www.senate.gov/~moynihan.

74. This perspective is summarized in Technical Panel on Trends in Income and Retirement Saving (1997).

75. A different approach might be to establish individual accounts from some other source, for example by using funds from a federal budget surplus. Thus President Bill Clinton recently suggested that Congress preserve the anticipated budget surplus for social security; see *Wall Street Journal* (1998). This would reduce both the actuarial imbalance and the unfunded liability of the current system, and hence would genuinely increase the rate of return to social security. Of course, such a plan is not costless, since one must take into account what those funds would have paid for in the absence of social security reform (e.g., a tax cut or a spending increase).

76. This argument applies even if, as some would argue, there is an inexplicably large equity premium, as we saw above.

77. As we will see, the same argument applies to the money's worth estimates of trust fund investment in equities.

78. In these figures the money's worth for the IA and PSA plans is everywhere above that for the Holdtax plan, though in principle one might expect them to be coincident or else cross; further research into this question continues.

79. This linear interpolation would be exact in the case of quadratic utility.

80. We arrive at this as follows. If the household were able to achieve a 50-50 split, the last $100 switched to equity would be worth zero. The 2 percent of payroll contribution (=1/6 of wealth) into stocks moves the investor one-third of the way toward the optimum, so the last $100 of this nets him $190 ($=2/3 \times \$285 + 1/3 \times \$0$). Therefore the average gain for this constrained household is approximately the average of these marginal gains, ($285+$190)/2 = $237.

81. This net present value gain of $59 would correspond to a risk-adjusted internal rate of return of 3.9 percent over 30 years on a full investment into stock, versus the 2.3 percent for an unconstrained investor, and the 7 percent for the first $100 of a totally constrained investor.

82. For a discussion of possible general equilibrium effects of increased demand for equities due to holding social security assets in equities see White (1996) and Munnell and Balduzzi (1998).

83. Additional stock in the hands of constrained households means less stock and less risk in the hands of unconstrained households. The effect is likely to be that unconstrained households will likely finance investment projects that are more risky.

84. The effect of this MB investment strategy on money's worth measures—versus holding only bonds in the trust fund—is not provided in the Advisory Council report. Nevertheless, one may compare the additional revenue gleaned from moving from a trust fund consisting of 40 percent stocks under the MB plan, to one where the trust fund held half of its portfolio in equities. This alternative, dubbed the MB+ plan by the Advisory Council, has PVB/PVT ratios that are equal to or surpass those of the PSA plan for all cohorts analyzed by as much as 5–7 percent (Advisory Council 1997: 218). On the other hand, money's worth for the MB+ trajectory is not pre-

cisely comparable to that for MB plan, since other plan features are not held constant; that is, the MB+ plan also raises taxes and borrowing as does the PSA plan, and benefits are boosted as revenue rises.

85. One caveat is that money management costs would likely be somewhat lower if the funds were centrally managed, instead of held in individual accounts (Mitchell 1998). On the other hand, individual accounts would afford the advantages of additional investment choice and probably additional service not provided by the government-run system.

86. In practice it seems unlikely that benefits would be left unchanged in response to a large market drop. There are numerous instances when benefits have been reduced under both private and public defined benefit pensions, including the cut in social security benefits due to the cost-of-living delay in 1983 (for a discussion of this change see Myers 1993).

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