Comparing the Risks of Social Security with and without Individual Accounts

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The introduction of individual accounts as part of Social Security reform has received a great deal of attention in the United States and the rest of the world. There have been arguments for or against converting the existing unfunded defined-benefit Social Security system into a two-tier program with both defined-benefit and funded individual-account segments (see e.g., Henry J. Aaron and Robert D. Reischauer, 1998; Aaron and Shoven, 1999; Sylvester J. Schieber and Shoven, 1999; President’s Commission on Strengthening Social Security, 2001; Martin Feldstein and Jeffrey B. Liebman, 2002). One of the arguments against introducing the second tier of individual accounts is the risks that their stock and bond investments would impose on Social Security participants—particularly low income and wealth households that do not otherwise participate in financial markets. The basic idea is that partial privatization would substitute risky individual accounts for safe defined-benefit plans. The purpose of this article is to evaluate the merits of that argument within the context of stylized two-tier plans.

Existing Social Security cannot accurately be characterized as offering risk-free defined benefits. Such safe benefits require that the financial risk of the system be transferred to other agents in the economy. Corporate defined-benefit plans transfer the investment risk from participants to the company’s stockholders. Additional layers of insurance are provided by the Pension Benefit Guarantee Corporation and the U.S. taxpayers. However, since Social Security is essentially a universal program, such risk transference is impossible. Our position is that, while Social Security appears to be a defined-benefit program, without the ability to transfer risks, it retains the risk properties of a pay-as-you-go (PAYGO) system. We model the existing Social Security as a pure PAYGO system in the spirit of Paul A. Samuelson (1958). Each year, those in the workforce contribute a fixed fraction of their labor earnings to the Social Security Administration (SSA), which in turn sends its payroll tax proceeds to the elderly population. In our model, the aggregate amount of money is divided equally among Social Security recipients. Thus, the PAYGO system is not risk-free for the individual participant. How much a person receives in retirement depends on the number of workers in the economy while they are retired, the productivity of those workers, and the number of elderly with whom they have to split the proceeds. In turn, the number of workers and retirees depends on fertility, mortality, immigration, and labor-force participation rates, each of which is subject to uncertainty. While the actual Social Security system has a trust fund to shield benefit payments from short-run SSA revenue variation, its actual ability to eliminate risk is highly doubtful. Our model does not use the trust-fund smoothing device.

Once existing Social Security is modeled as risky, then the introduction of a second individual-account tier becomes a portfolio problem. That is exactly how we model the issue. We model individual accounts as mandatory accounts invested in stocks and bonds in 60–40 proportions. We then solve for the efficient risk–return frontier for the two tiers of Social Security and evaluate the optimal weights on each part for investors with particular tolerances for risk. Implicitly we are doing these calculations for someone who does not otherwise participate in financial markets. The analysis is therefore relevant for the nearly half of the population that does not accumulate any financial assets.

I. Simulating a Two-Tier System

We assume that individuals work for 45 years (from age 20 to age 64) and earn the average

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wage in the economy; after this, they have 15 years of retirement. Workers contribute 10.5 percent of their wages to a two-tier system. A fraction $\gamma$ of this contribution is applied to a pure PAYGO system (i.e., it is immediately paid to the current elderly), and the remainder is deposited in an individual account that holds 60 percent stocks and 40 percent corporate bonds. We assume that the individual accounts are continuously rebalanced to maintain the 60-40 mix; thus, the realized return at the end of each year is $0.6r_s + 0.4r_b$, where $r_s$ and $r_b$ are the returns on stocks and bonds, respectively. Note that by varying $\gamma$, we can simulate the entire range of social-security systems: when $\gamma = 0$, we have a pure individual-accounts system, when $\gamma = 1$, we have a pure PAYGO system, and when $\gamma$ is between 0 and 1, we have a two-tier system.

Every year, each retiree receives a PAYGO benefit equal to workers' total PAYGO contributions in that year (i.e., an individual worker's PAYGO contribution multiplied by the population aged 20-64) divided by the number of retirees. Each retiree also withdraws an amount from his or her individual account. The amount withdrawn is computed as follows: the retiree assumes that asset returns in the future will be the arithmetic mean of the returns realized in his or her lifetime. Each year in retirement, the retiree updates his or her withdrawal plan based on the new realization in returns. With this approach, the retiree withdraws an amount such that, if he or she were to withdraw the same amount every year, the account would be left with a zero balance upon death.\footnote{We make this assumption about withdrawals (rather than assuming that workers annuitize their resources) because we want to capture the fact that, in the economy as a whole, income after retirement is necessarily risky.}

To show the range of outcomes associated with each system, we use a bootstrap procedure. We begin with a data set containing 76 observations on stock and bond returns (from 1926–2001); 72 observations on real wage growth (from 1930–2001); and 100 observations on population growth for the two age groups, 20–64 and 65+ (from 1901–2000). Our stock and bond return data are based on the inflation-adjusted large-company stock index and the long-term corporate-bond index from Ibbotson Associates (2002). To compute the growth rate of wages in the economy, we added together "Wage and Salary Accruals" and "Employer Contributions to Social Insurance" from table 1.14 of the National Income and Product Accounts. We then divided this amount by the Bureau of Labor Statistics' estimate of total nonfarm employment and deflated it using the annual average of the Consumer Price Index for All Urban Consumers (CPI-U). Our wage growth series is the growth rate of this measure of average real wages. Our population data come from Census Bureau estimates: we compute the growth rates of the young population (ages 20–64) and the elderly population (ages 65 and over) in each year.

We simulate a 60-year history of asset returns, population, and wages using a bootstrap procedure. The bootstrap procedure is performed as follows. First, we randomly select a series of 60 years, with replacement, from 1926–2001, and take the asset returns (for both stocks and bonds) associated with these. Second, we randomly select 60 years, with replacement, from 1930–2001, and take the real wage growth rates associated with these. Third, we select 60 years, with replacement, from 1901–2000, and take the population growth rates (for both young and old) associated with these. Finally, we initialize the wage and population levels at their 2000 levels (since 2000 is the most recent year we have for population) and apply the growth rates we drew to generate the path of wages and population over 60 years. For each of the 1,000 60-year histories, we choose values of $\gamma$ between 0 and 1 at increments of 0.01 and compute the resulting stream of benefits and contributions from both tiers of the system combined. This procedure gives us 1,000 benefit and contribution streams for each of the 101 values of $\gamma$.

II. Analysis

For each stream of benefits and contributions generated by the bootstrap procedure, we compute a lifetime internal rate of return (IRR). This procedure gives us 1,000 realizations of the IRR for each value of $\gamma$.

Figure 1 is a histogram of the lifetime IRR's associated with a pure PAYGO system ($\gamma = 1$), as well as those associated with a pure
individual-accounts system (γ = 0). Note that the return distributions from the two systems overlap. As one would expect, a pure individual accounts system generates higher average returns, but with a greater variance. In this case, the mean lifetime IRR is 0.0620, with a standard deviation of 0.0203. A pure PAYGO system generates a lower mean lifetime IRR (0.0102); however, the standard deviation is only 0.0055.

More importantly, the PAYGO system is not without risk: very low, and even negative, lifetime returns occasionally occur due to changes in demographics. Thus, a strictly mixed system (somewhere between pure PAYGO and pure individual accounts) should allow diversification of the two types of risk: demographic and financial. Figure 2 confirms that this effect, although weak, is present. The figure depicts the relationship between the mean and standard deviation of the returns for the different values of γ. While the pure PAYGO system does have the lowest mean return, one can raise the mean and lower the variance by allowing 1 percent of contributions to be diverted to individual accounts. Moreover, the figure shows that a system in which 2 percent of contributions go into individual accounts generates the same amount of risk as a pure PAYGO system (and a higher return).

Of course, the system with the minimum variance is only optimal for an individual who is infinitely risk-averse. Starting from the minimum variance system, most people would probably be willing to accept some more risk to get a higher mean return. To explore this further, for each simulation of benefits and contributions, we also compute the lifetime utility for individuals with varying degrees of risk-aversion. To do this, we assume constant relative risk-aversion and a discount factor for utility equal to 0.98. We also assume that no saving or borrowing takes place outside of the social-security system. This is a reasonable assumption because we are concerned with the effect of risk on those individuals who very close to zero as well. As a result, the variance of a portfolio in which a fraction, λ, is invested in a pure PAYGO system and the remainder in a pure individual-accounts system is

$$\lambda^2 \text{Var(PAYGO)} + (1 - \lambda)^2 \text{Var(IA)}$$

where Var(PAYGO) and Var(IA) are the variances of the pure PAYGO and pure individual-accounts systems, respectively. Substituting our estimates of the variances into this formula, we find that the value of λ that minimizes risk is 0.9323. The risk-minimizing portfolio is thus about 6.8 percent individual accounts and 93.2 percent PAYGO. Achieving this balance requires less than 6.8 percent of contributions going to individual accounts because, on average, wealth held in an individual account grows faster than wealth held in the PAYGO system. Thus, a system in which 1 percent of contributions is diverted to individual accounts results in significantly more than 1 percent of lifetime wealth actually being held in individual accounts.
cannot "undo" the effect of social security in their private portfolios. Under this assumption, in each year, a young person consumes his or her after-tax wage (i.e., 89.5 percent of the wage), and an old person consumes his or her total social-security benefit. For each risk-aversion parameter, we obtain the expected utility associated with each of the 101 values of $\gamma$ by averaging the 1,000 draws of lifetime utility.

Table 1 shows the optimal system for individuals with different coefficients of relative risk-aversion. Individuals with a coefficient of relative risk-aversion of 5 or lower prefer a pure individual-accounts system. This result probably reflects the fact that coefficients of relative risk-aversion in this range cannot explain the equity premium. However, even individuals with a coefficient of relative risk-aversion of 20 would choose a system in which 40 percent of contributions are diverted to individual accounts.

### III. Sensitivity Analysis

Our bootstrap procedure implicitly makes three assumptions. First, the procedure assumes that asset returns, population growth rates, and wage growth rates are not contemporaneously correlated (although it allows for the stock return to be correlated with the bond return, and for the old population growth rate to be correlated with the young population growth rate). Thus, by construction, the correlation between the benefit streams of the PAYGO and individual-accounts systems is zero (although it may differ from zero in our particular bootstrap sample). Allowing correlation between the two lifetime returns reduces the magnitude of effect described above, but it does not change the qualitative result. To illustrate this, we draw 60 years between 1930 and 2000 (the years for which we have observations on all the variables) and choose the asset returns, population growth rates, and wage growth rate associated with these. The individual-accounts system has a mean lifetime IRR of 0.0567 and a standard deviation of 0.0200, while the PAYGO system has a mean return of 0.0080 and a standard deviation of 0.0057. Of the 101 values of $\gamma$ we consider, the variance-minimizing value is 1 (pure PAYGO). However, by using a finer grid for $\gamma$ (increments of 0.001 between 0.99 and 1), we find that the minimum variance system is 0.5 percent. This is lower than the variance-minimizing value of $\gamma$ in the base case because there is a positive correlation between the PAYGO and individual-accounts lifetime returns. However, we find that individuals with a coefficient of relative risk aversion of 4 or below would still choose a pure individual-accounts system. Individuals with a coefficient of relative risk-aversion of 20 would choose a system in which 40 percent of contributions are diverted to individual accounts.

Second, our bootstrap procedure assumes that the asset returns and growth rates are not serially correlated. However, serial correlation is probably present, at least for wages and population growth. For example, it is reasonable to believe that the growth rate of the young population today is correlated with the growth rate of the old population 50 years from now. Moreover, wage growth is likely to be serially correlated as well, as low wage growth in one year (e.g., due to a recession) is likely to be followed by low wage growth the following year. This criticism can be addressed to a certain extent by drawing four-year strings of growth rates. For example, if one initially draws the year 1950 for asset returns, then one would take the stock and bond returns from 1950–1953 as the first four observations in the simulated asset-return history. This process would continue until one has put together a full 60-year history. Following this procedure does not change the results much. The individual-accounts system has a mean return of 0.0596 and a standard deviation of 0.0184, while the PAYGO system has a mean return of 0.0096 and a standard deviation of 0.0082. The variance-minimizing system is one

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<th>Coefficient of relative risk-aversion</th>
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in which 98 percent of contributions go to the PAYGO tier. An individual with a coefficient of relative risk-aversion of 4 or below would choose no PAYGO component, while an individual with a coefficient of relative risk-aversion of 20 would want a 34-percent PAYGO system in which 66 percent of contributions go to individual accounts.

Third, the procedure assumes that any growth rate realized in the past is just as likely to be realized in the future. While this assumption may be reasonable for wages and asset returns, it is probably not reasonable for population growth, since population growth has decreased over time. To address this issue, we ran our procedure again, using only the last 10 years of population growth rates (from 1991–2000). This also gives us very similar results. The individual-accounts system has a mean IRR of 0.0613 with a standard deviation of 0.0211, while the PAYGO system has a mean return of 0.0293 with a standard deviation of 0.0054. The system with the minimum variance is a 99-percent PAYGO system. An individual with a coefficient of relative risk-aversion of 2.2 or below would choose a 100-percent individual-accounts system, and an individual with a coefficient of relative risk-aversion of 20 would choose an 87-percent PAYGO system with 13 percent of contributions going to individual accounts.

The sensitivity analysis shows that, even when our assumptions are modified, the variance-minimizing system is a two-tier program. When one considers the positive covariance between the PAYGO and individual-accounts returns, the variance-minimizing individual-accounts component shrinks; however, it remains positive. The utility-maximizing PAYGO component for high risk-aversion parameters appears to be sensitive to the assumptions and the particular sample drawn. However, we consistently obtain the same qualitative result: even very risk-averse individuals would prefer a two-tier system to a pure PAYGO system.

IV. Concluding Remarks

We have parameterized the risk and return characteristics of both individual-accounts and PAYGO tiers by bootstrapping actual returns and demographic statistics from the 20th century. The expected real IRR’s are roughly 6 percent for individual accounts and 1 percent for PAYGO. These strike us as sensible orders of magnitude. The returns of a PAYGO system are substantially less volatile than the returns of 60–40 stocks and bonds individual accounts. However, the risk-minimizing structure for Social Security involves a small individual-accounts tier. Thus, the message of the paper is that two-tier programs make sense on pure risk–return efficiency grounds. More importantly, the optimal (utility-maximizing) structure for Social Security involves a substantial individual-accounts component, even for highly risk-averse participants. The advantages of portfolio diversification that we have explored in this paper apply to those who solely rely on Social Security for their retirement security.

REFERENCES


