SOCIAL SECURITY BENEFIT UNCERTAINTY UNDER INDIVIDUAL ACCOUNTS

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Social Security reforms that include individual accounts change both the expected benefit and the benefit risk. This article uses a long-term stochastic forecasting model to estimate the distribution of expected benefits under a simple individual account, recognizing uncertainties in the current system. Introducing individual accounts increases the overall variability of benefit levels relative to current law; indeed the standard deviations of expected benefit gains exceed the level of those gains. The increase in uncertainty about benefit replacement rates is even larger, however, because individual accounts partially sever the link between earnings and benefits in the existing system. (*JEL H55*)

I. INTRODUCTION

Various Social Security reform proposals put forth in recent years have included individual accounts. Two of the three reform options offered by the 1994–1996 Advisory Council on Social Security (1997) incorporated such accounts. One Advisory Council option included mandatory individual accounts requiring workers to contribute an additional 1.6% of payroll, invested in indexed bond or equity funds managed by the federal government. Another option included a two-tiered system with privately held Personal Security Accounts (PSAs) that would allow workers to contribute five percentage points of their payroll tax to their PSA where it could be invested in "financial instruments" (Advisory Council on Social Security, 1997, p.30). The Kolbe-Stenholm 21st Century Retirement Security Act (Kolbe and Stenholm, 2002) proposal for Social Security reform includes an Individual Security Account (ISA) to which workers would contribute 3 percent of the first $10,000 of income plus 2 percent above $10,000, investing the funds in stocks, bonds, or government debt. Most recently, the President's Commission to Strengthen Social Security (CSSS) presented three proposals that all included a version of voluntary individual investment accounts; details are discussed in Section II.

These proposals often tout expected rates of return (based on historical experience) that would lead to higher overall retirement income for Old-Age Insurance (OAI) worker

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ABBREVIATIONS

ARMA: Autoregressive Moving Average
AR: Autoregressive
BLS: Bureau of Labor Statistics
CSSS: Commission to Strengthen Social Security
DI: Disability Insurance
NIPA: National Income and Product Accounts
OAI: Old-Age Insurance
OASDI: Old-Age, Survivors, and Disability Insurance
SSA: Social Security Administration
VAR: Vector Autoregression

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beneficiaries who participate in the individual accounts. For example, based on Social Security Administration (SSA) estimates, the CSSS report (2001) shows that prototypical workers are expected to be better off under a system with individual accounts, even in cases where the current-law benefit is reduced in order to eliminate the projected funding gap in Social Security. However, reporting only expected benefits under individual accounts using average historical rates of return ignores the risk associated with investing in private securities, as noted by Feldstein and Rangulova (2001). One approach to controlling for the increased risk in evaluations of individual account proposals is to use a lower (appropriately risk-adjusted) rate of return. An alternative approach, which is used here, is to first generate sequences of future returns for private securities using Monte Carlo simulation, then solve for benefits under each sequence of future returns, and finally analyze the distribution of benefit outcomes across simulations. The latter is preferable because it acknowledges the higher expected return from investing in private securities, but it also produces direct measures of the increased risk (e.g., the probability that benefits are actually lower under the proposed alternative).[1]

The investment risk considered in this article is modeled on the principle that underlies the most basic CSSS approach to individual accounts. Participants contribute a fixed fraction of their current-law payroll tax to the individual account and in return they promise to give up a fraction of their existing current-law scheduled benefit at retirement. The amount by which the scheduled benefit is reduced equals the tax diverted to the individual account, accrued forward at a designated "offset" rate, usually the government bond rate plus or minus a wedge. Therein lies the investment risk—participants are better off if and only if their accounts earn more than the designated offset rate. The results show that the expected benefit gain is positive for a 2 percent individual account carve-out with a simple benefit offset using the SSA assumptions for the expected rates of return on stocks and bonds, but the standard deviation of that gain is much larger than the gain itself.

Although expected gains from individual accounts are uncertain, it is important to keep in mind that even without individual accounts, future current-law benefits are uncertain because key determinants such as future real wage growth and inflation are uncertain. For example, higher real wage growth increases benefits because the computation of lifetime average earnings, used to determine benefits, is based on past earnings adjusted by both inflation and real wage growth. Therefore introducing individual accounts does not add uncertainty into a currently riskless system, rather it replaces some of the risk due to uncertain wage growth with risk from uncertain financial market returns. Indeed, one result that stands out below is that benefits under the current system are already highly uncertain. Under the simple 2 percent carve-out proposal, participants would face an increase in the standard deviation of real benefit levels of 25 to 50 percent.

Using benefit replacement rates (annual benefits divided by the average of the last 10 years of earnings) as the outcome measure, however, shows individual accounts have a much larger effect on uncertainty about future outcomes. The reason is straightforward—replacement rates are more variable under individual accounts because the link between earnings and benefits that exists in the current system is being partially severed. Under current law, benefits are a direct function of average earnings; under a plan with an individual account and benefit offset, benefits are partially a function of average earnings and partially a function of the investment returns received on the individual account.[2]

1. See Bajtelsmit et al. (2003) for another use of the Monte Carlo technique to measure investment return variability for individual accounts.

2. Benefits are computed by first indexing historical annual earnings for inflation and real wage growth up to the year the individual reached age 60; earnings after that age are considered in nominal values. The highest 35 years of indexed earnings are then averaged to compute the average indexed monthly earnings (AIME). The primary insurance amount (PIA) is computed using the following progressive formula:

$$PIA = 0.90 * (\min(\$612, AIME)) + 0.32 * (\max(0, \min(\$3,689 - 612, AIME - \$612))) + 0.15 * (\max(0, AIME - \$3,689)),$$

where the dollar values are applicable for 2004. For workers claiming at the full retirement age, benefits equal the PIA, for those claiming earlier (later), benefits are reduced (increased). The full retirement age is increasing over time, from 65 years for cohorts born before 1938 to 67 years for cohorts born in 1960 or later. The example workers considered here claim at age 65 and thus would

Replacement rates also show how uncertainty would vary across different types of beneficiaries, even under the simple proposal considered here. Since the existing benefit system is progressive, the 2 percent carve-out subjects a higher *fraction* of the existing benefit to investment risk for high-earner participants. Low-earner participants may still be more averse to the investment risk because their *absolute* benefits are lower.

This article estimates the effect on benefit risk using a long-term stochastic forecasting model containing three components: a Social Security budget model that solves for aggregate system financial outcomes based on key demographic and economic inputs, a stochastic macrodemographic model that generates those key inputs in a Monte Carlo setting, and a representative micromodel that solves for person-level outcomes that are consistent with the underlying stochastic environment and policy rules.

In order to limit the scope of the article and make the results directly comparable to those in the CSSS report, the representative micromodel is based on the same scaled example workers used by the SSA. The key innovation relative to the CSSS estimates is therefore quantifying the uncertainty about returns on the individual accounts.[3] Because the key demographic and economic assumptions can all be generated using Monte Carlo simulation, it is possible to explicitly consider benefit risk by solving the model repeatedly and analyzing the distribution of outcomes across simulations.

The individual account alternative considered here is intended to have no impact on the expected actuarial deficit in the Social Security system in order to distill the pure effect on risk from individual accounts. In so doing, this article does not address the thorny issue of whether benefits would be cut or taxes raised in the event of depletion of the Social Security Trust Fund. If one chooses to assume that benefits will be cut (as the CSSS did), then one could compare expected benefit outcomes with benefits *payable* under current law (as the CSSS did) rather than current-law scheduled benefits. Choosing a baseline for comparison is crucial in evaluating policy alternatives, but for the purpose of evaluating benefit risk under current law versus an individual account alternative, the issue is appropriately set aside.

II. INDIVIDUAL ACCOUNT PROPOSALS FROM THE PRESIDENT'S COMMISSION TO STRENGTHEN SOCIAL SECURITY

Under the direction of the principles established by President George W. Bush, the CSSS put forward three reform options that included some form of a voluntary individual account. The CSSS final report (2001) explains these options in detail, including their recommendations for issues such as investment options and annuitization of balances at retirement.

The first option in the CSSS report would allow workers to contribute 2 percent of their current-law payroll tax to the individual account. At retirement, participants' current-law scheduled benefit would be offset by a theoretical annuity equal to the stream of (inflation-adjusted) income that would have been "purchased" by the 2 percent carve-out accrued forward using the government bond rate plus 50 basis points. (In this article, the accumulated balance used to determine the benefit offset is referred to as a "notional" account.) Individuals that choose to participate would be betting that they can earn more on their individual investments than 50 basis points above the government bond rate.[4] The CSSS benefit offset approach effectively charges participants for the interest their deferred taxes would have earned had they been deposited in the Old-Age, Survivors, and Disability Insurance (OASDI) Trust Fund. In that sense, the risk of the individual account is completely shifted onto participants and not onto future taxpayers. The commission noted that this option is a generic individual account plan which does not contain other changes to the existing system, and thus does not purport to bring the system into fiscal balance.

The second CSSS option allows participants to contribute 4 percentage points of their

receive just under 100 percent of their PIA for cohorts claiming in the earliest years. Benefits will decrease to 87 percent of the PIA for cohorts claiming in 2025 and later.

3. For a similar exercise in the context of investing the trust funds directly into corporate bonds and equities, see Harris et al. (2001).

4. Individual accounts also incur administrative costs in the accrual phase and in the annuitization purchase that are not charged against the accrual of the notional account or the notional annuity; thus individuals will actually have to earn slightly more than the government bond rate plus any offset to increase their benefits under an individual account.

payroll tax, up to $1,000 (price indexed) per year, to an individual account. Upon retirement, their scheduled benefit will be offset by the notional annuity purchased by 4 percentage points of payroll, to the cap, accrued forward using the government bond rate *minus* 100 basis points. However, the second plan also includes a fairly dramatic change in the scheduled benefit computation from wage indexing to price indexing that would slow benefit growth (relative to scheduled benefits) enough to bring the system into balance.

The third CSSS option calls for 1 percent in new contributions (an "add-on") along with a 2.5 percent carve-out of current payroll taxes, with the latter limited to $1,000 (price indexed) annually. In this plan the benefit offset is based on a notional account accrued forward using the government bond rate minus 50 basis points. To account for increasing life expectancy and address fiscal solvency, this plan would change the actuarial adjustments for those who retire before or after the full retirement age.[5]

The CSSS report also discussed the investments that participants would be able to make with their individual accounts and how the accounts would be handled upon retirement, both key determinants of the additional risks introduced into the system. They recommended a two-tier investment structure dictated by the size of the individual account. Early in workers' careers, when account balances are low, the funds would be invested in a limited set of broad index funds managed by a low-cost, centralized governing board. Once account balances reach a threshold, individuals would be allowed to shift their balances into funds managed by a myriad of private-sector administrators. Account balances, however, must still be invested in broadly diversified funds. Individuals would not have access to the funds in the accounts prior to retirement.

Upon retirement, account balances must be annuitized or gradually withdrawn, and only balances above a minimum threshold could be taken out in a lump sum. Inflation-indexed annuities would be made available (which is essentially what the current Social Security system provides), along with standard annuities and annuities that include the option for leaving a bequest. For married retirees, a two-thirds joint and survivor annuity would be required unless both spouses agree to a different arrangement.

As noted in the introduction, the goal of this analysis is to isolate the issue of uncertainty about benefits under individual account alternatives, so the simplest possible scenario is used. All of the results presented below are based on a simulation structured to replicate the CSSS plan 1 approach, a 2 percent carve-out with a benefit offset equal to an accrual of the notional balance at the government bond rate plus a 50 basis point wedge. It is also assumed that administrative costs are smoothed across accounts so that a constant 30 basis point charge is subtracted from the annual expected portfolio return. Finally, balances are annuitized at retirement for the example workers analyzed here as single-life, inflation-adjusted annuities using the government bond rate minus administrative costs and the SSA unisex life tables.

III. MODELING SOCIAL SECURITY OUTCOMES

The results presented in this article are projected using a model that combines three systems: a budget model, a stochastic macro-demographic model, and an example worker micromodel.

A. Social Security Budget Model

The budget model tracks Social Security finances over time given policy rules and values for the demographic and economic inputs, capturing the basic features of budgetary projections made by the actuaries at SSA and described by Frees (1999). The crucial test of the budget model is that it exhibits responses to variations in policy parameters (tax rates and benefit formulas) and input assumptions (mortality improvement, fertility, immigration, wage growth, inflation, interest rates, unemployment, and disability rates) that match those in the actuaries' estimates. Given these responses, any set of alternative policy rules and/or stochastically generated input assumptions will lead to simulated changes in financial projections that basically match what the Social Security actuaries would predict.

5. The second and third options include adjustments in benefit rules for low-income widows/widowers and a larger minimum benefit for all long-time, low-wage workers. The third model also includes a decrease in the third benefit replacement factor in the PIA formula from 15 percent to 10 percent.

The Social Security budget model has two independent submodels dealing separately with the demographic and financial aspects of the OASDI system. The demographic model tracks population using a "cell-based" approach, projecting person counts by single year of age, sex, and marital status groups. The inputs to the demographic model are annual fertility, total immigration, and rates of mortality improvement (by detailed age and sex). Demographic processes are calibrated to match Social Security "intermediate" projections when the inputs are set accordingly, and changes in the inputs (jointly or separately) produce changes in population counts that are also consistent with the sensitivity analysis reported by the SSA actuaries in the annual report to the OASDI Board of Trustees (2003). The financial part of the Social Security budget model is also generally "cell-based" in nature. The approach in the model is to track variables like labor force participation, average benefits, and beneficiary counts by age and sex, then multiply by the population counts from the demographic modules to solve for determinants of aggregate system financial flows.

B. Stochastic Macrodemographic Model

The goal of the stochastic macrodemographic model is to generate values for the economic and demographic inputs to the Social Security budget model in a Monte Carlo setting. The basic approach involves using standard time-series techniques applied to the stochastic inputs, as in Frees et al. (1997) and Chang and Cheng (2002). The demographic inputs are the rate of mortality improvement across detailed age and sex groups, the overall fertility rate, and the level of immigration. The economic inputs for the budget model are real wage growth, inflation, the unemployment rate, interest rates, and rates of disability incidence and termination. For simulations involving investment in private securities, the stochastic simulator also generates values for equity and corporate bond returns. The goal of the macrodemographic model is to create realistic stochastic variation in the annual values for each input, including correlations between those variables.

The stochastic macrodemographic model starts with SSA intermediate projections to set central tendencies for each of the nine inputs. The SSA intermediate values are based on extrapolating historical averages for (generally) stationary processes such as wage and price growth rates, and in that sense are consistent with the underlying time-series analysis used to build the macrodemographic model. Most of the stochastic inputs are treated as independent time-series processes, although inflation, unemployment, and interest rates are modeled together in a vector autoregression (VAR) and short-run wage growth dynamics are affected by the other three economic variables. In all cases the specifications were chosen using standard time-series techniques (Congressional Budget Office, 2001).

The three demographic models are all estimated using data from the SSA (see Table 1). Mortality improvement is modeled as an AR(1) process for each of 42 separate age-sex groups. The data are available back to 1900. Although the equations are estimated separately, the rates of mortality improvement across age groups are correlated because the vector of innovations is drawn from a multivariate normal distribution estimated using the historical error terms, which are correlated. The overall fertility process is characterized as an ARMA(4,1) model estimated on data back to 1917. Identifying a stationary characterization for the fertility process is somewhat complicated by distinct breaks in the series at various points in history, notably at the end of the baby boom. Experiments with an alternative to the ARMA representation (a first-difference model) did change implied fertility dynamics, but the effect on variability in system finances was modest (Congressional Budget Office, 2001). Finally, the immigration process is also dominated by distinct breaks in the time-series at various points in history, but in this case, because of changes in policy. Again, the ARMA(4,1) representation is most appropriate for immigration.

Three of the four economic variables (inflation, unemployment, and the real interest rate) passed the test for inclusion in a VAR, while the fourth (real wage growth) was rejected. The VAR model uses two annual lags for each of the three variables and is estimated using data from the Bureau of Labor Statistics (unemployment and Consumer Price Index for Urban Wage Earners and Clerical Workers [CPI-W] inflation) and SSA (real interest rates on new issues of OASDI Trust Fund assets) for the period 1954–1999. Unemployment rates

TABLE 1
Equations in Stochastic Macrodemographic Model

Variable	Description of Stochastic Process
Mortality Improvement	Separate AR(1) equations for each of 21 age and two sex groups estimated using SSA data for 1900–1995. Model draws two sets of 21 correlated errors using multivariate normal distribution.[a]
Fertility	ARMA(4,1) equation for overall fertility rate estimated using SSA data for 1917–1997.[a]
Immigration	ARMA(4,1) equation for total immigration estimated using SSA data for 1901–1995.[a]
Unemployment	VAR model with two lags each on unemployment, inflation, and real interest rate estimated using BLS and SSA data for 1954–1999.[a]
Inflation (CPI-W)	VAR model with two lags each on unemployment, inflation, and real interest rate estimated using BLS and SSA data for 1954–1999.[a]
Real Wage Growth	Level of nominal wage growth as a function of the three economic variables, equation estimated using NIPA, BLS, and SSA data for 1954–1999; real wage (comparable to SSA's "differential") is nominal wage less inflation.[a]
Real Interest Rate	VAR model with two lags each on unemployment, inflation, and real interest rate estimated using BLS and SSA data for 1954–1999.[a]
DI Incidence	AR(1) model for overall DI incidence rate estimated using SSA data for 1975–1999.[a]
DI Termination	AR(1) model for overall DI termination rate estimated using SSA data for 1975–1999.[a]
Equity Returns	Total returns a white-noise process estimated using Ibbotson Associates (2001) large-cap data for the period 1954–1999.[b]
Corporate Bond Returns	Level of large-cap bond returns as a function of inflation, unemployment, and interest rate estimated using Ibbotson Associates (2001), SSA, and BLS data for the period 1954–1999.[b]

[a]For details on the parameter estimates and the associated statistics see Congressional Budget Office (2001, pp. 35–55). Available at www.cbo.gov.

[b]For details on the parameter estimates and the associated statistics see Smith and Sabelhaus (2003, pp.15–17). Available at www.cbo.gov.

are transformed using a log-odds ratio prior to estimation, so the predicted values are constrained to the zero-one range in all cases. Although real wage growth does not lead the other three variables, it is strongly correlated with contemporaneous values. After controlling for current values of inflation, unemployment, and interest rates, the real wage growth residuals are white noise, which suggests the interesting dynamics occur through the other variables, because real wage growth (by itself) is highly autocorrelated.

The last two inputs to the Social Security budget model are disability incidence and termination. Finding reasonable equations for variations in disability incidence and termination rates is made difficult because consistent data only exist back to 1975, and is further complicated because of changes in policy (stated and implicit) with respect to eligibility for the program. The problem is similar to the fertility model; there are clear breaks in the data that are (ex post) explainable, but it is not clear how to use that information when predicting future variability. Because there is no clear signal from the data, both models are specified as simple AR(1) processes.

In policy experiments involving trust fund investment in private securities or individual accounts, the stochastic model generates values for equity and corporate bond returns using a random returns or "white noise" process. The alternative to white noise is to introduce some sort of mean-reverting process, for example, one based on the dividend-to-price ratio. Annual stock yields are not correlated over time, but there is some evidence that the current level of the stock market is correlated with future returns, and therefore future yields are, in a sense, "predictable" (see, e.g., Campbell et al., 1997; Campbell and Shiller, 1998). The evidence of mean reversion is statistically weak, however, so (following Feldstein and Rangulova, 2001) the random returns process is adopted.

Given the choice of a white-noise process for equity returns, one still has to select values for expected returns and the standard deviation of returns in the simulations. Published data on equity yields are available from Ibbotson Associates (2001) back to 1926, and the exact time period used to measure the average and variance for yields matters a lot. In the simulations involving equity investment, the model assumes a white-noise process with expected returns of 6.5 percent (the value used by SSA actuaries in their analysis of the CSSS plans (2002)) and a standard deviation of 19.795 percent, which should, if anything, bias the answers toward generating less positive gains from equity investments.

Although equity returns are an independent white-noise process, real corporate bond yields are integrated with the rest of the macro model. The equation for corporate bond returns uses the three variables in the VAR: unemployment, inflation, and the real interest rate on government bonds. Thus the equation captures both the overall variability in corporate bond yields and the short-run macrodynamics in the rest of the model. As noted above, although Ibbotson data on corporate bond yields are available back to 1926, the range for the other variables (in a consistent format) is limited to 1954 and later, so the equation is estimated for that period.[6]

C. Example Worker Micromodel

The micromodel is based on the same "scaled example" workers used by SSA (Goss and Wade, 2001; Nichols et al., 2002) in their distributional analysis of current law and alternative policies. Outcomes for example workers are tied to the economic/demographic environment and the Social Security budget model, thus alternative policies will impact the example worker outcomes.

In every birth cohort there are three example workers: low, medium, and high earners. The example workers have hump-shaped age-earnings profiles over the interval from 22 to 64 years which are derived from actual earnings patterns in SSA data files. The workers are unisex and have no specified marital status. In all cases, earnings for any given cohort at a given age are expressed relative to the average wage index, so earnings for example workers are tied to average wages (which are determined by the macrodemographic model) in every simulation. Averaged over each worker's lifetime, earnings are roughly 45 percent of economy-wide average wages for the low earner, 100 percent for the medium earner, and 160 percent for the high earner.

The connection between the policy rules in the budget and micromodels is also direct. Example workers pay payroll taxes or receive benefits according to the rules in place each year. In addition, example workers contribute to individual accounts based on contribution rates and designated sources of contributions. For each year that the workers contribute, balances in the individual account and the notional account are tracked. At age 65, the current-law scheduled benefit, the single annuity purchased with the accrued individual account, and the offset annuity that the notional account could "purchase" are computed. The benefit with the individual account is the current-law benefit plus the purchased annuity minus the offset annuity. The expected gain equals the purchased annuity minus the offset annuity.

IV. SOCIAL SECURITY BENEFIT UNCERTAINTY

This section analyzes how expected Social Security benefits and uncertainty about those benefits would be affected by the introduction of individual accounts. The starting point for the analysis is measuring uncertainty about benefits under current law. It is important to recognize that future benefit levels are highly variable because real wage growth and inflation (which determine benefits) are themselves highly variable. This current-law variability explains why, even though the model suggests that the standard deviation of benefit gains from individual accounts is generally larger than the level of expected gains, participants would not face an overwhelming increase in the overall variability of real benefit levels under the introduction of an individual account.

The conclusion that overall benefit uncertainty does not explode when individual accounts are added to the system is in part attributable to a focus on benefit levels. Individual accounts do substantially increase the variability of benefit replacement rates because

6. Another possible correlation exists between asset returns and real wage growth. The macrodemographic model used here is intentionally restricted to mimic the Social Security actuaries modeling approach so that the median outcomes are directly comparable, thus it is not feasible to address this correlation directly. However, in a modified version of this model with a Cobb-Douglas production function, standard first-order conditions, and exogenous total factor productivity, Smith and Sabelhaus (2003) show that the effect of introducing that correlation does not significantly change the results shown here.

they partially sever the link between earnings and benefits in the existing system. Thus, to some extent, conclusions about benefit variability depend on the benefit outcome of interest. The benefit replacement rate measure also shows an important difference across earnings groups; because high-earner participants have lower replacement rates under the current system, their expected gains from individual accounts (relative to current benefits) are higher, but the relative variability in their replacement rates is also higher.

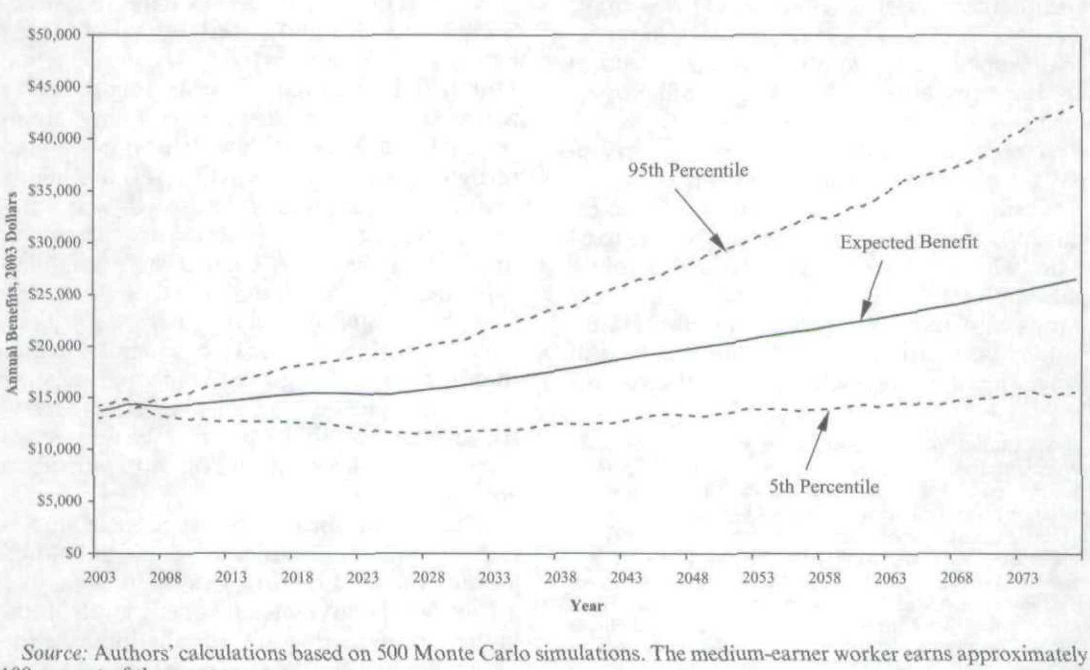
A. Benefit Uncertainty Under Current Law

One aspect of Social Security often overlooked in reform debates is that benefits under current law are highly uncertain. Fluctuations in real wage growth and inflation work through the existing benefit formula to cause variations in projected benefit outcomes. Thus introducing individual accounts does not add uncertainty into a currently riskless system, rather it replaces some of the risk due to uncertain wage growth with risk from uncertain financial market returns. Before the variability of outcomes under an individual account is considered, it is important to quantify the uncertainty that exists in the current system.

The solid line in Figure 1 shows expected benefits (in 2003 dollars) under current law for SSA example medium-earner workers claiming in each of the next 75 years at age 65. In addition, the estimated 5th and 95th percentiles of benefits are shown as dotted lines. The variability of benefit levels is driven by variability in wage growth and inflation that change individual earnings for the example worker and thus alter future benefits. Wage growth and inflation also affect the aggregate indexing formula for benefit computations. Since this aggregate indexing formula is only applied to earnings up to age 60, the variability picks up dramatically for example workers who reach age 60 in 2003 or later, those claiming in 2008 or later. The uncertainty about benefit levels for future beneficiaries is sizeable. Although benefits are expected to roughly double over the 75-year projection period as wages continue to rise, the range between the 5th and 95th percentiles spans 14 percent real growth in the benefit level to over 300 percent.

FIGURE 1

Benefit Variability Under Current Law: SSA Example Medium-Earner Worker Claiming at 65, 2003–2077



Source: Authors' calculations based on 500 Monte Carlo simulations. The medium-earner worker earns approximately 100 percent of the average wage.

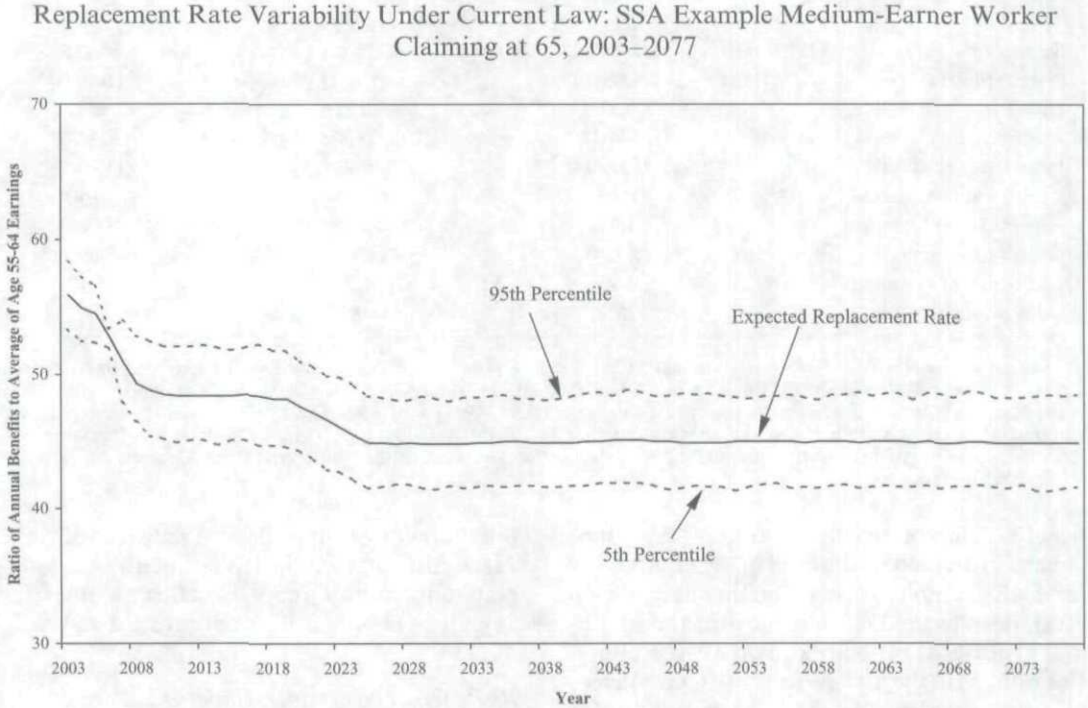
The conclusion that benefits in the current system are uncertain holds true even if the metric is benefit replacement rates (annual benefits divided by the average of the last 10 years of earnings adjusted for inflation). Figure 2 shows benefit replacement rates for the same example medium-earning workers claiming at age 65. The expected replacement rate falls between 2003 and 2025 because scheduled increases in the full retirement age will lower benefits (at age 65) relative to earnings. After the full retirement age increases are phased in, the example medium-earning worker claiming at age 65 expects a replacement rate of approximately 45 percent of the average of the last 10 years of earnings with a 90 percent confidence interval spanning 42 to 49 percent of final average earnings. The strong link between earnings and benefits limits the uncertainty in replacement rates. Some uncertainty remains under current law because of how the replacement rate is defined here and how inflation is treated in the benefit computation. The replacement rate is benefits divided by the average of the last 10 years of earnings adjusted only for inflation, where benefits are a linear function of the average of the top 35 years of earnings indexed for inflation and real wage growth (see note 2). Also, when benefits are computed, only earnings up to age 60 are indexed for real wage growth and inflation. Thus real wage growth and inflation that occurs between age 60 and 64 for these example workers will alter the denominator but not the numerator.

Current-law benefit variability is also apparent across the three SSA example workers. Tables 2 and 3 are divided into three panels of rows corresponding to the projection years 2020, 2035, and 2075. Each panel includes benefit outcomes for the example low-, medium-, and high-earning workers retiring at age 65 in each year. The first rows of each panel show the mean, standard deviation, and coefficient of variation for scheduled benefits, in 2003 dollars (Table 2), or benefit replacement rates (Table 3) under current law.

The variability of annual benefit outcomes is quite large relative to the level of annual

FIGURE 2

Replacement Rate Variability Under Current Law: SSA Example Medium-Earner Worker Claiming at 65, 2003–2077



Source: Authors' calculations based on 500 Monte Carlo simulations. The replacement rate equals the annual benefit divided by the average of inflation-adjusted earnings over ages 55–64. The medium-earner worker earns approximately 100 percent of the average wage.

TABLE 2

Benefit Uncertainty Under Current Law and a 2 Percent Carve-Out with Offset

	Example Worker Benefits at Age 65		
	Scaled Low Earner	**Scaled Medium Earner**	**Scaled High Earner**
2020			
Scheduled benefit	$9,264	$15,311	$20,220
(Standard deviation)	(1,092)	(1,803)	(2,383)
Coefficient of variation	0.12	0.12	0.12
Benefit with individual account	$9,297	$15,385	$20,337
(Standard deviation)	(1,153)	(1,947)	(2,624)
Coefficient of variation	0.12	0.13	0.13
Expected gain	$33	$73	$118
(Standard deviation)	(183)	(407)	(651)
Coefficient of variation	5.55	5.58	5.52
Odds of negative gain	50%	50%	50%
2035			
Scheduled benefit	$10,273	$16,976	$22,416
(Standard deviation)	(1,924)	(3,176)	(4,196)
Coefficient of variation	0.19	0.19	0.19
Benefit with individual account	$10,611	$17,728	$23,620
(Standard deviation)	(2,175)	(3,814)	(5,312)
Coefficient of variation	0.20	0.22	0.22
Expected gain	$339	$752	$1,204
(Standard deviation)	(733)	(1,629)	(2,606)
Coefficient of variation	2.16	2.17	2.16
Odds of negative gain	38%	38%	38%
2075			
Scheduled benefit	$15,658	$25,868	$34,155
(Standard deviation)	(4,861)	(8,027)	(10,603)
Coefficient of variation	0.31	0.31	0.31
Benefit with individual account	$17,007	$28,876	$38,969
(Standard deviation)	(6,053)	(10,920)	(15,500)
Coefficient of variation	0.36	0.38	0.40
Expected gain	$1,350	$3,008	$4,814
(Standard deviation)	(2,323)	(5,177)	(8,285)
Coefficient of variation	1.72	1.72	1.72
Odds of negative gain	28%	28%	28%

Source: Authors' calculations based on 500 Monte Carlo simulations. Example workers are assumed to contribute 2 percent of payroll starting in 2004 into an individual account, investing 50% in equities with a 6.5% mean return, 30% in corporate bonds with a 3.5% mean return, 20% in government bonds with a 3.0% mean return, and 30 basis points in administrative cost. At retirement, the annuity purchased with the individual account is offset by a reduction in the scheduled benefit equal to the notional balance accrued at the government bond rate plus 50 basis points. All numbers are in 2003 dollars.

benefits. The coefficient of variation (standard deviation divided by the level of benefits) is 0.12 for each example worker claiming at age 65 in 2020, despite the fact that most of their earnings histories are already known with certainty. For retirees in the distant future, the coefficient of variation rises to 0.31. The variability of benefit replacement rates (Table 3) does not grow over time because the uncertainty caused by wage growth and inflation affects both the numerator and denominator. Still, the variability of benefit replacement rates suggests uncertainty about benefit outcomes for any given cohort of future retirees does exist.

B. Benefit Uncertainty Under a 2 Percent Carve-Out with a Simple Benefit Offset

Given this background of uncertainty under current law, the next step is to consider how

TABLE 3
Uncertainty in Replacement Rates Under Current Law and a 2 Percent Carve-Out with Offset

	Example Worker Replacement Rates at Age 65		
	Scaled Low Earner	Scaled Medium Earner	Scaled High Earner
2020			
Replacement rate with scheduled benefit	63.9	47.5	39.2
(Standard deviation)	(3.0)	(2.2)	(1.8)
Coefficient of variation	0.05	0.05	0.05
Replacement rate with individual account	64.1	47.7	39.4
(Standard deviation)	(3.2)	(2.5)	(2.2)
Coefficient of variation	0.05	0.05	0.06
Expected gain	0.2	0.2	0.2
(Standard deviation)	(1.2)	(1.2)	(1.2)
Coefficient of Variation	6.00	6.00	6.00
2035			
Replacement rate with scheduled benefit	60.4	44.9	37.0
(Standard deviation)	(2.9)	(2.1)	(1.8)
Coefficient of variation	0.05	0.05	0.05
Replacement rate with individual account	62.3	46.8	38.9
(Standard deviation)	(5.1)	(4.7)	(4.5)
Coefficient of variation	0.08	0.10	0.12
Expected gain	1.9	1.9	1.9
(Standard deviation)	(4.2)	(4.2)	(4.2)
Coefficient of variation	2.21	2.21	2.21
2075			
Replacement rate with scheduled benefit	60.3	44.8	37.0
(Standard deviation)	(2.9)	(2.2)	(1.8)
Coefficient of variation	0.05	0.05	0.05
Replacement rate with individual account	65.1	49.6	41.8
(Standard deviation)	(8.4)	(8.2)	(8.1)
Coefficient of variation	0.13	0.17	0.19
Expected gain	4.8	4.8	4.8
(Standard deviation)	(7.8)	(7.8)	(7.8)
Coefficient of variation	1.63	1.63	1.63

Source: Authors' calculations based on 500 Monte Carlo simulations. Example workers are assumed to contribute 2 percent of payroll starting in 2004 into an individual account, investing 50% in equities with a 6.5% mean return, 30% in corporate bonds with a 3.5% mean return, 20% in government bonds with a 3.0% mean return, and 30 basis points in administrative cost. Replacement rates equal the annual benefit at claim divided by the average of inflation-adjusted annual earnings over ages 55 to 64.

that variability would change under a simple individual account alternative. The second and third set of rows in each panel of Table 2 show the effect on individual benefits for the example workers under a 2 percent carve-out with a simple benefit offset. Table 3 shows the same experiment using benefit replacement rates as the outcome of interest.

The individual account alternative shown in Tables 2 and 3 is structured to replicate the CSSS plan 1. Example workers age 55 and younger in 2002 contribute 2 percent of their current-law payroll tax to an individual account starting in 2004. The assumed annual expected return for the individual investment account is 4.6 percent, reflecting a portfolio assumption of 50 percent in equities with a 6.5 percent expected return, 30 percent in corporate bonds with a 3.5 percent expected return, and 20 percent in government bonds with a 3.0 percent expected return, minus a 30 basis point administrative cost. For simplicity, it is assumed the individual account is balanced each year to maintain this allocation. The notional account is also tracked with a 2 percent contribution each year and annual expected return of the government bond rate plus 50 basis points.

At retirement, the annual current-law scheduled benefit for each example worker is computed along with the annuity values of the individual account and the notional account. The annuity values are computed as a single-life, inflation-indexed annuity using unisex life tables where the sum of expected payments equals the balance of the individual or notional account, given the age of the worker (and his future probability of being alive), and the effective interest rate (equal to the long-term real interest rate, and for the individual account annuity, minus an assumed administrative cost of 30 basis points).[7] The benefit with the individual account equals the scheduled benefit minus the notional annuity plus the individual account annuity. That is,

$$\text{Annual Income} = \text{Scheduled benefit} - \text{Notional annuity} + \text{Individual account annuity}.$$

Thus the expected gain equals the individual account annuity minus the notional annuity.

For example, a medium earner participating in the individual account during a full working career is expected to have an individual account balance of \$120,000 and a notional account balance of \$94,000 upon reaching age 65 (all dollar amounts are presented in 2003 dollars). The scheduled annual benefit for this worker would be \$24,700. The individual account balance could purchase a real annuity of \$7,700. The benefit offset is computed as the real annuity value of the notional account balance, and would be \$6,500. The actual benefit paid by the Social Security system would be the difference of the scheduled benefit and the offset, \$24,700 – \$6,500 = \$18,200. The worker's full retirement benefit would include the actual benefit paid by Social Security plus the individual account annuity, \$18,200 + \$7,700 = \$25,900. The gain from the individual account is the increase above the scheduled benefit, \$25,900 – \$24,700 = \$1,200, or the difference between the individual account and the notional account annuities, \$7,700 – \$6,500 = \$1,200.

The first result that stands out in Tables 2 and 3 is that expected gains for the individual accounts are positive for each type of worker in every year; however, the gains are not statistically different from zero given the magnitude of the standard deviation of those gains. Over time, the ratio of the standard deviation to the expected gain in benefit levels—the coefficient of variation—falls from more then five to less than two (Table 2). This decline reflects the additional years workers are able to contribute to the individual account. Since contributions to the accounts cannot start until 2004, the workers claiming in 2020 are only able to contribute to an individual account for 15 years. However, the uncertainty surrounding benefit gains drops by more than half for workers claiming in 2035. With 30 years to contribute to individual accounts, workers have more years to average across good and bad market returns.

Another measure of the potential for gains or losses under an individual account is the odds that the individual will have a negative gain, that is, where the benefit with the individual account is actually less than the scheduled benefit. In 2020, 50 percent of the simulations return a negative gain; however, gains and losses at this point are small given small individual account balances. The odds drop to 38 percent by 2035, as the additional years for participating in the individual account and the benefits of compounding reduce the share of bad outcomes for future retirees. By 2075, the share of negative outcomes is 28 percent, which is still a significant probability that full-career participants will end up with a smaller benefit than what is promised under current law. It is important to keep in mind that the strong possibility of negative outcomes in this particular experiment is directly

7. The formula for the annuity calculation is the following:

$$\textit{Individual account balance} = \sum_{A=\textit{Claim age},\,100} \textit{Annuity payment} * P(\textit{alive at } A|\textit{alive at Claim age}) * [1/(1+\textit{Effective rate})]^{A-\textit{Claim age}}.$$

attributable to the specified benefit offset mechanism. In order to be better off with an individual account, participants must do more than receive positive investment returns, they must receive returns in excess of the government bond rate plus 50 basis points and the costs of account administration and annuitization.

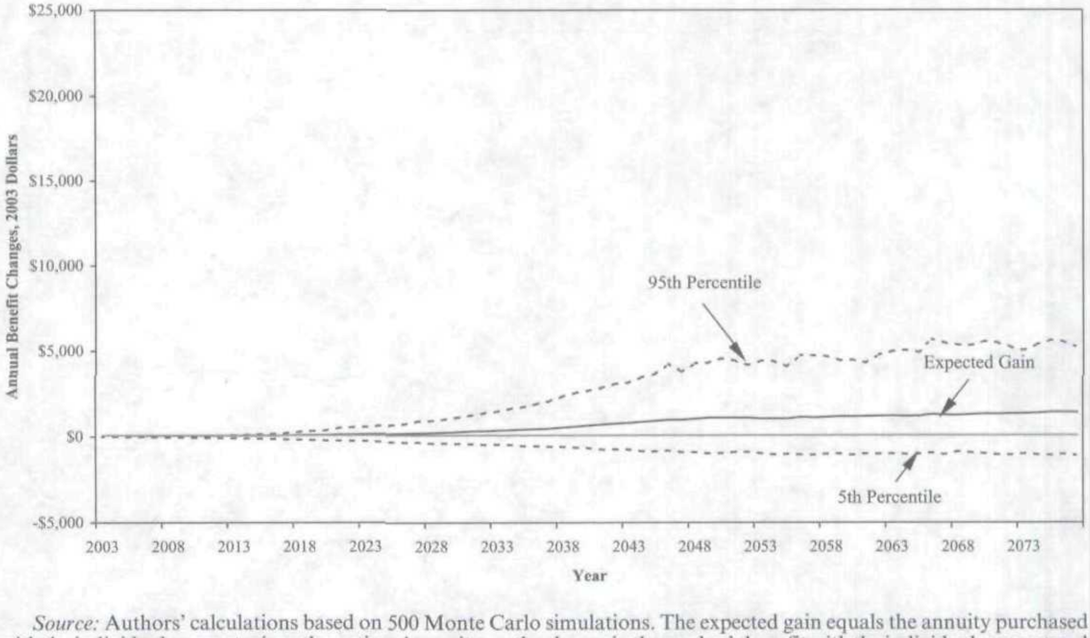
Figures 3 through 5 show expected gains in Social Security benefits along with the 5th and 95th percentiles for each cohort of the three SSA example workers over the next 75 years. Although the odds of negative gains seen in Table 2 are the same across the three types of earners, these figures show that the magnitudes of the potential gains and losses are quite different. This is not surprising given the much higher contributions that high earners make relative to low earners in this simple plan with no contribution cap.

Even though the variability of gains from the individual accounts is large, Table 2 shows that the overall variability of postreform benefits (the reduced scheduled benefit plus the annuity from the individual account) is not dramatically larger than the variability of the scheduled benefit itself. The standard deviations are about the same in the early years when individual account balances are small; the coefficient of variation is only slightly higher for the medium and high earners. By 2075, the coefficient of variation of the benefit with the individual account is higher for each of the types of workers, although the magnitude of the increase is not large, from 16 percent to 33 percent.

The result that individual accounts only increase uncertainty about future Social Security outcomes by no more than one-third is a function of looking at benefit levels. The conclusion changes when looking at benefit replacement rates. Table 3 shows that the coefficient of variation for the benefit replacement rate with the individual account more than doubles for workers claiming in 2075. Again, the stark increase in uncertainty due to the introduction of individual accounts reflects the partial severing of the link between earnings and benefits that reduced uncertainty about replacement rates under current law.

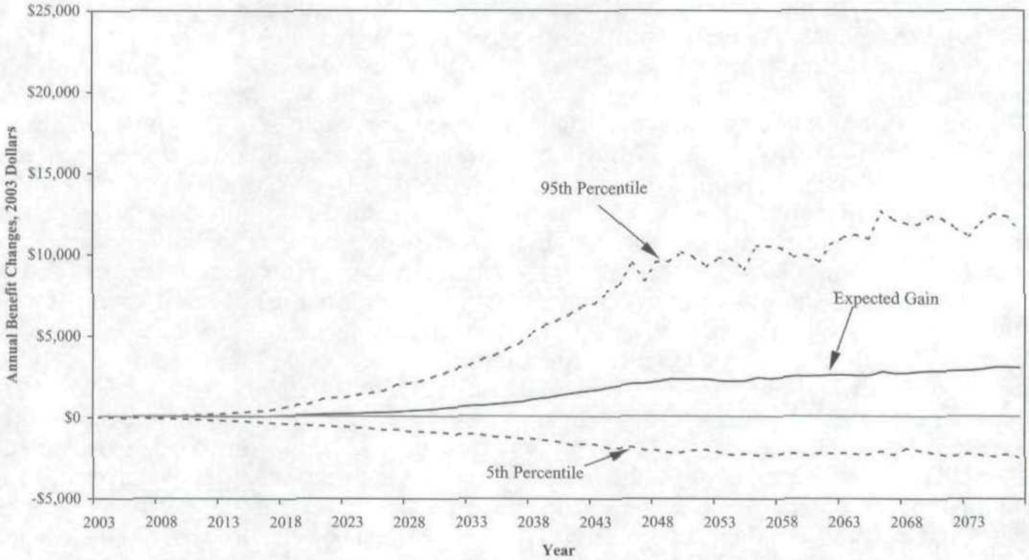
FIGURE 3

Variability of Expected Gains from 2 Percent Carve-Out with Offset: SSA Example Low-Earner Worker Claiming at 65, 2003–2077



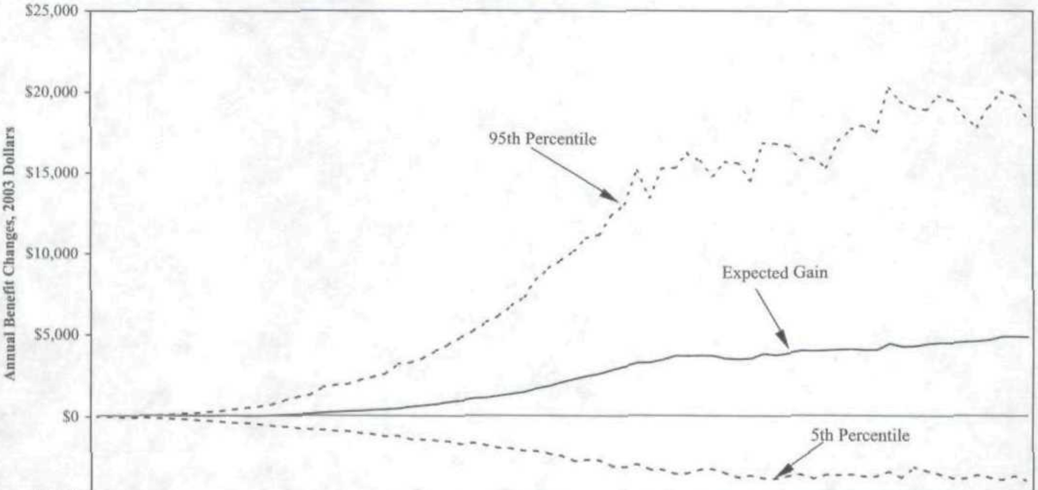
Source: Authors' calculations based on 500 Monte Carlo simulations. The expected gain equals the annuity purchased with the individual account minus the notional annuity, or the change in the worker's benefit with the individual account and offset relative to current law. The low-earner worker earns approximately 45 percent of the average wage.

FIGURE 4
Variability of Expected Gains from 2 Percent Carve-Out with Offset: SSA Example
Medium-Earner Worker Claiming at 65, 2003–2077



Source: Authors' calculations based on 500 Monte Carlo simulations. The expected gain equals the annuity purchased with the individual account minus the notional annuity, or the change in the worker's benefit with the individual account and offset relative to current law. The medium-earner worker earns approximately 100 percent of the average wage.

FIGURE 5
Variability of Expected Gains from 2 Percent Carve-Out with Offset: SSA Example
High-Earner Worker Claiming at 65, 2003–2077



Source: Authors' calculations based on 500 Monte Carlo simulations. The expected gain equals the annuity purchased with the individual account minus the notional annuity, or the change in the worker's benefit with the individual account and offset relative to current law. The high-earner worker earns approximately 160 percent of the average wage.

There is also an important distributional effect on risk and returns. When considering benefit levels (Table 2), the relative uncertainty introduced with individual accounts is similar across the low, medium, and high earners. However, a different story emerges when replacement rates are considered in Table 3. Since the current-law benefit formula is progressive, that is, replacement rates fall as earnings rise, the 2 percent carve-out subjects a higher *fraction* of the existing benefit to investment risk for high-earner participants. The increase in the replacement rate coefficient of variation between the scheduled benefit and the benefit with the individual account is much larger as earnings increase. For example, in 2075 the low-earner coefficient of variation with the individual account is more than 2.5 times larger than for the scheduled benefit, while the high-earner coefficient of variation is almost 4 times larger. The introduction of individual accounts interacts with the progressive structure of the current system and thus makes benefits of high earners more uncertain. However, low earners may still be more averse to increasing real benefit variability because their absolute benefit levels are lower.

A final question to consider is how the change in expected benefits and benefit variability under the reform plans might be expected to affect individual well-being. In particular, Smetters (2001) has criticized simply relying on estimating ranges for potential outcomes, arguing that a Black and Scholes (1973) option-pricing approach may capture the utility implications of severe negative outcomes, and is thus more appropriate for valuing the change in risk and returns.[8] In their article, Feldstein and Rangulova (2001) complemented the estimated ranges for benefit outcomes with explicit utility valuation of the alternative policy, which addresses this question directly. They found that, although the exact value depends on the assumed coefficient of relative risk aversion, the general conclusion that the change in risk is not particularly onerous does hold up well. The same conclusion applies to the estimates here, and perhaps even more so, because our stochastic benchmark is not simply a fixed scheduled benefit as in Feldstein and Rangulova (2001).

8. See also Lachance et al. (2003) for an application of this approach to the valuation of defined contribution versus defined benefit income streams.

C. Comparing Stochastic Results to SSA Low- and High-Yield Scenarios

Similar to the low- and high-cost scenarios used in the annual OASDI Trustees Report (2003), the SSA's analysis of the CSSS plans (2002) includes a low-and high-yield assumption for the individual account to provide some bounds on their estimated outcomes. For a low yield, the SSA assumes a conservative individual account portfolio of 100 percent government bonds (or similarly, a lower overall portfolio yield of 2.7 percent, in contrast to the intermediate scenario yield of 4.6 percent). For a high yield, the SSA assumes a more risky individual account portfolio of 60 percent equities, 24 percent corporate bonds, and 16 percent government bonds (or similarly, a higher overall portfolio yield of 4.92 percent).

Under these low- and high-yield assumptions, the SSA projects a range of expected annual benefits between 95 percent and 101 percent of the benefit for the medium earner in 2032 under the intermediate portfolio assumptions. This is a much narrower range than that suggested by the stochastic results presented here. For the medium earner in 2032, one standard deviation around the expected scheduled benefit gives a range of 82 percent to 118 percent of the expected benefit, while one standard deviation around the benefit with the individual account gives a slightly broader range of 80 percent to 120 percent. These results suggest that the low- and high-yield scenarios used by the SSA do not capture a reasonable range of uncertainty for the system with individual accounts, due mostly to the fact that their measurements do not capture the uncertainty of the system under current law.

V. CONCLUSION

Adding a 2 percent individual account carve-out to the existing Social Security system would increase the expected benefits for participants under reasonable assumptions about expected asset returns, but those gains—at least under the simple offset method used here—would be highly uncertain. However, the extent to which these uncertain returns are deemed to affect worker's retirement security is driven by the choice of outcome measure. The introduction of a simple individual account would increase the overall variability of outcomes as measured by benefit replacement rates far more than as measured by benefit levels.

The introduction of an individual account would only increase the coefficient of variation of benefit levels by 16 percent to 33 percent because uncertainty about real wage growth and inflation already cause significant uncertainty about future benefits under current law. The additional uncertainty of asset returns adds only a marginal amount of risk to an already risky benefit. The standard deviation of a worker's benefit in 2075 is already 31 percent of his benefit; adding the individual account raises it only by between 5 and 9 percentage points, to a maximum of 40 percent for a high-earning worker.

The variability of benefit replacement rates (annual benefits divided by the average of the last 10 years of earnings) is much more sensitive to the introduction of individual accounts because the connection between earnings and benefits under existing rules would be partially severed under the individual account alternative. The introduction of an individual account would increase the coefficient of variation of replacement rates by 260 percent to 380 percent. Using replacement rates to analyze outcomes also highlights other aspects of individual accounts. For example, because high-earner participants have lower benefit replacement rates in the existing system, the added variance for high-earner participants relative to low-earner participants is much larger (46 percent greater) than when measured in benefit levels (14 percent greater).

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