

**Valuing Intergenerational Transfers:
Social Security's Individual Value and Aggregate Burden**

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Abstract

We show that the discount rate for uncertain future expenditures (revenues) should be lower (higher) than the risk-free rate. We then apply these results to the individual's valuation of the Social Security contract, to aggregate measures of Social Security's obligations, and then to illustrate a "Big Bang" reform of the system. Individually, the Social Security contract has a negative value for new entrants to the program. When the value of the program is adjusted for risk, it is possible for a "Big Bang" transition to a prepaid Social Security system to be Pareto improving.

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Debt

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1. Introduction

Government intergenerational programs with long horizons, such as Social Security and Medicare, accounted for one-third of federal spending in 2007 and their combined spending as a percentage of GDP is expected to grow 50 percent within the next 20 years. The present value of the difference between Social Security's costs and dedicated tax revenues over the next 75-year period is \$6.6 trillion and grows to \$15.8 trillion over the infinite horizon.¹ However, these estimates are discount rate sensitive. Increasing the real discount rate from the 2.9% used in the 2007 Report to 3.0% decreases the 75-year present value by \$282 billion and an increase to 3.3% decreases the present value by over \$1 trillion.²

Given these significant financing shortfalls, do simple reforms exist that can alleviate some or all of the debt? If so, should such a transition to a reformed system be a sudden big-bang or gradual. Either way any transition must answer the question of how to deal with the debt of the old regime. This retirement system debt is the result of a larger-than-normal working generation paying taxes at a rate only sufficient to fund the retirement of a small retired generation. This same tax rate, when applied to the coming small working generation, will be woefully insufficient to fund the retirement of the new large retired generation.

One way to deal with the implicit debt of an inherited pay-as-you-go Social Security system is to recognize the debt by making it explicit, while at the same time making current and future working generations pay for servicing the newly recognized

¹ From the 2007 Social Security Trustees Report pp. 58-60.

² Gokhale and Smetters (2006) used a benchmark real discount rate of 3.65% to calculate the Social Security's (infinite horizon) fiscal imbalance at \$9.5 trillion, but a significantly larger \$11.5 trillion fiscal imbalance when the discount rate was decreased to 3.30%.

debt. It has been shown in several contexts that, when the additional taxes raised to service the additional debt are taken into account and when the debt management taxes are scheduled in such a way that the total debt (explicit and implicit) schedule remains unchanged after privatization, the true rate of return that each generation can get from a privatized system would be the same low rate of return implicit in any previously existing pay-as-you-go Social Security system. Moreover, it has been found in these contexts that privatization of an existing pay-as-you-go system with transition costs financed through the issuance of additional external debt, leaves the nation=s capital stock unchanged.³

Since discount rate choice can generate very different results for long-horizon present value calculations, it is important that the choice of discount rate be based solidly on economic theory. At first glance, using a long-term government borrowing rate for budget-related discounting seems to be a natural and reasonable choice.⁴ However, several complications suggest that the choice of the correct discount rate is not so obvious. In this paper, we focus one such complication: the fact that future Social Security expenditures and revenues are uncertain and taxpayers bear the consequences of this uncertainty.⁵

³ See Murphy and Welch (1998), Geanakoplos, Mitchell and Zeldes (1998) and Mariger (1997) for discussions of this point.

⁴ It should be pointed out that there is no agreed-upon procedure to generate a long-term borrowing rate from current multiple market rates of return on government bonds associated with various maturities and/or historical variations in bond returns. For example, Gokhale and Smetters (2006) chose a 3.65% discount rate because it is consistent with the rates on outstanding 30-year Treasury securities. In the Social Security Trustees' reports, the real discount rate for long-run analysis is a weighted average of historical real bond returns, and the historical rates are in turn set equal to the average market yield on all outstanding marketable U.S. securities not due or callable until after 4 years from the date the rate is determined. The chosen discount rate by Trustees under the intermediate assumption is 2.9% in their 2006 and 2007 reports.

⁵ Other complications affecting discount rate choice include the capital income tax wedge between the marginal productivity of capital and the consumer's rate of interest and issues of intergenerational equity. For discussions of these complications, see Lind (1982), Liu, Rettenmaier and Saving (2004, 2005), and Intergovernmental Panel on Climate Change (1996).

We employ a simple expected utility model to analyze how uncertain future costs (expenditures) and benefits (revenues) are evaluated by a risk-averse individual. We find that uncertain future expenditures should be discounted at a lower rate than the risk-free government borrowing rate, but uncertain future revenues should be discounted at a higher rate than the risk-free government borrowing rate. This asymmetric adjustment of the discount rate is based on the intuition that when a benefit is uncertain, it is worth less to a risk-averse individual than its expected value, and hence a higher discount rate is necessary. On the other hand, when a cost is uncertain, it causes more pain to a risk-averse individual than its expected value, and a lower discount rate is appropriate.

Using a constant relative risk aversion utility function and the results of the Social Security actuaries' stochastic model we derive risk-adjusted discount rates. We apply these discount rates to two aspects of the Social Security system. First, we use them to calculate the value of the Social Security program to current risk-averse participants. We then apply these results to analyze a "Big Bang" transition from the current generation transfer based Social Security system to a pre-paid system. Second, we use the risk-adjusted discount rates to calculate the program's aggregate burden.

The paper is organized as follows. In Section 2, we summarize relevant related literature. In Section 3 we use an expected utility model to establish asymmetric discount rates for future costs and benefits. Then in Section 4 we calibrate the rate of return adjustments using the Social Security Administration's stochastic model. In Section 5, we estimate the value of the current Social Security contract to representative current participants and the aggregate net value across all current participants assuming different levels of risk aversion. We and then identify the degree to which future generations could

pay off the debt in the current program and still be better off themselves. Finally, we conclude in Section 6.

2. Related Literature

Our approach to accounting for the risk in government budget through discount rate adjustments based on residual taxpayers' welfare can be compared to valuing government financial risk based on the capital asset pricing theory. Three recent examples of the capital asset pricing approach are CBO (2005), PBGC (2006), Lucas and Zeldes (2006), and Lucas and Phaub (2007), which address issues closely related to those addressed here. The main argument in those studies is that government obligations, whenever feasible, should be valued at market prices by projecting their pattern of cash flows onto assets that are priced.⁶ Two observations regarding these alternative approaches are in order.

First, for most cases where private counterparts of government obligations are easily identified, the two approaches generate qualitatively similar results. For example, Lucas and Phaub (2007) found that accounting for relevant risks reduces the values of government loans and investments in private securities but increases the costs of deposit insurance and loan and pension guarantees. According to our analysis, loans and investments represent future revenues to the government whereas insurance and guarantees represent future expenditures. Therefore, accounting for uncertainty in those

⁶ Hirshleifer (1964) and Sandmo (1972) show that when a public project has a comparable private counterpart in terms of risk properties, the appropriate discount rate is the rate of return on capital with similar riskiness. However, for a pure generation transfer program, such as Social Security, there is no private investment counterpart. On the other hand, Arrow and Lind (1970) argued that the discount rate for risky public projects is still the rate for risk-free bonds because the risk associated with a marginal project is shared by so many benefit recipients that each individual's risk burden becomes negligible. In our context, however, the risk is systemic for the bill paying generation and cannot be shared across generations.

flows implies a higher (than risk-free) discount rate, or smaller present value, for revenues, and a lower discount rate, or larger present value, for expenditures.

The future potential liabilities of the Pension Benefit Guaranty Corporation (PBGC) provide another example. To PBGC, the potential future benefits to the plans it has guaranteed are its future obligations. In a Congressional Budget Office (2005) evaluation of the PBGC guarantees, the present values of the 10, 15, and 20 year prospective net costs discounted at Treasury rates approximately double when adjusted for risk.⁷ The CBO's adjustment based on a "cost of risk" is qualitatively similar to our recommendation to adjust the risk-free rate downward for discounting uncertain future expenditures.

Second, the application of the relevant theory to generation transfer programs can make it appear that the two approaches generate very different results depending on how the program is characterized. The valuation of an artificial security to establish a market valuation will depend on the particular construction. For example, endowing each individual with the ownership of the currently scheduled Social Security benefit would allow a market in these benefits. Since the valuation only involves benefits, the taxes that must be paid to achieve the benefits are appropriately ignored. The market value of the asset based on these future benefits would be less than the present value of the expected benefits if a risk free rate of interest is used for discounting.

On the other hand, endowing each individual with the commitment to pay the cost rate required to pay currently scheduled benefits would allow a market to develop in

⁷ PBGC (2006) used the private annuity market price for annuity plans with longevity-contingent benefits to impute the interest factors (or equivalently the discount rates) used to calculate the present value of future benefits guaranteed. These interest factors are generally below the risk-free interest rate and consistent with our finding that uncertain future expenditures should be discounted at below the risk-free rate.

which individuals could pay to escape these uncertain future payments. In this case the cost to avoid the uncertain payments would be greater than the present value of the expected payments when the risk free rate is used to discount.

3. Discount Rates for Uncertain Future Costs and Benefits

In this section and the next, we evaluate a stream of uncertain future costs and benefits from the perspective of a risk-averse individual. The results derived can be applied to various situations with appropriate interpretations of costs and benefits. For example, in evaluating the value of Social Security contract to an individual, the costs and benefits are respectively Social Security payroll-tax payments and Social Security benefits during one's lifetime; in evaluating the aggregate burden of unfunded Social Security obligations, the costs and benefits are respectively projected Social Security expenditures and revenues.

Denote the certain initial period cost (expenditure) and benefit (revenue) as $(e_{t_0}^e)$, and the random future expenditures and revenues as $\{\tilde{e}_t^e, \tilde{r}_t^r\}_{t=1}^{\infty}$ where \tilde{e}_t^e represent future realized period t values of expenditure and revenue.⁸ Denote the expected values of period t expenditure and revenue by (e_t^e) . Denote the random period t expenditure and revenue as:

$$(1) \quad \begin{aligned} \tilde{e}_t^e &= (1 - \rho^e) \\ \tilde{r}_t^r &= (1 - \rho^r) \end{aligned}$$

where the $\rho_i^j; j \in \{e, r\}$ are respectively the random components of period t expenditure and revenue, and $E \rho_i^j = \forall i \in \{0, 1, \dots\}$.

⁸ Throughout the paper, “ $\tilde{\cdot}$ ” indicates that the variable or parameter is random.

Uncertain future expenditures and revenues are evaluated according to the expected lifetime utility

$$(2) \quad U = E(u(C_0)) + \sum_{t=1}^L \beta^t E(u(\tilde{C}_t))$$

where C_0 and \tilde{C}_t are respectively, initial period consumption and period t uncertain consumption, $u(\cdot)$ is strictly increasing and concave, β is the utility discount factor, E is the expectation operator. All expectations are taken in the initial period.

The consumption possibilities for the individual are directly affected by the stream of expenditures and revenues. At any time t the level of consumption can be expressed as

$$(3) \quad C_t = \tilde{y}_t - \tilde{C}_t \quad ; 1$$

where \tilde{y}_t is net income in period t from all sources other than the expenditures and revenues under evaluation.

We employ a simple idea to determine how uncertain future expenditures and revenues should be evaluated by the individual. Essentially, the individual would discount certain future expenditures or revenues using the risk-free rate of return. So our approach to evaluating uncertain future expenditures and revenues is to turn them into initial period certainty equivalents. The certainty equivalent of a period t unit increase in period t expected expenditure or revenue are respectively

$$(4) \quad CE_t^e \equiv \frac{dE[u(C_t^e)]}{-E[u'(C_t^e)]} = \frac{E[u'(C_t^e)](1 + \rho^e)}{E[u'(C_t^e)]}$$

$$CE_t^r \equiv \frac{dE[u(C_t^r)]}{E[u'(C_t^r)]} = \frac{E[u'(C_t^r)](1 + \rho^r)}{E[u'(C_t^r)]}$$

In words, CE_t^e is the ratio of the marginal (dis)utility of e_t to the marginal (dis)utility of certain period t expenditure (or revenue).

From the definition of certainty equivalence an individual must be indifferent between a dollar invested for one period at the risk free rate and that dollars certainty equivalent invested at a risk adjusted rate of return we have that

$$(5) \quad (1 + r^e)E_t = (1 + r^r)E_t$$

where r^e , r^r are respectively, the risk-free rate of return, the risk-adjusted rate of return for future expenditures and the risk-adjusted rate of return for future revenues. The following proposition establishes a basis for the asymmetric risk adjustments for discounting uncertain future expenditures and revenues.

Proposition. *Suppose all random variables are normally distributed. If ρ^e (or equivalently \tilde{e}_t) are independent random variables, each also independent of \tilde{y}_t , then $i_t^e < i_t^r$ and $i_t^e > i_t^r$.*

Proof.

From the fact that⁹

⁹ From Rubinstein (1976) we have that if \tilde{x} and \tilde{y} are jointly normal and $g(\cdot)$ is any function that is at least once differentiable, then $\text{cov}(g(\tilde{x}), \tilde{y}) = [g'(\tilde{x})] \text{cov}(\tilde{x}, \tilde{y})$.

$$(6) \quad \begin{aligned} E[u'(C_t^e) \tilde{C}_t] &= \rho \phi(v, 0) & \square \\ E[u'(C_t^r) \tilde{C}_t] &= \rho \phi(v, 0) & \square \end{aligned}$$

we have

$$CE_t^e > 1$$

$$CE_t^r < 1,$$

or equivalently, $i_t^e < i_t^r$ and $i_t^e > i_t^r$.

Q.E.D.

Thus, uncertain future expenditures should be discounted at a lower rate than the risk-free bond return and uncertain future revenues should be discounted at a higher rate than the risk-free bond return.¹⁰ The independence conditions required for the *Proposition* seem strong, but serve as a reasonable benchmark case in the applications considered in this paper.

4. A Calibration Procedure

The *Proposition* indicates the direction of risk adjustments in the discount rate; namely, adjusting the risk-free bond return downward for uncertain future expenditures and upward for uncertain future revenues. However, it is also important to know what factors affect the size of such adjustments. In this section, we calibrate our model to find how the magnitude of risk and the level of risk aversion, among other things, affect the appropriate risk adjusted discount rates.

The two equations in (5) give the discount rates for period t expenditure and revenue, respectively. To evaluate these discount rates we assume a constant relative risk aversion utility function, $u(C) = \frac{1}{1-\alpha} C^{1-\alpha}$, where $\alpha > 0$ is the coefficient of relative

¹⁰ Although the idea of asymmetric discounting treatment of the risks associated with future benefits versus the risks associated with future costs has antecedents in the literature on government discounting (Haveman 1994 and Bazelon and Smetters 1999), our analysis here formally provides a foundation for the asymmetric discount rate adjustments.

risk aversion.¹¹ To simplify the matter assume that ρ_t^e or ρ_t^r is the only random variable in the expression of \tilde{C}_t . So $\tilde{C}_{t|t}^e = (1 - \gamma \rho_t^e)$ or $\tilde{C}_{t|t}^r = (1 + \gamma \rho_t^r)$, where $CE_t^e = \tilde{C}_t^e$, $\gamma_m^e \equiv eC$ and $\gamma_m^r \equiv rC$. The relevant certainty equivalent values for one unit changes in planned period t expenditure and revenue become

$$(7) \quad CE_t^e = \left\{ \frac{E \left[\left(1 + \gamma \rho_t^e \right)^{-\alpha} \right]}{E \left[\left(1 - \gamma \rho_t^e \right)^{-\alpha} \right]} \right\}$$

$$CE_t^r = \left\{ \frac{E \left[\left(1 + \gamma \rho_t^r \right)^{-\alpha} \right]}{E \left[\left(1 + \gamma \rho_t^r \right)^{-\alpha} \right]} \right\}$$

Therefore,

$$(8) \quad (1 + i_t^e) = \left\{ \frac{E \left[\left(1 + \gamma \rho_t^e \right)^{-\alpha} \right]}{E \left[\left(1 - \gamma \rho_t^e \right)^{-\alpha} \right]} \right\}^{-1}$$

$$(1 + i_t^r) = \left\{ \frac{E \left[\left(1 + \gamma \rho_t^r \right)^{-\alpha} \right]}{E \left[\left(1 + \gamma \rho_t^r \right)^{-\alpha} \right]} \right\}^{-1}$$

so that the difference between i_t^e and i_t^r depends on risk attitude α , the nature of ρ_t^e or ρ_t^r , and the ratio of expenditure or revenue to individual consumption γ_t^e or γ_t^r .

Assume a simple probability distribution for $\rho_t^j, j \in e, r$,

¹¹ $\alpha = 1$ when $\alpha = 1$. We ignore this special case in the formal presentation below, but the results still hold for this case. Estimates of α are obtained in two separate literatures. The reciprocal of α , namely the intertemporal elasticity of substitution, is the focus parameter in the macro literature on life-cycle consumption. On the other hand, α itself is the focus parameter in the finance literature on the risk premium puzzle. Existing estimates of α range from 1 to 30, with a concentration between 2 and 6 (see Hall (1988), Campbell and Mankiw (1989), Attanasio and Weber (1995), Kocherlakota (1996), and Meyer and Meyer (2005)).

unborn generations would have sufficient additional resources to compensate the transition's early generations, without time travel, such payments cannot be made.

If we account for risk aversion in the pre-retirement population, can early generations be compensated, during their lifetime, for paying the transition "double payment?" We begin to answer this question by estimating the value of the existing program, defined as the current law benefit formula and the payroll tax rate required to fund the benefits defined by that formula, to all current beneficiaries. Then we allow generations, for whom the system has a negative value, to buy their way out of the system and see if the resulting revenue could repay the transition costs for each paying generation during that generation's lifetime.¹³

There are several accounting metrics used to assess the financial status of the Social Security system. Figure 1 can be used to introduce two of the conventional measures: the 75-year open group and 100-year closed group unfunded obligations. The most widely known is the 75-year open group unfunded obligation. This measures the present value of the difference between expected revenues and cost of the program over a 75-year period. It is known as an open group calculation because new participants are added to the calculation in each year.¹⁴ In Figure 1 we see that the difference between the open group cost rate and income rate, once multiplied by the underlying taxable payroll yields a present value of \$6.6 trillion.

¹³ Note here that the calculations have no bearing on any of the issues of reform. Rather, the calculations are purely hypothetical and simply note that for risk-averse individuals about to enter the labor force and given the option of participating in the current system, how much would they pay, or have to be paid, to be indifferent concerning that participation.

¹⁴ Formally the current value of the Social Security Trust Fund is used to offset the 75-year present value of the difference between tax revenues and benefit payments. In 2008, the Trust Fund was valued at \$2.2 trillion producing the official unfunded obligation of \$4.3 trillion. Given that our exercise is forward looking, and all benefit payments will come from future tax revenue, the relevant present values are based solely on flows in 2008 and later.

The closed group calculation is limited to current participants, defined as those 15 years of age and older. It extends over a 100-year period until the youngest members of the group have passed away. The present value of the net payments (lifetime benefits received less remaining lifetime taxes) to current participants is the closed group unfunded obligation. The closed group is well suited of an application of our model because we can distinguish between current and future participants and their relative perspective on uncertain tax payments paid by members of the closed group. As we see in Figure 1, the present value of the closed group obligation is \$17.4 trillion.¹⁵ Between 2008 and 2030 most of the program's costs are due to benefit payments to members of the closed group, but thereafter the closed group's share declines. Initially, all tax revenues come from the closed group, but as members of this group exit the labor force their relative share declines rapidly.

Since the system cannot be maintained at the existing tax rate and benefit schedule, a closed group debt consistent with the system being self supporting must involve higher tax rates or a reduced benefit schedule. For our current and subsequent calculations we assume that scheduled benefits will be paid and thus tax revenues must rise to cover the benefit's costs. In Figure 2 we again show the closed group's costs and revenues under the statutory tax rate and also show the tax revenues assuming that members of the group and all subsequent new entrants will pay the cost rate that balances the Social Security budget each year. If the tax rate is immediately adjusted to the cost rate and then adjusted to the prevailing cost rate in all following years, the closed-group funding gap drops to \$15.4 from \$17.4 assuming the non-risk adjusted discount rate.

¹⁵ The actuaries calculate the closed group debt assuming, as we do, that the current benefit structure remains in place, thus assuming that Congress would amend the current law to allow the payment of benefits after the Trust Fund is exhausted.

Now we turn our attention to risk adjusting the discount rates. These adjusted rates will then be used to recalculate the closed-group obligation from the perspective of current participants and then from the perspective of future participants. We assume that the non-Social Security part of government is independent of the outcome of the pay-as-you-go Social Security program. We also assume that the benefit formula is fixed and only the payroll tax rates required to fund these benefits is uncertain. Using the stochastic projections reported in the 2008 Social Security Trustees Report we estimate the mean and standard deviation of the cost rate as a share of projected taxable payroll to estimate the parameters required to derive the appropriate discount rates.¹⁶ As expected, the error surrounding the projections increases as we go forward in time.

Since in our model only consumption matters, we express everything in terms of consumption. Taxable payroll, the base of computations for the Trustees Report stochastic model, is a little over 54 percent of consumption in 2008 which means the cost of the program is 6.1 percent of consumption. As mentioned, we assume that scheduled benefits will be paid with certainty to members of the closed group and thus from the perspective of the closed group variation in the annual costs of participating in the program determines the risk adjustment. The left-hand panel of Figure 3 presents the annual risk adjusted interest rate i_t^* implied by equation (10) from the perspective of the closed group's members. The annual interest rate estimates are based on risk aversion parameters ranging from 0 to 6. From the perspective of current participants – the members of the closed group – uncertain future costs of participation must be discounted at lower rates and the lowest rates are associated with the highest risk aversion. From

¹⁶ The 2008 Annual Report of the Board of Trustees of the Federal Old-Age and Survivors Insurance and Federal Disability Insurance Trust Funds (2008). The implied variation in consumption is derived from the stochastic model's distribution of cost rates as depicted in Figure VI. E2. p. 170 of the Trustees Report.

their perspective, the closed group obligation can be thought of as the closed-group's aggregate net benefits. Their net benefits are diminished the higher the risk aversion for any given amount of projected uncertainty.

In contrast, the right hand panel of Figure 3 shows the annual risk adjusted interest rate i_t^r from the perspective of future participants. From the perspective of future participants any revenues to the program that are paid by current participants are uncertain and therefore must be discounted at higher rates depending on the level of risk aversion. From the perspective of future participants, the closed group obligation can be thought of as the net burden the closed-group imposes on them. The net costs grow with higher risk aversion for any given amount of projected uncertainty in the tax revenues from the closed group members.

Figure 4 presents the net remaining lifetime benefits expected from Social Security for the members of the closed group. The benefits include all components of the OASDI program including spousal benefits, survivor's benefits, and disability benefits. The net benefits are presented on a per capita basis as of 2008 for each birth year from 1910 to 1993. As shown in the figure net benefits rise from the oldest birth years to birth year 1947, age 61 in 2008, and then decline for younger cohorts. This profile reflects the interactions of projected longevity from 2008 forward, relative initial benefits by birth year, and remaining lifetime tax payments. Because the older cohorts are no longer in the labor force their net benefits can only be affected by the modest income tax payments on Social Security benefit. As suggested by the figure, the remaining lifetime taxes adjusted for risk aversion primarily affect those birth cohorts who have the longest remaining labor force participation horizons. Consider the older workers who are not yet retired, say

those between 50 and 60 years of age in 2008. Based on the risk adjusted discount rates presented in the first panel in Figure 3 and combined with the fact that they have only a few years remaining in the labor force, their risk adjusted net benefits will not diverge significantly from the net benefits calculated with no risk adjustment.

However, the net benefits of the younger members of the closed group are significantly affected. In Table 1, below, we show the average net benefits the members of the 1987 birth cohort who are 21 in 2008. The net benefits are presented assuming risk neutrality and for the three levels of risk-aversion. For convenience, and to distinguish the exact form of current Social Security we are evaluating from what is current law, hereafter we refer to our assumed Social Security as Fixed Benefit Schedule Social Security (FBSSS).¹⁷ Even with the amount of redistribution inherent in the current benefit formula, the FBSSS contract has a negative value for average members of the 1987 birth cohort even if participants are risk neutral. This simply means that the implicit return to the OASDI program including all benefits (survivors and disability in addition to the retirement benefits) is less than the government borrowing rate.¹⁸ Upon reflection this result is not surprising because the new entrants to the labor force are faced with having to support the population surge of the retiring baby boom generation.

One interpretation of the results in Table 1 is as an estimate of the value of the FBSSS contract to a 21-year old new labor force entrant. Essentially, the contract gives ownership of the current system to each individual. Such ownership is the right to the

¹⁷ We ignore the political risk faced by the benefit promises in spite of the fact that in both 1979 and 1983, when the system required large transfers from general revenues, Congress elected to cut benefits. Introducing benefit uncertainty would require a discount rate higher than the risk free bond return for uncertain future benefits, making the Social Security contract even less attractive and hence strengthening our results.

¹⁸ This conclusion is also suggested in the Trustees Report Table IV. B7. in which the present value of costs less taxes for future participants are a negative \$1.5 trillion.

benefits using the current benefit formula and the commitment to pay whatever cost rate is required to pay the benefits of all those who remain in the system. Alternatively, if the assumed levels of risk aversion are interpreted as market levels, the values in Table 1 represent the market price individuals would have to pay market participants to assume their contract.

Table 1
Value of the Social Security Contract
1987 Birth Cohort
 2008\$

	$\alpha = 0$	$\alpha = 2$	$\alpha = 4$	$\alpha = 6$
Average member's net benefit	-\$39,207	-\$44,802	-\$52,279	-\$61,158
Additional tax rate average member is willing to pay to forego participation	3.43%	3.92%	4.58%	5.36%

The estimates in the first row of Table 1 represent what 21-year old individuals would be willing to pay to void their contract. Interpreted in this way, these values can be used to assess the feasibility of moving to a privatized system through the sale of opt-out certificates. In this case we let 21-year olds out of the current contract but impose on them a fixed tax rate from now until they reach the currently legislated full retirement age of 67 that makes them indifferent between leaving and remaining in the current system.

In the second row of Table 1, we show the maximum certain tax rate that the 1987 birth cohort would be willing to pay to opt out of the FBSSS contract. The average risk neutral members of the 1987 birth cohort would be willing to pay 3.43 percent of remaining lifetime taxes to be released from the Social Security program. However,

assuming a risk aversion of 6, members of this birth year would be willing to forego 5.36 percent of their earnings. From Table 1 we see that regardless of the level of risk aversion new entrants to Social Security could conceptually pay to avoid participation and could potentially pay off the closed group obligation. The question that must be answered, however, is whether new entrants into the Social Security program through the infinite horizon, could provide the resources to pay for all those currently in the system and compensate those cohorts who are the first to have to pay for their own retirement benefits. If all those younger than 15 years of age in 2008, including those yet to be born, are assumed to opt out of Social Security in exchange for guaranteed fixed tax rates that make them indifferent, can they provide the required revenue to pay for the deficits that will be incurred as those who remain in Social Security and eventually exit the system via death? It is this debt that those exiting the system must pay if the phasing out of the program is to be done in a Pareto manner.

But first we must estimate the value of the net benefits to the closed group. Table 2 presents two sets of estimates from the respective perspectives of current and future participants. The estimates identify the present value the closed group obligation under risk aversion parameters ranging from 0 to 6. The first set of estimates in the left-hand column identifies the present value of the net benefits from the perspective of members of the closed group. As mentioned, the closed group obligation under no uncertainty and assuming that the revenue rate is immediately adjusted to the cost rate that will pay benefits on a pay-as-you go basis is \$15.4 trillion. Adjusting for uncertainty using the interest rates depicted in the first panel of Figure 3 lowers the present value of net benefits by as much as \$1.5 trillion when the risk aversion parameter is 6. Thus the range

of costs that must be covered by the opt-out tax payments of future payments would range from \$15.4 trillion down to \$13.9 trillion.

Estimating the closed group obligation from the perspective of future participants calls for the use of the discount rates depicted in the right hand panel of Figure 3 because future participants view the closed group members' tax payments as uncertain revenues. The risk adjustment indicates that the net cost of the closed group from this perspective rises by as much as \$1.3 trillion to \$16.7 trillion.

Table 2
The Risk Adjusted Closed Group Obligation
\$2008 Trillions
Assumes pay-as-you-go tax rate = cost rate beginning in 2008

α	Closed Group's net benefits Current Participants' Perspective	Closed Group's net costs Future Participants' Perspective
0	\$15.4 Trillion	\$15.4 Trillion
2	\$15.1 Trillion	\$16.0 Trillion
4	\$14.5 Trillion	\$16.4 Trillion
6	\$13.9 Trillion	\$16.7 Trillion

In order to estimate the ability of future taxpayers to pay off the net benefits expected by the closed group members as calculated in the first column of Table 2, we estimate the opt-out tax rates or "buy-out" tax rates that future participants would be willing to pay to buy out of Social Security. In Figure 5 we show the buy-out tax rates, defined as the maximum certain tax rate that average members of birth years 1978 to 2000 would be willing to pay to give up participation in the FBSSS system, for various levels of risk aversion.

If we assume that future participants, beginning with individuals born in 1994 and later pay a buy-out tax rate that makes them indifferent between remaining in FBSSS and paying for their own retirement benefits, we can address the question of the possibility of a Pareto big-bang transition to a prepaid system. Risk neutral members of the 1994 birth year would be willing to pay a 4.21 tax rate to buy out of Social Security, but if the relevant risk aversion parameter is 6 then they would be willing to pay a 7.93 rate. As seen in the figure the buy-out tax rates rise for younger cohorts, such that the rate for birth year 2000 ranges from 4.51 to 10.72.

Using the projections contained in the 2008 Social Security Trustees Report, we have estimated the revenue shortfalls that would occur if beginning in 2008, all those in the 1994 birth cohort and beyond were taxed at a rate that made them indifferent between leaving and remaining in the current system. Further we assume that these shortfalls are covered by borrowing until the shortfalls become surpluses, as they certainly must once the closed group is entirely gone from the system, since at that time the total system cost is zero and opt-out tax is positive.¹⁹ The issue then becomes whether or not the present value of the revenue from the buy-out taxes is sufficient to cover the closed group debt.

In Table 3 below, we again show the closed group's net benefits assuming different levels of risk aversion. These are the transition costs that must be paid by future participants. The next column shows the approximate infinite horizon present value of the buy-out taxes paid by all generations beginning with the 1994 birth cohort.²⁰

¹⁹ This borrowing is in lieu of the taxes that would have to have been paid by the opt-out generations to pay for the benefits of those who remain in the current system. Thus, the issue becomes whether the revenues from the opt-out generations will be sufficient to pay off this debt.

²⁰ We have approximated the infinite horizon by going out 500 years to the year 2506.

Consistent with the theoretical discussions of the possibility of a Pareto improving “Big Bang” transition, the present value of the buy-out tax revenues for a risk neutral population is insufficient to pay off the bonds that would have to be issued during the deficit years of the closed group. However, once we account for risk aversion, the flows of buy-out tax revenues exceed the transition costs. For risk aversion level $\alpha=2$ the potential \$15.5 trillion revenue from the taxation of generations that will benefit from the conversion exceeds the \$15.1 trillion in net benefits with the same risk aversion level. For risk aversion level $\alpha=4$ potential buy-out taxes exceed the net benefits by \$4.4 trillion and with a risk aversion level of 6 potential buy-out taxes exceed net benefits by almost \$10 trillion.

Table 3
Present Value of Buy Out Tax Receipts vs Transition Costs
\$2008 Trillions

α	Closed Group’s net benefits Current Participants’ Perspective (Transition Costs)	Buy-Out Tax Receipts Paid by Future Participants
0	\$15.4 Trillion	\$12.6 Trillion
2	\$15.1 Trillion	\$15.5 Trillion
4	\$14.5 Trillion	\$18.9 Trillion
6	\$13.9 Trillion	\$23.8 Trillion

6. Concluding Discussion

An uncertain revenue stream is worth less than its expected value to a risk-averse expected utility maximizing individual. By the same token, a risk-averse expected utility

maximizing individual will be willing to give up more than the expected value of an uncertain cost stream to avoid the uncertainty. We devise a simple model consistent with this proposition that allows us to derive discount rates appropriate for calculating the burden of government generation transfer programs from the perspective of the ultimate bill-paying generation. When the ultimate bill-paying generation is risk-averse, the traditional approach of discounting these flows using the risk-free government borrowing rate understates the burden of the future deficits on those who ultimately must pay the bills.

Accounting bill-payer risk aversion requires adjusting the discount rate based on the government borrowing rate downward for uncertain future expenditures and upward for uncertain future revenues. The real government bond return used in the two most recent Trustees' reports is 2.9%. However, when the future is uncertain due to economic and/or political risks, the estimated future expenditures (revenues) should be discounted at a lower (higher) rate. Depending on the magnitude of uncertainty and level of risk aversion, a range of sensitivity analyses with respect to risk adjustments in the discount rate may be warranted.

We applied these findings to the current Social Security program in two ways. First, we applied our results to the question of the possibility that an immediate transformation of the current generation transfer system to a prepaid system could be done in a manner that was Pareto improving. In this experiment we assumed that beginning in 2008, all potential new entrants to the system were out of the current Social Security contract. Each cohort was assumed to pay the tax rate that made them indifferent between remaining in the old system and opting out. For any population with a

coefficient of risk aversion greater than two, we find that a Pareto improving transition is potentially feasible.

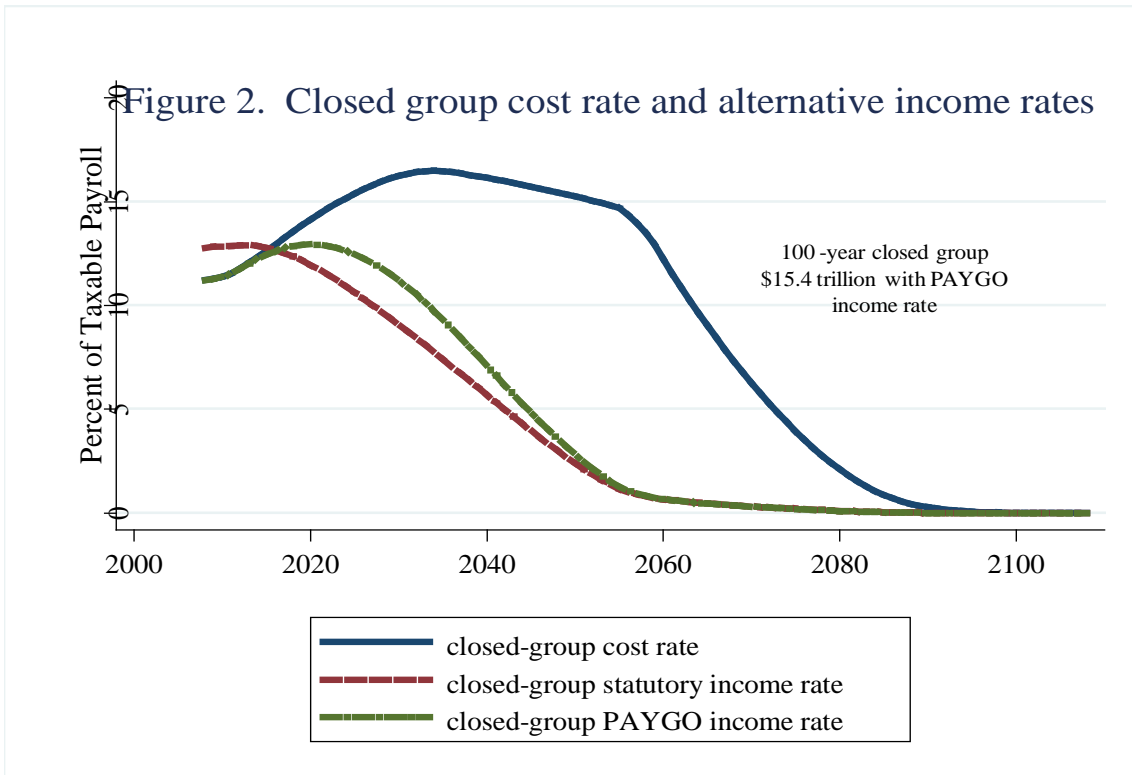
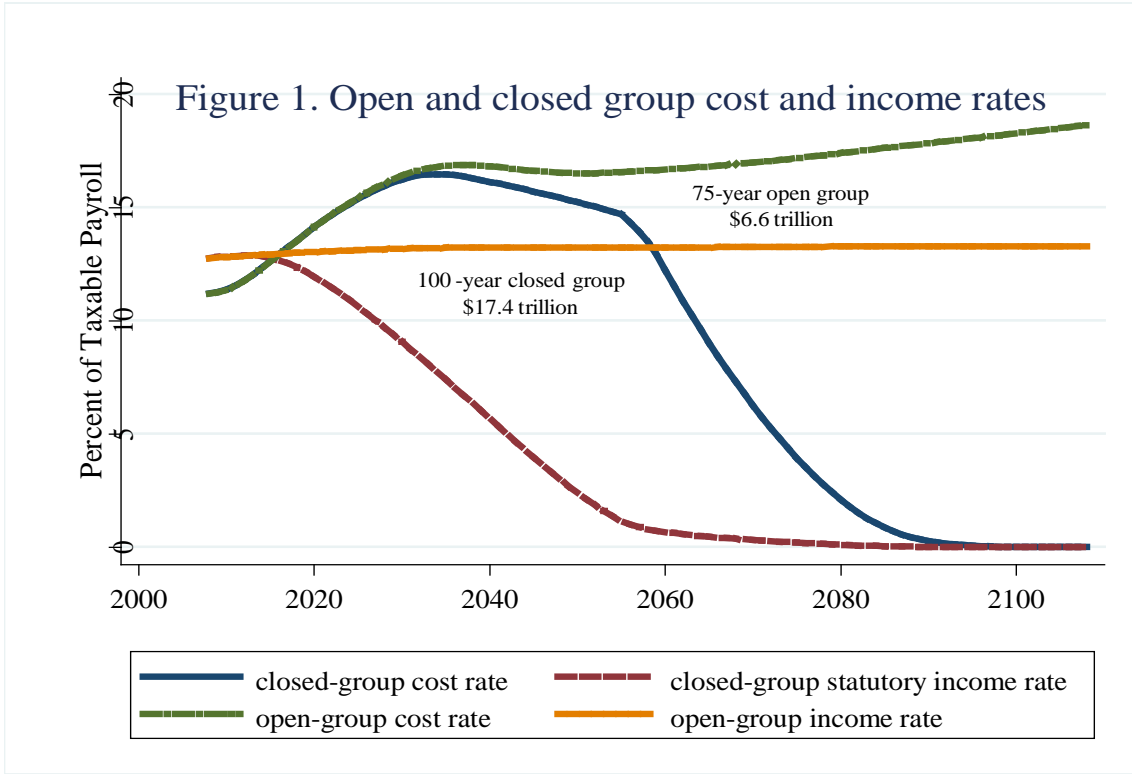


Figure 3.

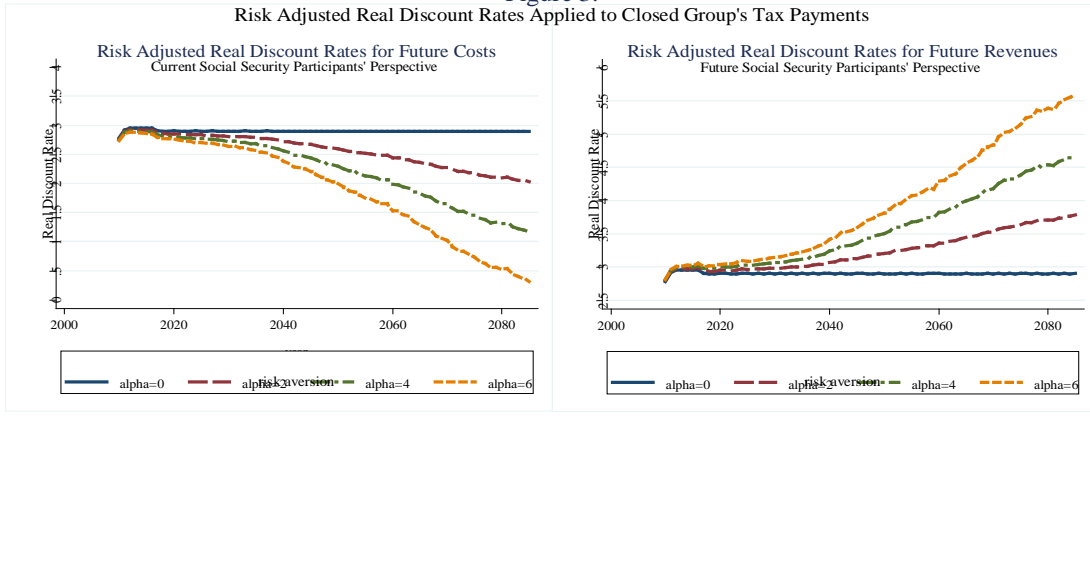


Figure 4. Closed-group cohorts' net benefits in 2008

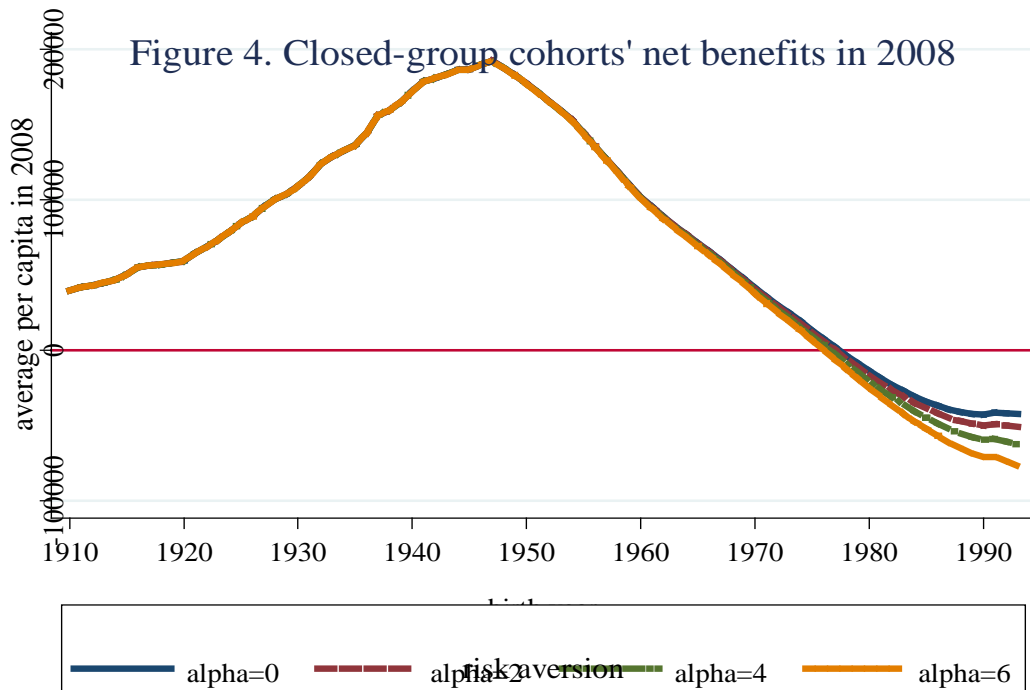
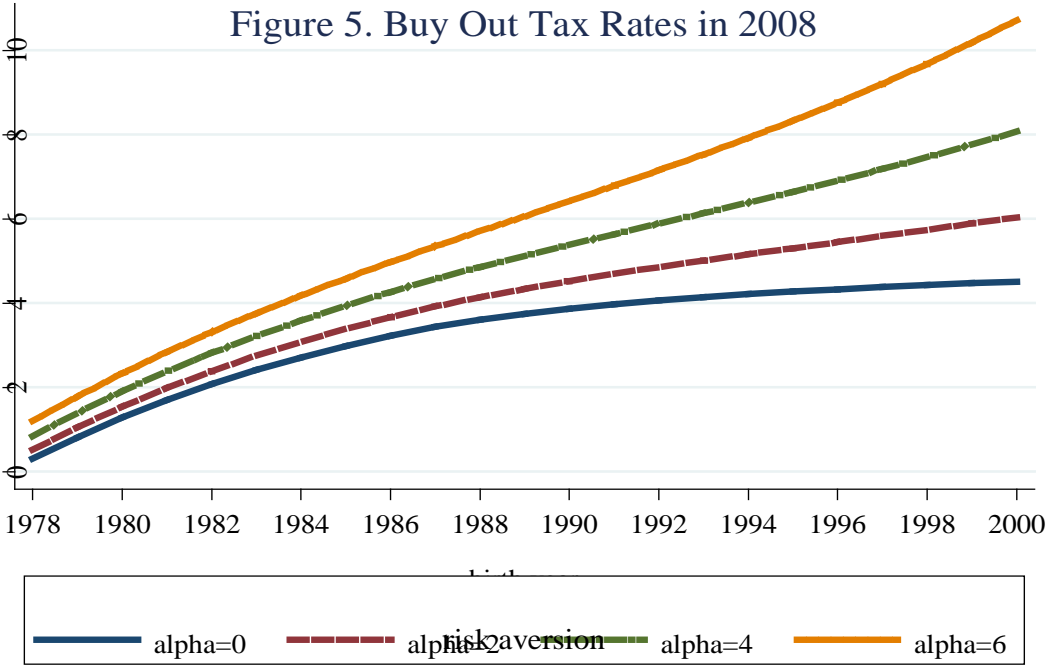


Figure 5. Buy Out Tax Rates in 2008



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