OPTING OUT OF SOCIAL SECURITY AND ADVERSE SELECTION

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ABSTRACT

This paper compares two general methods of privatization social security: forced participation in the new privatized system versus allowing people to choose between the new system or remaining in social security (i.e., opting out). Simulations are performed using a large scale perfect-foresight OLG simulation model that incorporates both intra-generational and inter-generational heterogeneity. The decision of any agent to opt out is endogenous and, for example, depends on the opting out decisions of all other agents vis-à-vis factor prices. Various tax bases are considered in financing the transition path. The *perceived* tax-benefit linkage also receives special consideration due to the informational problems inherent in many social security systems. We consider two cases: full and no perception.

Both methods of privatizing social security lead to large long-run gains for all lifetime income classes despite the intra-generational progressivity of social security. But they differ in their short run effects due to adverse selection associated with opting out. Adverse selection is a key reason why many economists oppose opting out and why, for example, numerous proposals to privatize the social security systems of the US and other countries mandate participation. This paper, however, shows this wisdom to be wide of the mark. Relative to forced participation that preserves accrued liabilities, the opting out method performs surprisingly well both in its distributional impact and speed of convergence. Opting out tends to do a better job at protecting the welfare of the initial elderly, even though the forced participation method is designed to fully protect their real value of social security benefits. This is because opting out continues to collect payroll tax revenue from those who stay with social security, reducing the requirements on general revenue. Moreover, opting out tends to be associated with quicker transition paths by reducing social security wealth more rapidly than forced participation. This is because many people are willing to forfeit their accrued claims to social security as the price of opting out. Yet opting out, combined with a decrease in the payroll tax rate for those who remain in social security, is better able to shift part of the transitional burden to future workers who benefit from privatization. These results suggest that giving people freedom of choice might actually generate more favorable outcomes than mandates.

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I. Introduction

A privatization plan that forces participation in the new system may be less likely to be implemented than one that gives people the choice to opt out of social security. While numerous proposals to privatize the US social security system involve forced participation in the new system, most actual privatization implementations around the world have given people the choice to opt out. This was true, for example, in Chile, Argentina, and other major reforms in Latin America. In these countries, people who accrued a sufficient level of benefits under the traditional public system were allowed to stay; only new workers were forced into the new system. In the U.K., even new workers are allowed to choose between the traditional public pension system and private accounts.

Allowing for choice comes at a cost. It generates a severe adverse selection problem in a system with self-financing earmarked taxes. When the economy is efficient, social security's overall internal rate of return (equal to growth rate of the tax base) is less than the marginal rate of return to capital. Social security therefore can be a good deal to some people only by being a bad deal to others. Those agents whose present value of future social security taxes (PVT) exceeds the present value of future benefits (PVB) will choose to opt out. The departure of these agents means that payroll taxes must increase on workers who choose to remain in social security—those for whom PVT < PVB—in order to provided present-law benefits for those remaining. This increase in the payroll tax will cause even more workers to opt out, *ad infinitum*—an upward tax spiral (no convergence).

Allowing for opting out therefore requires some financing from general revenue. Augmenting social security finances in this way allows the payroll tax to be set at any desired rate which eliminates the upward tax spiral. The distributional impact of privatization, of course, will

depend on which taxes are increased. The choice of the tax instrument will also affect the speed of convergence to the new steady state. This is important because privatization plans with shorter transitional periods might be more likely implemented than plans whose benefits will be realized only after several decades.

Literature Review

The literature dealing with social security privatization—although growing—is still limited. The list includes Feldstein (1975), Seidman (1983), Arrau and Schmidt-Hebbel (1993), Feldstein (1995), Kotlikoff (1996), Kotlikoff, Smetters and Walliser (1997), Altig and Gokhale (1997), Feldstein and Samwick (1997), and Huang, İmrohoroğlu, and Sargent (1997). Some of these papers employ partial-equilibrium models while others allow for general-equilibrium effects. The analysis in most of these papers corresponds to forced participation in the new system. There are fewer papers dealing specifically with opting out. Gustman and Steinmeier (1995) have considered some partial-equilibrium responses to allowing people to choose between a private saving plan and social security. Samwick (1996) considers a partial-equilibrium three-period model with idiosyncratic earnings uncertainty and heterogenous rates of time preference in which the government offers a menu of buy-out options. He shows that an appropriate menu choice can lead to significant buying out with little impact on saving.

Model Overview

This paper uses a new perfect foresight dynamic simulation model to compare the equity and macroeconomic effects of privatizing social security. Since the decision to opt out by any agent will

be affected by the exact time path of factor prices—which, in turn, is affected by the opting out decisions of other agents—the opting out choice is determined endogenously for each agent. Although the model is built to emulate the US economy, its findings present general lessons. The model is a substantially enhanced version of the Auerbach-Kotlikoff (1987) life-cycle overlapping-generations model. The new model incorporates intra-generational heterogeneity based on micro-data estimation in addition to the inter-generational heterogeneity of its predecessor. The model also includes the salient features of the US social security system including the statutory progressive bend-point formula used by the Social Security Administration to calculate retirement benefits as a function of average wage-indexed pre-retirement wage income. Incorporating key features of the income tax system is also important. Since the current income tax base covers only 57 percent of national income in the US, the model includes an array of tax-base reductions which allows us to use actual tax schedules. These tax-base reductions produce two kinks in the consumer's budget constraint. The first kink is associated with the statutory non-refundable deductions in the income tax system. The second kink is associated with social security's payroll tax ceiling. The model also includes a simple treatment of the Medicare and Disability Insurance programs. A more complete description of the model is given in Section II.

Forced Participation Versus Choice

This paper considers two main types of privatization plans.

The first type is forced participation in which the phase out of social security benefits is determined by law and everyone is required to participate. The beginning of the phase out is delayed for a decade in order to fully protect the benefits of existing beneficiaries. Benefits to existing

workers, although still progressive, are reduced by a percentage that is linear in age. This linear reduction is designed to protect the approximate value of accrued liabilities for existing workers. As Feldstein (1997) notes, our general methodology in this first approach is similar to the popular "recognition bond" approach used throughout many Latin American countries—except, in our case, participation is mandatory. Benefits are financed in the transition period using either the existing payroll tax base (i.e., self-financed earmarking) or from general revenue in the form of income taxation or consumption taxation.

The second type of privatization plan allows for opting out of social security. Workers can stay in the current system under the current benefit and tax rules, or they can opt out. Workers who opt out neither pay future taxes nor collect future benefits; any accrued benefits are forfeited as the price of opting out. In contrast, opting out plans implemented throughout Latin America have usually not required that accrued benefits are forfeited upon opting out, thereby not leading to as quick of a reduction in unfunded liabilities as our plan. Adverse selection will cause the value of benefits to be paid to workers who remain in the system to exceed the revenue collected. A subsidy is received from general revenue financed by either an income tax or a consumption tax.

Modeling the Perceived Link Between Taxes and Benefits

The *perceived* link between payroll taxes and social security benefits plays a role in the desirability of opting out. A weak link means that the payroll tax is more distorting and social security is less desirable as a retirement saving vehicle. Although full perception of incentives is a common assumption in most analysis of government programs, it tends to be less appropriate for social security where the financing tax is not a pure tax but a benefit tax. What matters for economic

decision making, therefore, is the *net* marginal payroll tax rate. The net marginal payroll tax is equal to the tax paid on an extra dollar of wage income less the present value of additional benefits received. While everyone faces the same statutory tax rate up to the covered earnings ceiling, the net tax rate varies significantly across lifetime income classes and over the lifecycle within each lifetime income class (Feldstein and Samwick, 1992; see below). It is highly unlikely, therefore, that people know the correct net tax rate they face. Moreover, some analysts believe that people often confuse social security benefit rules with private pension rules. Private pensions typically use a much shorter period as the basis for calculating retirement benefits. Both of these factors suggest that the payroll tax might in practice be more distorting than it need be.

The US Social Security Administration does not provide its pensioners with the information they need to know their net marginal tax rate. The US Social Security Administration will, upon request, provide individuals with an estimate of their future benefits. This information, though, does not indicate the *marginal* benefit associated with an extra dollar of payroll taxes—the actual information needed in order to know to the net payroll tax rate. Hence, people might be fairly unaware of the net tax rates they face even if they are fully aware of their future benefits.

Most of the simulations presented herein are performed under two alternative assumptions of the perceived marginal tax-benefit linkage: full perception and no perception. In the full perception case, agents know their exact net marginal tax rate, which is less than the statutory rate. In the no perception case, agents view the payroll tax as a pure tax, and so view the statutory rate as the marginal rate. In each case, agents are fully aware of their future level of benefits. In the case of consumption tax financing, a deterioration in the real value of social security benefits paid to existing beneficiaries is avoided by CPI indexing.

Summary

Both methods of privatizing social security lead to large long-run gains for all lifetime income classes despite the intra-generational progressivity of social security. But they differ in their short run effects due to adverse selection associated with opting out. Adverse selection is a key reason why many economists oppose opting out and why, for example, numerous proposals to privatize the social security systems of the US and other countries mandate participation. This paper, however, shows this wisdom to be wide of the mark. Relative to the forced participation method that preserves accrued liabilities, the opting out method performs surprisingly well both in its distributional impact and speed of convergence. Opting out tends to do a better job at protecting the welfare of the initial elderly, even though the forced participation method is designed to fully protect their real value of social security benefits. This is because opting out continues to collect payroll tax revenue from those who stay with social security, reducing the requirements on general revenue. Moreover, opting out tends to be associated with quicker transition paths by reducing social security wealth more rapidly than forced participation. This is because many people are willing to forfeit their accrued claims to social security as the price of opting out. Yet opting out, combined with a decrease in the payroll tax rate for those who remain in social security, is better able to shift part of the transitional burden to future workers who benefit from privatization. These results suggest that giving people freedom of choice might actually generate more favorable outcomes than mandates.

II. Outline of The Benchmark Economy[1]

This section provides an outline of the benchmark economy calibrated to the 1996 US economy. The solution method is discussed in the Appendix.

Demographic Structure

The model's cohorts are distinguished by their dates of birth and their lifetime labor-productivity endowments. Following Fullerton and Rogers (1993), each cohort includes 12 lifetime-earnings groups.[2] Each of these 12 groups has its own initial endowment of human capital and its own pattern of growth in this endowment over its lifetime. The lifetime-earnings groups also differ with respect to their bequest preferences. All agents live for 55 periods with certainty (corresponding to adult ages 21 through 75), and each j-type generation is $1+n$ times larger than its predecessor. At model age 21, each j-type cohort gives birth to a cohort of the same type. Population growth is exogenous, and each cohort is $(1+n)^{20}$ larger than its parent cohort.

Preferences and Household Budget Constraints

Each j-type agent who begins her economic life at date t chooses perfect-foresight consumption paths (c), leisure paths (l), and intergenerational transfers (b) to maximize a

[1] Some of this section follows Section II of Altig, Auerbach, Kotlikoff, Smetters and Walliser (1997) which investigates the effects of fundamental tax reform.

[2] Our model has several strengths relative to Fullerton and Rogers (1993) and, at least, one weakness. The strengths include a rational-expectations solution, a social security system, a tax system with progressive marginal tax rates, an array of tax base reductions, government debt, bequests, and other features. The model herein, however, lacks the multi-sectoral detail on the production side present in the Fullerton-Rogers model. The omission of this production detail probably has little relevance for our purposes since privatization does not change the inter-sectoral distortions.

time-separable utility function of the form

$$(1) \qquad U_t^j = \frac{1}{1-\frac{1}{\gamma}} \left[\sum_{s=21}^{75} \beta^{s-21} \left(c_{s,t+s-21}^{j\,1-\frac{1}{\rho}} + \alpha l_{s,t+s-21}^{j\,1-\frac{1}{\rho}} \right)^{\frac{1-\frac{1}{\gamma}}{1-\frac{1}{\rho}}} + \beta^{54} \mu^j \, b_{75,t+54}^{j\,1-\frac{1}{\gamma}} \right].$$

In (1) α is the utility weight on leisure, γ is the intertemporal elasticity of substitution in the leisure/consumption composite, and ρ is the intratemporal elasticity of substitution between consumption and leisure. The parameter μ^j is a j-type specific utility weight placed on bequests left to each child when the agent dies. The term $\beta = 1/(1+\delta)$ where δ is the rate of time preference, assumed to be the same for all agents.

Letting $a_{s,t}^j$ be capital holdings for type j agents, of age s, at time t, maximization of (1) is subject to a sequence of budget constraints given by

$$(2) \qquad a_{s+1,t+1}^j = (1+r_t)\,(a_{s,t}^j + g_{s,t}^j) + w_{s,t}^j (E_{s,t}^j - l_{s,t}^j) - c_{s,t}^j - \sum_{k \in \tilde{\mathbf{T}}} T^k(B_{s,t}^{j,k}) - N b_{s,t}^j.$$

$$l_{s,t}^j \le E_{s,t}^j$$

where r_t is the pretax return to savings, $g_{s,t}^j$ are gifts received from parents, $E_{s,t}^j$ is the time endowment, $b_{s,t}^j$ denotes bequests made to each of the $N = (1+n)^{20}$ children, and the functions $T^k(\cdot)$ with tax base arguments $B_{s,t}^{j,k}$ determine net tax payments from income sources $k \in \tilde{\mathbf{T}} = \{C, K, W, Y, P\}$. $T^C(\cdot)$, $T^K(\cdot)$, $T^W(\cdot)$, $T^Y(\cdot)$ and $T^P(\cdot)$ are consumption taxes, capital income taxes, wage taxes, income taxes and social security payroll taxes, respectively. Social security benefits are represented in equation (2) as negative taxes with the base switching at the point of retirement from the contemporaneous payroll base to average indexed yearly earnings in the pre-retirement years. All

taxes are collected at the household level and the tax system includes both a personal income tax and a business profits tax. The bases for the wage and payroll taxes are smaller than total labor income due to the base reductions discussed below.

An individual's earnings ability is an exogenous function of her age, her type, and the level of labor-augmenting technical progress, which grows at a constant rate λ. We concentrate all skill differences by age and type in an efficiency parameter ϵ_s^j. Thus, the wage rate for an agent of type j and age s is $w_{s,t}^j = \epsilon_s^j w_t$, where w_t is the growth-adjusted real wage at time t. ϵ_s^j increases with age to reflect not only the accumulation of human capital, but also technical progress. To permit balanced growth for our specifications of preferences given the restriction on leisure shown in equation (2), we assume that technical progress also causes the time endowment of each successive generation to grow at rate λ.[3] Thus, if $E_{s,t}^j$ is the endowment of type j at age s and time t, then $E_{s,t}^j = (1+\lambda) E_{s,t-1}^j$, for all s, t, and j. Notice that the endowment $E_{s,t}^j$ depends only on an agent's year of birth. Because E grows at rate λ from one cohort to the next, there will be no underlying trend in w_t.

The growth-adjusted earnings ability profiles take the form

$$\epsilon_s^j = e^{a_0^j + a_1^j s + a_2^j s^2 + a_3^j s^3}. \tag{3}$$

Values of the a coefficients for j-type groups 1 through 12—in ascending order of lifetime income—are based on regressions fitted to the University of Michigan's Panel Study of Income Dynamics and are taken from Altig, Auerbach, Kotlikoff, Smetters and Walliser (1997). Groups 1 and 12 comprise the bottom and top 2 percent of lifetime wage income earners, and groups 2 and

[3] See Auerbach, et al. (1989) for a more complete discussion of this strategy for dealing with balanced growth.

11 the remaining 8 percent of the top and bottom deciles. All other groups constitute 10 percent of the population. For example, group 3 is the second decile of lifetime-wage income, group four the third decile, and so on up to group 10. The estimated earnings-ability profiles, scaled to include the effects of technical progress. Given our benchmark parameterization, peak hourly wages valued in 1996 dollars are \$4.00, \$14.70, and \$79.50 for individuals in classes 1, 6, and 12, respectively. More generally, steady-state annual labor incomes derived from the model's assumptions and the endogenous labor supply choices range from \$9,000 to \$130,000. These calculations do yet include labor compensation in the form of fringe benefits (discussed below).

Transfers are received by children, with interest, at the beginning of the period after they are made by their parents. We restrict all parental transfers to bequests, so that $b_{s,t}^j = 0$, for $s \neq 75$, and $g_{s,t}^j = 0$, for $s \neq 56$. In the steady state, therefore, $g^j = b^j$, for all j (where we have dropped the age subscripts for convenience). The parameters μ^j are derived endogenously for the initial steady state such that the ratio of the bequest to economy-wide mean income corresponds to the ratio originally estimated by Menchik and David (1982) and updated by Fullerton and Rogers (1993). Bequests range from \$4,800 to \$450,000 for the lowest and highest lifetime earnings classes, respectively.

Choices for the remaining technology, preference, and demographic parameters are summarized in Table 1. The benchmark values for δ, γ, ρ, and n are those in Auerbach and Kotlikoff (1987). The parameter α is chosen so that agents devote, on average, about 40 percent of their available time endowment (of 16 hours per day) to labor during their prime working years (real-life ages of roughly 21-55).

The Non-Social Security Government Budget Constraint

At each time t, the government collects tax revenues and issues debt (D_{t+1}) which it uses to finance government purchases of goods and services (G_t) and interest payments on the inherited stock of debt (D_t). Letting ϕ^j be the fraction of j-type agents in each generation, the non-social security part of the government's budget constraint evolves according to

$$(4) \qquad D_{t+1} + (1+n)^t \sum_{j=1}^{12} \phi^j \sum_{s=21}^{75} (1+n)^{-(s-21)} \sum_{k \in \{\tilde{T}-P\}} T^k(B_{s,t}^{j,k}) = G_t + (1+r_t)D_t.$$

The exclusion of social security taxes in equation (4) reflects the fact that social security currently uses self-financing earmarked taxes.

Government expenditures are assumed to be unproductive and generate no utility to households.[4] The values of G_t and D_t are held fixed per effective worker throughout the transition path. Any reduction in government outlays resulting from a change in the government's real interest payments is passed on to households in the form of a lower tax rate. The level of government debt, D_t, was chosen such that the associated real interest payments equal about 3.5 percent of national income in the initial steady state. The statutory tax schedules (described below) generate a level of revenue above debt service such that the benchmark steady-state ratio of government purchases, G_t, to national income equals 0.214. These values correspond very closely to the corresponding 1996 values for the combined local, state, and federal government in the United States. See Table 2.

[4] Since G remains fixed in all of our experiments, incorporating G into the utility function is unimportant.

Non-Social Security Taxes

The benchmark tax system in our initial steady state is designed to approximate the salient aspects of the 1996 U.S. (federal, state, and local) tax and transfer system. It features a hybrid tax system (incorporating wage-income, capital-income, and consumption tax elements) and payroll taxation for the Social Security and Medicare programs. To adjust for tax evasion, we reduce income taxes by 2.6 percentage points. This adjustment is consistent with the degree of tax evasion reported in Slemrod and Bakija (1996). In the various alternative tax structure experiments we assume that evasion reduces the post-reform tax base (income net of deductions and exemptions) by the same percentage as before the reform. Thus, the level of tax evasion falls when the tax base shrinks.

We approximate the hybrid current U.S. tax system by specifying a progressive wage-income tax, a flat capital-income tax, a flat state income tax, and a flat consumption tax.

Wage Income Taxation

The wage-income tax structure has four elements: 1) a progressive marginal rate structure derived from a quadratic approximation to the 1996 federal statutory tax rates for individuals, 2) a standard deduction of $4000 and exemptions of $5660 (which assumes 1.2 children per agent, consistent with the model's population growth assumption), 3) Itemized deductions—applied only when they exceed the amount of the standard deduction—that are a positive linear function of income estimated from data reported in the *Statistics of Income*,[5] and 4)

[5] The data used in this estimation was taken from all taxable returns in tax year 1993. The function was obtained by regressing deductions exclusive of mortgage interest expense on the midpoints of reported income ranges. (The deduction of interest expense on home mortgages was included in our calculation of the capital-income tax rate, as we will subsequently describe.) The regression yielded a coefficient of 0.0755 with an R^2 equal to 0.99.

Earnings-ability profiles that are scaled up to incorporate pension and non-pension components of labor compensation.[6]

The model's initial economy-wide average marginal tax rate on wage income is about 21 percent, about the figure obtained from the NBER's TAXSIM model reported in Auerbach (1996). The average wage-income tax rate equals 12.1 percent. For all individuals in the highest lifetime income class (group 12), the average effective marginal tax rate on labor income is 28.6 percent. The highest realized effective marginal tax rate is 34 percent. For lifetime income class 6—whose members have peak labor earnings of about $35,000—the average tax rate and average marginal tax rate are 10.6 and 20.0 percent, respectively. For the poorest class (group 1), the corresponding rates are zero and 5.5 percent.[7]

Capital Income Taxation

Following Auerbach (1996), we assume that income from residential capital and non-residential capital are taxed at flat rates of 6 percent and 26 percent, respectively. Given the roughly equal amounts of these two forms of capital, the effective federal marginal tax rate on total capital income is 16 percent. However, this rate applies only to new capital. Existing capital faces a higher tax rate which, given depreciation schedules, is estimated to be 20 percent. We model this gap by assuming that all capital income faces a 20 percent tax, but that 20 percent of new capital may be expensed, thereby generating a 16 percent effective rate on new capital.

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[6] Benefits as a function of adjusted gross income were kindly provided by Jane Gravelle of the Congressional Research Service and Judy Xanthopoulos of the Joint Committee on Taxation, respectively. Based on this information we regressed total benefits on AGI. The regression yielded a coefficient of 0.11295 with an R^2 equal to 0.99. In defining the wage-tax base, we therefore exempt roughly 11 percent of labor compensation from the base calculations.

[7] The average marginal rate for people with the lowest income exceeds zero due to positive shadow tax rates in peak earnings years.

State Income Taxation

In addition to the federal taxation, both capital and wage income are subject to a proportional state income tax of 3.7 percent. This value corresponds to the amount of revenue generated by state income taxes in 1996 divided by national income.

Consumption Taxation

Consumption taxes in the initial steady state reflect two elements of the existing tax structure. First we impose an 8.8 percent tax on consumption expenditures consistent with values reported in the National Income and Product Accounts on indirect business and excise revenues. However, because contributions to both defined benefit and defined contribution pension plans receive consumption tax treatment, we levy an additional 2.5 percent tax on household consumption goods expenditures to account for the indirect taxation of labor compensation in the form of pension benefits (Auerbach 1996). This 2.5 percent tax replaces the wage tax that otherwise would apply to labor compensation in the form of fringe benefits.

Social Security, Medicare and Disability

The model has a social insurance system that incorporates social security Old-Age and Survivors Insurance (OASI), Social Security Disability Insurance (DI), and public health insurance taking the form of Medicare (HI).

OASI benefits are calculated according to the progressive statutory bend-point formula. U.S. Social Security benefits are based on a measure of average indexed monthly earnings (AIME) over a 35-year work history. The AIME is converted into a primary insurance amount (PIA) in accordance with a progressive formula. In particular, the 1996 benefit formula has two bend points.

The PIA is calculated as 90 percent of the first $437 of AIME, 32 percent of the next $2,198 of AIME, and 15 percent of AIME above $2,198. We approximate the benefit formula with a sixth-order polynomial which is applied to the dollar-scaled AIME generated by the model. This polynomial approximation is very accurate with a $R^2 = 0.99$ (Figure 1). We achieve replacement values between 25 and 75 percent for the lifetime richest and lifetime poorest, respectively. Since approximately 50 percent of Social Security benefits are paid to survivors and spouses, we multiply benefits by a factor of two.

An earmarked tax applied to wage income up to a limit of $62,700—the earnings ceiling in 1996—is used to pay for OASI benefits. Define $\omega^j_{s,t} \equiv w^j_{s,t}(E^j_{s,t} - l^j_{s,t})$ as the wage income earned by the j-type agent who is age s in year t. Also define $\bar{\omega}^j_{65,t}$ as the average indexed yearly earnings for the j-type agent age 65 at time t. Labor income earned before turning age 65 is adjusted upward by the growth rate of the economy in calculating $\bar{\omega}^j_{65,t}$. Payroll taxes at time t—with retirement benefits modeled as negative taxes—equals

$$T^P(B^{j,k}_{s,t}) = \begin{cases} \tau \cdot \omega^j_{s,t} & ; \quad s \le 64 \ , \ \omega^j_{s,t} \le \$62{,}700 \\ \tau \cdot \$62{,}700 & ; \quad s \le 64 \ , \ \omega^j_{s,t} > \$62{,}700 \\ -2 \cdot R(\bar{\omega}^j_{s,t}) \cdot \bar{\omega}^j_{s,t} & ; \quad s > 64 \end{cases} \tag{5}$$

where $R(\cdot)$ is the statutory replacement rate function shown in Figure 1.

Budget balance for a self-financing pay-as-you-go social security system with earmarked taxes at time t requires:

$$\sum_{j=1}^{12} \phi^j \sum_{s=21}^{75} (1+n)^{-(s-21)} T^P(B^{j,P}_{s,t}) = 0 \tag{6}$$

The value of τ is solve for endogenously as a function of benefit rules via equation (6). The value of τ is 9.9 percent in the initial steady state, which is close to its actual value in 1996.[8]

The net marginal tax rate is a component of the consumer's first-order conditions. Let $PVT(\omega^j_{s,t})$ and $PVB(\omega^j_{s,t})$ be the present value of payroll taxes and benefits, respectively, for the j-type agent age s at time t. The net marginal tax rate for those below the earnings ceiling in each case considered herein is:

$$\theta(\omega^j_{s,t}) = \left\{ \begin{array}{ll} \tau \cdot \left[1 - PVB'(\omega^j_{s,t}) \big/ PVT'(\omega^j_{s,t})\right] & ; \ \textit{full perception linkage} \\ \tau & ; \ \textit{no perception linkage} \end{array} \right\} \tag{7}$$

where $PVB'(\cdot) = \partial PVB(\cdot) \big/ \partial \omega$ and $PVT'(\cdot) = \partial PVT(\cdot) \big/ \partial \omega$. The net marginal tax rates under the perception linkage are shown in Figure 2 by income class and age. These tax rates are typically relatively higher for both richer and younger agents. The higher rates for richer agents reflect the progressive manner in which social security benefits are calculated. The higher rates for younger agents reflect the compound interest effect of being required to save in a social security system whose internal rate of return is less than after-tax rate of return to capital (reported below). Notice that the net tax rates are generally quite large and positive even for the lifetime poor because the after-tax rate of return to capital is higher than the internal rates of return faced by these agents. Rich agents whose labor income exceeds the payroll tax (e.g., class 12 in select years) face a zero marginal tax rate.

The HI and DI programs are modeled very simply. The HI and DI levels of lump-sum

[8] The employer-employee combined payroll tax equaled 10.52 percentage points. About 1 percentage point represents a net increase to the social security trust fund.

transfers are picked to generate payroll tax rates of 2.9 percent and 1.9 percent, respectively, corresponding to their 1996 statutory rates. Like the OASI tax, DI contributions apply only to wages below $62,700. The HI tax, in contrast, is not subject to an earnings ceiling. Lump-sum HI and DI benefits are provided on an equal basis to agents above and below age 65, respectively.

Aggregation and Technology

Aggregate capital (K) and labor (L) are obtained from individual asset and labor supplies as

$$K_t = (1+n)^t \sum_{j=1}^{12} \phi^j \sum_{s=21}^{75} (1+n)^{-(s-21)} a_{s,t}^j - D_t, \tag{8}$$

(where, recall, D_t is government debt at time t) and

$$L_t = (1+n)^t \sum_{j=1}^{12} \phi^j \sum_{s=21}^{75} (1+n)^{-(s-21)} \epsilon_s^j (E_{s,t}^j - l_{s,t}^j). \tag{9}$$

Output (net of depreciation) is produced by identical competitive firms using a neoclassical, constant-returns-to-scale production technology. The aggregate production technology is the standard Cobb-Douglas form

$$Y_t = AK_t^{\theta} L_t^{1-\theta}, \tag{10}$$

where Y_t is aggregate output (national income) and θ is capital's share in production. Denote the capital-labor ratio as κ. The time-t competitive post-tax capital rate of return equals

$$r_t = \left[\theta A \kappa_t^{\theta-1}(1-\tau_t^K) + q_{t+1} - q_t\right] \Big/ q_t. \tag{11}$$

where $q_t = \left(1 - z_t \tau_t^K\right)$ is Tobin's q at time t and z is the level of capital investment expensing.

Given our parameter choices, the model generates a pre-tax interest rate of 9.3 percent, a net national saving rate of 5.3 percent, and a capital/national-income ratio of 2.6. Consumption accounts for 73.4 percent of national income, net investment for 5.2 percent, and government purchases of goods and services for 21.4 percent. These figures are close to their respective 1996 NIPA values. The post-tax interest rate equals 0.08 and is calculated following Auerbach (1996). Summary statistics for the initial economy are provided in Table 2.

Limitations

The model herein incorporates many complex features of the economy and fiscal institutions. However, as any model, our model also abstracts in important ways from reality and the exact numerical results should therefore be interpreted cautiously. In particular, while the model captures the fact that Social Security provides retirement income and redistributes from rich to poor, it does not capture other insurance aspects of social security; for example, the model does not incorporate aggregate rate of return risk. The paper therefore does not deal with the unfunded liability facing government as the insurer of last resort; or, tacitly, the paper assumes that this obligation is pre-funded. Relaxing these assumptions could lead to both smaller short-run costs along with smaller long-run gains. The paper also assumes that adverse selection in the private annuities market is either unimportant numerically or is effectively dealt with via mandated annuitization. On the other hand, certain aspects of the model bias the long-run utility gains downward. This includes calculating the general equilibrium decline in the interest rate associated with privatization in a closed economy setting. Another assumption is our conservative modeling of the saving and labor

supply elasticities which are around zero (uncompensated elasticities). Some other model assumptions have a less clear impact. For example, while introducing binding borrowing constraints would reduce the degree Social Security wealth reduces private saving, including them would also make Social Security's high payroll tax even more utility decreasing. With this said, recall that the main focus of this paper is on the *relative* comparison of forced participation plans versus opting out. The ability of opting out to better protect the utility of the initial elderly and to provide for quicker convergence is likely to be robust to numerous modeling assumptions.

III. Forced Participation in the New System

Forced participation has three steps: a) requiring workers to contribute to private accounts; b) giving retirees and workers social security benefits roughly equal to only those they have accrued as of the time of the reform; and c) financing social security benefits during a transition period.

In our model, privatizing social security contributions just requires setting the model's social security payroll tax rate to zero; i.e., there is no need to add a formal private pension system to the model. Since the agents in our model are not liquidity constrained, forcing them to contribute to private accounts will not affect their net saving or labor supply decisions because they are free to borrow against their mandated retirement accounts. This said, it is worth noting that in the particular economies simulated herein, only the poorest 10 percent of agents actually seek to borrow against social security. So were we to add a liquidity constraint (specifically, a constraint against negative net wealth), it would not materially alter our findings.

To capture the second feature of privatization, namely giving retirees and workers their full accrued social security benefits, we phase out social security benefits starting 10 years after the

privatization reform occurs. The 10-year delay reflects the need to give current retirees the same benefits they would otherwise have received. In the model, social security benefits are received for 10 years from 45 to 55 (real age 55 to real age 65). Starting in the 11th year of the reform, we phase out social security benefits by 2.2 percent (of the baseline benefits) per year for 45 years.

We use three alternative taxes to pay for social security benefits during the privatization transition: proportional payroll taxation using social security's tax base, income taxation with the tax base reductions noted earlier, and a consumption taxation.

The transition to a privatized social security system alters the income-tax base. Since we maintain a constant level of government purchases per effective worker in each transition, we need to adjust income-tax rates along the transition path even in those simulations in which income taxes are not used to pay the social security benefits accrued under the old system. The shares of (endogenous) revenues to be made up by the two components of the income tax, the progressive wage tax and the proportional capital income tax, are determined such that the average wage tax and the average capital income change proportionally.

Macroeconomic Effects

Tables 3 - 7 present the macroeconomic effects of twelve alternative privatization reforms.[9] Runs 1 through 6 correspond to forced participation explored in this section and runs 7 through 12 correspond to opting out explored in the next section. The top panels of Figures 3 - 5 graph the

[9] We also reported forced participation results in Kotlikoff, Smetters and Walliser (1997). The current simulations, which benefit from several model enhancements, are included as a comparison with the opting out results.

information corresponding to runs 1, 3, and 5 in which the tax-benefit is perceived.[10] Year 1 (1997) is the first year of the transition path. An agent born (economically) in year -10, for example, is 11 years old (age 31 in real-life).

Consider first Runs 1, 3, and 5 which use payroll taxation, consumption taxation, and income taxation, respectively, to privatize social security. In each of these runs, agents perceive the tax-benefit linkage they face. These tables and figures show that each of these three runs produces the same quite striking long-run results. The capital stock rises by 39 percent, labor supply rises by 5 percent, output, as well as output per person, rises by 13 percent, the real wage rises by 7 percent, and the real interest rate falls by 19 percent.

Although the long-run position of the economy is the same in each of these runs, the time it takes to get close to the economy's long-run position, and the size of the short-run economic response, depends critically on the choice of the tax used to finance transitional social security benefits. Consider payroll-tax finance. After 25 years, the capital stock is only 5 percent larger, which is only 13 percent of its ultimate increase. In the case of income-tax finance, the capital stock is actually 5 percent smaller 25 years after the transition, notwithstanding the fact that it ultimately ends up 39 percent larger. With consumption-tax finance the transition is much faster, but it's still rather slow. After 25 years the capital stock is 13 percent larger which is only one-third of its long-run increase.

One reason why the transitions take time is that social security benefits are reduced gradually over a 55-year period. A second reason the transitions are slow is that the capital stock is a stock and

[10] The cases in which the tax-benefit linkage is not perceived were not qualitatively different enough to merit graphing them.

even substantial changes in annual saving rates take quite a while to materially alter it. This feature of neoclassical economies—that policy-induced economic transitions are very slow—was one of the main messages of Auerbach and Kotlikoff (1987). The third reason the transitions are slow applies in the case of income-tax finance. Using this tax instrument means that in the short run, there will be quite high marginal tax rates on labor supply and capital income. This gives households an incentive to substitute current leisure and consumption for future leisure and consumption. Indeed, in the case of income-tax finance, the short-term disincentive to work leads to a 5 percent decline in aggregate labor supply.

With consumption-tax finance, the short-run saving incentives are quite different. The additional consumption tax starts out at a 10 percent rate and then declines over time to zero. The temporarily high price of consumption gives agents an incentive to delay their consumption expenditures and, consequently, save more. Moreover, using the consumption tax rather than an income or wage tax to finance transitional social security benefits places a larger fiscal burden on the initial elderly and a lower one on those who are young and middle aged. Since the elderly, who are closer to the end of their lives, have higher propensities to consume than do the young and middle aged, redistributing from them to younger cohort leads to less overall consumption and more national saving. Furthermore most of this redistribution to the young occurs through a efficient one-time tax on existing non-social security wealth.

No Perceived Tax-Benefit Linkage

Runs 2, 4 and 6 repeat each simulation under the assumption of no perceived tax-benefit linkage. This assumption increases the payroll tax's distortion of labor supply and increases the

efficiency gains from privatizing social security. This translates into growth in capital, labor supply, and output that is 1 to 2 percentage points larger than with perceived tax-benefit linkage. Notice that assuming no perceived linkage reverses the sign on the short-run labor supply response to payroll tax financing from negative to positive. These results suggest therefore that the degree of tax-benefit linkage can play an important role in determining the gains from privatization.

Welfare Effects

Table 8 and the bottom panels of Figures 3 -5 show the welfare effects of the different privatization policies. The welfare effects are measured as the percentage increase in both consumption and leisure in each year of remaining life (entire life for newborns) in the pre-privatization economy needed to generate the same level of utility the agent enjoys as a result of the privatization reform (i.e., equivalent variation). The first thing to note is that all households, poor and rich alike, who are born in the long run gain from privatizing social security. For each of the income classes, the welfare gain exceeds 4 percent. The gains are larger for middle income classes. Class 9, for example, enjoys an 8 percent welfare gain. The welfare gain for the top income class is 4 percent; for the bottom income class it is 6 percent.

What explains these differences? The answer is that different features of the privatization policy affect different income groups differently. First, we are eliminating the progressive social security benefit schedule. Second, we are eliminating the regressive (due to the ceiling on taxable earnings) social security payroll tax. Third, we are adjusting downward long-run income tax rates due to the expansion of the income-tax base associated with the long-run improvement of the economy. This reduction in income-tax rates benefits income-tax payers, a set of agents that doesn't

include the very poor who pay no income taxes because of the tax exemptions and deductions. Fourth, this reform, which replaces social security's payroll tax with another distortionary tax that hits the rich as well as the poor at the margin, has a bigger impact on households with higher earnings since they already face higher marginal income tax rate. Since the distortion rises with the square of the tax rate, those households face a multiple of the labor supply distortion of low income households. However, those households which have earnings above the payroll tax ceiling in the initial steady state (represented by class 12) benefit less from privatization since their labor supply was not affected by the payroll tax at the margin.

In considering these long-run welfare effects, it is important to bear in mind that the privatization reforms being simulated do not include redistributive features. But the privatization of social security could be made more progressive. One could, for example, privatize social security by having the government match workers' contributions to their individual retirement accounts on a progressive basis. Obviously, this would produce relatively higher gains for low income classes.

The tables and figures show not only the long-run winners from privatization, but also the short-run losers. In the experiment that continues to finance social security benefits with a payroll tax (Run 1), benefits accrue to richer income classes earlier during the transition. The reason for this finding is straightforward: social security replaces a larger fraction of income for the poor than for the rich, a factor that is enhanced by the progressive benefit schedule and payroll tax ceiling. Reducing benefits and removing the redistribution caused by social security thus requires a larger growth in wages for the poor than for the rich to improve their welfare relative to the status quo. However, the richest income class does not benefit as much from privatization as the not-so-rich (e.g., income class 9) since the richest are above the payroll tax ceiling for most of their lives.

In contrast, financing the transition with an income tax (Run 3) puts a higher burden on the middle class and especially the very high income classes. This result follows from the specifics of the income tax code which exempts low income households from taxation. Thus, class 1 does not contribute at all to financing the transition when income-tax finance is employed. Class 12, however, gets hit especially hard since the non-distortionary payroll tax (class 12's income exceeds the payroll tax ceiling) is replaced by a fully distortionary income tax. Run 3 also raises the tax rate on capital income which affects high earners the most.

Finally, consider consumption-tax financing (Run 5). Nearly all generations over age 25 (real age 45) at the time of the reform are made worse off by the reform, although their welfare losses are moderate. (The exception is the 54-year olds in income class 1 who are paying back a loan against social security benefits; recall that only income class 1 borrows in the model.) In the case of initial 54 year-olds, there is a 0.1 percent loss for the income class 3, a 1 percent loss for middle income classes, and a 1.5 percent loss for the highest income class. For 25-year olds, the welfare losses are more uniform across income classes, ranging from 2 to 3 percent.

IV. Opting Out

Opting out of Social Security involves three steps: a) allowing workers to opt out of social security, thereby eliminating both the payroll tax they face as well as any claims to future social security benefits; b) collecting payroll taxes and paying benefits to those who do not opt out; and c) using general revenue to pay for the gap between payroll taxes collected and benefits received. Workers will choose to opt out of Social Security if their present value of future Social Security taxes exceeds the present value of their future benefits. The decision for each worker to opt out,

therefore, depends endogenously vis-a-vis factor prices on whether other workers opt out; i.e., the program searches for the Nash equilibrium..

We consider two alternative taxes to supplement social security's revenue: income taxation with the tax base reductions noted earlier, and consumption taxation. Since all agents eventually choose to opt out of social security by the final steady state, these taxes are purely transitional. As a result, all of the opting out experiments converge to the same final steady state—and the same steady state as the forced participation experiments reported earlier, a fact that facilitates the comparison of transition paths.

Participation

The solid lines in the top panel of Figure 6 show those generations by income class who participate in the new privatized system—that is, opt out of social security—for the income tax finance case.[11] All agents younger than 25 years of (real-life) age opt out as do all future agents. The participation lines therefore are not continued past transitional year 50 for resolution.

The effects of adverse selection can be seen both inter-generationally and intra-generationally. Inter-generationally, many living agents, especially older people, stay with social security because they have accrued enough benefits and so it is not worth switching. Intra-generationally, a poor agent is less likely to opt out of social security than a richer agent of the same age. This reflects the progressive nature in which social security benefits are computed.

Macroeconomic and Welfare Effects: A Comparison with Forced Participation

[11] The consumption tax finance case produces similar qualitative participation rates.

The impact of adverse selection on macroeconomic variables can be seen by comparing each opting out run with its forced-participation counterpart that uses the same transitional finance tax. The macroeconomic responses corresponding to the opting out runs 7 - 12 are reported in Tables 3 - 7 and are graphed in Figures 7 - 10 for the perceived tax-benefit linkage cases. The welfare effects for each run is shown in Table 8 and, for the cases of perceived tax-benefit linkage, in the bottom panels of Figures 7 - 10.

Consider income tax financing of benefits. Comparing Run 4 (forced participation) with Run 7 (opting out) shows that opting out leads to a quicker rate of convergence relative to forced participation. For example, whereas the capital stock is 5 percent smaller after 10 years under the forced participation scheme, it is only 2.5 percent smaller under opting out. The reason is that the opting out plan reduces social security wealth for young and middle-age transitional savers by more than the forced participation plan. Whereas the forced participation plan compensates young and middle-age savers in proportion to their accrued benefits, many of these same savers are willing to forfeit their social security wealth under the opting out plan.[12] Notice that opting out also does a slightly better job at protecting the welfare of the initial elderly. The welfare of this age group is about one half a percentage point higher under opting out than under forced participation. The reason is that the opting out plan continues to collect some revenue from payroll taxes whereas forced participation does not. The opting out plan therefore puts more emphasis on wages and salaries than interest income, the latter of which is the most important source of income for the

[12] Specifically, let $a > 0$ equal a person's accrued benefits and let b equal a person's net future benefits. b is negative for everyone, even the poor, due to the low internal rate of return paid by social security. The social security benefit paid to people in the forced participation plan equals a whereas the benefit paid in opting out is $\max(0,a+b) < a$.

elderly. The benefits of quicker convergence and protection of the elderly welfare, however, do not come for free. Opting out leads to larger welfare losses for middle-age agents across the entire income distribution. For example, opting out increases the welfare loss for 25-year olds (46 in real life) in income classes 6 through 9 by almost 1 percentage point relative to forced participation. Middle-age agents tend to not opt out (Figure 6, top panel) and pay both the existing payroll tax and higher income taxes.

Now consider consumption tax financing of benefits. The rate of convergence during the first two decades is now very similar for both forced participation (Run 5) and opting out (Run 9). Around year twenty, however, the rate of accumulation under the opting out plan actually accelerates. By year forty, the capital stock is 5 percentage points larger under the opting out plan. Once again, the opting out plan better protects the welfare of the initial elderly at a cost to middle age workers. The continued collection of some payroll tax revenue necessitates a smaller hit on the non-social security wealth of the initial elderly.

Reducing the Payroll Tax Rate

Runs 11 and 12 consider a variation of the opting out plan in which the payroll tax is reduced to one-half of its present law value. By raising less payroll tax revenue from middle-age workers, the intention here is to distribute more of the transitional pain to the tails of the age distribution: both older workers, who pay little or no payroll taxes due to retirement, and younger workers who pay little or no payroll taxes because they opt out.

Comparing Run 11 with opting out Run 7 for income transition finance shows that middle-age workers are now significantly better off when the payroll tax is reduced, by as much as 1.5

percentage points of remaining lifetime utility. Moreover, middle-age agents now fare better than relative to forced participation, by as much as 1 percentage point. Interestingly, hardly detectable traces of burden are shifted to the initial elderly. This is because the decrease in the payroll tax rate causes fewer people to opt out (Figure 6, bottom panel). The payroll tax revenue therefore drops by only 20 percent in going from Run 7 to Run 11 (about 7 percent of the pre-privatization payroll tax revenue) instead of 50 percent which could be expected from the outset. Only a small amount of additional general revenue is therefore needed. Hence, this opting out variation still does a better job at protecting the welfare of the initial elderly than forced participation. Instead, most of the burden is shifted to the more plentiful young workers whose welfare decreases, although by less than one half a percent. Notice, however, that the costs to young workers is only slightly larger than that corresponding to forced participation (Run 3). For 10-year old workers in income class 6, the additional loss is only 0.1 percentage points. There is no loss for income class 9 workers and income class 12 workers are actually better off (0.3 percentage points). Only income class 3 workers are moderately worse off (0.4 percentage points). Income class 1 workers are worse off by 0.4 percentage points but still have sizeable positive gains (1.2 percentage points). The rate of convergence of the capital stock is a only little slower than straight opting out but still faster than that corresponding to forced participation. In sum, this variation of the opting out plan moderates the impact of middle age workers and appears to stack up rather well against forced participation. So what is the cost of all this good news? Relative to Runs 3 and 7, notice that Run 11 reduces the gains to generations born during the first decade after privatization. However, everyone of these agents still faces positive gains and so this burden shifting might be a desirable outcome. Similar results hold for consumption tax financing (Runs 5, 9 and 12).

V. Conclusion

Our simulation study shows that social security's privatization can have a significant and beneficial long-run impact on the economy and individual welfare. Although the long-run gains are substantial, they do not come overnight. Even if one uses consumption taxation, which produces the most rapid transition, to finance the reform, the half-life of the transition exceeds 25 years.

This paper also shows that a policy that allows people to opt out of social security may, despite adverse selection, produce more favorable macroeconomic and distributional outcomes than a privatization plan that forces participation. This was shown using a large-scale rational-expectations simulation model.

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Appendix: Solving the Model

The model solves for the full rational-expectations dynamic (Nash) equilibrium with a Gauss-Seidel algorithm. The calculation starts with a guess for certain key variables and then iterates on those variables until a convergence criterion is met. The identifying restrictions of the model are used to compute the remaining economic variables as well as the updates for the iterations. The solution involves several steps and inner loops that solve for household-level variables before moving to an outer loop which solves for the time-paths of aggregate variables and factor prices. Since the decision to opt out by any agent will be affected by the exact time path of factor prices—which, in turn, is affected by the opting out decisions of other agents—the opting out choice is determined endogenously for each agent. The solution algorithm iterates until each agent, given the prevailing path of factor prices, prefers his/her intertemporal allocation of consumption and leisure and his/her decision whether to opt out.

The household optimization problem is subject to the constraint that leisure not exceed the endowment of time (equation (2)). For those households who would violate the constraint, the model calculates shadow wage rates at which they exactly consume their full-time endowment.

The household's budget constraint is kinked due to the tax deductions applied against wage income. A household with wage income below the deduction level faces marginal and average tax rates equal to zero. A household with wage income above the deduction level faces positive marginal and average tax rates. Due to the discontinuity of the marginal tax rates, it may be optimal for some households to locate exactly at the kink. Our algorithm deals with this problem as follows. We identify households that choose to locate at the kink by evaluating their leisure choice and corresponding wage income above and below the kink. We then calculate a shadow marginal tax

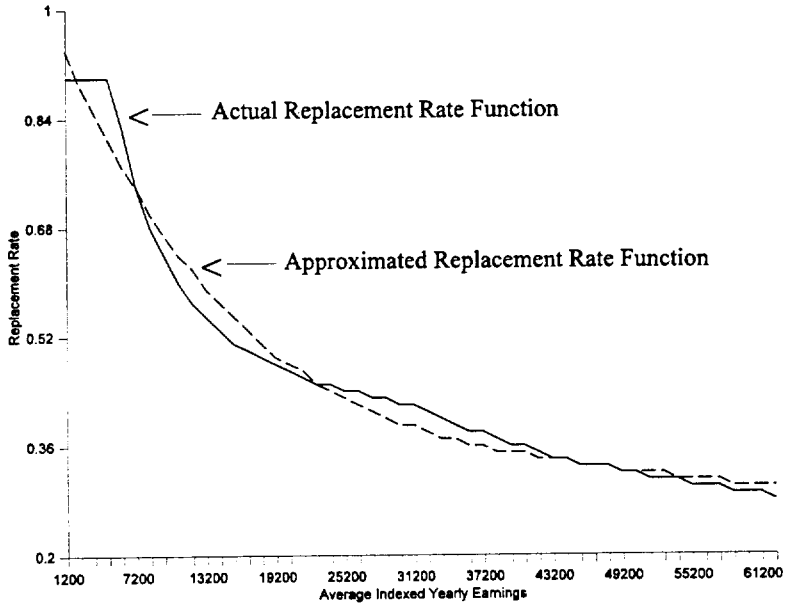
rate from the first-order conditions that puts those households exactly at the kink. This procedure generates optimal forward-looking leisure and consumption choices for all periods of life.

The payroll tax ceiling introduces additional complexity by creating a non-convexity in the budget constraint. For those above the payroll tax ceiling, the marginal tax rate on labor falls to zero. We evaluate the utility on both sides of the non-convex section and put households on the side that generates highest utility.

The sequence of calculations is as follows. An initial guess is made for the time-paths of these aggregate variables as well as for the shadow wage rates, shadow tax rates, endogenous tax rates, the separate OASI / DI / HI payroll tax rates, and the Social Security and Medicare wealth levels. The corresponding factor prices are calculated along with the forward-looking consumption, asset and leisure choices for all income classes in each current and future cohort. Shadow wages and shadow taxes are calculated to ensure that the time endowment and the tax constraints discussed above are satisfied. Households' labor supply and assets are then aggregated by both age and lifetime income class at each period in time. This aggregation generates a new guess for the time-paths of the capital stock and labor supply. The tax rate which is endogenous for the particular simulation, is updated to meet the revenue-neutrality requirement. The payroll tax is also updated to preserve the pay-as-you-go financing of OASI and HI benefits.[13] The tax rate for DI benefits is also updated. The algorithm iterates until the capital stock and labor supply time-paths converge.

[13] Note that the Social Security replacement rate and absolute level of Medicare benefits are exogenous.

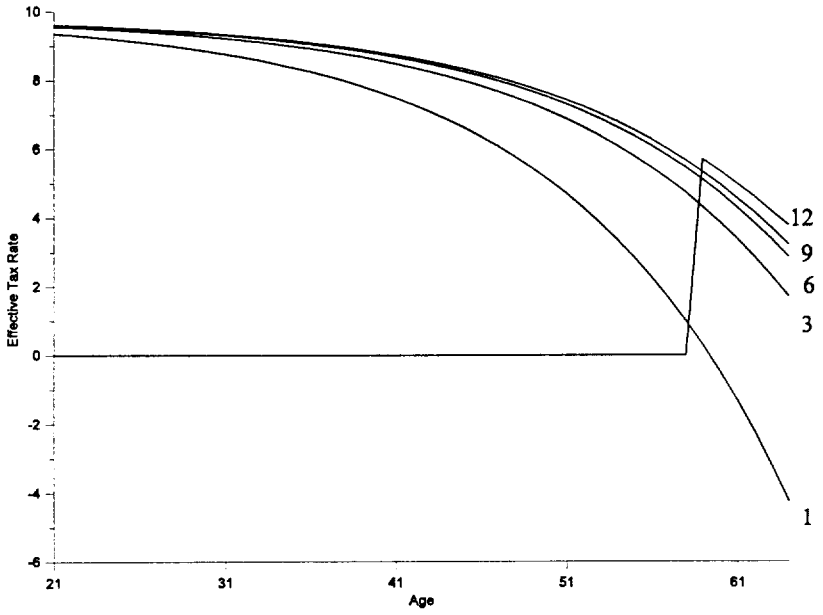
Figure 1
The US Replacement Rate as a Function of Average Indexed Yearly Earnings, $R(\cdot)$, for a Single Person Retiring in 1996: Actual and Polynomial Approximated



Notes: 1. Actual replacement rate computed using the statutory formula for a person turning age 62 in 1996. The monthly benefit equals 90 percent of first $437 of covered Average Indexed Monthly Earnings (*AIME*) plus 32 percent of the next $2,198 plus 15 percent above $2,635. *AIME* converted to Average Indexed Yearly Earnings (*AIYE*) by multiplying times 12. Replacement rates for single worker with retired spouse equals $1.5 \cdot R(\cdot)$.

2. Predicted $R(AIYE) = 0.9927 - 4.37\text{E-}05 \cdot AIYE + 1.2\text{E-}09 \cdot AIYE^2 - 1.9\text{E-}14 \cdot AIYE^3 + 1.5\text{E-}19 \cdot AIYE^4 - 6.1\text{E-}25 \cdot AIYE^5 + 9.8\text{E-}31 \cdot AIYE^6$. The regression $R^2 = 0.99$.

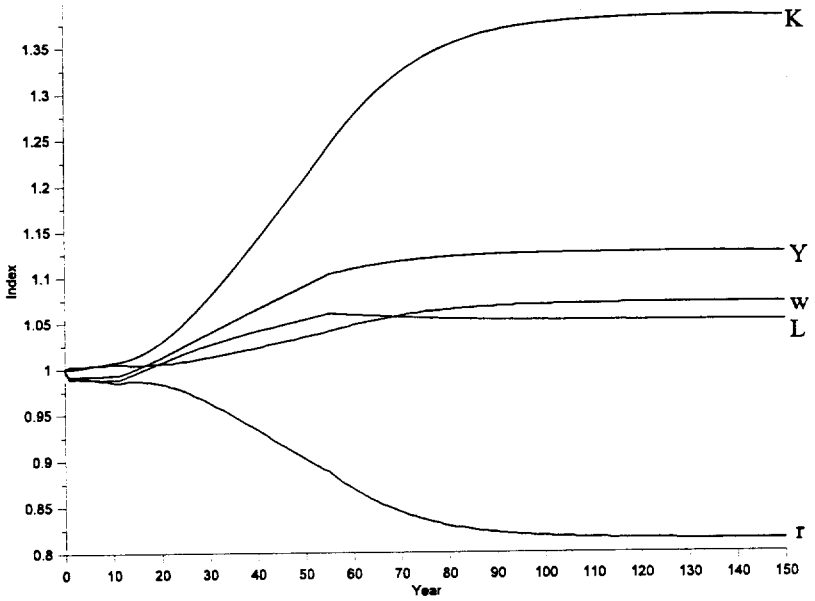
Figure 2
Effective Marginal Social Security Tax Rates by Age and Income Class



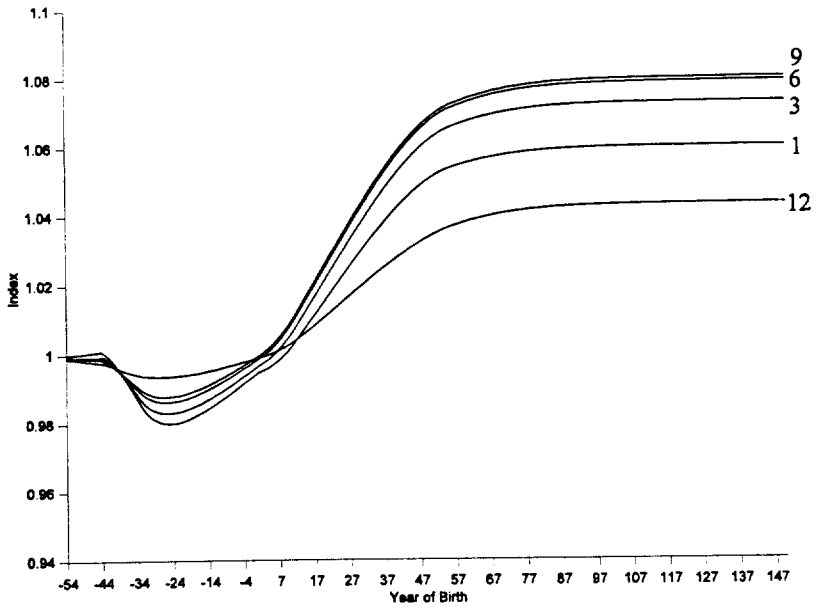
Forced Participation

Figure 3
Payroll Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



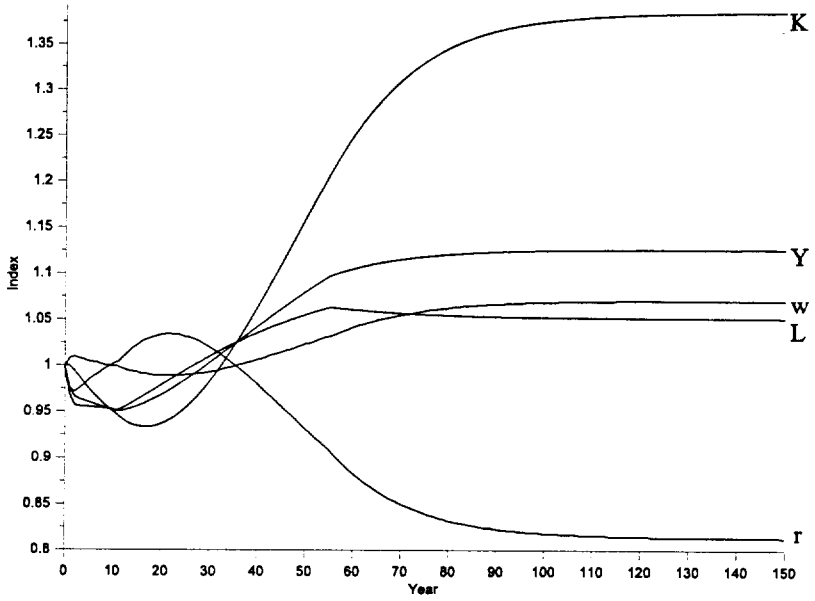
Remaining Lifetime Utility



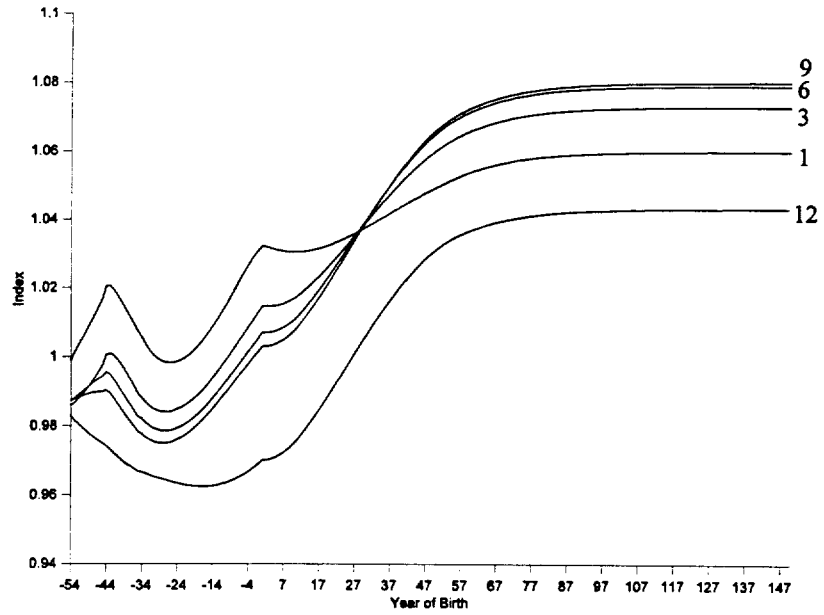
Forced Participation

Figure 4
Income Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



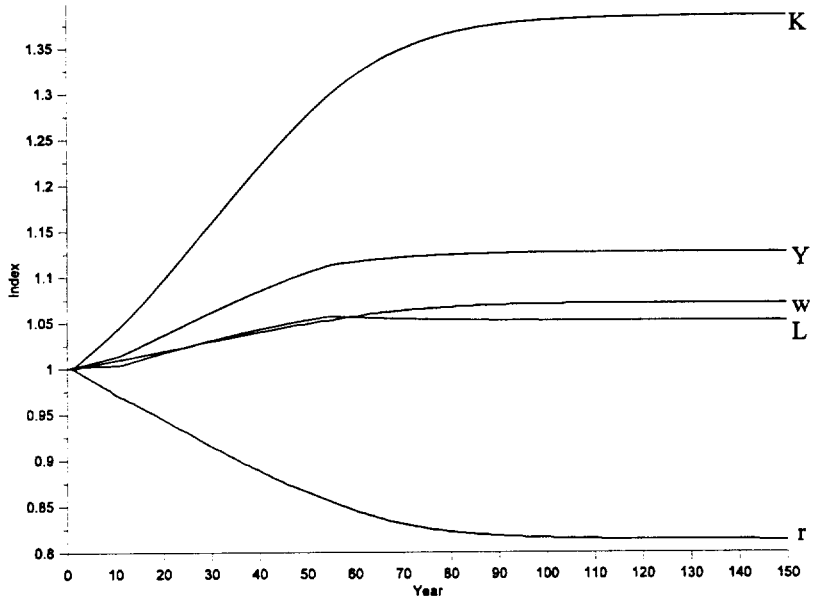
Remaining Lifetime Utility



Forced Participation

Figure 5
Consumption Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



Remaining Lifetime Utility

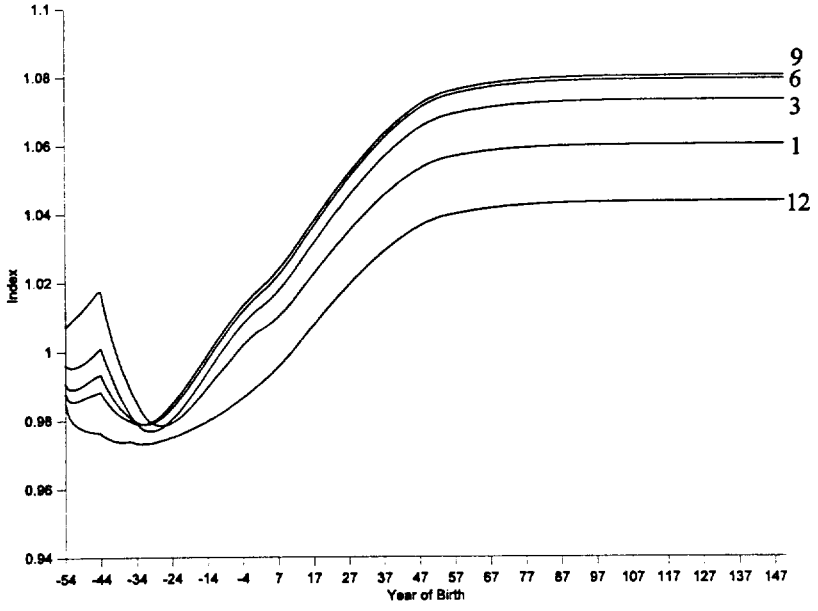
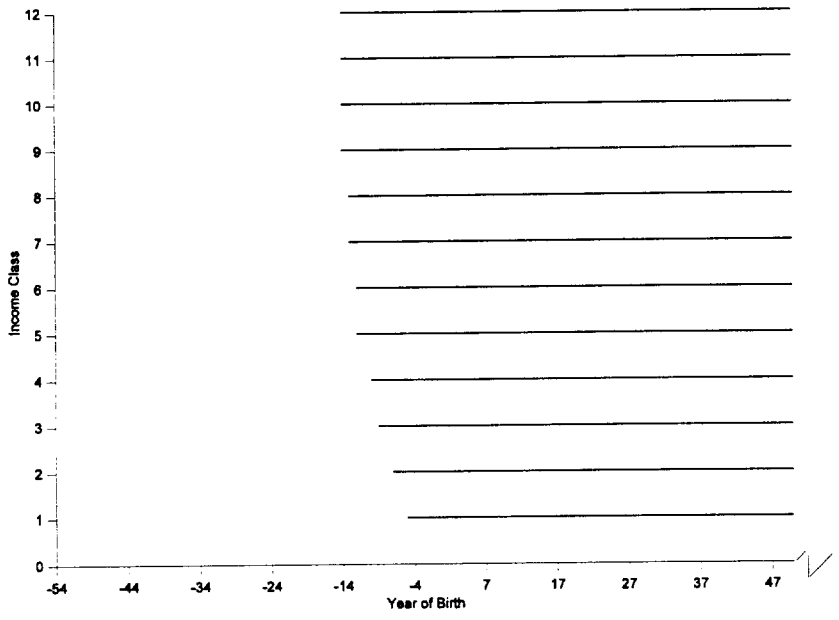


Figure 6
Who Opts Out of Social Security?

Income Tax Finance of Transition with Tax-Benefit Linkage and New Payroll Tax Equal to Present Law Value (Solid line denotes generations that opt out)



Income Tax Finance of Transition with Tax-Benefit Linkage and New Payroll Tax Equal to One-Half Present Law Value (Solid line denotes generations that opt out)

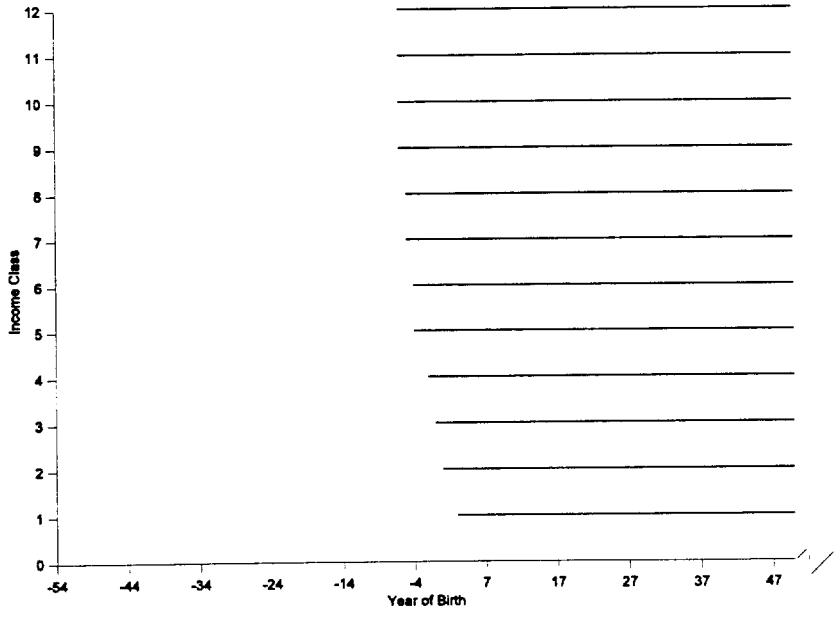
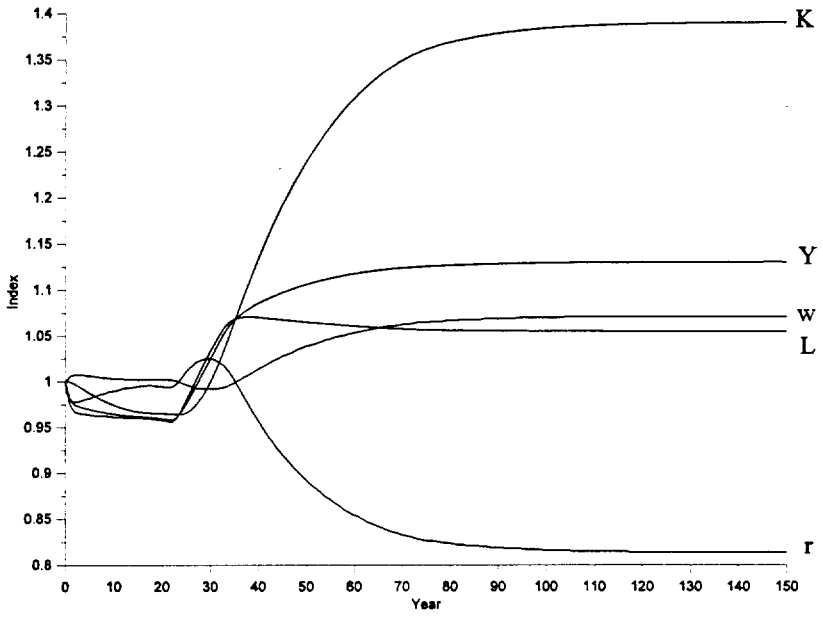


Figure 7
Income Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



Remaining Lifetime Utility

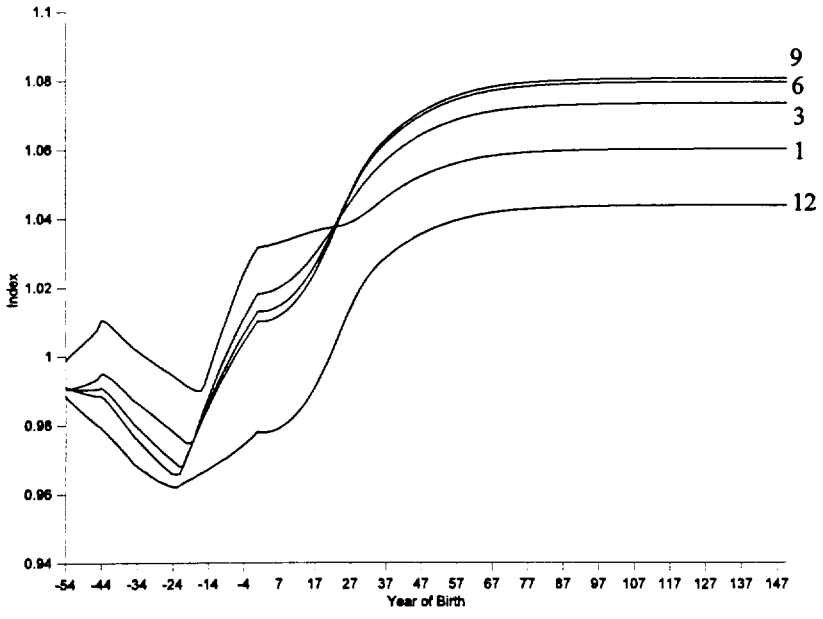
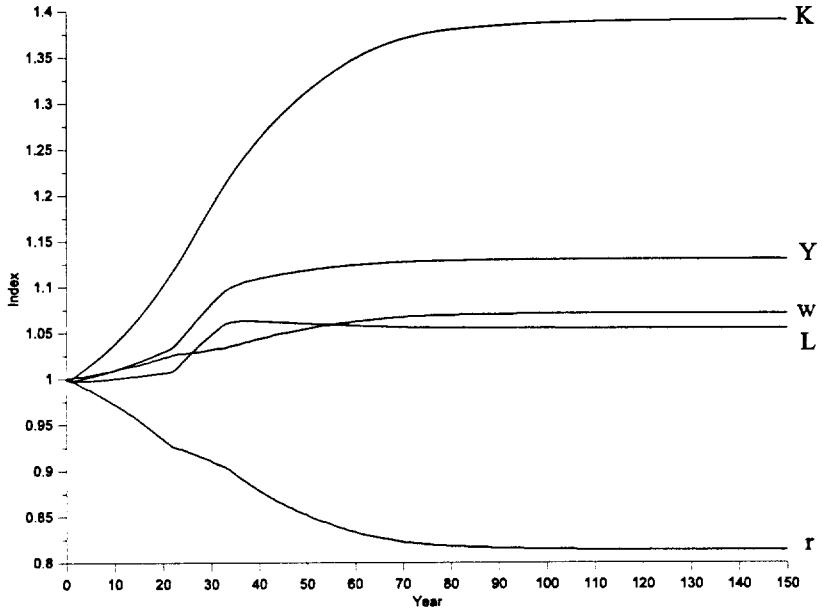


Figure 8
Consumption Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



Remaining Lifetime Utility

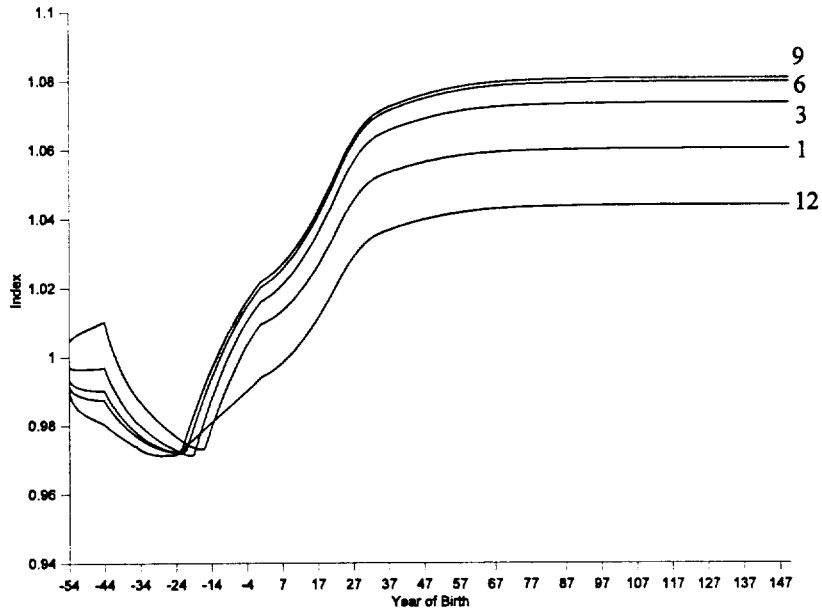
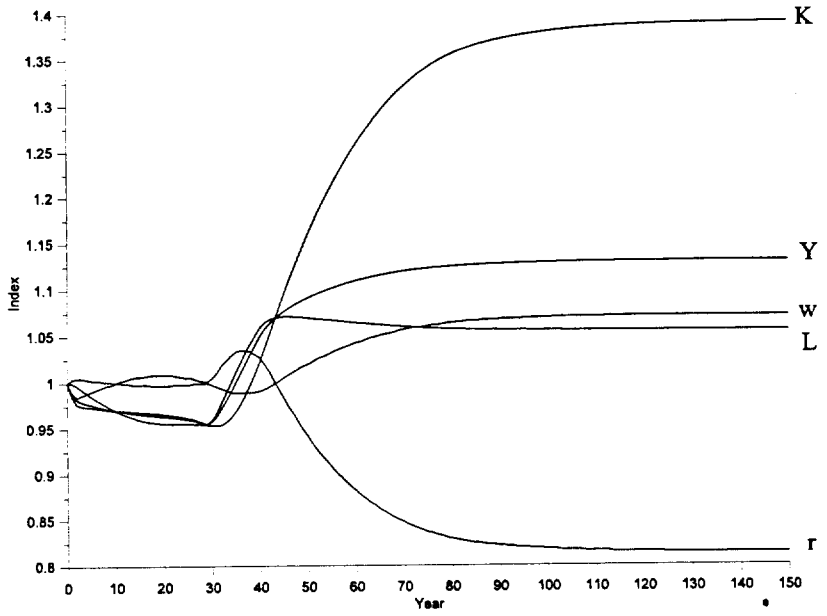


Figure 9
Income Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



Remaining Lifetime Utility

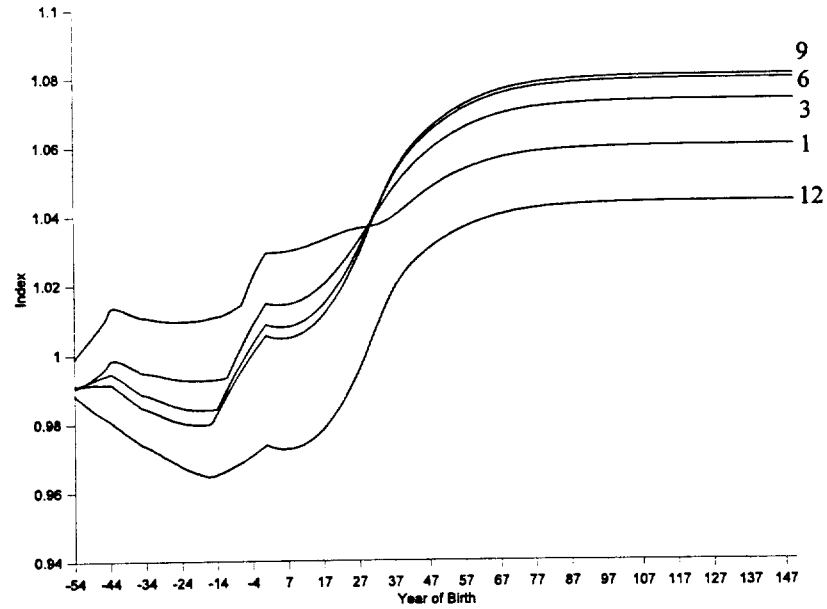
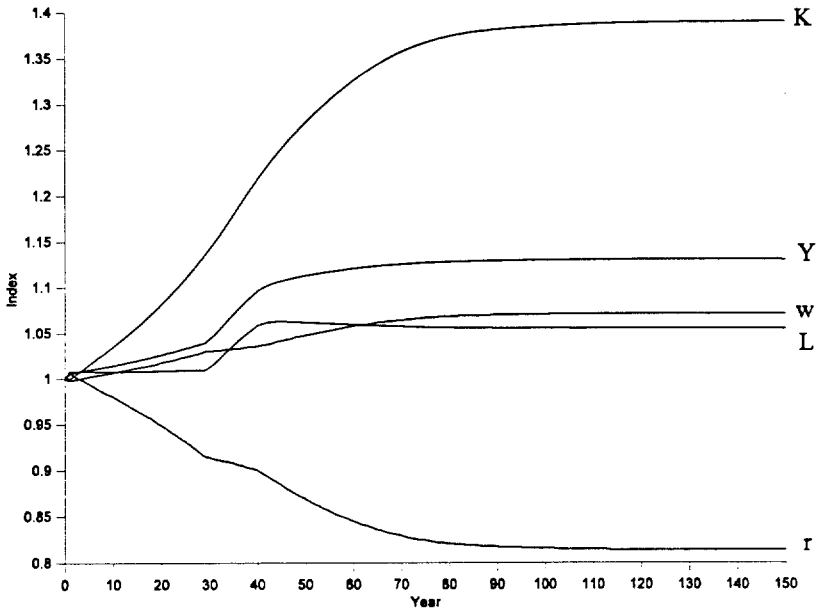


Figure 10
Consumption Tax Finance of Transition with Tax-Benefit Linkage

Macro Effects



Remaining Lifetime Utility

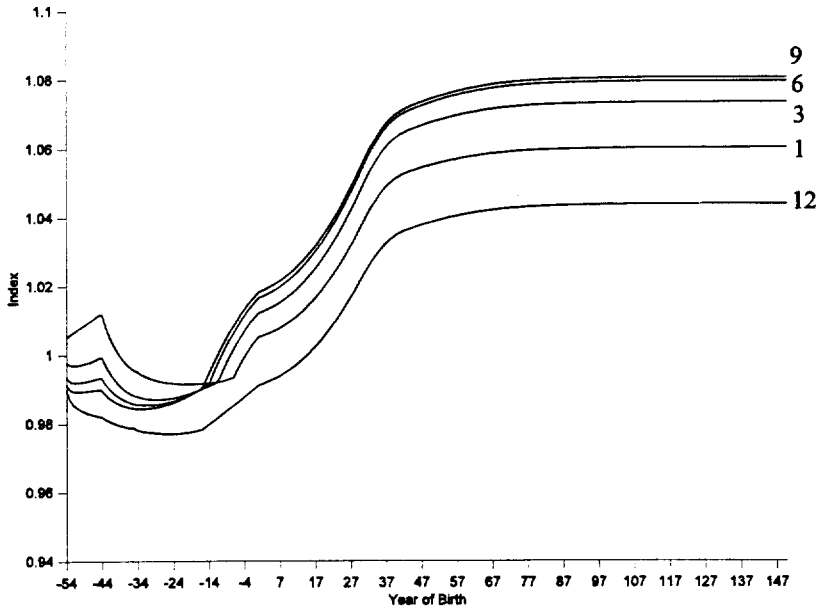


Table 1.	Benchmark Parameter Definitions and Values	
Symbol	Definition	Value
	PREFERENCES	
α	Utility weight on leisure	1.00
δ	Rate of time preference	0.015
γ	Intertemporal substitution elasticity	0.25
μ^j	Utility weight placed on bequests by income class	[1]
ρ	Intratemporal substitution elasticity	0.80
	HUMAN CAPITAL	
ε_s^j	Productivity of agent in income class j at age s.	[2]
	DEMOGRAPHICS	
n	Population growth	0.01
N	Number of children per adult, $(1+n)^{20}$	1.22
ϕ^j	Fraction of agents of income class j	[3]
	TECHNOLOGY	
λ	Technological change	0.01
b	Adjustment costs	0.00
θ	Net capital share	0.25
	DEBT, TAXES, DEDUCTIONS IN INITIAL STEADY STATE	
—	Debt service as fraction of National Income	0.0350
—	Disability tax rate	0.0185
—	Medicare tax rate	0.0290
—	Progressive Social Security (OAI) replacement rate	[4]
—	Social Security marginal tax-benefit linkage	0.25
—	Payroll tax ceiling	$62,700
$T^{C'}$	Proportional consumption tax	0.113
$T^{K'}$	Proportional capital income tax	0.20
$T^W(\cdot)$	Kinked progressive wage tax with standard deduction	[5]
$T^{Y'}$	State proportional income tax less evasion adjustment	0.011
—	Itemized deductions proportional wage base reduction	0.0755[6]
—	Fringe benefits proportional wage base reduction	0.1129[6]
z	Expensing[7]	0.20

Footnotes:

[1] Calibrated endogenously in the initial state to match the level of bequests—as a fraction of mean national income—in Fullerton and Rogers (1993, Table 3-8), calibrated to 1996 dollars.

[2] See Appendix for estimation procedure.

[3] ϕ^1=0.02, ϕ^2=0.08, ϕ^i=0.10 ($3 \le i \le 10$), ϕ^{11}=0.08, ϕ^{12}=0.02

[4] The statutory progressive bendpoint formula for 1996, scaled up by a factor of 2 to account for the fact that other non-DI benefits (mainly spousal and survivors benefits) account for 50% of all benefits paid (see 1996 OASDI Trustees Report, Table II.C7).

[5] The 1996 statutory tax function for a single individual with a deduction equal to $9661 ($4,000 standard deduction, $2,550 personal exemption and $2,550·$N$ exemption for dependents).

[6] Total proportional base reduction above the standard deduction therefore equals 0.18845.

[7] Deductions for new investment above economic depreciation and adjustment costs.

Table 2. Key Endogenous Equilibrium Values for the Initial Steady State and the Corresponding Empirical Values

Model		Empirical Estimate and Calculation	
Concept	Value	Estimate	Calculation (using NIPA unless indicated)
COMPOSITION OF NATIONAL INCOME (PERCENT)			
Personal Consumption	0.734	0.720	Personal consumption expenditures - housing services
Net Saving Rate	0.053	0.056	(National saving - capital consumption allowance)/NI
Government Consumption	0.214	0.212	Consumption expenditures + gross investment for federal (defense and nondefense) and state and local - consumption of fixed capital
TAX RATES AND GOVERNMENT REVENUE			
Avg. Marginal Wage Tax[1]	0.214	0.217	Auerbach (1996) based on the NBER TAXSIM model.
Government Revenue	0.239	0.239	Total receipts - contributions for social insurance - property taxes (state and local)
Social Security(OAI)Tax[2]	0.100	0.100	1996 tax rate is 10.52 which includes trust fund contributions equal to about 0.5 to 0.7.
CAPITAL-OUTPUT RATIO AND BEFORE-TAX INTEREST RATE			
Capital-Income Ratio	2.564	2.660	1993 current-cost net stock of fixed reproducible wealth in the SCF - gov't owned fixed capital / 1993 NI
Before-Tax Rate of Return[3]	0.097	0.093	The average from 1960-94 of the sum of interest, dividends, retained earnings and all corporate taxes to the replacement value of capital stock (Rippe, 1995).

Footnotes:
[1] Does not include the payroll tax.
[2] The combined OASDI-HI payroll tax therefore equals 0.147 which is close to the actual value of 0.153 and exactly equal to the correct value for the payroll tax after subtracting 0.006 for contribution to the trust fund.
[3] The social marginal rate of return (i.e., before corporate taxes).

Table 3

Percentage Change in Capital Stock Relative to Steady State

Run	Opting Out?	Finance of Social Security Benefits	Tax-Benefit Linkage	New Social Security Tax Rate	Year of Transition 5	10	25	150
1	No	W	Yes	n/a	0.0	0.1	5.2	39.0
2	No	W	No	n/a	0.5	1.1	6.1	39.8
3	No	Y	Yes	n/a	-2.4	-5.0	-4.6	39.0
4	No	Y	No	n/a	-2.2	-4.3	-3.5	39.8
5	No	C	Yes	n/a	1.8	4.1	12.8	39.0
6	No	C	No	n/a	2.1	4.7	13.6	39.8
7	Yes	Y	Yes	PL	-1.2	-2.5	-3.4	39.0
8	Yes	Y	No	PL	-1.4	-3.1	-4.0	39.8
9	Yes	C	Yes	PL	1.5	3.8	14.2	39.0
10	Yes	C	No	PL	1.4	3.4	14.1	39.8
11	Yes	Y	Yes	PL / 2	-1.4	-3.0	-4.5	39.0
12	Yes	C	Yes	PL / 2	1.5	3.5	11.0	39.0

C : Consumption Tax
n/a: non-applicable. For forced privatization, payroll tax is endogenous for payroll tax financing and zero for income tax and consumption tax financing.
PL: Present Law payroll tax rate
PL / 2: Present Law payroll tax rate divided by 2.
W: Payroll Tax
Y: Income Tax

Table 4

Percentage Change in Labor Supply Relative to Steady State

Run	Opting Out?	Finance of Social Security Benefits	Benefit-Tax Linkage	New Social Security Tax Rate	Year of Transition 5	10	25	150
1	No	W	Yes	n/a	-1.1	-1.1	1.8	5.5
2	No	W	No	n/a	0.3	0.4	3.2	7.0
3	No	Y	Yes	n/a	-4.5	-4.7	0.0	5.5
4	No	Y	No	n/a	-2.9	-3.1	1.1	7.0
5	No	C	Yes	n/a	0.3	0.4	2.4	5.5
6	No	C	No	n/a	1.8	1.9	3.9	7.0
7	Yes	Y	Yes	PL	-3.6	-3.9	-2.1	5.5
8	Yes	Y	No	PL	-3.8	-4.0	-0.6	7.0
9	Yes	C	Yes	PL	-0.2	0.0	2.4	5.5
10	Yes	C	No	PL	-0.2	0.3	3.9	7.0
11	Yes	Y	Yes	PL / 2	-2.6	-3.0	-3.8	5.5
12	Yes	C	Yes	PL / 2	0.8	0.8	0.9	5.5

C : Consumption Tax
n/a: non-applicable. For forced privatization, payroll tax is endogenous for payroll tax financing and zero for income tax and consumption tax financing.
PL: Present Law payroll tax rate
PL / 2: Present Law payroll tax rate divided by 2.
W: Payroll Tax
Y: Income Tax

Table 5

Percentage Change in Output Relative to Steady State

Run	Opting Out?	Finance of Social Security Benefits	Benefit-Tax Linkage	New Social Security Tax Rate	Year of Transition 5	10	25	150
1	No	W	Yes	n/a	-0.8	-0.7	2.6	13.0
2	No	W	No	n/a	0.4	0.6	3.9	14.4
3	No	Y	Yes	n/a	-4.0	-4.8	-1.5	13.0
4	No	Y	No	n/a	-2.7	-3.4	0.0	14.4
5	No	C	Yes	n/a	0.6	1.3	4.9	13.0
6	No	C	No	n/a	1.9	2.6	6.3	14.4
7	Yes	Y	Yes	PL	-3.0	-3.5	-2.4	13.0
8	Yes	Y	No	PL	-3.2	-3.8	-1.4	14.4
9	Yes	C	Yes	PL	0.2	1.0	5.2	13.0
10	Yes	C	No	PL	0.2	1.1	6.4	14.4
11	Yes	Y	Yes	PL / 2	-2.3	-3.0	-4.0	13.0
12	Yes	C	Yes	PL / 2	1.0	1.5	3.3	13.0

C : Consumption Tax
n/a: non-applicable. For forced privatization, payroll tax is endogenous for payroll tax financing and zero for income tax and consumption tax financing.
PL: Present Law payroll tax rate
PL / 2: Present Law payroll tax rate divided by 2.
W: Payroll Tax
Y: Income Tax

Table 6

Percentage Change in Wages Relative to Steady State

Run	Opting Out?	Finance of Social Security Benefits	Benefit-Tax Linkage	New Social Security Tax Rate	Year of Transition 5	10	25	150
1	No	W	Yes	n/a	0.4	0.5	0.8	7.1
2	No	W	No	n/a	0.1	0.2	0.7	6.9
3	No	Y	Yes	n/a	0.5	0.0	-1.0	7.1
4	No	Y	No	n/a	0.2	-0.3	-1.2	6.9
5	No	C	Yes	n/a	0.4	0.9	2.4	7.1
6	No	C	No	n/a	0.1	0.6	2.3	6.9
7	Yes	Y	Yes	PL	0.6	0.3	-0.3	7.1
8	Yes	Y	No	PL	0.6	0.2	-0.9	6.9
9	Yes	C	Yes	PL	0.4	0.9	2.8	7.1
10	Yes	C	No	PL	0.4	0.8	2.4	6.9
11	Yes	Y	Yes	PL / 2	0.3	0.0	-0.2	7.1
12	Yes	C	Yes	PL / 2	0.2	0.7	2.4	7.1

C : Consumption Tax
n/a: non-applicable. For forced privatization, payroll tax is endogenous for payroll tax financing and zero for income tax and consumption tax financing.
PL: Present Law payroll tax rate
PL / 2: Present Law payroll tax rate divided by 2.
W: Payroll Tax
Y: Income Tax

Table 7

Percentage Change in Interest Rates Relative to Steady State

Run	Opting Out?	Finance of Social Security Benefits	Benefit-Tax Linkage	New Social Security Tax Rate	Year of Transition 5	10	25	150
1	No	W	Yes	n/a	-1.0	-1.4	-2.5	-18.6
2	No	W	No	n/a	-0.1	-0.7	-2.0	-18.2
3	No	Y	Yes	n/a	-1.5	0.0	3.2	-18.6
4	No	Y	No	n/a	-0.6	0.9	3.6	-18.2
5	No	C	Yes	n/a	-1.1	-2.7	-6.9	-18.6
6	No	C	No	n/a	-0.2	-2.0	-6.5	-18.2
7	Yes	Y	Yes	PL	-1.8	-1.0	1.1	-18.6
8	Yes	Y	No	PL	-1.9	-0.7	2.7	-18.2
9	Yes	C	Yes	PL	-1.2	-2.7	-7.8	-18.6
10	Yes	C	No	PL	-1.1	-2.3	-6.8	-18.2
11	Yes	Y	Yes	PL / 2	-0.9	0.0	0.5	-18.6
12	Yes	C	Yes	PL / 2	-0.5	-1.9	-6.8	-18.6

C : Consumption Tax
n/a: non-applicable. For forced privatization, payroll tax is endogenous for payroll tax financing and zero for income tax and consumption tax financing.
PL: Present Law payroll tax rate
PL / 2: Present Law payroll tax rate divided by 2.
W: Payroll Tax
Y: Income Tax

Table 8
Percentage Change in Remaining Lifetime Utility for Selected Income Classes

		Year of Birth						
Run	**Class**	-54	-25	-10	1	10	25	150
1	1	0.0	-2.0	-1.3	-0.6	0.1	2.2	6.0
	3	-0.1	-1.7	-1.1	-0.4	0.5	3.0	7.4
	6	-0.1	-1.4	-0.8	-0.2	0.8	3.3	8.0
	9	-0.1	-1.2	-0.7	-0.1	0.9	3.5	8.1
	12	-0.1	-0.6	-0.4	-0.1	0.3	1.5	4.4
2	1	-0.2	-1.8	-1.1	-0.5	0.2	2.3	6.0
	3	-0.1	-1.4	-0.7	-0.2	0.7	3.2	7.4
	6	0.0	-1.1	-0.4	0.1	1.1	3.6	8.0
	9	0.0	-0.9	-0.3	0.2	1.2	3.7	8.1
	12	0.0	-0.3	-0.1	0.1	0.5	1.8	4.4
3	1	-0.1	-0.2	1.6	3.2	3.1	3.5	6.0
	3	-1.4	-1.6	0.0	1.4	1.7	3.3	7.4
	6	-1.3	-2.1	-0.7	0.7	1.1	3.2	8.0
	9	-1.2	-2.4	-1.0	0.3	0.8	3.1	8.1
	12	-1.7	-3.6	-3.6	-3.0	-2.5	-0.2	4.4
4	1	-0.1	0.0	1.9	3.3	3.1	3.6	6.0
	3	-1.3	-1.2	0.4	1.7	1.9	3.5	7.4
	6	-1.1	-1.8	-0.2	1.0	1.4	3.5	8.0
	9	-1.1	-2.1	-0.5	0.6	1.1	3.4	8.1
	12	-1.6	-3.2	-3.2	-2.7	-2.1	0.1	4.4
5	1	0.7	-2.1	-0.6	0.5	1.3	3.2	6.0
	3	-0.4	-2.0	0.0	1.2	2.1	4.2	7.4
	6	-0.9	-1.7	0.3	1.6	2.6	4.8	8.0
	9	-1.2	-1.6	0.5	1.7	2.7	4.9	8.1
	12	-1.5	-2.5	-1.8	-1.0	-0.1	1.7	4.4

Table 8 Cont.

Run	Class	-54	-25	-10	1	10	25	150
6	1	0.7	-2.0	-0.3	0.6	1.4	3.4	6.0
	3	-0.3	-1.8	0.4	1.4	2.3	4.4	7.4
	6	-0.8	-1.4	0.8	1.8	2.8	5.0	8.0
	9	-1.1	-1.3	1.0	2.0	3.0	5.1	8.1
	12	-1.3	-2.2	-2.4	-0.8	0.1	1.9	4.4
7	1	-0.1	-0.5	0.7	3.2	3.4	3.8	6.0
	3	-0.9	-2.1	-0.2	1.8	2.2	4.2	7.4
	6	-0.9	-2.9	-0.5	1.3	1.7	4.3	8.0
	9	-0.9	-3.3	-0.7	1.0	1.4	4.2	8.1
	12	-1.1	-3.8	-3.0	-2.2	-1.9	0.9	4.4
8	1	-0.1	-0.6	0.8	3.2	3.4	3.8	6.1
	3	-1.0	-2.1	-0.1	1.9	2.2	4.3	7.5
	6	-0.9	-3.0	-0.4	1.4	1.7	4.4	8.2
	9	-0.9	-3.4	-0.6	1.1	1.5	4.4	8.3
	12	-1.2	-3.7	-2.9	-2.1	-1.8	1.0	4.6
9	1	0.5	-2.2	-1.0	0.9	1.6	4.2	6.0
	3	-0.3	-2.7	-0.2	1.6	2.4	5.2	7.4
	6	-0.6	-2.8	0.3	2.0	2.9	5.8	8.0
	9	-0.8	-2.8	0.5	2.2	3.1	5.9	8.1
	12	-1.0	-2.9	-1.6	-0.6	0.1	2.5	4.4
10	1	0.5	-2.3	-0.9	1.0	1.6	4.2	6.1
	3	-0.3	-2.7	-0.1	1.7	2.5	5.4	7.5
	6	-0.6	-2.7	0.4	2.1	3.0	6.0	8.2
	9	-1.5	-2.7	1.1	2.7	3.7	6.3	8.3
	12	-1.0	-2.7	-1.4	-0.5	0.3	2.7	4.6

Table 8 Cont.

Run	Class	-54	-25	-10	1	10	25	150
11	1	-0.1	1.0	1.2	2.9	3.0	3.6	6.0
	3	-0.9	-0.7	-0.4	1.5	1.5	2.9	7.4
	6	-0.9	-1.5	-0.8	0.9	0.9	2.6	8.0
	9	-0.9	-1.9	-1.0	0.6	0.6	2.4	8.1
	12	-1.1	-3.2	-3.3	-2.6	-2.7	-0.9	4.4
12	1	0.5	-0.8	-0.8	0.5	1.0	2.8	6.0
	3	-0.2	-1.3	-0.5	1.2	1.8	3.8	7.4
	6	-0.6	-1.4	0.1	1.7	2.2	4.3	8.0
	9	-0.8	-1.4	0.3	1.8	2.4	4.4	8.1
	12	-1.0	-2.3	-1.7	-0.9	-0.4	1.3	4.4