Distributional Effects in a General Equilibrium Analysis of Social Security

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Abstract

This paper reviews our recent general equilibrium analyses of the distributional effects of social security. The model computes the perfect foresight transition path of a life-cycle economy consisting of multiple overlapping generations. It includes intragenerational heterogenity and a detailed specification of U.S. fiscal institutions. Some very preliminary analyses is also presented of the newest version of the model which is near the end its development phase. The newest version of the model will permit a more realistic patterns of births and length of life.

We reach several conclusions. First, Social Security's privatization has the potential to substantially raise long-run living standards. But achieving these gains takes a considerable amount of time and the cost is spread out to transition generations. Second, Social Security's privatization helps the long-run poor even if the privatization policy does not include an explicit redistribution mechanism. This reflects both the opportunity cost of the current pay-as-you-go system as well as the impact of privatization on capital deepening. Third, privatization that features voluntary rather than compulsory exit from the old system have particularly low transition costs and particularly favorable macroeconomic and distributional consequences despite selection. Fourth, we find that privatization, like that advocated by the World Bank (1994), that try to help the lifetime poor born in the long run by providing a minimum flat benefit can actually make them worse off relative to a privatization without a flat benefit. However, combining privatization with a progressive match to contributions does benefit the lifetime poor relative to privatization without a match. We also present some very preliminary results based on the newest version of the model. These include estimates of the impact that demographics will have on the payroll tax rate needed to maintain current law benefits and the impact that demographics will have on capital deepening, and the impact that a simple privatization plan might have.

I. Introduction

This paper reviews and extends our recent general equilibrium analyses of the distributional effects of social security. The model is based on the Auerbach and Kotlikoff (1987) model which computes the perfect foresight transition path of a life-cycle economy consisting of multiple overlapping generations. But unlike the original A-K model, the new version of the model includes intragenerational heterogenity and a much more detailed specification of U.S. fiscal institutions.[1] The newest version of the model, which is near the end its development phase, includes an even more detailed and accurate description of demographics.

We reach several conclusions. First, Social Security's privatization has the potential to substantially raise long-run living standards. But achieving these gains takes a considerable amount of time and the cost is spread out to transition generations. Second, Social Security's privatization helps the long-run poor even if the privatization policy does not include an explicit redistribution mechanism. This reflects both the opportunity cost of the current pay-as-you-go financed Social Security system as well as the impact of privatization on capital deepening. Third, privatization that features voluntary rather than compulsory exit from the old system have particularly low transition costs and particularly favorable macroeconomic consequences despite selection. Fourth, we find that privatization, like that advocated by the World Bank (1994), that try to help the lifetime poor born in the long run by providing a flat benefit can actually make them worse off relative to a privatization without a flat benefit. However, combining privatization with a progressive match to contributions does benefit the lifetime poor relative to privatization without the match. We also present some very

[1]Prior applications of the AKSW Model include Kotlikoff (1996), Kotlikoff, Smetters, and Walliser (1997, 1998a, 1998b, 1999a, and 1999b), and Altig, Auerbach, Kotlikoff, Smetters, and Walliser (1997).

preliminary conclusions based on the newest version of the model. These include very rough estimates of the impact that demographics will have on the payroll tax rate needed to maintain current law benefits and the impact that demographics will have on capital deepening, and the impact that a simple privatization plan might have.

The paper proceeds in Section II with a review of some of the recent simulation literature on Social Security. Section III describes our base model that does not include our newest enhancements to the demographic structure. Section IV uses the model to explore privatization. The results presented here draw on Kotlikoff, Smetters, and Walliser (1997, 1998a,1998b, 1999a, and 1999b). Section V presents some very preliminary results using the demographic variant of the model.

II. Literature Review

Feldstein's (1974) seminal article on social security's impact on national saving has, over the years, stimulated a plethora of related studies. The majority of these have been theoretical and empirical, but an ever growing number involve simulating on computers social security's dynamic general equilibrium effects in macroeconomic models with microeconomic foundations. Early contributions here include Kotlikoff (1979), Auerbach and Kotlikoff (1981), and Seidman (1983). These papers confirmed Feldstein's theoretical prediction and empirical deduction that unfunded social security systems could significantly reduce nations' long-run capital intensivities and living standards. Kotlikoff and Auerbach and Kotlikoff examined how introducing "pay-as-you-go" social security would worsen an economy's economic position. Seidman, in contrast, appears to be the first to study the economic gains from eliminating the policy.

More recent contributions include Auerbach and Kotlikoff (1987, 1989), Hubbard and Judd

(1987), Hansson and Stuart (1989), Arrau and Schmidt-Hebbel (1993), Kotlikoff (1996), Samwick (1996), Hubbard, Skinner, and Zeldes (1994a,1994b, 1995), Kotlikoff, Smetters and Walliser (1997, 1998a, 1998b, 1999a, and 1999b), Huang, İmrohoro lu, and Sargent (1997), and Imrohoroglu, Imrohoroglu, and Joines (1995, 1999), Knudsen, et.al, (1999), Fougere and Merette (1998, 1999), Scheider (1997), Raffelhuschen (1989,1993), Cooley and Soares (1999a, 1999b), Huggett and Ventura (498), Nardi, İmrohoro lu, Sargent (1999), Galasso (1999), and others. These studies have included a range of additional important factors, including demographics, land, earnings uncertainty, liquidity constraints, and majority voting on the system's continued existence. They have also examined the different ways a transition to a privatized social security system could be financed.

III. Description of Our Model

This section describes the our base model as well as its calibration and solution methods. It draws heavily in parts on Altig, et. al. (1997), Kotlikoff, Smetters, and Walliser (1999a, 1999b), and the review presented in Kotlikoff (2000). Section IV describes how the model described in this section is currently being modified to more accurately capture demographics. We report some very preliminary simulation results in that section.

Demographic Structure

The model contains a fixed number of overlapping cohorts. Each period in the model corresponds to a year. Adults live for 55 years (from age 21 through 75). Like Fullerton and Rogers (1993), our model incorporates intragenerational heterogeneity in the form of 12 lifetime-earnings groups. Each group has its own initial skill level and its own longitudinal age-skill profile. The twelve groups also have distinct bequest preferences. Our model has both advantages and disadvantages relative to Fullerton and Rogers' (1993) model. Some of the advantages are the inclusion of a Social Security system, a detailed description of non-Social Security taxes, the existence of government debt, endogenous bequests, and the ability to compute the economy's perfect-foresight transition path. The principal disadvantage is not having a highly detailed production sector that includes multiple sectors and intermediate production. However, the omission of this production-sector detail may matter little for our purposes since the social security policies we examine do not differentially impact particular industries or types of capital goods.

<u>Preferences and Budget Constraints</u>[2]

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 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   is the intratemporal elasticity of substitution between consumption and leisure. The parameter ^{j} is a j-type specific utility weight placed on bequests left

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[2]This description of the model draws heavily on Kotlikoff, Smetters, and Walliser (1999).

to each child when the agent dies. The term = 1/(1+) where 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

$$a^{j}_{s+1,t+1} = (1+r_t)\ (a^{j}_{s,t}+g^{j}_{s,t}) + w^{j}_{s,t}(E^{j}_{s,t}-l^{j}_{s,t}) - c^{j}_{s,t} - \sum_{k\in\tilde{T}} T^{k}(B^{j,k}_{s,t}) - Nb^{j}_{s,t}. \tag{2}$$

$$l^{j}_{s,t} \le E^{j}_{s,t}$$

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 $\tilde{T}$ = {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 . 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 .[3] Thus, if $E_{s,t}^j$ is the endowment of type j at age s and time t, then $E_{s,t}^j = (1+ \ ) E_{s,t-1}^j$, 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 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, et. al. (1997). Groups 1 and 12 comprise the bottom and top 2 percent of lifetime wage income earners, and groups 2 and 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

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

\$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. As discussed below, these calculations do yet include labor compensation in the form of fringe benefits.

Bequests 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 ^{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 , , , 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 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 existing stock of debt (D_t). Letting ^{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

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

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 0.239. These values correspond very closely to the corresponding 1996 values for the combined local, state, and federal government in the United States.

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

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

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) earnings-ability profiles that are scaled 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

[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.

[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.

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.

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.

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

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.

<u>Social Security, Medicare, and Disability</u>

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 annual 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

(5) $$T^P(B^{j,k}_{s,t}) = \begin{cases} \tau \cdot \omega^j_{s,t} & ; \quad s \leq 64 \;,\; \omega^j_{s,t} \leq \$62{,}7000 \\ \tau \cdot \$62{,}700 & ; \quad s \leq 64 \;,\; \omega^j_{s,t} > \$62{,}7000 \\ -2 \cdot R(\bar{\omega}^j_{s,t}) \cdot \bar{\omega}^j_{s,t} & ; \quad s > 64 \end{cases}$$

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:

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

The value of is solve for endogenously as a function of benefit rules via equation (6). The value of   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:

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

where $PVB'(\cdot) = \partial\, PVB(\cdot) \big/ \partial\omega$ and $PVT'(\cdot) = \partial\, PVT(\cdot) \big/ \partial w\omega$. The simulations presented herein assume full perception, i.e., that agents correctly foresee how the payroll taxes they pay relate to their future benefits. Simulations for the no perception case can be found in Kotlikoff, Smetters and Walliser (1999*b*). Under full perception, the net marginal 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). Rich agents whose labor income exceeds the payroll tax face a zero marginal tax rate.

The HI and DI programs are modeled very simply. The HI and DI levels of lump-sum 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 taxes, DI contributions apply only to

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[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.

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. In the simulations using the new model, we have updates the payroll tax rates and payroll tax ceiling to their 1999 values.

Aggregation and Technology

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

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

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

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

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

(10) $$Y_t = A K_t^{\theta} L_t^{1-\theta},$$

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

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

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 non demographic version of the AKSW 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).

Solving the Model

The model uses a Gauss-Seidel algorithm to solve for the perfect foresight general equilibrium transition path of the economy. The calculation starts with a guess for certain key variables and then iterates on those variables until a convergence criterion is met. 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.

Our optimization problem includes 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 follows: An initial guess is made for the time-paths of aggregate factor supplies 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 supplies 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 relevant revenue requirement. OASI, HI, and DI payroll tax rates are also updated to preserve the pay-as-you-go financing of these benefits.[9] The new supplies of capital and labor generated by the household sector of our model are weighted on an annual basis with the initial guess of these supplies to form a new guess of the time path of these variables. The algorithm then iterates until the capital stock and labor supply time-paths converge.

IV. Simulations Results

This section describes the results of six simulations. Additional simulations are presented in the next section which include some preliminary results of our model with enhanced demographics. The label "Year of Birth" in the tables and figures refers to the year of an agent's birth relative to the year the reform begins. So, for example, the index "-10" refers to a person born 10 years before the reform and whose current age is 11, which corresponds to a real-world age of 32. The index "1" refers to a person born the year the reform begins.

<u>The Choice of the Tax Used to Privatize Social Security</u>

Simulations 1 through 3 study how different methods of financing the transition to a privatized social security system affect the macro economy, different cohorts, and different lifetime income classes within each cohort. In these simulations, participation in the new system is mandatory and privatization entails: a) having workers contribute to private accounts; b) paying retirees and workers in retirement those Social Security benefits that they had accrued as of the time

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

of the reform; and c) financing these accrued Social Security benefits during the transition with either a payroll tax, an income tax, or a consumption tax.

Since our model does not include liquidity constraints, privatizing Social Security contributions simply requires setting the model's Social Security payroll tax rate to zero; i.e., since agents are able to borrow against any government-stipulated saving, there is no mechanical need to add a formal private pension system to the model to which workers are forced to contribute. Doing so would not change any agents' labor supply or consumption behavior. This said, it is worth noting that in the particular economies simulated here, only the poorest 10 percent of agents actually seek to borrow against their future Social Security. So were we to prohibit borrowing in our model, it would not materially alter our findings.

To provide existing retirees at the time of the reform their full accrued benefits, we wait 10 years until after the reform is announced to start phasing out Social Security benefits. Since benefits in the economy's initial steady state are provided for 10 years between agents' ages 46 and 55, the 10-year delay in cutting benefits permits the 10 initial generations of retirees to receive the same benefits they would have enjoyed absent the reform. Starting in the 11th year of the reform, benefits are phased out by 2.2 percent (of the baseline benefits) per year for 45 years. This phase-out pattern is designed to approximate the provision to initial workers of the full value in retirement of those benefits they had accrued as of the time of the reform.

In simulations 1 and 3 that use, respectively, a payroll tax and a consumption tax to finance benefits, the tax rates applied are proportional. Simulation 2 raises progressive income tax rates to finance transition benefits. This is done by increasing the two components of the income tax, the progressive wage tax and the proportional capital income tax, such that the average wage tax and the average capital income tax change proportionally. The macroeconomic changes in factor supplies along the economy's transition path alter the income-tax base used to finance government purchases. In order to maintain a constant level of government purchases per effective worker in each transition, we adjust income-tax rates along the transition path even in those simulations in which income taxes are not used to pay the benefits accrued under Social Security.

Macroeconomic Effects. The top panels of Figures 1 through 3 and the first three rows of Tables 1 through 5 show the macroeconomic impact of the three alternative methods of financing the transition. In Tables 1, 2, and 3, the capital stock, labor supply, and output are measured per 21 year-old. In simulations 1 though 6, which are generated by our base model discussed above, the percentage changes are relative to the initial steady state values of the variables in question.

The first thing to note is that all three simulations generate the same long-run outcome. This is to be expected, since in the long run Social Security is fully phased out and the tax used to pay for benefits during the transition equals zero. The long-run economic impact is considerable. Compared to the initial steady state, the economy's capital stock ends up 39.0 percent higher, its labor supply ends up 5.5 percent higher, and its output ends up 13.0 precent higher. The relative changes in factor supplies effect a 7.1 percent rise in the long-run real wage rate and an 18.6 percent decline in the interest rate.

Although all three policies do the same long-run macroeconomic good, they differ markedly with respect to their short-run macroeconomic impact and the speed with which they approach their common steady state. Consumption tax finance, by imposing a relatively high burden on the initial elderly (who have the highest consumption propensities due to their proximity to their terminal state), crowds in capital formation from the initiation of the reform onwards. In contrast, wage taxation generates essentially no additional capital formation during the first decade of the policy. Indeed, even after 25 years, the capital stock is only 5.2 percent larger than its initial value. Income tax-finance of the transition is even worse on this score. It actually reduces the capital stock for more than a quarter of a century after the reform begins. At the quarter century mark, the capital stock is 4.6 lower than its starting value. The differences in these results are quite striking and serve as an important lesson to those advocating privatization. Most proposals to privatize Social Security, which, incidentally, do not rely on consumption-tax finance may still, however, entail rapid attainment toward the new steady state if they phase out benefits under the old system at a faster rate. The tradeoff, however, is that it might cause greater harm to initial retirees and workers.

Welfare and Distributional Effects. The bottom panels of Figures 1-3 and the first 3 sections of Table 6 show the winners and losers within and across generations of the three alternative ways of financing the transition. The first thing to note is that all agents alive in the long run, regardless of their lifetime income class are better off as a result of Social Security's privatization. The welfare gains – measured as full remaining lifetime wealth equivalent variations -- vary from 6.0 percent for the lowest lifetime earners, to over 8 percent for the middle and upper income lifetime earnings, to only 4.4 percent for the highest lifetime earners. Hence, Social Security's privatization improves the welfare across all income classes for those born in the long run and is, broadly speaking, progressive when measured with respect to its long-run welfare effects. This may seem surprising given that Social Security benefits are very progressive and one might think that losing them should be very important to the lifetime poor. However, the opportunity cost of investing in Social Security is quite high even for a poor person since its internal rate of return is quite low relative to the private market return. Moreover, the system's taxes are regressive due to the ceiling on taxable earnings. The poor benefit more than the very rich from the privatization of Social Security because the regressiveness of the payroll tax outweighs the progressivity of the benefit schedule.

While everyone alive in the long run wins from privatizing Social Security, their winnings come at the price of reduced welfare for initial and intermediate generations. But the different financing mechanisms spread out the transitional losses quite differently. Consumption tax financing (simulation 3) is hard on initial older generations since it raises resource using a wealth levy. Increasing progressive tax rates (simulation 2), however, hits them even harder. The wage tax transition is the least painful for the oldest retirees alive at the time of the reform, as they pay no wage taxes. Despite the fact that funding Social Security is simply a redistribution mechanism between generations that does <u>not</u> improve <u>efficiency</u> (that is, unless people don't perceive their Social Security tax-benefit linkage properly), it can be shown that greater funding can increase <u>social welfare</u> provided that the social welfare function places enough weight on the utility of future generations (Feldstein, 1995; 1998). This is an important point for policymakers to keep in mind since they influence the distribution of resources across generations.

<u>Making Privatization Voluntary</u>

A mandatory privatization plan may face less chance of being enacted than one that provides workers the choice to simply opt out of Social Security. Indeed, most actual privatizations have given people the choice. This was true, for example, in Chile, Argentina, and other major reforms in Latin America; 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 leads those agents whose present values of future Social Security taxes (PVT) exceed the present value of their future benefits (PVB) (including benefits already accrued) to opt out of the existing system.

Permitting voluntary exit from Social Security involves three elements: a) eliminating both future payroll taxation as well as all future benefit claims for those who opt out, b) collecting payroll taxes from and paying benefits to those who stay in, and c) using general revenue to finance the gap between payroll taxes collected and benefits received. Agents who stay in Social Security face the same payroll tax rate and receive the same benefits as they would under current law. Agents endogenously decide whether or not it is better for them to opt out of Social Security taking into account the entire future path of factor prices and tax rates. Since the opting out decision of one agent affects the decision of other agents via changes in factor prices, the simulation iterates until a final competitive (Nash) equilibrium is arrived at.

Providing workers with the option to leave Social Security may sound more generous than forcing them to leave with just their accrued benefits, but the opposite is actually the case. Consider first those who opt out of Social Security. In so doing, they forfeit all the benefits they have accrued up to that point in their working careers. Hence, compared with compulsory privatization, which guarantees the full value of accrued benefits, voluntary privatization is less generous. Next consider those who decide to stay in the old system. In so doing, they make sure they'll receive their past accrued benefits (also provided by a compulsory system), but the price for so doing is staying in a system which, at the margin, may represent a net tax; i.e., for those remaining in the old system, each dollar contributed in the future may deliver additional benefits that total less than a dollar in expected present value.

In the actual simulation, the loss of their accrued benefits leads most existing workers to remain in the old system. On the other hand, all agents younger than 25 years of (real-life) age opt out as do all future agents. Since the System's benefits are provided on a progressive basis, one would expect the opting-out cut-off age for high earners to be larger than that for low earners. This indeed turns out to be the case. High earners in their mid 30s choose to opt out, whereas the poorest agents opt out only through age 27.

Macroeconomic Variables. To be sure, only a fraction of initial workers voluntarily leave the Social Security System under opting out which means that they will eventually collect full benefits, whereas they would have collected only partial benefits under the forced phase out considered earlier. However, those that do leave forfeit their right to collect any future Social Security benefits, whereas they would have collected at least some benefits under forced privatization plan considered earlier. On net, the aggregate decrease in Social Security wealth is about the same over time between the two options. This is shown in Simulation 4 that reports the results of when agents are given the choice to remain in the current system or to opt out. The transition is financed via a consumption tax, similar to Simulation 3 that forces participation. Notice that the intermediate gains to macroeconomic variables about the same for both Simulations. For the case of income tax financing (not shown), opting out outperforms forced participation.

Welfare and Distribution. Regarding distributional burdens, however, the opting out does a slightly better job of protecting the welfare of the initial elderly. Whereas the welfare of oldest agents alive at the time of the reform in income class 6 is reduced by 0.9 percent in Simulation 3, it is reduced by 0.6 percent in Simulation 4. For members of income class 12, who hold even more wealth and therefore are even more exposed to the wealth levy associated with consumption tax financing, these values are 1.5 percent and 1.0 percent, respectively. Opting out leads to a smaller need to increase consumption taxes immediately since some payroll tax revenue is still being collected from those who remain in Social Security. Opting out, however, leaves middle-aged agents alive at the time of the reform (e.g, those born in year of birth -25) because many of them choose to remain in Social Security (and, therefore, pay a high payroll tax) and must help pay for, via a consumption tax, the revenue that is lost when younger and higher earning workers opt out of Social Security.

To address the welfare impact that opting out has on middle-aged workers alive at the time of the reform, Simulation 4+ considers the same opting out experiment but with a "plus": workers who remain in Social Security only have to pay half the current tax rate. The immediate payroll tax revenue lost from this policy change is offset, in a large part, by fewer workers choosing to opt out. Eventually, all new workers, however, choose not to participate in Social Security, even at a reduced payroll tax rate, because the rate of return they can receive in the capital market is sufficiently higher than the internal rate of return to Social Security. The net effect of this policy change is reduce the revenue collected from those alive at the time of the reform and therefore push more of the burden toward future generations. This is why Simulation 4+ leads to a slower transition relative to Simulations 3 and 4, as shown in the tables. However, on the distributional side, Simulation 4+ more evenly distributes the burden associated with privatization both over time and across lifetime income groups. While the utility of a middle-age agent (born in year -25) of income class 1 decreases by 2.1 percent in Simulation 3, it decreases by only 0.8 percent in Simulation 4+. This comes, in part, at the cost to future transitional workers who gain from privatization in both cases, but less so in Simulation 4+.

Privatization with a Flat Benefit

The World Bank has, in the past, encouraged developing countries to include a "first pillar" as part of their reforms. This first pillar is a flat benefit that is received by all workers independent of their contribution level. While trying to protect the poor, the first pillar has two major drawbacks. First, the tax used for its finance adds a work disincentive. Second, the flat benefit is typically financed on a pay-as-you-go basis and therefore vitiates most of the potential long-run gains from privatizing the old system. We investigate this policy by a) providing a wage-indexed flat minimum annual benefit that equals $6000, b) paying a weighted average of the old OASI and the new flat minimum benefit during the transition, c) financing the transition with a progressive income tax.

As Tables 1 and 2 indicate, the long run increases in capital and labor under this policy are less than one third of their values in the absence of a flat, minimum benefit. Furthermore, the added work disincentives associated with financing the minimum benefit, reduces labor supply by almost 3 percent after the first 25 years of the transition, compared to no change for Simulation 2. Less labor supply translates into less saving by workers, less national saving, and less domestic investment. Indeed, in the twenty fifth year of this policy the economy's capital stock and output are, respectively, 8.7 percent and 4.4 percent below their initial values.

How does adding a flat benefit to an income-tax financed policy alter the well being of the poor in the long run? The surprising answer, provided in the fifth section of Table 6, is that makes them worse off relative to privatization without the flat benefit. In the long run, the welfare of the poorest earners is 5.7 percent higher than in the initial steady state, whereas without a flat benefit (Simulation 2), it is 6.0 percent higher. Although the flat benefit harms the long-run poor, it substantially improves the well being of the initial poor. For example, those members of the lowest earnings class who are born 10 years before the policy is enacted enjoy a 3.1 percent improvement in welfare in Simulation 5 compared to a 1.6 percent improvement in Simulation 2. In contrast to the long-run poor who are only mildly harmed by the flat benefit, the long-run middle class and rich are substantially harmed. For the long-run highest earners, welfare rises by only .5 percent in Simulation 5, compared to 4.4 percent in Simulation 2. For those long-run members of earnings class 6, the flat benefit lowers the welfare gain from 8.0 percent to 4.4 percent. To summarize, the inclusion of the flat benefit redistributes from those alive in the long run, but particularly from those with higher earnings, toward those who are poor during the transition.

Privatization with a Progressive Matching Contribution

The plan we consider in this section envisions having the government match contributions to the privatized system on a progressive basis. The government's match is calculated as a function of labor income and falls steadily as a percentage of earnings, starting at about 5 percent for the poorest. In absolute terms, it increases from about $470 at annual earnings of $10,000 to around $840 for annual earnings of $21,000 and remains constant thereafter. On a life-time basis, the match provides a transfer to the poor whose long-run value exceeds the flat minimum benefit by 30 percent. Workers fully incorporate in their labor supply and saving decisions the marginal subsidy associated with the progressive contribution match. In order to compare the results of this option to the flat benefit, an income tax is used to finance the transition, including the match.

As Tables 1 though 5 indicate, this method of helping the poor leads to the worse short-run macroeconomic outcomes of all the simulations presented thus far. By year 25, the capital stock is smaller by 9.7 percent, labor is lower by 3 percent and national income is down by 4.7 percent.

Unlike the flat benefit, whose general equilibrium feedbacks worsen the plight of the long-run poor, the progressive matching contribution raises their welfare by 8 percent in the long run. The primarily sacrificers here are those in the top earnings classes of their respective cohorts.

The progressive match performs quite well when a consumption tax is used to finance the transition (not shown here to save space; see Kotlikoff, Smetters and Walliser, 1999*b*). All of the short-run and long-run gains to macroeconomic variables are positive and very similar to those shown in Simulation 3. And the long-run gains are substantially larger relative to using a consumption tax to finance a flat benefit. For example, the capital stock increases by 39 percent under the progressive match but by only 23 percent under the flat benefit. For national income, these values are 12.4 and 7.5 percent, respectively. These results confirm the importance of the choice of the tax base used to finance the transition.

V. Preliminary and Future Work: Including More Realistic Demographics

This section outlines how we are currently modifying the model described in the previous section. We have already made a large amount of progress toward this end but we are not yet satisfied enough with the model's design and calibration to regard our simulations as final. And so we offer the results in this section only as a "sneak peek" – but a fairly good quality one – into our work at hand.

The New Model

Our current work expands the treatment of demographics in four dimensions. First, it permits much more realistic patterns of births. Second, it permits a more realistic length of life. Third, it permits a more realistic age-distribution of inheritances. And fourth, it permits the economy to initiate its transition with arbitrary initial demographic conditions; i.e., the initial period's population age distribution is not necessarily stable.

Births and Children. In the new version of the model, children have utility from consumption and leisure from birth through age 21. These levels of child utility enter their parent's utility function in a linearly additive manner. The form of this utility function is identical to that of the adults; i.e., it is a time separable CES function and runs through the child's 21st age. The child utility functions are multiplied by a child-utility preference parameter. They are also multiplied by the number, which could be a fraction, of children per parent. Since parents give birth to children (or, to be more precise, give birth to fractions of children) at different ages, each parent's utility function has a child utility function for each of the different ages at which she gives birth.

Children are assumed to have a wage of zero prior to reaching age 21. Consequently, they choose to supply no labor. On the other hand, they do consume when young. Their consumption is determined by their parents and enters their parents' budget constraints.

The new model features a realistic distribution of births by the age of parents instead of assuming that all children arrive when the parents reach age 21. Newborns of each cohort are allocated to adults over age 21 based on the actual age-distribution of new mothers observed in U.S. data. For example, if 30 year-old females give birth to 5 percent of newborns each year in the U.S., 5 percent of the model's newborns each year are assigned as children to that year's 30 year-olds. There is nothing in the mathematics of our model that precludes adults giving birth to fractions of children in a given year. This allows us to avoid having to keep separate track of those agents in a given cohort who do and do not have children in a given year. Instead, we can focus on the average agent in a particular income class and generation.

Length of Life. Average longevity in the US has increased by a couple of years since the original Auerbach and Kotlikoff (1987) model and will continue to do so in the future. So the 55-period model, in which people are independent economic actors for 55 years, was updated to allow for 60 periods, or whatever age the programmer chooses. We are in the process of indexing this age to the year index but that feature has not been implemented yet. We might also doubly index this age to the income class if we can find suitable empirical data to match. As it stands now, an agent is an independent actor for 60 years which means that agents live for a total of 81 years (the first 21 years as dependents). This corresponds to a realistic average age several decades from now.

Inheritances. The parent's utility from bequests is also modified in the new version of the model; specifically, this utility is multiplied by the number of children the parent has when she reaches her maximum age of life and passes on. However, all recipients of bequests are no longer the same age. Instead, we assume that decedents divide their bequests evenly among all their offspring and that their offspring receive these inheritances at whatever age they have achieved as of the time of their parents' death.

Calibration. In calibrating the new model's demographics, we use the Social Security Administration's projections of aggregate annual births to determine the size of each successive cohort. In addition, we use the current age distribution of the U.S. population to populate our model in the first year of the transition; i.e., we do not assume a stable initial distribution of the U.S. population.

We, however, have not yet fully implemented some of the model's calibration to our satisfication. This includes fully matching the model's initial wealth and Social Security benefit distribution to their empirical counterparts – although we are now very close. Some of the short-run results presented below might reflect this fact, although the medium- to long-run results tend to be fairly robust to a reasonable range of choices for the model's initial conditions. Also, we currently assume that those in the top three lifetime income classes, representing the top 20 percent of the wage distribution, face only an the inframarginal Social Security tax in each period of their life; i.e., for this group, the marginal Social Security tax is always zero. All wage groups below the top three are assumed to face the Social Security tax rate at the margin. Although this assumption is likely to lead to very little bias (it did in our base model presented earlier), we plan to implement the procedure used in our base model in the near future. Finally, the aggregate variables produced by model are normalized by the number of 22 year olds in the economy who enter their first year of independent economic activity. This normalization worked fine for our base model in which the population grows at a constant rate. But the representation of this output has to be modified in the near future to allow for the fact that the number of 22-year olds does not grow at a constant rate.

Preliminary Simulation Results

This section presents preliminary results from three simulations (Simulations 7, 8, and 9). The percentage changes in those variables shown in Tables 1 though 5 are, in the case of these three simulations, measured relative to the economy's year-1 position.

Simulating the Demographic Transition Under Current Policy. Simulation 7 considers how the Social Security System fare over time if there is no change in the pay-as-you-go nature of the system. In order to maintain benefits, the growth in the fraction of the population over age 65 means that Social Security payroll tax rates will have to rise if no other financing mechanism is put into place. Indeed, Simulation 7, entitled "Current Policy in Demo Model," eventuates in a 5 percentage point rise in the payroll tax rate. This is the bad news about the demographic transition.

The good, and somewhat surprising news, is that, notwithstanding Social Security's problem, the nation's aging is a positive thing for the economy overall if we look out to the medium term. Table 3 documents this point. It shows that output per 21 year-old is 2.5 percent lower five years from now (year 1 in the simulation), but 12.9 percent higher 25 years from now. In the very long run, after the nation's population distribution has stabilized, output per 21 year-old is only 3.3 percent higher than its current value.

The explanation for this unusual growth pattern is the medium term capital deepening arising from the large numbers of baby boomers arriving at retirement with significant holdings of capital. Since the work force coming behind them is relatively small in size, there is a substantial rise in the capital-labor ratio. For example, in the 25th year of the transition, the capital-labor ratio is 47 percent higher than its current value. This capital deepening translates into almost a 10 percent rise in the real wage in the medium term and an 8 percent rise in the real wage in the long term.

Stabilizing Fertility in the Demographic Model. One question frequently raised about the demographic problems confronting Social Security is whether they would be resolved with a large increase in fertility. [Note: we are currently redoing this simulation to allow for an even larger increase in fertility. It will be completed by the time of the conference. The short answer is that a large increase in fertility would be too late to save Social Security from its upcoming financial woes.]

Privatization in the Demographic Model. Our final simulation, number 9, enacts the privatization policy of Simulation 1; i.e., Social Security benefits are phased out after 10 years and transition costs are financed with a proportional labor tax on wages. As Tables 1 though 5 indicate, compared to status quo/current policy transition, privatization produces an even more dramatic improvement in the economy's medium as well as long run positions. According to Table 3, privatization raises living standards 25 years out by 18.8 percent, and, in the long run, by 20 percent. Associated with this policy, is a 56 percent increase in the capital-labor ratio by year 25 and a corresponding 11.1 percent rise in real wages. The combination of capital deepening and reduced payroll taxation generates a significant medium term increase in labor supply. In year 25, labor supply is 7.0 percent above its initial (year 1) value, compared to only 2.7 percent above in the current policy demographic simulation.

Table 6 displays the welfare effects associated with privatization. Welfare changes are measured relative to the utility levels that the particular agents in each generations would have enjoyed under the status-quo (baseline) policy, which is considered in Simulation 7. [To do: It will be completed by the time of the conference.]

VI. Conclusion

[To do: It will be completed by the time of the conference.]

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